2024

School of EE Lab Introductions

KAIST EE

KAIST EE

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Advanced Radio Technology Labarotory

■ **Contact information**

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Lab. : ITC bldg. (N1), 719 TEL : 7522
Website : http://artlab.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

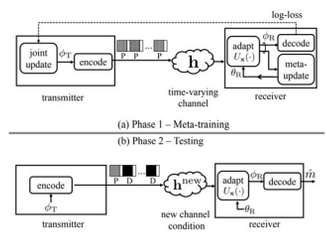
Postdoctoral Fellows : 0 PhD Students: 10 Master's Student: 6

■ **Research Areas**

The Advanced Radio Technology Laboratory (ART Lab) has researched advanced antenna technology to improve performance and spectral efficiency of communication systems. In particular, we mainly focused on machine learning based communication, wireless communication for autonomous vehicles, and future wireless systems. Specific research topics are given as follows.

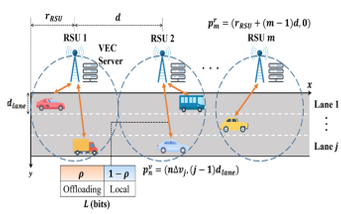
● **ML for Communications and Communications for ML**

ML driven communications have an advantage in handling the increasing volume of communication and computation costs. Recently, ART Lab has been working on federated learning, reinforcement learning, and problems related to spectrum usage efficiency.



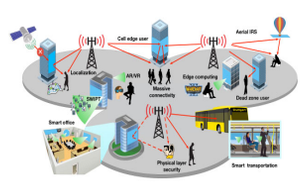
● **Wireless Communications for Autonomous Vehicles**

Autonomous vehicles have sparked tremendous research interest, such as V2X, IoV, UAV-assisted systems, and VEC. ART Lab is interested in dealing with huge traffic data in such communication systems, including energy-efficient task offloading over VEC systems and trajectory design in UAV-assisted networks.



● **Future Wireless System**

ART Lab has been actively working on multiple-input multiple-output (MIMO), space division multiple access (SDMA), and intelligent surface systems (e.g. RIS) for future wireless communications. Also, we focus on 6G communication technology such as utilization of sub-THz band and spatial mode multiplexing.



■ **Recommended courses & Career after graduation**

Recommended courses : Signal and Systems, Communication Engineering**, Probability and Statistics, Linear Algebra**

Career after graduation : ① Professor ② Research institute (e.g. ADD, ETRI) ③ Company (e.g. Samsung Electronics, KT)

■ **Introduction to other activities besides research**

ART lab promotes friendship among students with :

① Birthday parties, ② Summer / Winter workshop ③ Spring / Autumn picnic ④ Home-coming day

■ **Introduction to the Lab.**

ART Lab encourages a positive research environment in which lab members feel free to share their ideas. We spend our time in graduate school energetically, aided by professor's considerate guidance. Our laboratory is open to those who want to research in a supportive environment with promising students.

■ **Recent research achievements ('22~'24)**

[1] Projects : Currently doing 13 projects (e.g. Samsung Electronics, Ministry of Science, ICT and Future Planning)

[2] Publications : Journal Papers 21 / Conference papers 14 / Patents 37

<Professor Kyeongha Kwon>

THE KWON GROUP

■ **Contact information**

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Lab.	**Nanofab Center, 204**	**Tel: 7567/7667**
Website	**https://krg.kaist.ac.kr**	

■ **Current state of the Lab. (2024 Fall)** PhD Student: 7 Master's Student: 10

■ **Research Areas**

▷ **Battery Management System (BMS)**

- Maximize the remaining useful life (RUL) for entire multi-storage platform
- Development of cell state prediction techniques with high stability
- Ongoing research topics:
  - ✓ EV/ESS battery management IC: Measurement & Power Control
  - ✓ Advanced diganosis device (e.g. EIS system) for safety
  - ✓ Algorithm optimization for embbeded system

▷ **Medical Application Specific Integrated Circuits (M-ASIC)**

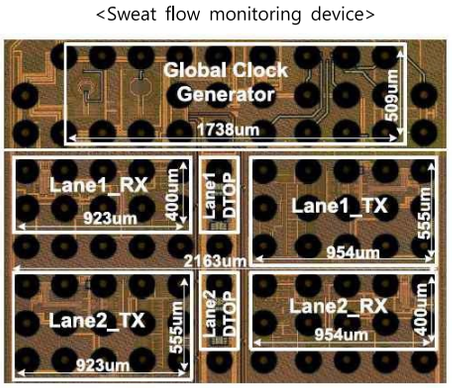
- Real-time monitoring of physical condition using small, wireless and low-power devices
- Flexible, skin-attachable systems to sense various biosignals
- Ongoing research topics:
  - ✓ Blood flow rate monitoring
  - ✓ Capnography: sensing CO2 concentration
  - ✓ Wireless power transfer for implanted cardiac stents

▷ **High-Speed Transceivers**

- Signal distortion due to channel and other environmental causes, resulting erroneous data at receiver
- Distortion compensation in transceiver ICs
- Ongoing research topics:
  - ✓ Crosstalk cancellation for PIM (Processing-in-Memory)
  - ✓ Dispersion compensation for optical communication
  - ✓ Low power on-chip transcievers

<Battery management system on EV>

<Sweat flow monitoring device>



<High speed transceiver die photo>

■ **Recommended courses & Career after graduation**

- Courses on circuits, signals and communcations: EE201, EE304, EE372, EE403, EE202, EE303, EE321, etc. (More information on our website)
- Potential career options after graduation include government-funded/private research institutes or companies related to IC design, medical devices, automobile, etc.

■ **Introduction to the Lab.**

- Horizontal organizational structure and lively workplace atmosphere
- Lab members with friendly relationship
- Group lunch/dinner and birthday celebrations
- Regular participation in workshops and seminars

■ **Recent research achievements**

"ASIL-D and AEC-Q100 Grade 0 Compliant Automotive RC Oscillator with Farey Sequence-based Calibration," **IEEE Custom Integrated Circuits Conference (CICC)**, 2024.

"ASIL-D compliant Battery Monitoring IC with High Measurement Accuracy and Robust Communication," **IEEE International Solid-State Circuits Conference (ISSCC) Digest of Technical Papers**, 2023.

"Soft, full Wheatstone bridge 3D pressure sensors for cardiovascular monitoring," **nature partner journal (npj) Flexible Electronics** (IF:12.018), Jan. 2024.

"Battery-free, cardiovascular implant for wireless monitoring of arterial/ventricular pressure, flow rate and temperature in real-time fashion," **Nature Biomedical Engineering** (IF:29.234), April 2023.

<Professor Dae-Shik Kim's Lab.>

Brain Reverse Engineering and Imaging Laboratory

■ **Contact information**

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Lab. : ITC building 521 TEL : 042-350-8172~4

Website : http://brain.kaist.ac.kr

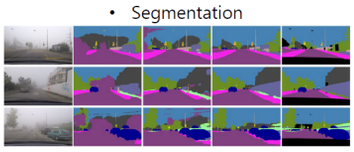
■ **Current state of the Lab. (in 2024 Fall Semester)**

PhD Students: 8 Master's Student: 4 Staff: 3

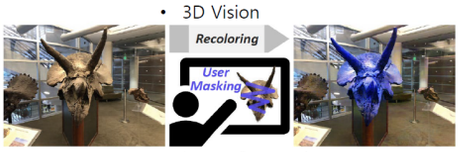
■ **Research Areas**

Deep Learning Group

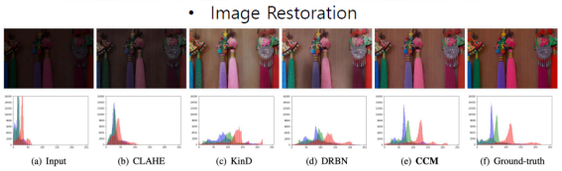
• Segmentation



• 3D Vision

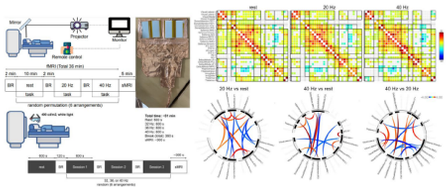


• Image Restoration

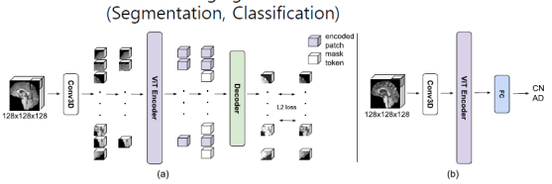


Brain Group

• fMRI experiment design and analysis



• Medical imaging
(Segmentation, Classification)



Our laboratory is divided into two main groups.

The AI group have studied image restoration, semantic segmentation and generation task (including 3D) in computer vision, as well as medical imaging. Inspired by the success of GPT, we have also focused on vision-language multi-modal task.

The brain imaging group have conducted brain analysis, including decoding human emotions and reconstructing arm, movements) using brain imaging technique (fMRI, EEG) and machine learning model.

■ **Recommended courses & Career after graduation**

<Recommended courses>

We recommend to take Introduction to Brain IT and coursework in machine learning, information theory, and signal processing.

<Career after graduation>

- Company: Samsung, LG, ETRI, Hyndai Motors, etc
- Study Abroad: UCLA, Standford, etc
- Start-up: Omnious, bHaptics, INNERVERZ

■ **Introduction to other activities besides research**

In our Laboratory, we freely share and socialize cultural life such as monthly birthday parties, cultural days, athletic competitions, strawberry festivals, opening and closing parties, MT.

Professor Dae-Shik Kim is currently serving as the director of Kyobo/Dplanex-KAIST AI Center for Future of Insurance.

■ **Introduction to the Lab.**

Our laboratory conducts studies that lead the current flow of science and technology. We are actively engaged in cutting-edge research in areas such as deep learning, language model, neuromorphic engineering and brain decoding, enriched by active collaboration with leading groups.

You can choose from a wide variety of topics, not limited to one, and there are many internal studies to try and choose from. Laboratory seminar rooms allow students to study without time and space limitations. Freshman tutorials are organized in the laboratory, so students who are new to deep learning can study with interest.

■ **Recent research achievements ('22~'24)**

[1] Kassymzhomart Kunanbayev, Vyacheslav Shen, Dae-shik Kim. (2024) "Training ViT with Limited Data for Alzheimer's Disease Classification: an Empirical Study", International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI), 2024.

[2] [Published as Front Cover] Ji-Man Yu*, Gyeong-Do Ham*, Seong-Yeon Kim, Jin-Ki Kim, Joon-Kyu Han, Seong-Yun Yun, Seong-Hak Kim, Sang-Won Lee, Seung-Bae Jeon, Dae-Shik Kim, and Yang-Kyu Choi "Self-Curable Synaptor with Tri-node Charge Trap FinFET for Semi-Supervised Learning", IEEE Electron Device Letters, Jan. 2024.

[3] Jae-Hyeok Lee and Dae-Shik Kim, "ICE-NeRF: Interactive Color Editing of NeRFs via Decomposition-Aware Weight Optimization", International Conference on Computer Vision (ICCV), Paris, France, 2023.

<Professor John Dongjun Kim's Lab.>

Computer Systems and Network Lab

■ **Contact information**

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Website : icn.kaist.ac.kr

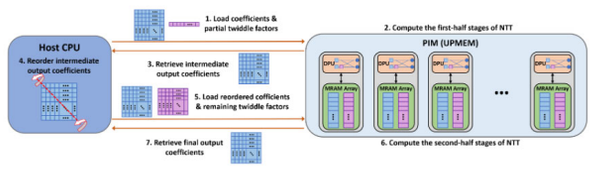
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 7 Master's Student: 7

■ **Research Areas**

● **Computer and System Architecture for Deep Learning**

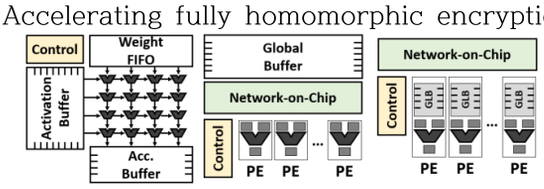
- Scale-out interconnection networks
- Efficient communication-centric architecture for accelerators



● **Memory-centric Network Architecture**

- Memory-centric network architecture for machine learning
- Processing-in-memory (PIM) Architectures

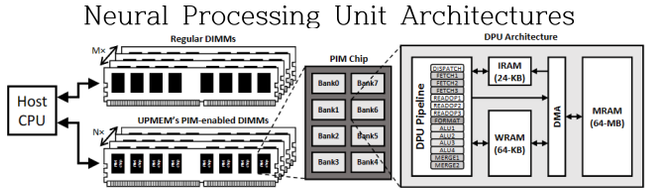
Accelerating fully homomorphic encryption



● **Architecture and Security**

- Side-channel attacks in CPU and GPU
- Fully homomorphic encryption (FHE)

Neural Processing Unit Architectures



● **Mobile System for Continuous Monitoring and Intervention**

- Monitoring Itching condition
- Language Development

Processing-in-Memory Architectures

■ **Recommended courses & Career after graduation**

Courses recommended include topics related to computer architecture, system programming, distributed systems, and operating systems. Students in the lab have participated in internship at Samsung, NVIDIA, and Deep Learning start-ups. After graduation, students have become professors at POSTECH, Kangwon University, as well as joined industry including Samsung Research, Arm Inc, as well as research positions at National Research Labs.

■ **Introduction to other activities besides research**

The lab provides a very open environment where you are encouraged to freely discuss with the professor and other students. We encourage collaboration with other professors in the department, within KAIST, as well as other institutions. We also actively collaborate with industry as well. We also encourage extracurricular activities to provide the best environment.

■ **Introduction to the Lab.**

The Computer Systems and Network Lab is led by Prof. John Kim at KAIST. Prof. John Kim graduated from Stanford University and was part of School of Computing at KAIST before joining School of Electrical Engineering. He has worked on the design of several microprocessors in the industry (Intel, Motorola) and has worked on the design of interconnect at Cray Inc. Currently, the lab addresses the system and architectural design challenges in high performance computing as well as mobile systems. All research in the lab target publications in top-tier conferences in systems and architecture.

■ **Recent research achievements ('21~'24)**

The research group publishes in top-tier conferences, including architecture (ISCA, MICRO, HPCA, ASPLOS) and top-tier conferences in other domains, including CHI, CCS, Usenix Security, UBICOMP, CSCW. Recent publications include

- SIGMETRICS'24 Scalability Limitations of Processing-in-Memory using Real System Evaluations
- ISCA'23 Decoupled SSD: Rethinking SSD Architecture through Network-based Flash Controllers
- HPCA'23 VVQ: Virtualizing Virtual Channel for Cost-Efficient Protocol Deadlock Avoidance
- HPCA'23 Logical/Physical Topology-Aware Collective Communication in Deep Learning Training
- MICRO'22 Networked SSD: Flash Memory Interconnection Network for High-Bandwidth SSD
- ISCA'22 Dynamic global adaptive routing in high-radix networks

<Professor Munchurl Kim's Lab.>

VIDEO AND IMAGE COMPUTING LAB
VIC LAB

Video and **I**mage **C**omputing **Lab**oratory

■ **Contact information**

Prof. : Rm# 1107, Bldg. N24 TEL : 042-350-7419
Lab. : Rm# 1106, 1108, Bldg. N24 TEL : 042-350-7519
Website : http://viclab.kaist.ac.kr

■ **Current state of the Lab. (2024 Fall Semester)**

Postdoctoral Fellows : 0 Ph.D. Students: 22 Master's Student: 6

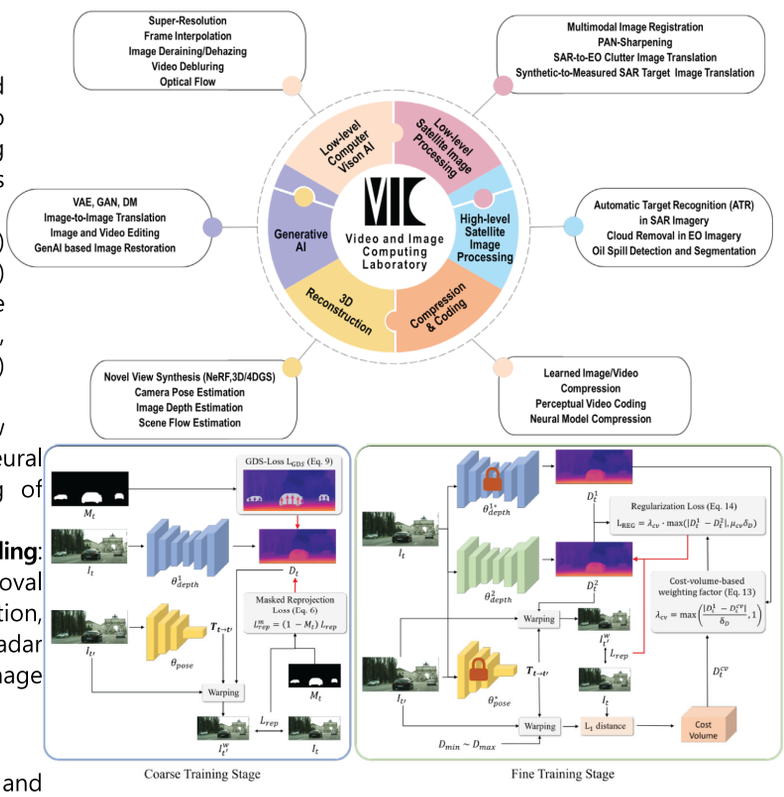
■ **Research Areas**

We are Video & Image Computing Lab at KAIST.
Our research of interest includes deep-learning based computer vision, computational image & video processing as well as image & video understanding and 2D/3D video coding. Our recent intensive works focus on Computer Vision research in the fields of :

[1] **Natural image and video restoration**: (1) super-resolution, (2) frame interpolation, (3) SDR-to-HDR inverse tone mapping, (4) image in-painting, (5) depth estimation, (6) image deraining, (7) image dehazing, (8) video motion debluring; (9) generative restoration of old photos;

[2] **3D image/video reconstruction**: (1) optical flow estimation, (2) camera pose estimation, (3) dynamic neural radiance field (NeRF) and Gaussian splatting learning of video for novel view synthesis;

[3] **Satellite image processing, analysis and understanding**: (1) PAN sharpening, super-resolution and cloud removal of Electro-Optical (EO) images, (2) super-resolution, detection and classification of Synthetic Aperture Radar (SAR) image targets, (3) SAR-to-EO image-to-image translation learning, etc.



Image/Video Restoration and Quality Enhancement

Based on deep convolutional neural neyworks and recurrent neural networks, we are focusing on (i) image/video super-resolution, (ii) video frame interpolation for high frame rates, (iii) SDR/HDR video (inverse) tone mapping, (iv) motion deblur, (v) compression artifact reduction, and (vi) denoising and demosaicking for camera's Bayer array images. Our research pursues studying high-performance algorithms for leading-edge levels as well as low-complexity algorithms for practical applications

Automatic Target Detection and Recognition for Synthetic Aperture Radar Imagery

Synthetic Aperture Radars (SAR) are widely used for surveillance systems because they can operate under all weather conditions due to a powerful penetrating property. We are studying deep learning based automatic target detection and recognition algorithms for SAR imagery where deep convolution neural networks explored to detect small-sized target candidates and classify them into appropriate categories. Since SAR data is difficul and expensive to acquire, we develop generative networks that can generate realistic SAR data from images acquired by other image sensors.

Deep Learning based 3D Image/Video Reconstruction

Novel view synthesis is being studied using Neural Radiance Fields (DeRF) Learning and Gaussian Splatting Model Learning. This makes it possible high-quality novel view generation at view points and distances.

■ **Recommended courses & Career after graduation**

Recommended classes are digital image processing, machine learning and deep learning. After graduation, students often work with global companies, start-up companies, academia and research institutes.

■ **Introduction to the Lab.**

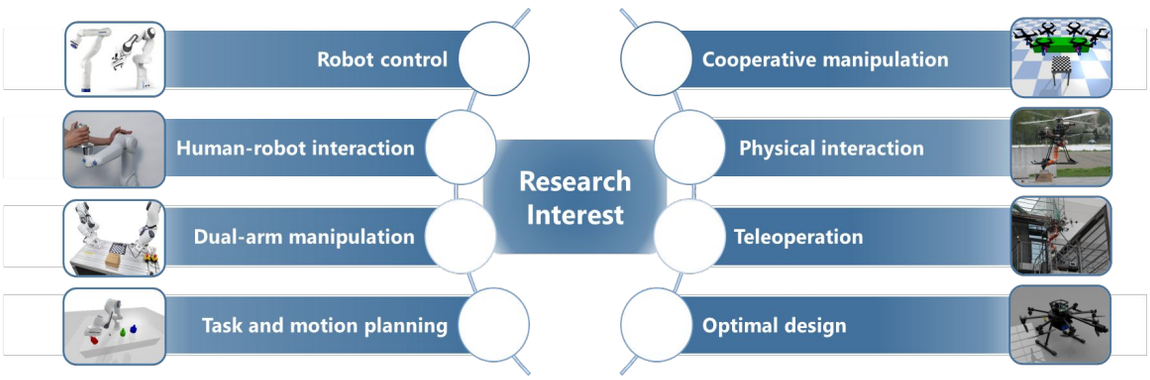
VIC Lab aims to send out leaders with expertise in image processing and machine learning. VIC Lab contributes to the academic field through the presentation of research papers and we are expected to improve our presentation skills, writing skills and expressive ability in their researches so that we can get international competitiveness.

■ **Recent research achievements (2024)**

[1] **CVPR** 2024 - FMA-Net: Flow Guided Dynamic Filtering and Iterative Feature Refinement with Multi-Attention for Joint Video Super-Resolution and Deblurring.
[2] **CVPR** 2024 - From-Ground-To-Objects: Coarse-to-Fine Self-supervised Monocular Depth Estimation of Dynamic Objects with Ground Contact Prior.
[3] **CVPR** 2024 - Novel View Synthesis with View-Dependent Effects from a Single Image.
[4] **ECCV** 2024 - SkateFormer: Skeletal-Temporal Transformer for Human Action Recognition.

Intelligent Robotics System Lab

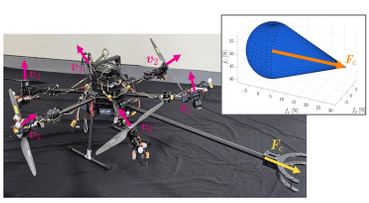
Lab Info	
Advisor	Prof. Min Jun Kim
Division	Signal
Website	https://sites.google.com/view/kaist-roboticslab
Members	Ph.D candidate 5 / MS candidate 9
Research Interest	Robotics



- We are interested in general robotic problems, particularly in ***physical interaction*** **problems with** ***robot mobilities*** (fixed, wheeled, aerial, semi-aerial, etc.)
- Combining physical interaction problems with mobility raises challenges, such as ***design, modeling, control, state estimation, perception, cognition, and planning***
- We develop intelligent robots with practically appealing scenarios in mind

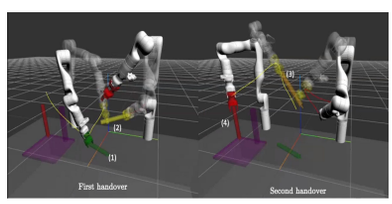
Robot Design

- **Cable-suspended** aerial manipulator
- Cable sustain **gravitational load**
- **Higher load**, **longer operation time**

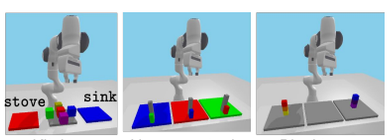


- **Fully actuated drone** with **non-isotropic wrench** shape
- **Energy efficient**, **greater force** in task direction

Planning



- **Simultaneous** grasp selection & motion planning through **constrained optimization**
- **Long-horizon task** addressing **motion & grasp constraints**

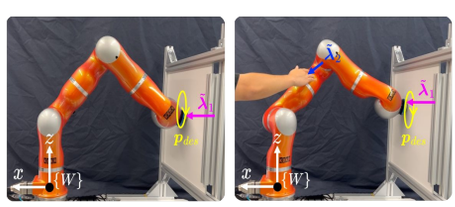


Kitchen Non-monotonic Blocktower

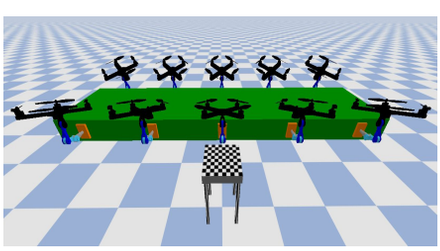
- **Task** & **motion planning** algorithm using **Reachability Tree** & **Monte Carlo Tree Search**
- **Rewards** generated from motion planning **enhance task planning**

Robot Control

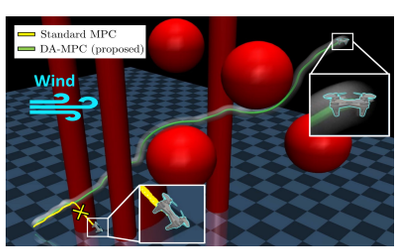
- **Constrained nonlinear disturbance observer for robotic manipulator**
- Enable **contact-responsive motion** (Left), **Ordinary DOB** results in **excessive torque** (Right)



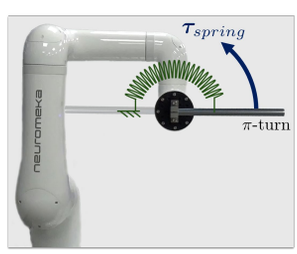
- **Multi-contact** feedback **MPC** for interactive tasks
- **Particle filter-based** contact estimation



- **Collaborative grasping** using **multiple AM**
- **Passivity**-based **decentralized impedance** controller



- **Disturbance-aware MPC** of underactuated robots
- **Robustify** MPC using **disturbance observer**



- **Memory**-based **SO(3) representations**
- Natural spring torque **beyond π-turn**

KAIST EE
KAIST ELECTRICAL ENGINEERING

<Professor Bongjin Kim's Lab.>

Kim Circuit Research Lab	■ **Contact information** Professor : bkiminus@gmail.com TEL : TBD Lab. : bkiminus@gmail.com TEL : TBD Website : http://bongjin.com

■ **Current state of the Lab. (in 2024 Fall Semester) – Kim Lab will be founded at KAIST in January 2025**

Postdoctoral Fellows : 0 PhD Students: 0 Master's Student: 0 (Current PhD Students: 3, Master's Student: 3 @ UCSB)

■ **Research Areas**

○ **Vision**: Develop VLSI circuit, system, and chip design techniques and application/domain-specific hardware accelerators for sustainable next-generation computing & communication

○ **Research plan:** VLSI Circuit/Chip Research

1. **Processing-in-Memory AI/ML Hardware Accelerators**
   - Hybrid analog/digital PIM macros & processors / On-device inference/training using foundry memory
2. **Scalable Optimization Problem Solvers**
   - Large scale, high-precision, densely-connected digital Ising Processor for solving domain-specific problems
3. **Next-Generation Computing & Communication**
   - Circuits for quantum computers, hardware security, and 2.5D/3D communications for Chiplet & HBM

■ **Recommended Courses**: Circuit courses (analog, digital, and mixed-signal), computer architecture, VLSI, Digital systems

■ **Career after graduation**: Recently graduated students joined academia and research institutes (Peking University, SLAC at Stanford, CAS) and industry (AMD, Micron, SK Hynix).

■ **Introduction to other activities besides research**

We will regular gather and have dinner at local restaurants and sometimes go for drinks. We will also plan for having regular fun activities.

■ **Introduction to the Lab.**

- Since Kim Circuit Research Lab was founded in Sep. 2017, we have been working on the design of domain- and application-specific hardware accelerators with special focuses on computing/processing-in-memory architecture for AI/ML applications, scalable next-generation computers for solving computationally-intensive problems. At KAIST, we will continue to contribute to the development of innovative VLSI circuit/chip solutions for sustainable next-generation computing & communication.

■ **Recent research achievements ('22~'24)**

- Recent top conference and journal publications: **6 ISSCC, 4 CICC/VLSI/ESSERC, 9 JSSC Papers** (from 2022 to 2024)
- Recent student awards: **2 SSCS Pre-Doctoral Awards, 1 SSCS Rising Star Award, Multiple SSCS Student Travel Awards**
- Recent Selected Publications

1. VIP-Sat: A Boolean Satisfiability Solver Featuring 5×12 Variable In-Memory Processing Elements with 98% Solvability for 50 Variables 218 Clauses 3-SAT Problems, IEEE ISSCC 2024
2. CTLE-Ising: A 1,440 Spins Continuous-Time Latch-based Ising Machine with One-Shot Fully-Parallel Spin Updates Featuring Equalization of Spin States, IEEE ISSCC 2023
3. A 65nm 8T SRAM Compute-In-Memory Macro with Column ADCs for Processing Neural Networks, IEEE JSSC, Nov. 2022
4. FlexSpin: A Scalable CMOS Ising Machine with 256 Flexible Spin Processing Elements for Solving Complex Combinatorial Optimization Problems, IEEE ISSCC 2022
5. A 28nm 29.2TFLOPS/W BF16 and 36.5TOPS/W INT8 Reconfigurable Digital CIM Processor with Unified FP/INT Pipeline and Bitwise in-Memory Booth Multiplication for Cloud Deep Learning Acceleration, IEEE ISSCC 2022

<Professor Sangsik Kim's Lab.>

KAIST INTEGRATED METAPHOTONICS GROUP

■ **Contact information**

Professor: Sangsik Kim (sangsik.kim@kaist.ac.kr)

Lab. : E3-2, #3220/3221 (TEL: 042-350-7472)

Website : https://kimgroup.kaist.ac.kr/

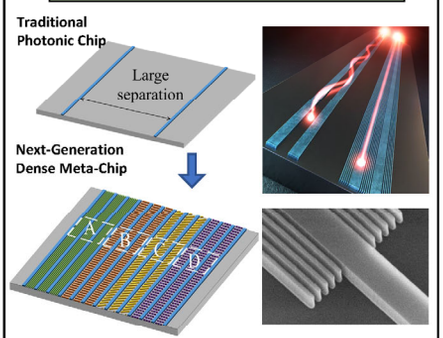
■ **Current state of the Lab. (in 2024 Fall Semester)**

Integrated MS/PhD Students: 5 Master's Students: 7 Undergraduates: 6 (+1 PhD student at Texas Tech)

■ **Research Areas**

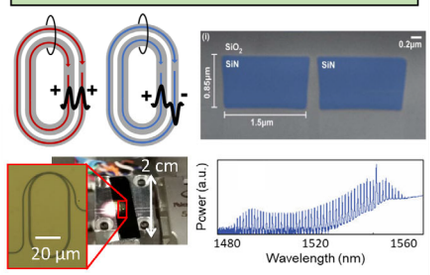
Integrated Nanophotonics	I. Small device size ⇒ scalable & portable system	II. Efficient nonlinear & quantum processes
	II. CMOS compatibility ⇒ mass production & low cost	IV. Nanofabrication ⇒ alignment-free & stable operation

On-Chip Metamaterials



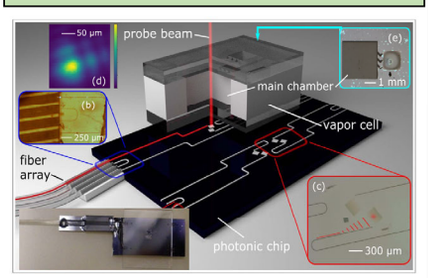
- High-density integration via metamaterials [2,4]
- Record-high coupling length (>1,000x) [4]
- Toward large-scale quantum/AI photonic chips

On-Chip Frequency Combs



- High-Q SiN microresonators
- Concentric microresonators for dispersion engineering [5] ⇒ Microcombs at visible & mid-IR frequencies & CMOS process compatibility
- Emerging quantum source having >100 qubits
- Pulse shapers for quantum process

On-Chip Atomic/Quantum System



- Photonic/Atomic hybrid integration [1,3]
- Collaboration with US NIST team
- Quantum sensor & atomic clock
  ⇒ Freq. referencing & Laser stabilization
  ⇒ Toward <1 cm precision GPS

■ **Recommended courses & Career after graduation**

✓ **Recommended courses:** 전기자기학 I/II (EE204/EE341), 광공학개론(EE352), 집적광학개론 (EE488)

✓ **Career after graduation:** Great for exploring both academia and industry (big tech & startups)

- National Labs: KIST, ETRI, KRISS (Domestic), NIST, SNL, ORNL (International)
- Industrial Companies: Samsung, Intel, IBM, IMEC, ASML, NTT, Meta (Facebook), Keysight, Lumentum, Finisar, AyarLabs, Hyperlight, PsiQuantum, IonQ

Our recent 4 PhD alumni went to Intel and Lumentum.

■ **Other activities besides research**

Voluntary activities include soccer, hiking, running...

■ **Introduction to the Lab.**

Our group is developing novel integrated nanophotonics chips using the semiconductor manufacturing processes. We explore both fundamental science and technical applications, bridging the gap between new science and future technologies. Our group is growing exponentially and looking for highly motivated and brilliant students to join this exciting journey with integrated photonics. For more details, please visit the FAQ page in our group webpage and feel free to email at sangsik.kim@kaist.ac.kr and other members!

■ **Recent research achievements**

[1] K. Kabir, M. Mia, I. Ahmed, N. Jaidye, S. Ahmed, S. Kim, ***Light: Science & Applications***, 12, 135 (2023)

[2] A. Yulaev*, S. Kim*, *et al.*, ***Nature Nanotechnology*** 17, 583 (2022) (*equal contribution)

[3] M. Mia, S. Ahmed, I. Ahmed, Y. Lee, M. Qi, and S. Kim, ***Optica*** 7, 881 (2020)

<Professor Sanghyeon Kim's Lab.>

3D integrated opto-electronic device Laboratory	■ Contact information		
	Professor	**Email: shkim.ee@kaist.ac.kr**	**Tel: 7452**
	Lab.	**Email: tlsgud907@kaist.ac.kr**	**Tel: 7552**
	Website	**https://www.3doedl.com/**	

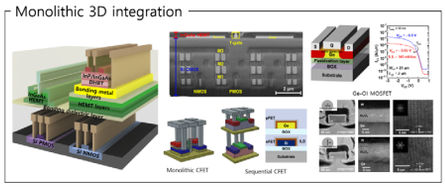
■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 12 Master's Student: 11

■ Research Areas : 3D integrated opto-electronic semiconductor devices (mainly using III-V compound semiconductor and Ge.), which is one of the most promising device research areas toward future 3D integrated systems

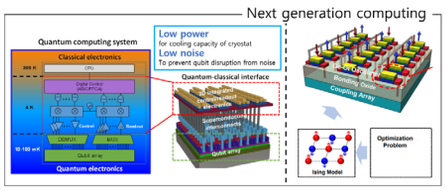
▶ Monolithic 3D integration

Monolithic 3D (M3D) integration provides increased bandwidth, smaller power consumption, smaller footprint, and increased functionality. We are exploring layer stacking and device technology to realize stackable 3D devices.



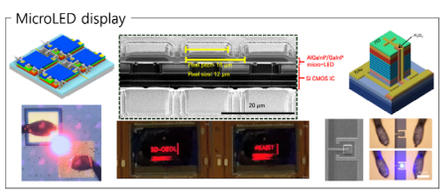
▶ Next generation computing

To reduce computing power, we are developing next-generation CMOS devices using III-V, Ge. Not only beyond conventional CMOS under Von-Neumann architecture, we initiated the research on semiconductor devices for artificial neural network / neuromorphic computing. To realize the ultra-low computing, we are developing 3D stackable neuronal and synaptic devices, which would be ultimate device structure minimizing the power consumption in the interconnect as well as the power consumption for computing.



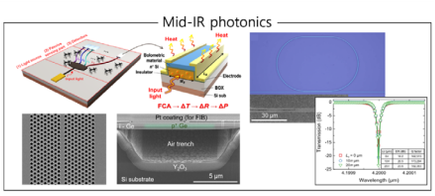
▶ MicroLED display

For ultra-small, but ultra-high resolution display, we are developing 3D stacked inorganic MicroLED display using wafer bonding and sequential device fabrication process.



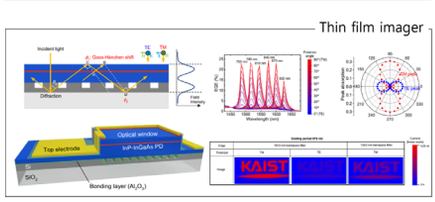
▶ Mid-IR photonics

For very compact on-chip gas sensor, we are developing Mid-IR integrated photonics platform using Ge-on-insulator structure.



▶ Thin film imager

Ultimate goal of the semiconductor-based hardware system would be a full imitation of the human's function such as feeling emotions, learning, and thinking, etc. To do that with semiconductor-based hardware, sensing the information will be an inevitable functionality. Sensing the visual information is one of the most important features to enable lots of tasks such as pattern recognition, real-time image processing, self-adaptive detecting, etc. Therefore, we are exploring the thin film imager using M3D integration technology.



■ Recommended courses & Career after graduation

Any courses about semiconductor devices and solid-state physics, semiconductor integration, photonics are recommended. Career path will include academia, major industries in semiconductor and display, etc. (Four Ph.D. alumni until now: Three academias (Postdoc at KAIST, Harvard, Yale), one industry (Staff engineer at Samsung Electronics))

■ Introduction to other activities besides research

We are encouraging students to participate in international and domestic conferences and also internship programs for their experiences. We are also planning to have enjoyable dinner and outer activities regularly.

■ Introduction to the Lab.

Prof. Kim opened the lab in KAIST on Feb. 2019. We are doing multi-disciplinary researches on various semiconductor electron and photonic devices with an emphasis on monolithic 3D integration (M3D). To contribute to future M3D semiconductor devices, we are fully supporting students' research and helping to broaden their research scope with world-class infrastructure.

■ Recent research achievements

Since the lab opened in 2019, 19 papers and 9 papers have been presented in IEDM and VLSI symposium on Technology and Circuits, respectively. (IEDM, VLSI are the most prestigious conferences in the semiconductor device society)

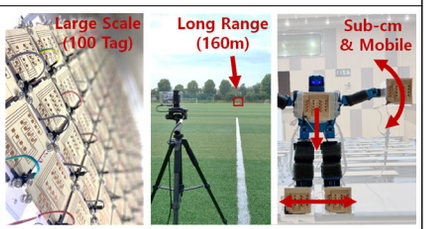
<Professor Song Min Kim's Lab.>

Smile LAB SMart and MobILE Systems (SMILE) Lab	■ Contact information		
	Professor	**Email:** songmin@kaist.ac.kr	**Tel:** 042-350-7453
	Lab.	N1 #918	
	Website	https://smile.kaist.ac.kr	

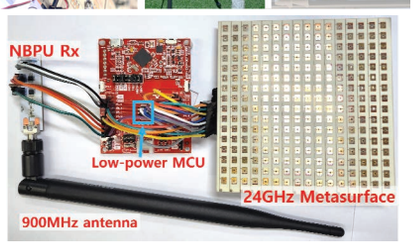
■ **Current state of the Lab. (in 2023 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 7 Master's Student: 4

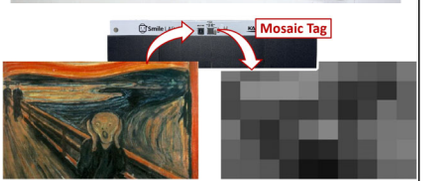
■ **Research Areas**



mmWave Backscatter Localization: Accurate localization of a large number of objects over a wide area is one of the keys to the pervasive interaction with the IoT. Our technique, for the first time, offers over (i) hundred-scale simultaneous 3D localization at (ii) sub-cm accuracy for over an (iii) hectometer distance. The performance practically applies to indoors and outdoors as well as under mobility.



Next-Generation Mobile Networking: Metasurface has recently emerged as an economic solution to expand mmWave coverage. However, their pervasive deployment remains a challenge, mainly due to the difficulty in achieving real-time NR-compatible wireless reconfiguration while maintaining multi-year battery life. We present the first intelligent metasurface that offers (i) real-time reconfiguration, (ii) compliance with the NR standard, and (iii) micropower operation 2.1-year lifetime on an AA battery.



Battery-free AI of Things: Despite the potential of vision-based monitoring, data leakage concerns hinder its wide deployment in personal spaces. Besides, continuous and pervasive monitoring without blind spots in complicated indoor spaces requires a scalable system. We design vision-based end-to-end action recognition framework that (i) intrinsically achieves data anonymity from the sensing stage and (ii) battery-free operation for blind spot-free continuous monitoring.

■ **Recommended courses & Career after graduation**

Computer networks, network programming, system programming, probability theory, wireless communication, and signal processing would be helpful (not required). You will have both top quality publications and rich experience in system implementation, offering freedom in career path: From academia and research labs to industry.

■ **Introduction to other activities besides research**

International trips to top conferences, frequent get-together parties, and more. Any new suggestions are welcome. We are open to all kinds of new and fun activities! We value the relationship among members. As an academic family, we should be the strongest supporter for each other throughout the career.

■ **Introduction to the Lab.**

We are recruiting in the areas of (i) wireless networks and communication (ii) RF systems (iii) A.I. on edge devices! Please contact us if you are passionate in one or more of these areas.

Our research is about innovation and practicality. We enjoy creative and interesting designs and seeing it work in practice through hands-on implementation on everyday devices, such as smartphones and wearables. Our ideas lie in the intersection of networking, communications, and signal/data processing. We share our excitement with the world by publishing in top conferences. **SMILE lab is looking for enthusiastic students to join our journey!** If interested, please do not hesitate to contact Prof. Kim at songmin@kaist.ac.kr

■ **Recent research achievements (2018-2024)**

Many top conference and premier journal papers: MobiCom, SenSys, MobiSys, ICDCS, INFOCOM, NSDI, TON, TCOMM, TMC, and TOSN. Most students have published top conference papers within the first two years after joining, thanks to their hard-work. The students were nominated **MobiSys'24 Best Paper Award** (3/263), following their previous work selected as **MobiSys'22 Best Paper Award** (2/176) -- selected as **SIGMOBILE Research Highlight,** the first in the world to win multiple Best Paper Awards at three major conferences in mobile/wireless networks as the first authors. Another student was nominated **ICDCS'18 Best Paper Award** (1/378). For details and videos please visit https://smile.kaist.ac.kr

<Professor Yongdae Kim's Lab.>

System Security Lab (SysSec)

Professor: Yongdae Kim

■ **Contact information**

Professor : **yongdaek@kaist.ac.kr** TEL : **042-350-7430**

Website : **syssec.kr, syssec.kr/~yongdaek**

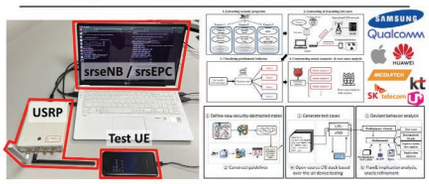
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 10 Master's Student: 5 Visiting Student: 2

■ **Research Areas**

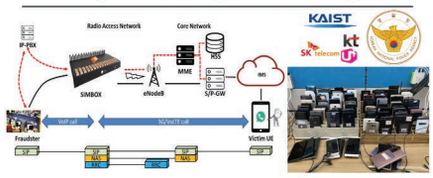
Research Area: Cellular Network

Fuzzing on Cellular Network and Devices



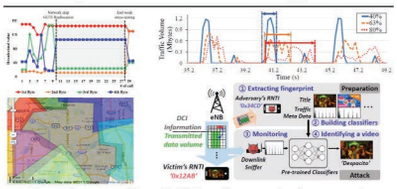
Finding security flaws at smartphone and cellular network

Preventing and Tracking Voice Phishing Crimes



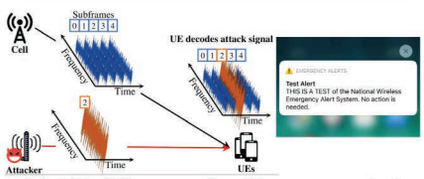
Device (SIMBOX) detection and location tracking

Tracking User's Locations and Applications



Location tracking & Video fingerprinting attack

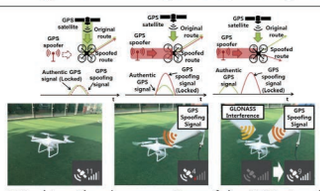
Physical Layer Injection Attack



Inject fake LTE messages (e.g. fake emergency alert)

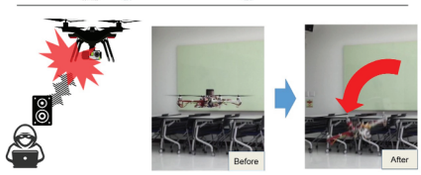
Research Area: Drones and Self-driving Cars

Hijacking Drones using GPS Spoofing Attack



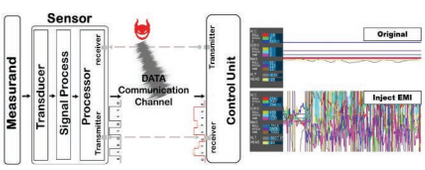
Hijacking the drones using a fake GPS signal

Dropping Drones using Sound Attack



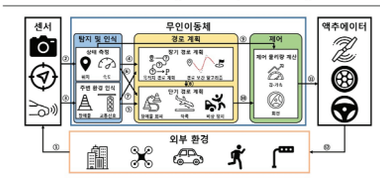
Dropping the drones using acoustic resonance

Dropping Drones using EM Attack



Crashing drones via EM attack on communication channel

Self-driving Safety Testing



Finding misbehaviors in a self-driving car

■ **Recommended courses & Career after graduation**

- **Academia**(faculty positions): Univ. of Central Florida, Liberty University, Sungshin Univ., Sungkyunkwan Univ., KyungHee Univ., Military Academy, etc.
- **Big companies**: Microsoft, Intel, U.S. Bank, VMWare, Qualcomm, Samsung, Hyundai Motors, NAVER, Theori, etc.
- **Research institutes**: NSR, ADD, ETRI, KEPCO, KATECH, etc.

■ **Introduction to other activities besides research**

- Engaging in practical research in **collaboration with leading corporations** (internship)
- Exploring diverse career paths through an active community and annual homecoming events with **alumni working in various fields**
- **Bug bounties, CTFs (extra $$$)**

■ **Introduction to the Lab**

Our lab conducts cutting-edge research to uncover security vulnerabilities in cellular network and various emerging systems. We are seeking passionate students to join us in discovering new vulnerabilities and advancing the field of cybersecurity!

■ **Recent research achievements ('22~'24)**

- A Systematic Study of Physical Sensor Attack Hardness (S&P '24)
- Delegation of TLS Authentication to CDNs using Revocable Delegated Credentials (ACSAC '23)
- BASECOMP: A Comparative Analysis for Integrity Protection in Cellular Baseband Software (NDSS '23)
- LTESniffer: An Open-source LTE Downlink/Uplink Eavesdropper, 16th ACM Conference on Security and Privacy in Wireless and Mobile Networks (WiSec '23)
- Un-Rocking Drones: Foundations of Acoustic Injection Attacks and Recovery Thereof, Network and Distributed Systems Security Symposium (NDSS '23)
- Preventing SIM Box Fraud Using Device Fingerprinting, Network and Distributed Systems Security Symposium (NDSS '23)
- Paralyzing Drones via EMI Signal Injection on Sensory Communication Channels, Network and Distributed Systems Security Symposium (NDSS '23)
- Lightbox: Sensor Attack Detection for Photoelectric Sensors via Spectrum Fingerprinting (TOPS '23)
- Revisiting binary code similarity analysis using interpretable feature engineering and lessons learned, IEEE Transactions on Software Engineering (IEEE TSE '22)
- Watching the Watchers: Practical Video Identification Attack in LTE Networks, USENIX Conference on Security Symposium (USENIX Security '22)
- DoLTEst: In-depth Downlink Negative Testing Framework for LTE Devices, USENIX Conference on Security Symposium (USENIX Security '22)

<Professor Yong-Hoon Kim's Lab.>

Atomic-Scale Devices Simulation Lab

■ **Contact information**

Professor : y.h.kim@kaist.ac.kr TEL : 042-350-7423

Lab. : ronggyulee@kaist.ac.kr TEL : 042-350-7523/7623

Website : http://nanocore.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows: 2 PhD Students: 4 Master's Students: 3 Secretary: 1

■ **Research Areas**

1st-principles (atomic-scale) electronic structure, quantum transport, & technology computer-aided design (TCAD) simulations

1. Theory & Computation

- semiconductor physics & electronic structure theory behind the TCAD technology
- high-performance computing (HPC) and artificial intelligence (AI) / machine learning (ML) acceleration

⇓

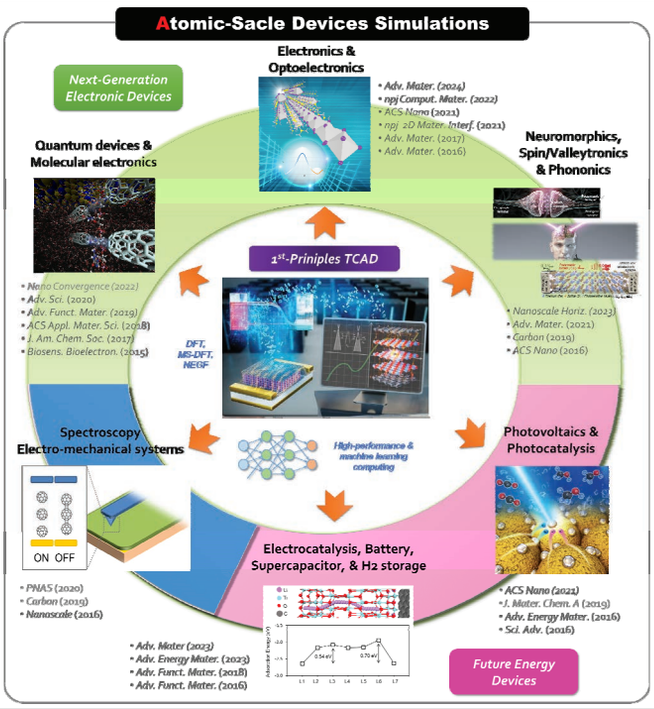
2. Functional Nano-Materials

- low-D vdW materials (graphene, TMDC, etc.)
- halide perovskites, oxides, etc.
- quantum dots, wires, & wells

⇓

3. More (than) Moore Nano-Devices

- "more Moore (sub-10 nm FET) & more than Moore" devices (multi-value logic, neuromorphic computing.)
- beyond CMOS & quantum technologies
- energy conversion & storage devices (solar cells, LED, electro/photocatalysis, supercapacitor)



■ **Recommended courses & Career after graduation**

- Lab members are expected to have strong interest in (1) advanced (quantum) semiconductor device/process physics,
  (2) TCAD & high-performance/AI computing
- In the past 5 years, 2 alumni were appointed as an assistant professor; 1 alumnus became permanent staff members in a National Lab; 3 alumni were hired at Samsung as research staff members

■ **Introduction to other activities besides research**


Daedunsan


Jeju island


Barcelona, Spain

- Annual winter schools at ski resorts, Annual summer schools at Jeju, Annual hiking trips, Weekly stroll+lunch
- Regular attendances to International conferences

■ **Introduction to the Lab.**

- Having established the multi-space excitation viewpoint for quantum transport and the multi-space constrained-search density functional theory (MS-DFT) formalism, we are the global leader in the development and application of atomistic TCAD simulations and and their multiscale & AI extensions.
- For the development of "More-Moore" / "More-than-Moore" devices and future quantum technologies, there are currently strong needs to introduce atomic-scale simulation techniques into semiconductor TCAD.
- Atomistic TCAD experts, while their number is very limited, are actively sought after not only by academina but also by the industry leaders like Samsung, Intel, & TSMC.

■ **Recent research achievements ('21~'24)**

- *"Ab initio theory of the nonequilibrium adsorption energy"*, Npj Comput. Mater. **10**, 60 (2024)
- "*High-κ Dielectric (HfO_2)/2D Semiconductor (HfSe2) Gate Stack for Low-Power …*", Adv. Mater. **36**, 2312747 (2024)
- *"Localized coherent phonon generation in monolayer MoSe2 from ultrafast exciton trapping …"*, Nanoscale Horiz. 8, 1282 (2023)
- *"Quantum hybridization negative differential resistance from non-toxic halide perovskite …"*, Nano Converg. **9**, 25 (2022)
- *"Gate-versus defect-induced voltage drop and negative differential resistance in vertical …"*, Npj Comput. Mater. **8**, 50 (2022)
- *"An optogenetics-inspired flexible van der Waals optoelectronic synapse and its application …"*, Adv. Mater. **33**, 2102980 (2021)

(19 papers of impact factor > 5 SCI journals in '21-'24; See http://nanocore.kaist.ac.kr for the full publication list)

- Samsung Next Generation ICT Project (2020-2023, http://samsungstf.org) & many other awards on group members.

〈Professor Lee-Sup Kim's Lab.〉

Multimedia VLSI Laboratory

■ **Contact information**

Professor	**Email:** leesup@kaist.ac.kr	**Tel:** 042-350-3460
LAb.	**Email:** yunki.han@kaist.ac.kr	**Tel:** 042-351-9854
Website	http://mvlsi.kaist.ac.kr	

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 1 Master's Student: 3

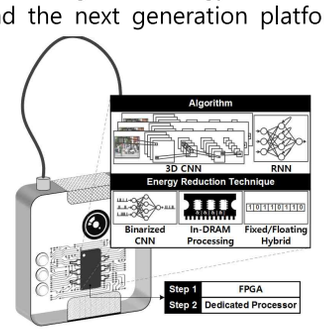
■ **Research Areas**

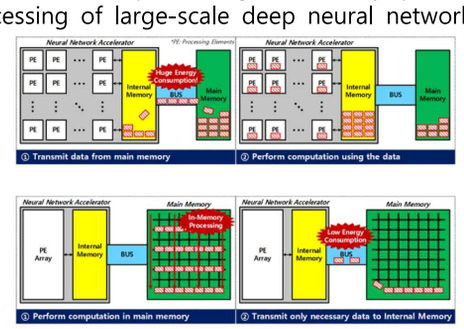
[Deep Learning & Neural Network Processor Design]

Deep learning algorithm is getting a huge attention recently. GPUs are widely used to run neural networks, but it is not appropriate to be integrated in mobile devices like smartphones, wearable devices, and drones because of its low energy-efficiency. We focuses on the design and implementation of a dedicated neural network processor in a both high-performance and energy-efficient way. To this end, researches on the datapath and memory architecture optimized for neural network, a flexible hardware architecture to handle a wide variety of neural network models, and hardware-friendly neural network algorithm are being performed. Finally, a neural network processor chip based on our ideas is designed, fabricated, and tested. We are performing state-of-the-art researches at the most recognized conference.

[Processing in-Memory for Deep Learning]

The conventional Von-Neumann architecture severely suffers from memory bottleneck issue in processing memory-dominant deep learning algorithms since massive amount of data should be transferred through the narrow bus from the main memory to the processor. Meanwhile, processing in-memory (PIM) technique which obeys Non-Von Neumann architecture processes data in the memory and transfers only necessary data to the processor, reducing the energy cost of memory transfers. Therefore, processing in-memory paradigm is the key direction and the next generation platform for efficient processing of large-scale deep neural networks.





■ **Recommended courses & Career after graduation**

▷ Recommended courses: Digital System, Computer Architecture, Digital Integrated Circuit, Computer Vision, Courses related to Deep Learning & Neural Network

▷ Career: Semiconductor Industries and Institutes (Samsung, SK hynix, Qualcomm, NVIDIA, ETRI, etc.)

■ **Introduction to other activities besides research**

▷ Coffee break after lunch
▷ Various hobbies with members
▷ Sports like soccer, badminton, ping-pong and so on
▷ Annual summer/winter field trips

■ **Introduction to the Lab.**

We perform a wide range of researches that covers whole SoC design parts including digital processors, memory architectures, and analog circuits. This is our own unique strength that you never see in other laboratories. Therefore, we have a great research environment to bring yourself to a brilliant processor engineer with a capability to design a whole processor system. Our members are encouraged to perform their own researches with freedom in a family-like atmosphere. As a result, we produce the state-of-the-art research performances with international conference and journal papers.

■ **Recent research achievements ('22~'24)**

[1] The most recognized journal: Yunki Han, Kangkyu Park, Youngbeom Jung, Lee-Sup Kim, "EGCN: An efficient GCN accelerator for minimizing off-chip memory access", IEEE Transactions on Computers, 2022.

[2] The most recognized conference: Junkyum Kim, Myeonggu Kang, Yunki Han, Yang-Gon Kim, Lee-Sup Kim, "Optimstore: In-storage optimization of large scale dnns with on-die processing", IEEE International Symposium on High-Performance Computer Architecture, 2021.

<Professor Joungho Kim's Lab.>

TeraByte Interconnection and Package Laboratory

■ **Contact information**

Professor : S-114-1, Nanofab Center TEL : +82-42-350-3458

Lab. : S-112, Nanofab Center TEL : +82-42-350-9870

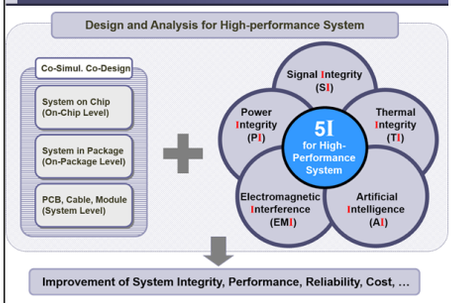
Website : https://tera.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 11 Master's Student: 18

■ **Research Areas**

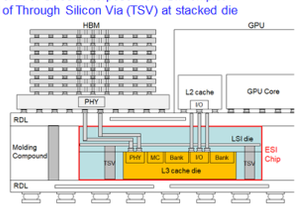
Core Research Field : 5 Is



R&D Application : Next Gen. HBM for AI Supercomputer

◆**Major R&D Area**

- SI & PI design of next gen. High Bandwidth Memory (HBM)
- Near-Memory Computing (NMC) Architecture in HBM (NMC-HBM)
- SI & PI of Silicon interposer for HBM chiplet
- SI of Through Silicon Via (TSV) at stacked die

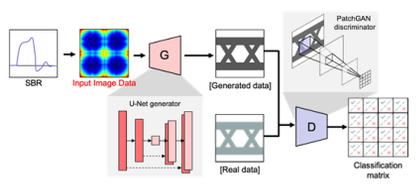


< Overview of L3E-GPU-HBM Architecture >

R&D Application : ML-based SI/PI Design

◆**Major R&D Area**

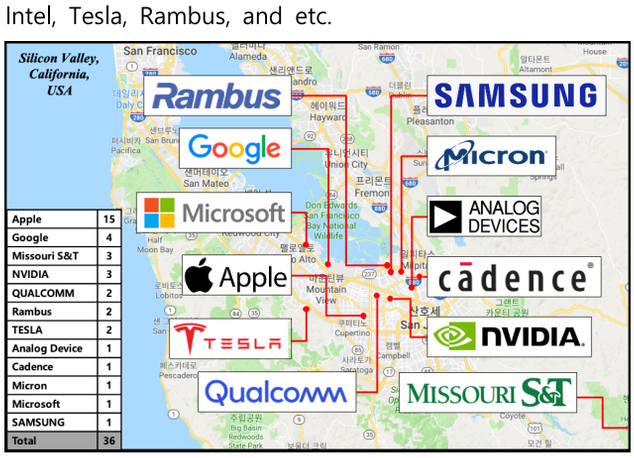
- Machine Learning (ML) based SI/PI design of 2.5D/3D Ics
- GAN-based eye diagram estimation for design of HBM interposer
- Transformer-based architecture for hardware design optimization considering PI



< Overview GAN-based eye diagram estimation >

■ **Recommended courses & Career after graduation**

- Fundamental of electromagnetics and circuit theory.
- Graduates are currently in various global companies: Samsung Electronics, SK Hynix, Apple, Google, Nvidia, Intel, Tesla, Rambus, and etc.



Apple	15
Google	4
Missouri S&T	3
NVIDIA	3
QUALCOMM	2
Rambus	2
TESLA	2
Analog Device	1
Cadence	1
Micron	1
Microsoft	1
SAMSUNG	1
Total	36

■ **Introduction to other activities besides research**

We encourage various extra-activities. We participate in activities such as soccer, e-sports and running. Every summer, we go to the beach for a laboratory workshop. Moreover, we are continuing good relations with graduates through frequent meetings and interactions.

■ **Introduction to the Lab.**

The TERA Lab aims to develop global talent, and many graduates have already entered the world's leading companies. The professor actively leads them to conduct creative research, and there is an atmosphere in which members of the lab can discuss freely. In the field of research, it deals with a lot of future-oriented and practical issues.

■ **Recent research achievements ('22~'24)**

[1] Best Paper Award, Seonguk Choi and et al, "Deep Reinforcement Learning-based Channel-flexible Equalization Scheme: An Application to High Bandwidth Memory" 2022 DesignCon

[2] Best Paper Award, Hyunwook Park and et al, "Scalable Transformer Network-based Reinforcement Learning Method for PSIJ Optimization in HBM" 2022 Electrical Performance of Electronic Packaging and Systems (EPEPS)

<Professor Joo-Young Kim's Lab.>

CastLab

■ **Contact information**

Professor : E3-2 #4202 TEL : 042-350-7461
Lab. : E3-2 #4209 TEL : N/A
Website : https://castlab.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 18 Master's Student: 19

■ **Research Areas**

1. Neural Processing Unit

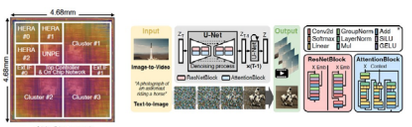
Neural Processing Unit (NPU) is AI-specialized hardware vital for edge and cloud computing. As AI usage grows, dedicated hardware becomes crucial for faster computations. In the edge scenarios like robotics, reinforcement learning, AR/VR demands real-time, energy-efficient processing, highlighting the need for dedicated hardware solutions.

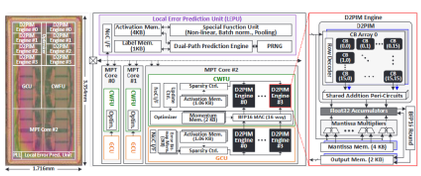
2. Processing-in-Memory

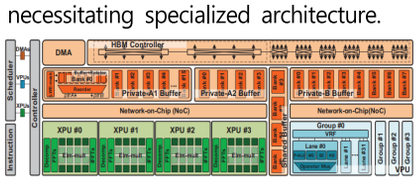
Traditionally, CPUs performed arithmetic and logic calculations, while memory stored data. However, technology scaling now results in compute units outpacing memory in speed, making data movement the bottleneck. The memory-centric approach, such as processing-in-memory (PIM), integrates computation into memory to avoid data movement.

3. Encryption

Privacy-preserving technology has become an increasingly crucial aspect in current information technology, in which private data are constantly being shared, processed, and stored online. Fully Homomorphic Encryption (FHE) enhances data privacy through encrypted computation. However, current hardware acceleration is insufficient for FHE due to complexity, necessitating specialized architecture.







■ **Recommended courses & Career after graduation**

- **Recommended Courses:** Digital System Design (EE303), Computer Architecture (EE312), Digital Electronic Circuits (EE372), Courses related to deep learning algorithms.
- **Career:** Silicon companies (Samsung, Apple, IBM) and IT companies (Microsoft, Google, Meta).

■ **Introduction to other activities besides research**

Beyond research , we enjoy a lot of activities including gatherings like strawberry parties, and lunch buddies; celebratory events for graduations and birthdays; sports like football and basketball.

■ **Introduction to the Lab.**

We aim to innovate modern computing systems through hardware specialization. To this end, we are focusing on co-design of multiple layers of computing system such as application, architecture, circuit, and technology.

■ **Recent research achievements ('22~'24)**

"AdapTiV: Sign-Similarity based Image-Adaptive Token Merging for Vision Transformer Acceleration", IEEE/ACM Symposium on Microarchitecture (MICRO), 2024.

"Morphling: A Throughput-Maximized TFHE-based Accelerator using Transform-domain Reuse", IEEE International Symposium on high-Performance Computer Architecture (HPCA), 2024.

"SP-PIM: A Super-Pipelined Processing-In-Memory Accelerator with Local Error Prediction for Area/Energy-Efficient on-Device Learning", IEEE Journal of Solid-State Circuits (JSSC), 2024.

"APINT: A Full-Stack Framework for Acceleration of Privacy-Preserving Inference of Transformers based on Garbled Circuits", IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2024.

"LPU: A Latency-Optimized Highly Scalable Processor for Large Language Model Inference", IEEE Micro, 2024.

"BLESS: Bandwidth Locality Enhanced SMEM Seeding Acceleration for DNA Sequencing", ACM/IEEE International Symposium on Computer Architecture (ISCA), 2024.

"Strix: an End-to-End Streaming Architecture with Two-Level Ciphertext Batching for Fully Homomorphic Encryption with Programmable Bootstrapping", IEEE/ACM Symposium on Microarchitecture (MICRO), 2023.

<Professor Junmo Kim's Lab.>

Statistical Inference and Information Theory Lab (SIIT)

■ **Contact information**

Professor : Junmo Kim TEL : 042-350-8088

Lab. : N1 214 TEL : 042-350-8088

Website : siit.kaist.ac.kr

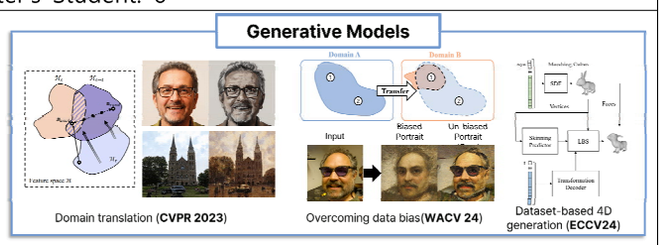
■ **Current state of the Lab. (in 2024 Fall Semester)**

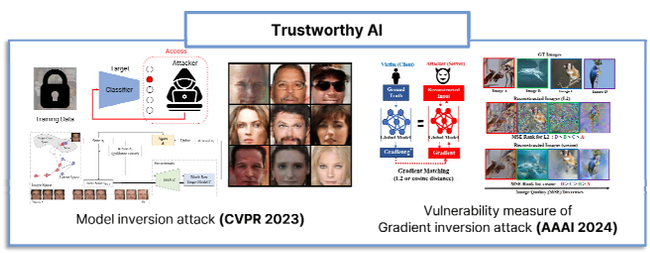
Postdoctoral Fellows : 1 PhD Students: 27 Master's Student: 6

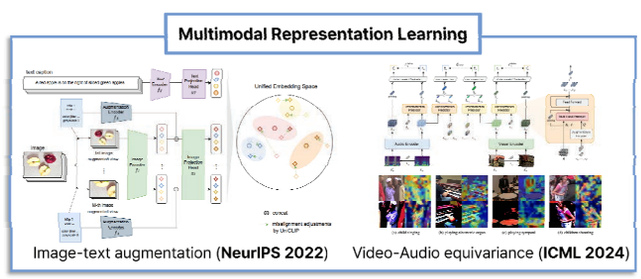
■ **Research Areas**

- Generative Models(CVPRW22, CVPR23, WACV24, ECCV24)
- Trustworthy AI(CVPR23, ICCV23, AAAI24)
- Human Pose Estimation & Reconstruction (ICCV21, CVPR23 FG23, ICCVW23)
- Representation Learning (NeurIPS22, AAAI23, ICML24)
- Object Detection (AAAI24)
- Continual Learning (ECCV22)
- Depth Estimation (ICRA23, ICRA23, ICASSP24)
- Domain Adaptation/Generalization (ICRA22)
- 3D/4D vision
- Augmentation Strategy
- Natural Language Processing

In addition to the main research areas mentioned above, students are encouraged to explore and develop their own topics, with active collaboration across various research areas.







■ **Recommended courses & Career after graduation**

Recommended courses: AI & Computing course

Career after graduation

- Industry: LG AI Research, Hyundai Motors, Samsung Research, SAIT, NAVER CLOVA, LG Energy Solution etc.
- Academia: Yonsei University, Ajou University, KNU, HBNU

■ **Introduction to other activities besides research**

- Birthday party(monthly)
- MT, Various activities(movie, ping-pong, ...)

■ **Introduction to the Lab.**

Students are encouraged to freely explore their research interests in an open and supportive environment, with access to high-performance GPU systems to fully support their research activities. In addition to regular seminars, students form study groups to explore specific topics and hold short-term sessions. Joint research projects with other labs are facilitated through partnerships with alumni professors. Furthermore, we encourage internships at renowned research institutes such as Meta, Microsoft, LG AI Research, NAVER, SAIT, and ETRI, helping students grow into leading AI researchers.

■ **Recent research achievements ('22~'24)**

2024: CVPR , ECCV 2, ICML 1, AAAI 3, WACV 2, ICASSP 1, INTERSPEECH 1

2023: CVPR 3, ICCV 2, AAAI 1, ICRA 2, WACV 1, ICIP 3

2022: NeurIPS 1, ECCV 2, IROS 2, UAI 1, ICIP 2, CVPR 1, ICRA 1, WACV 1, ACSAC 1

<Professor Changick Kim's Lab.>

CILAB **Computational Intelligence Laboratory**

■ **Contact information**

Professor : changick@kaist.ac.kr TEL : 042-350-7421

Lab. : ksos104@kaist.ac.kr TEL : 042-350-7521

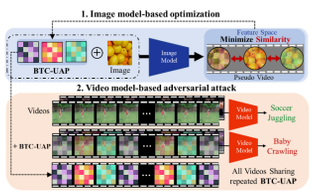
Website : https://cilabs.kaist.ac.kr/

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows: 0 PhD Students: 15 (full-time) / 9 (part-time) Master's Student: 7

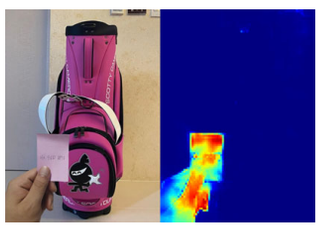
■ **Research Areas**

▶**Adversarial Attack**



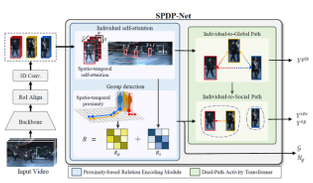
- Imperceptibly perturb input data, with the intent of misleading ML models into generating erroneous predictions.
- It can be applied to image or video models, and large language models (LLMs), and can also be executed cross-modally.

▶**Multimedia Forensics**



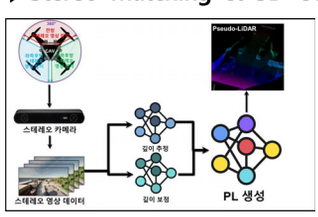
- Uncovering signs of tampering or manipulation in digital images and videos.
- Detecting deepfakes and generative AI-created content to preserve media authenticity.

▶**Group activity recognition**



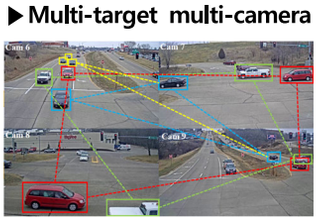
- Analyzes individual, group, and crowd behaviors in wide-view panoramic videos.
- Identifying individual actions and the relationships between people.

▶**Stereo Matching & 3D Object Detection**



- Predicting pseudo-lidar from stereo camera input.
- Detecting obstacle with 3D object detection to avoid collision.

▶**Multi-target multi-camera tracking**



- Track and identify multiple objects across the distributed multi-camera system.
- Wide applicability to surveillance and intelligent transportation systems.

▶**Long-Tail Recognition**

- Resolving the data imbalance problem in real world applications such as wild animal classification.

▶**Image segmentation**

- Human face parsing & body part segmentation.

▶**Large Visual Language Model (LVLM)**

- Hallucination mitigation

▶**Image Generation Model (Diffusion Model)**

- Diffusion model architecture, text-to-image generation

■ **Recommended courses & Career after graduation**

We recommend taking courses related to **computer vision (CV) and deep learning**. Depending on your area of interest, the courses of **computer graphics and signal processing** can be helpful. Those are not mandatory but it would be better to get used to computer vision and deep learning. About career, based on steady research and various industry-academic cooperation experiences, you can have great research capabilities and industrial adaptability.

■ **Introduction to other activities besides research**

Smooth teamwork must precede innovative research. With this conviction, through outside activities, we build feelings of empathy and compassion for each other, and recharge our energy for research. We celebrate birthdays every month to make good memories of our lab life. Also, on fine days, we go on a picnic together. If you would like to see more pleasant memories of ours, please visit our homepage.

■ **Introduction to the Lab.**

Professor Kim has advised his students at KAIST since 2005 and serves as the head of the Center for Security Technology Research. The mission of the CI Lab. is to analyze computer vision systems and develop the systems for various applications. Our lab collaborates with many industries and institutions to perform innovative research work and has published our research in top-tier conferences and journals.

■ **Recent research achievements ('21~'24)**

- 17 top-conference papers (CVPR, ECCV, ICCV, and etc.)
- 10 international journals (TPAMI, IJCV, and etc.)

<Professor Hyun-Sik Kim's Lab.>

Circuit Lab

Electrical Engineering | KAIST

■ **Contact information**

Professor : hyunskim@kaist.ac.kr TEL : 042-350-7457

Lab. : (Chief Student) 3xcv01250@kaist.ac.kr

Website : https://www.ICdesignLab.net/

■ **Current state of the Lab. (in 2024 Fall Semester)**

Ph.D. Students : 13 Master's Student: 6

■ **Research Areas**

Our research group is focused on innovations in the CMOS integrated chip designs of analog IC, DDI, PMIC, ROIC, and CIS. And, ultimately we plan to build a complete system-on-a-chip solution by incorporating our knowledge in those fields.

☐ **Power Conversion and Management IC (PMIC)**

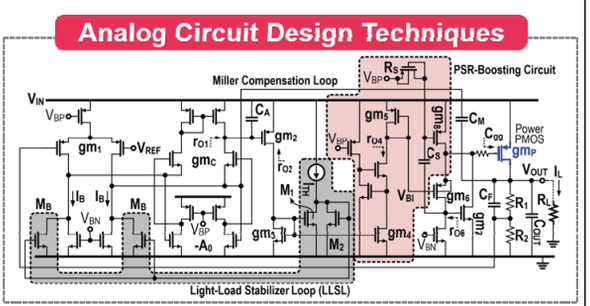
- Switch-mode DC-DC power converter using inductive, capacitive, and hybrid techniques
- Fully-monolithic high-speed switching PMIC for modern SoCs
- Energy-harvesting interface circuit and system
- Fast-response high-PSR low-dropout (LDO) regulator
- Battery charger and management circuit

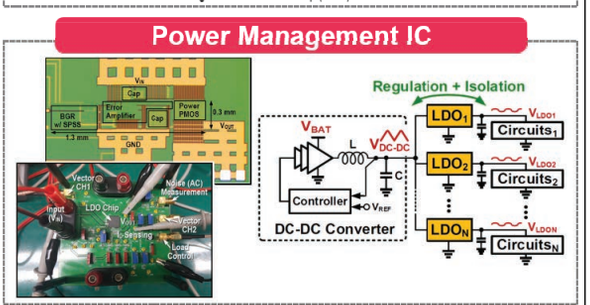
☐ **Display Driving Circuits and Systems**

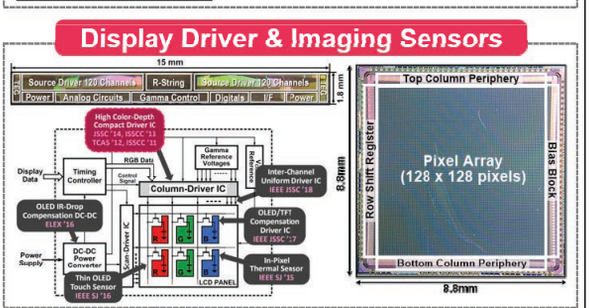
- High-resolution area-efficient digital-to-analog converter (DAC)
- OLED display driver with pixel-readout and active-compensation
- Low-power high-speed output driving buffer amplifier
- Fully-integrated system-on-wafer (SoW) for micro-LED displays
- Displays with touch-sensing functionality

☐ **Readout IC (ROIC) and Imaging Sensor**

- Low-noise high-sensitivity readout circuit and system
- Ultra-high-speed time-delayed integration (TDI) image sensor
- Photon-counting detector for nuclear particles and X-ray







■ **Recommended courses :** Circuit Theory, Electronic Circuits, Analog Electronic Circuits, Analog Integrated Circuits, Power Electronics, Digital Circuits

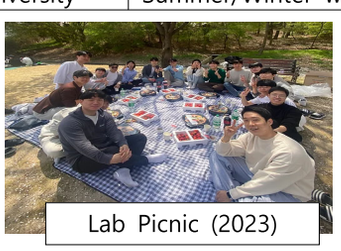
■ **Careers after graduation :** Samsung, LG, SK-Hynix, Research Institute, Silicon-Valley, Academia, University

■ **Introduction to our laboratory**

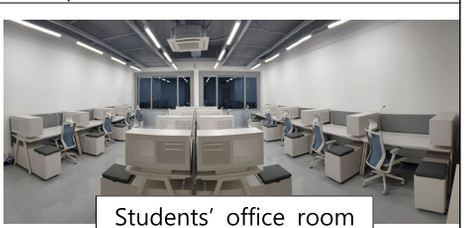
Young and active research environments, Horizontal peer relationship, 24-hours academic discussion, Opened and wide opportunities to attend international conference, Summer/Winter workshop, Refreshed clean office room

■ **Lab. Photo**

VLSI 2022 (Hawaii)



Lab Picnic (2023)



Students' office room

■ **Recent research achievements (2020~2024)**

- Conference Presentations: (top) ISSCC 12편, (top-tier) VLSI Symposium 14편, (major) CICC 2편, (major) ESSCIRC 1편
- Journal Publication: IEEE JSSC 14편, IEEE TPEL 1편, IEEE TIE 1편, IEEE SSC-L 5편, IEEE SSC-M 1편
- Awards: 반도체설계대전 국무총리상, 삼성휴먼테크 은상(21) & 동상(22), 삼성디스플레이논문대회 금상(22) & 금상(21)

<Professor Hoirin Kim's Lab.>

SSSC
Statistical Speech & Sound Computing Lab.

■ **Contact information**

Professor : 2111, LG Innovation Hall (N24) TEL : 7417
Lab. : 2105, LG Innovation Hall (N24) TEL : 7617
Website : https://sites.google.com/site/kaistsssclab/

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 2 Master's Student: 4

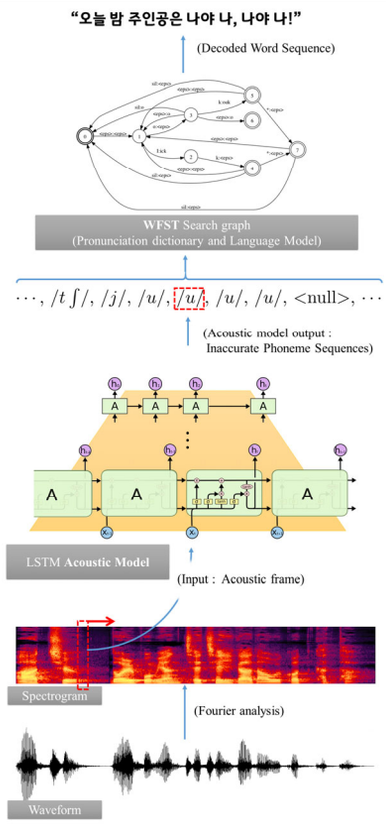
■ **Research Areas**

SSSCLAB has been researching machine learning and deep learning for speech and sound signals. In recent years, with the advance of smart devices & AI, our research fields have attracted much interest day by day.

Speech recognition is a technology that converts human speech into words or sentences. We are also studying **speech synthesis** technology (familiar as **TTS**) that generates a human-like voice from any text. They help humans communicate with computers or machines naturally.

In addition, we have studied natural language processing-based **language modeling** to complement the syntactic consistency of recognized strings and **speaker recognition** to recognize the user's identity. We are also studying **voice conversion** technology that mimics a specific speaker's voice as felt non-artificial.

There are many interesting researches such as **speech enhancement** that restores noisy speech to clean, **wake-up word detection** (ex. Hey Siri, OK Google), **voice activity detection**, **speaker diarization**, **acoustic event detection**, etc.



Current Research Projects
Research on Unified Interactive Learning Schemes of End-to-End Speech Recognition and Synthesis based on Deep Learning of Speech Chain Mechanism
Development of Voicephishing Prevention Technology Based on Speech and Text Deep Learning
Development of Speech Technology for Machine Learning Diagnosis of Cognitive-Affective Disorder Patients

■ **Recommended courses & Career after graduation**

- Recommended : Signals and Systems, Digital Signal Processing, Probability and Random Processes, Linear Algebra, Information Theory, ML or DL related course.
- Alumni have been entering IT companies, research institutes, or universities. (Samsung Electronics, Samsung Research, LG Electronics, etc.)

■ **Introduction to other activities besides research**

Through summer MT, welcome party, year-end party, and homecoming day, we promote friendship among students. In addition, we encourage attendance at domestic/international conferences in related fields, so that students can get various research experiences.

■ **Introduction to the Lab.**

SSSCLAB was founded in 2000 and carries out various projects related to speech and sound signal processing. We accumulates rich practical experience achieving excellent academic research results. Also, we provide stable and strong financial support and a comfortable research environment so that students can continue their studies and research activities. SSSCLAB has produced out 13 Ph.D. and 31 Master graduates for 23 years.

■ **Recent research achievements ('23~'24)**

[1] Kangwook Jang, *et al.,* "STaR: Distilling Speech Temporal Relation for Lightweight Speech Self-Supervised Learning Models" ICASSP 2024. **(Best Student Paper Awarded)**

[2] Jisub Um, *et al.,* "Utilizing Adaptive Global Response Normalization and Cluster-Based Pseudo Labels for Zero-Shot Voice Conversion" Interspeech2024,

[3] Myunghun Jung, *et al.,* "AdaMS: Deep Metric Learning with Adaptive Margin and Adaptive Scale for Acoustic Word Discrimination" Interspeech2023.

<Professor Hoon Kim's Lab.>

PHOTONICS SYSTEMS RESEARCH LAB

■ **Contact information**
Professor : Bldg. E3-2 Room 4204 TEL : 042-350-7433
Lab. : Bldg. E3-2 Room 4210 TEL : 042-350-7633
Website : http://psrl.kaist.ac.kr

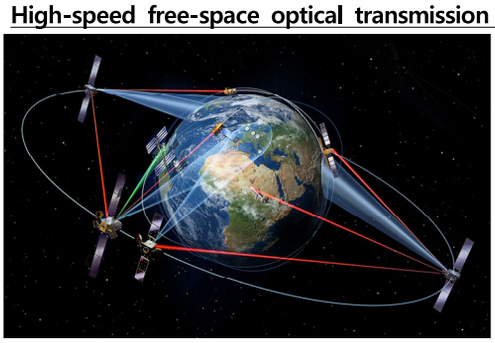
■ **Current state of the Lab. (in 2024 Fall Semester)**

PhD Students: 13 Master's Student: 7

■ **Research Areas**

Our research is centered around photonic systems and related technologies, including free-space optical communications, high-capacity fiber-optic transmission systems, optical access networks, and lightwave subsystems.

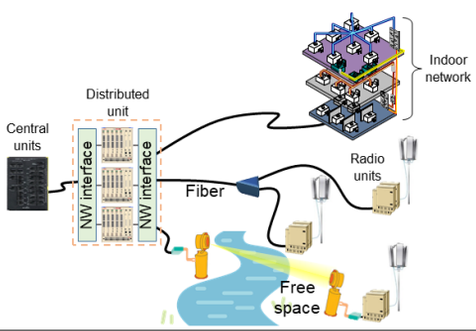
High-speed free-space optical transmission system



In an era of expanding commercial satellite networks and frequent satellite launches, it is expected that we will soon reach a point of radio frequency (RF) saturation. Furthermore, there's a growing need for instant, large-scale data transfer from satellites to ground stations, which existing RF communications struggle to meet. To address these challenges, laser optical communication emerges as a transformative solution. By harnessing light in the hundreds of terahertz range, laser optical communication enables high-speed signal transmission with minimal losses, distinguishing it from RF systems. It can achieve data transmission rates of over tens of gigabits per second, making it a promising option for space communication. Our research focuses on leveraging free-space optical communication technology for various applications.

Transmission technologies for 6G

Optical networks form the backbone of our communication systems. To enable the next generation (6G) mobile communication services, the optical network must evolve into a low-delay, high-speed network, with speeds reaching up to tens of terabits per second. Our research is focused on investigating various cost-effective technologies to achieve this goal.



■ **Recommended courses & Career after graduation**

- Recommended courses include Introduction to Optical Communication (EE441), Introduction to Optical Engineering (EE352), and Digital Signal Processing (EE432).
- Potential career paths after graduation include national research institutes, major companies, and academia.

■ **Introduction to other activities besides research**

- Every spring, we have our annual strawberry party and homecoming event.
- We plan to have a regular sports day with other lab members in KAIST working on photonics.

■ **Introduction to our Lab.**

- Welcome to the Photonics Systems Research Lab, founded in 2014 and led by Prof. Hoon Kim. Prof. Kim has accumulated 22 years of experience in photonics systems, with a career that has included positions at renowned organizations like Bell Labs, Lucent Technologies., Samsung Electronics, and National University of Singapore. Our main focus lies in exploring the fundamental limits of various photonics systems and developing practical implementation methods. Prof. Kim currently serves as the Editor of *Optics Communications* and the Senior Editor of *IEEE Photonics Technology Letters*.
- We actively engage in academic exchanges with international research institutes and universities. We also participate in prominent international conferences such as OFC and OECC.

■ **Recent research achievements ('22~'24)**

- International journal publications : 17, International conference presentations: 19.
- Best Student Paper Awards : Photonics Conference 2021, 2022, COOC2022, SPPCom 2024.

<Professor Yong Man Ro>

Integrated Vision and Language Laboratory
Image and Video Systems Laboratory

■ **Contact information**

Professor	**Email: ymro@kaist.ac.kr**	**Tel: 042-350-3494**
Lab.	**N1 building #418**	**Tel: 042-350-8094**
Website	https://www.ivllab.kaist.ac.kr/	

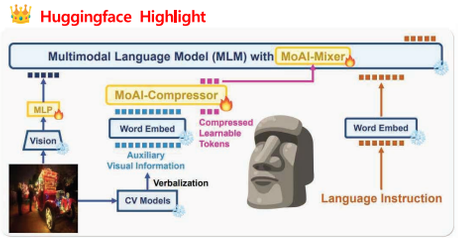
■ **Current state of the Lab. (in 2024 Fall Semester)**

Ph.D. Students: 18, M.S. Students: 2, Undergraduate Interns: 2

■ **Research Areas**

★ **Multimodal Large Language Model**

Huggingface Highlight

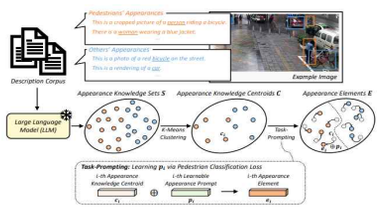


paper link

#LVLM #MLLM

By transferring all visual intelligence to LLMs, we explore value beyond just being a language model.

★ **Integrating Vision and Language**



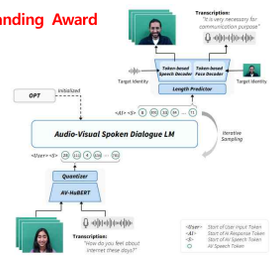
paper link

#ObjectDetection
#LLM

To address the challenges in fine-grained detection, our research focused on integrating semantic knowledge from language-derived appearance elements with vision knowledge.

★ **Human and Machine Teaming**

Outstanding Award

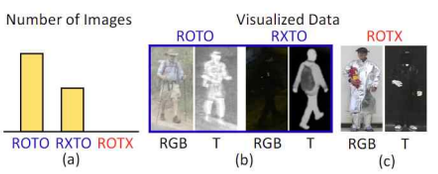


paper link

#HumanMultimodal
#SpeechDialogue

Towards inclusive human multimodal conversation, we presented face-to-face spoken MultiDialogue dataset. We are exploring real-like human-to-human conversation research. (ACL24 Outstanding paper, KAIST Newspaper)

★ **Multi-sensory Vision**



paper link

#MultiSenor
#ObjectDetection

The fusion of RGB and thermal images results in data bias. We overcame this issue through causal reasoning and proposed a novel pedestrian detector.

■ **Recommended courses & Career after graduation**

Recommended courses include probability, digital signal processing, machine learning, introduction to multimedia, image processing/computer vision, various programming courses.

■ **Introduction to other activities besides research**

IVY&IVL Lab regularly holds common activities such as summer/winter MT, etc.

■ **Introduction to the Lab.**

Homepage

IVY&IVL Lab is currently focusing on large language model (LLM)-related multimodal LLM that integrates vision and language. We are trying to bridge the knowledge gap between vision and language for building unified frameworks. The Lab members help/encourage each other research in an autonomous atmosphere with stable support. We are seeking highly-motivated students who have a desire to go towards world-class research institutes in our interesting research field.

■ **Research achievements**

In the recent 3 years (2022-2024), more 40 AI top tier conferences (CVPR, ICCV, ECCV, NeurIPS, ACL, EMNLP, etc) have been published. So far, We have published 156 SCI journal papers (SCI-indexed, referee peered), 363 International conference papers.

<Professor Seung-Tak Ryu's Lab..>

MSICL
Mixed Signal IC Laboratory

Mixed Signal Integrated Circuits Laboratory

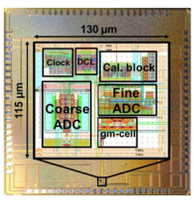
■ **Contact information**

Professor : Seung-Tak Ryu TEL : 042-350-7425
Lab. : E3-2 #4230, 4224 TEL : 042-350-7525, 7625
Website : http://msicl.kaist.ac.kr

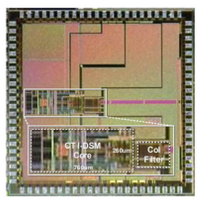
■ **Current state of the Lab. (in 2024 Fall Semester)**

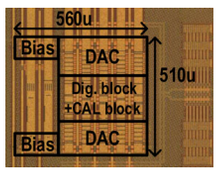
Postdoctoral Fellows : 0 PhD Students: 12 Master's Student: 8

■ **Research Areas**



<10b 500MS/s Pipelined SAR ADC>


<400kS/s 4-ODE CT I-DSM ADC>



<12b 1GS/s CS-DAC w/ cal.>

MSICL researches Analog/Mixed signal circuit design. The major research topic is data converters, which converts analog signal to digital signal or vice-versa. This research area has gained significance along with semiconductor advancements. As digital circuits gain popularity for their enhanced computational capabilities and reduced power consumption, analog circuits assume a pivotal role in transferring natural signals to digital systems. Since numerous signals in human-related contexts remain analog, the research on analog circuits is essential with the development of circuit systems. However, the number of analog circuit designer is insufficient compared to analog circuit demands.

The research scope of MSICL encompasses a range of subjects including: High-speed ADCs (SAR/Pipeline/Flash/Time-domain/Time-Interleaved/etc.) and DACs (Current-domain), High-resolution ADCs (Delta-Sigma Modulator/Noise-shaping SAR), Radiation-tolerant Data converters, Synthesizable Data converters, Design Automation, Random Number Generator, and more.

■ **Recommended courses & Career after graduation**

- Recommended courses: Electronic Circuits (EE304), Digital Electronic Circuits (EE372), and Analog Electronic Circuits (EE403).

- Career after graduation: Engineers in industry, professors, researchers in national research centers

■ **Introduction to other activities besides research**

To foster the friendship of lab members, numerous events are organized throughout each season. During spring and fall, outings are arranged, while in summer and winter, regular workshops take place.

(2024 Summer Workshop) ->

■ **Introduction to the Lab.**

As aforementioned, MSICL researches Analog/Mixed signal circuit designs. Data converters which is the major topic of our Lab becomes more important in IC system and undergoes lack of manpower. Since our circuit design treats both analog and digital circuits, the students who have interests in circuit design can get a good chance to study IC circuits. Also, MSICL performs the many projects with companies and researching institute such as Samsung, Hynix, ETRI and so on. So the students can improve the executive ability as well.

■ **Recent research achievements ('23~'24)**

[1] Charlie Tahar, "TID-Tolerant StrongARM Comparator and Sampling Network for Satellite Application High-Voltage ADCs", IEEE ASSCC, 2024.
[2] Bo Gao, "A 28nm CMOS 12-bit-600-MS/s 15.6mW Pipelined ADC with Two-Stage Gainboosting FIA-based RA", IEEE ASSCC, 2024.
[3] Lizhen Zhang, "A 5x OSR 1MHz-BW 81dB-SNDR 5th-Order Noise-Shaping SAR ADC with Zero-Optimized 3rd-Order Integrator", IEEE ASSCC, 2024.
[4] Kent Edrian Lozada*, Dong-Hun Lee*, "A 25kHz-BW 97.4dB-SNDR SAR-Assisted Continuous-Time 1-0 MASH Delta-Sigma Modulator with Digital Noise Coupling", IEEE JSSC, 2024.
[5] Yedam Kim, "A 100kHz-BW 99dB-DR Continuous-Time Tracking-Zoom Incremental ADC with Residue-Gain Switching and Digital NC-FF ", IEEE VLSI, 2024.
[6] Kent Edrian Lozada, "A 0.38mW 200kHz-BW 92.1dB-DR Single-Opamp 4th-order Continuous-Time Delta-Sigma Modulator with 3rd-order Noise Coupling", IEEE VLSI, 2024.
[7] Jae-Hyun Chung, "A 1.5-MHz BW 81.2-dB SNDR Dual-Residue Pipeline ADC With a Fully Dynamic Noise-Shaping Interpolating-SAR ADC .", IEEE JSSC, 2024.
[8] Jae-Hyun Chung, "An 81.2dB-SNDR Dual-Residue Pipeline ADC with a 2nd-Order Noise-Shaping Interpolating SAR ADC," IEEE CICC, 2023.
[9] Chang-Un Park, "A 12-bit 1GS/s Current-Steering DAC with Paired Current Source Switching Background Mismatch Calibration," IEEE CICC, 2023.

<Professor Hyun Myung's Lab.>

URL | URBAN ROBOTICS LAB @ KAIST

■ **Contact information**

Professor : Hyun Myung TEL : 042-350-7451

Lab. : Urban Robotics Lab TEL : 042-350-7551

Website : https://urobot.kaist.ac.kr/

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 2 PhD Students: 33 Master's Student: 12

■ **Research Areas**

- Autonomous robot navigation (SLAM, self-driving car, mobile robot, legged robot, drone, etc.)
- Spatial artificial intelligence & Machine learning
- Intelligent robots
- Monitoring & inspection for smart cities
- Swarm robots

■ **Recommended courses & Career after graduation**

- Recommended courses: EE381, EE581, EE585
- Career after graduation: Robotic researcher for gov. research institutes, industries (Samsung Elec., Hyundai Motor Company, Naver labs, etc.); Professor in academia

■ **Introduction to other activities besides research**

- Summer/winter workshop
- Lab tour
- Strawberry party

■ **Introduction to the Lab.**

Our lab focuses on the research and development of robotics technologies for smart cities. The research fields include autonomous robot navigation, spatial AI, machine learning, monitoring, inspection, control, and rehabilitation for smart cities and civil infrastructures. We also deal with big data informatics supporting sensing, analysis, and design activities needed to construct and operate smart and sustainable built environments.

■ **Recent research achievements ('22~'24)**

- **Published Journal/Conference Papers**

2024 (published paper: 13)

Hyungtae Lim, Beomsoo Kim, Daebeom Kim, Eungchang Mason Lee, and Hyun Myung†, "Quatro++: Robust Global Registration Exploiting Ground Segmentation for Loop Closing in LiDAR SLAM," *International Journal of Robotics Research*, vol.43, no.5, pp.685-715, Apr. 2024.

Changki Sung, Wanhee Kim, Jungho An, WooJu Lee, Hyungtae Lim, and Hyun Myung†, "Contextrast: Contextual Contrastive Learning for Semantic Segmentation," in Proc. The I*EEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR 2024)*, Seattle, USA, Jun. 2024.

Wooju Lee, Dasol Hong, Hyungtae Lim†, and Hyun Myung†, "Object-Aware Domain Generalization for Object Detection," in Proc. *AAAI Conference on Artificial Intelligence (AAAI 2024)*, Vancouver, Canada, Feb. 2024.

2023 (published paper: 32)

Hyungtae Lim, Lucas Nunes, Benedikt Mersch, Xieyuanli Chen, Jens Behley, Hyun Myung†, and Cyrill Stachniss, "ERASOR2: Instance-Aware Robust 3D Mapping of the Static World in Dynamic Scenes," in Proc. *Robotics: Science and Systems (RSS 2023)*, Daegu, Korea, Jul. 2023.

I Made Aswin Nahrendra, Byeongho Yu, and Hyun Myung†, "DreamWaQ: Learning Robust Quadrupedal Locomotion With Implicit Terrain Imagination via Deep Reinforcement Learning," in Proc. *IEEE Int'l Conf. on Robotics and Automation (ICRA)*, pp. 5078-5084, London, UK, May 2023.

2022 (published paper: 49)

Hyunjun Lim, Jinwoo Jeon, Hyun Myung†, "UV-SLAM: Unconstrained Line-Based SLAM Using Vanishing Points for Structural Mapping," in Proc. *IEEE Int'l Conf. on Robotics and Automation (ICRA)*, pp. 1518-1525, Philadelphia, USA, May 2022.

Wooju Lee, Hyun Myung†, "Adversarial Attack for Asynchronous Event-based Data," in Proc. The 36th *AAAI Conference on Artificial Intelligence (AAAI 2022)*, pp. 1237-1244, Virtual, Jun. 2022.

- **Awards**

First place at Quadruped Robot Challenge (QRC) hosted at the 2023 IEEE Conference on Robotics and Automation (ICRA), London, UK.

First place overall in LiDAR session & first place in academia (second place overall) in the vision-only session at HILTI SLAM Challenge 2023 held at 2023 IEEE International Conference on Robotics and Automation (ICRA), London, UK

The only one to complete the entire course and win a prize in the autonomous flight technology contest hosted by the Defense Acquisition Program Administration and Daejeon City, sponsored by the Agency for Defense Development and Daejeon Techno Park, 2023.

<Professor Gun-Woo Moon's Lab.>

■ **Contact information**

Professor : gwmoon@kaist.ac.kr TEL : 042-350-3475

Lab. : dmdm0402@kaist.ac.kr TEL : 042-350-8075

Website : http://kpel.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 7 Master's Student: 4

■ **Research Areas**

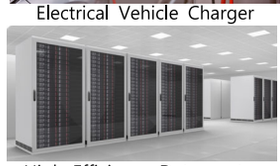
Electrical Vehicle Charger

Electrical vehicles essentially have rechargeable batteries that can be fully charged by connecting the vehicle plug to and external electric power source. Therefore, battery charger is one of the key components of EV.

Electrical Vehicle Charger

Power Supply for Data Center

Data center is increasing rapidly due to the extension of internet. Accordingly, power consumptions of data center is rising as a global issue. Therefore, this research proposes new technologies to obtain high efficiency and high power density of data center.



High Efficiency Data center

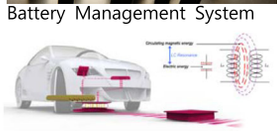
Battery Management System with Cell Balancing Circuit

As the number of charging and discharging periods increase, the unbalanced cells are faced to the limit with the use of the battery power. Therefore, the cell balancing circuit is required to prevent the unbalance between the cell.

Battery Management System

Wireless Power Transfer System

Wireless Power Charging System for large-capacity battery in electrical vehicles, and dual-band wireless power architecture for multiple load conditions.



Wireless Power Transfer

■ **Recommended courses & Career after graduation**

Recommended courses : Circuit theory, Electronics circuits, Control system, Power electronics systems, Electro-magnetics

Career after graduation: Professors, Research institute (ADD, KARI, KERI, KRRI, KISTI, etc.), Industry (Samsung Electronics, Hyundai Motors, Intel, Apple, etc.)

■ **Introduction to other activities besides research**

Exercise Activity : Soccer, Futsal, Basket ball, Foot volleyball,

Workshop : Summer and Winter workshop.

Etc. : Year-end party and Home coming day.

■ **Introduction to the Lab.**

KPEL is leading world-class power electronics researches. Main research area contains power supply for data center, charging system for electrical vehicle, wireless power transfer system, battery management systems. KPEL is contributing domestic company's sales with technical transfer by linking with industry. KPEL published 209 SCI journals, 304 international conferences, and 206 patents.

■ **Recent research achievements ('22~'24)**

International Journal (Total 16)

2024 : 8. (IEEE Trans. Power Electronics [I.F : 6.6] / IEEE Trans. Industrial Electronics [I.F : 7.5])
2023 : 6. (IEEE Trans. Power Electronics [I.F : 6.6] / IEEE Trans. Industrial Electronics [I.F : 9.6])
2022 : 2. (IEEE Trans. Power Electronics [I.F : 6.3] / IEEE Trans. Industrial Electronics [I.F : 7.5])

International Conference (Total 13)

2022-2024 : 13. (ECCE Asia – Japan / ECCE Asia – Korea / ECCE Asia – China)

Award

[1] "Highlighted Paper", IEEE Transactions on Power Electronics
[2] Human Tech Paper Award (Samsung Electronics)
[3] Outstanding Presentation Award, IEEE APEC
[4] Korea Power Electronics Conference : 4 Best Paper

<Professor Jaekyun (Jae) Moon's Lab.>

MoonLab
Distributed & Robust Machine Learning Lab

■ Contact formation

Professor : Jaekyun (Jae) Moon TEL : 010-3596-3487
Lab. : N1 617 TEL : 042-350-3487
Website : http://moonlab.kaist.ac.kr/

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 7 Master's Student: 0

■ Research Areas

We work on distributed/federated machine learning, robust AI and resource-efficient AI, addressing all key issues in the deployment of practical AI systems.

▶ Distributed/Federated Learning [1-3]

- Federated learning (FL) is a distributed learning framework which enables collaborative training across multiple nodes without sharing their data. We focus on reducing communication costs in FL by employing the concept of Evolutionary Strategy.
- In practical FL,trained FL models should work well on unseen target domains.We propose a new FL strategy to equip the model with a domain generalization capability

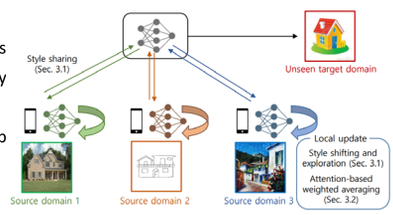


Fig 1. Practical federated learning

▶ Handling Out-of-Distribution Data [4-5]

- Current out-of-distribution machine learning algorithms are vulnerable to data. We focus on making AI models operate robustly on arbitrary test domains.
- Model calibration is the technique of aligning a model's predicted probabilities with the true probabilities of the target classes, making its prediction more reliable. We focus on improving model calibration on out-of-distribution scenarios

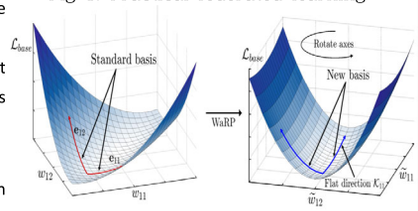


Fig2. Weight space rotation algorithm

▶ Resource and Data Efficient AI [6-9]

- Handling the substantial communication burden in federated learning (FL) remains a significant challenge. We focus on achieving lossless gradient sparsification for communication-efficient FL
- Class-incremental few-shot learning (CIFSL) aims to continuously train a single model, where new sets of classes are provided with only a few data. We focus on addressing the issues of forgetting and overfitting via weight space rotation

▶ Robust AI against Adversarial Attacks [10-11]

- Adversarial examples can distort the model prediction, resulting in performance degradation. We focus on making multi-exit networks robust against adversarial attacks for reliable AI systems
- Malicious clients in FL can disrupt the proper FL training and significantly degrade performance by interfering with the training process of FL. We propose a robust FL method that can mitigate the impact of adversarial attacks

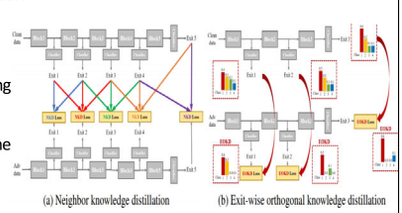


Fig3. Multi-exit network architecture

■ Recommended courses & Career after graduation

Classes that strength backgrounds on mathematics and probabilities/statistics are desired. Graduates pursue career in research and R&D at numerous domestic and overseas companies and institutions.

■ Introduction to other activities besides research

Horizontal, non-hierarchical relationships are valued among lab members. Strong emphasis is placed on quality of life. Environments are maintained. where free discussions and stimulating interactions are encouraged. Regular meals, picnics and MTs with all members participating add spices ot life at MoonLab.

■ Introduction to the Lab.

Moon Lab pursues math-oriented research but also seeks to have impacts on applications. Students chooses topics after much discussions with Professor and may also change the course of research along the way.

■ Recent research achievements ('22~'24)

[1] J. Park*, D.-J. Han* J. Kim, S. Wang, C. G. Brinton, J. Moon, "StableFDG: Style and Attention Based Learning for Federated Domain Generalization," Neural Information Processing Systems (**NeurIPS**), Dec. 2023.
[2] M. M. Rahimi, H. I. Bhatti, Y. Park, H. Kousarand J. Moon, "EvoFed: Leveraging Evolutionary Strategies for Efficient and Privacy-Preserving Federated Learning," Neural Information Processing Systems (**NeurIPS**), Dec. 2023.
[3] D.-J. Han, D.-Y. Kim, M. Choi, C. G. Brinton and J. Moon, "SplitGP: Achieving Both Generalization and Personalization in Federated Learning," IEEE International Conference on Computer Communications (**INFOCOM**), May 2023.
[4] W. Choi, J. Park, D.-J. Han, Y. Park and J. Moon, "Consistency-Guided Temperature Scaling Using Style and Content Information for Out-of-Domain Calibration," AAAI Conference on Artificial Intelligence (**AAAI**), Feb. 2024.
[5] J. Park*, D.-J. Han*, S. Kim and J. Moon, "Test-Time Style Shifting: Handling Arbitrary Styles in Domain Generalization," International Conference on Machine Learning (**ICML**), July 2023.
[6] D.-Y. Kim, D.-J. Han, J. Seoand J. Moon, "Achieving Lossless Gradient Sparsification via Mapping to Alternative Space in Federated Learning" International Conference on Machine Learning (**ICML**), July 2024
[7] D.-J. Han*, J. Park*, S. Ham, N. Lee and J. Moon, "Improving Low-Latency Predictions in Multi-Exit Neural Networks via Block-Dependent Losses," IEEE Transactions on Neural Networks and Learning Systems (**TNNLS**), 2023.
[8] Y. Park, S. Kim, W. Choi, D.-J. Han and J. Moon, "Active Learning for Object Detection with Evidential Deep Learning and Hierarchical Uncertainty Aggregation," International Conference on Learning Representations (**ICLR**), May 2023.
[9] D.-Y. Kim, D.-J. Han, J. Seoand J. Moon, "Warping the Space: Weight Space Rotation for Class-Incremental Few-Shot Learning," International Conference on Learning Representations (**ICLR**), May 2023.
[10] S. Ham, J. Park, D.-J. Han, J. Moon, "NEO-KD: Knowledge-Distillation-Based Adversarial Training for Robust Multi-Exit Neural Networks," Neural Information Processing Systems (**NeurIPS**), Dec. 2023.
[11] J. Sohn, L. Shang, H. Chen, J. Moon, D. Papailiopoulosand K. Lee, "GenLabel: MixupRelabeling using Generative Models," International Conference on Machine Learning (**ICML**), July 2022.

<Professor Seong Ook Park's Lab.>

Micro Millimeter-wave and Antenna Laboratory

■ **Contact information**

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Lab. : (Email) gksthf30638@kaist.ac.kr (TEL)010-4622-3402

Website : ma.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 12 Master's Student: 1

■ **Research Areas**

Research at Microwave (Millimeter-wave) and Antenna Laboratory includes electromagnetic theories for antenna analysis, active beam scanning antennas, Radar systems, and synthetic aperture radar.

[5G and beyond 5G (6G) Antenna Technologies]

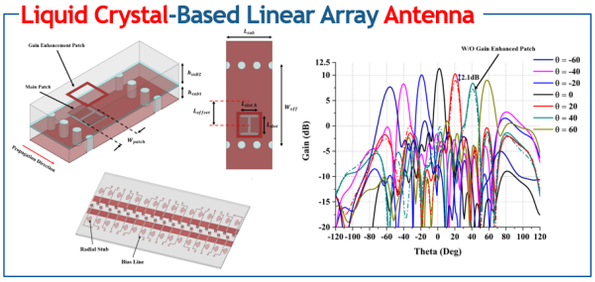
We develop a core technology of active antenna systems to design wide beam scan enhanced gain antenna, 5th and 6th generation mobile channel sounder system, and an accurate calibration with mmWave Antenna Measurement.

[Radar Surveillance System with AI and Synthetic Aperture Radar (SAR)]

We have realized and develop various radar systems, such as drone detecting system, an active electronic scanning radar, Synthetic Aperture Radar System, and radar target classification using deep learning technologies.

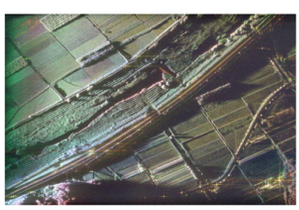
AI Algorithm for Auto-Driving Using MIMO Radar

Liquid Crystal-Based Linear Array Antenna



Synthetic Aperture Radar System (SAR)

Satellite Image



Chirp-Pulse Polarimatric SAR image

Drone Classification/ Identification based on AI

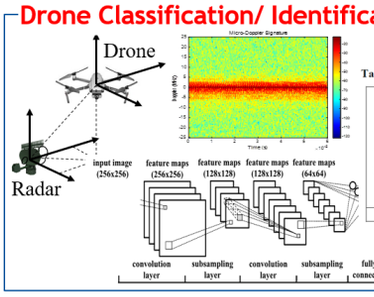


Table 3. Classification Rate Results of 24 Class Dataset

Class Number	Rate	Class Number	Rate	Class Number	Rate
1	100%	9	95.4%	17	98.4%
2	99.2%	10	85.1%	18	94.5%
3	95.2%	11	93.4%	19	100%
4	98.6%	12	100%	20	99.1%
5	98.4%	13	99.1%	21	84.2%
6	99.2%	14	95.1%	22	99.2%
7	96.6%	15	98.4%	23	93.2%
8	98.4%	16	94.5%	24	97.1%

Total Classification Rate: 96.1%

■ **Recommended courses & Career after graduation**

Electromagnetics, Electronic Circuits, Signal Processing, and Antenna are recommended for undergraduate courses. For graduate courses, Electromagnetic Theory, Microwave Engineering, and Antenna Engineering are recommendable.

SAMSUNG 삼성전자 · 국방과학연구소 Agency for Defense Development · SAMSUNG 삼성종합기술원 · HYUNDAI MOBIS · ETRI

■ **Introduction to other activities besides research**

We hold an annual Homecoming Day to promote interaction between students and alumni, and share information about academic research and industrial trends. Also, there are plenty of soccer(5vs5) matches to maintain a sound body and mind.

■ **Introduction to the Lab.**

Microwave (Millimeter-wave) and Antenna Laboratory have undertaken a number of government-sponsored projects. Based on the accumulated research experiences, we pursue creative and future-oriented research. Prof. Seong-Ook Park makes leads us to write decent papers on key technologies of our fields. Moreover the lab's atmosphere is fairly friendly and supportive which is the greatest strength of our lab.

■ **Recent research achievements ('22~'24)**

International Journals (13) - *IEEE Transactions on Aerospace and Electronic Systems, IEEE Transactions on Instrumentation and Measurement, IEEE Transactions on Antennas and Propagation, IEEE Sensors Journal, IEEE Access, Journal of Electromagnetic Engineering and Science.*

International Letters (2) - *IEEE Geoscience and Remote Sensing Letters, IEEE Antennas and Wireless Propagation Letters.*

International Conferences (3)

⟨Professor In-Cheol Park's Lab⟩

Integrated Computer Systems Laboratory

■ Contact information		
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■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 1 Master's Student: 10

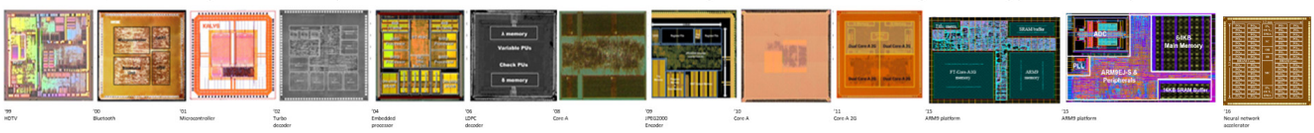
■ Research Areas

Intelligence Computing Systems Laboratory (ICSL) was established in 2000 by Professor In-Cheol Park. The research focus of ICSL is on computer architecture, embedded processors, and VLSI architectures for computationally intensive function blocks, such as multimedia signal processing and communication system. The current research scope of ICSL is VLSI designs for error correcting code blocks, deep neural networks, and communication systems.

• Design of microprocessors: Many kinds of processors were developed such as single-chip programmable SoC platform, and multithread embedded processor. A SoC platform based on 32-bit embedded processor and on-chip bus was developed together with its corresponding development environment including software.

• VLSI design for error-correcting codes: Error correction is one of the most important techniques used in communication and storage systems to recover messages corrupted in noisy environments. In addition, low-power LDPC decoders optimized for NAND flash were devised. Also, LDPC and polor decoders for communication standards such as 5G-NR were developed to achieve near-optimal error-correcting performance with high throughput.

• VLSI design for neural networks: The neural network accelerators were proposed to achieve high energy efficiency while supporting the scalable structure, which can compute a neural network algorithm in multiple processors. In addition, processing-in-memory hardware architecture was designed to achieve high energy efficiency.



■ Recommended courses & Career after graduation

'Digital system design', 'Digital signal processing', 'Signals and systems', 'Introduction to computer architecture', and 'Electronic circuits' are recommended as prerequisite courses. Most graduates are employed as professors or as researchers in major companies such as Samsung Electronics, SK Hynix, Google, Meta (Facebook), and Apple or national research centers such as ETRI and ADD.

■ Introduction to other activities besides research

Our laboratory members enjoy out-of-study activities. We usually go out for dinner. We sometimes go out for drinks.

■ Introduction to the Lab.

ICSL provides one personal PC (Intel Core i7, 32GB RAM), two FULL HD monitors, 512GB SSD, and 1TB HDD per person, and servers for simulations and EDA tools. We have one project and one research meetings every week, which provide proper guidance for works and researches. Our research topics focus on everything related to VLSI architectures including communications systems, storage systems, neural networks and error-correction codes.

■ Recent research achievements (2023-2024)

[1] Jeongmin Kim et al, "Hardware-Efficient SoftMax Architecture With Bit-wise Exponentiation and Reciprocal Calculation", IEEE Transactions on Circuits and Systems-I: Regular Papers, Aug. 2024

[2] Kangjoon Choi et al, "Hardware-Friendly Approximation for Swish Activation and Its Implementation", IEEE Transactions on Circuits and Systems II: Express Briefs, Apr. 2024

[3] Boseon Jang et al, "Area-Efficient QC-LDPC Decoding Architecture With Thermometer Code-Based Sorting and Relative Quasi-Cyclic Shifting", IEEE Transactions on Circuits and Systems-I: Regular Papers, vol.71, no.6, pp2897-2910, Apr.2024

[4] Suchang Kim et al, "A CNN Inference Accelerator on FPGA With Compression and Layer-Chaining Techniques for Style Transfer Applications", IEEE Transactions on Circuits and Systems-I: Regular Papers, vol. 70, no. 4, pp. 1591-1604-982, Jan. 2023.

<Professor Hyuncheol Park's Lab.>

Laboratory for Information Transmission

■ Contact information

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Laboratory	**email: robco@kaist.ac.kr**	**Tel: 042-350-7520**
Website	**http://lit.kaist.ac.kr**	

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows: 1 PhD Students: 10 Master's Student: 3

■ Research Areas

In Laboratory for Information Transmission (LIT), we conduct researches on theoretical analysis and practical design of transmission technologies in modern wireless communication systems. Especially, extensive researches on performance analysis and development of 5G and beyond 5G mobile communication technologies are performed. LIT has been selected as the Research Laboratory of Beyond 5G (B5G) mobile communication supported by the Ministry of Science and ICT, and Samsung Network Innovation Center. Detailed research topics are listed below.

- Massive MIMO

Massive multiple input multiple output (MIMO) is a technology that increases the transmission speed and reliability of wireless communication by using several tens or hundreds antennas in base stations. Our research topics are power-efficient and intelligent transmission/reception schemes of massive MIMO system.

- Machine learning based wireless communication

Adopting unsupervised machine learning and deep reinforcement learning in wireless communication systems, we are solving problems that are not easy with conventional methods, or improving the performance.

- Integrated sensing and communication (ISAC) system

- Beamforming scheme at mmWave and terahertz bands

- Meta/transfer learning for NAND flash memory system

– Multimodal learning for sensing and channel estimation

Currently, ongoing research projects include "Development on The Disruptive Technologies for Beyond 5G Mobile Communications Employing New Resources", "Massive MIMO Systems with Multi-numerology", "Machine Learning-based NAND Flash Memory Management Scheme", "Development of Intelligent THz beamforming technology realizing 6G mobile communications", "Development of Key Technologies for the Integration of AI, Communication, and Sensing for Future Mobility Services", "6G·Cloud Research and Education Open Hub".

■ Recommended courses: Signal and systems, Probability and random processes, Communication engineering

■ Career after graduation: The LIT has produced 24 Ph.Ds and 41 Masters, and the alumni have been active in various fields in research institutes such as the Agency for Defense Development (ADD) and Electronics and Telecommunications Research Institute (ETRI), companies such as Samsung Electronics and LG Electronics, schools, and government agencies.

■ Introduction to other activities besides research

The LIT has two workshops in winter and summer every year, celebrates the birthdays of individual students and makes friendships among professor and students. The lab. members interact with alumni every year through homecoming day, and the alumni share their experiences in various cases such as careers and researches.

■ Introduction to the Lab.

The LIT has a vision becoming world class communication laboratory. We aim to establish basic research and development of core technologies in information theory, signal processing and communication, and to perform researches for advanced theoretical topics as well as practical issues. By doing so, we obtain creative and practical skills necessary for the development of communications, and become high-quality engineer who will play a key role in the field of communications industry and academia.

LIT members are helping to unleash their passion and abilities by creating a comfortable and enjoyable research environment.

■ Recent research achievements (2022-2024)

Publications: **13 International Journals, 6 International Conferences**

Awards: Awards: The 28th SAMSUNG Human Tech Paper Award (1 Bronze prize and 1 Encouragement prize), outstanding researcher in the 2022 Ph.D. program of KAIST EE, 2023 Hyung-Gyu Lim LINKGENESIS Best-Teacher Award Grand Prize.

⟨Professor Joonwoo Bae⟩

QIT@KAIST

Quantum Information Theory Lab

■ Contact information		
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Website	https://sites.google.com/view/qitkaist/home	

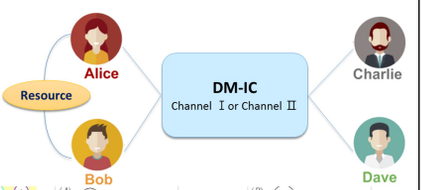
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 6 PhD Students: 10 Master's Student: 5

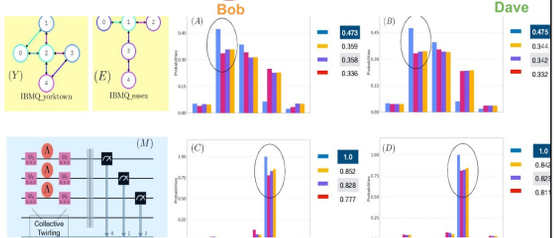
■ **Research Areas : Quantum Information Theory - Fundamentals to Applications**

We're working on fundamental problems in quantum information theory to understand the information processing in the most fundamental level and to break the limits in today's technologies

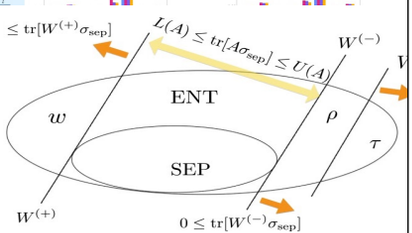
- Quantum protocols : Quantum protocols can realize the information-theoretic security, enhance channel capacities, and open monogamous correlations in a network theory. Quantum protocols are based on resources, entanglement, quantum steering, and non-local probabilities.



- Quantum Computing (Algorithms and Hardware Interface):
Quantum dynamics is special in that it is restricted to linear and invertible transformations, allowing exponential increase of the dimension. This defines non-standard computation based on the laws of quantum mechanics and solve hard problems appearing in cryptographic applications. We develop quantum algorithms that are better fitted with current quantum technologies, and also devote our efforts to deal quantum noise.



- Entanglement Theory : Entanglement is a resource in quantum information processing. We are interested in the verification of entangled states, their structure, and the usefulness. We apply various mathematical tools to characterize and prove entanglement properties.



■ **Recommended courses & Career after graduation**

Courses: Basics of quantum information and quantum computing. [Spring: EE480,EE488 / Fall: EE547,QU513,EE807]

All careers related with quantum ICT are open for future positions, academic jobs, business, and related companies.

■ **Introduction to other activities besides research**

The group is international. There are postdoctoral researchers from abroad, and frequent visitors from Europe, Asia, and the US. We enjoy going out to eat. We will discover nice restaurants nearby.

■ **Introduction to the Lab.**

Quantum Information Theory (QIT) studies how information is processed in the most fundamental level and characterizes capabilities of quantum systems in information processing. The group aims to advance QIT in a practical point of view. We're interested in feasible quantum information applications, developing its fundamentals, and theoretical tools to solve problems. We interact with computer scientists, mathematicians, and physicists.

■ **Recent research achievements (2022-2024)**

[1] Feature Map for Quantum Data in Classification, Hyeokjea Kwon, Hojun Lee and Joonwoo Bae, 2024 International Conference on Quantum Communications, Networking, and Computing (QCNC), pp. 41-48 (2024)

[2] Detecting Entanglement-Generating Circuits in Cloud-Based Quantum Computing, Jiheon Seong and Joonwoo Bae, spj Intelligent Computing 2 0051 (2023)

[3] Entanglement witness measurement of time-bin two-qubit states using fiber based Franson interferometers, Hwang K, Seong J, Park K, Kim J, Pramanik T, Bae J and Shin H, Frontiers in Physics 11 1254044 (2023)

[4] Contextual advantages and Certification for Maximum Confidence Discrimination, K. Flatt, et. al., PRX Quantum 3 030307 (2022).

[5] Quantum vs. Noncontextual Semi-Device-Independent Randomness Certification, C. Roch i Carceller et. al., Physical Review Letters 129 050501 (2022).

[6] Measurement crosstalk errors in cloud-based quantum computing, Seungchan Seo and Joonwoo Bae, IEEE Internet Computing Vol 26 Issue 1 page 26-33 (2022).

<Professor Hyeon-min Bae's Lab.>

NAIS Nanoscale Advanced Integrated Systems LAB

■ **Contact information**

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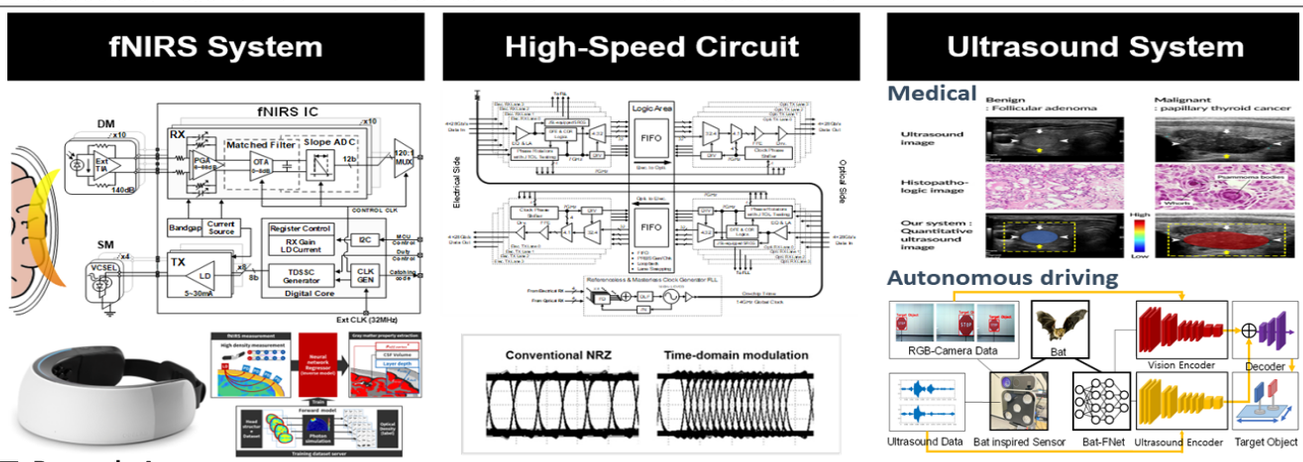
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 9 Master's Student: 8



■ **Research Areas**

At NAIS lab, we engage in a wide range of research regarding various application fields based on high-speed communication integration circuit technology. As the research topics take system-wide approach, students will be able to experience and accumulate broad spectrum of knowledge during the process of completing the research. The objective of all research performed at NAIS lab is to implement and commercialize innovative systems through disruptive technology. NAIS lab encourages students to experience venture ecosystem by getting involved in establishing ventures based on the research performed during the graduate school years. OBELAB and Poin2Tech are start-ups that were established, based on the research conducted during the graduate school years at NAIS lab. Alumnis are strongly involved in those companies.

■ **Recommended courses & Career after graduation**

One of the most important virtue at NAIS lab is 'craftsmanship'. For this, NAIS lab focuses on research and development involving communication circuits, and it is recommended that students take courses in circuit, digital, and communication-related subjects. Graduates of NAIS lab pursue careers both in industry and academia. They seek to enhance the degree of completion of their own research at NAIS lab.

■ **Introduction to other activities besides research**

We like to explore famous restaurants around Daejeon. Lab members are also active in physical activities.

■ **Introduction to the Lab.**

NAIS lab was established in 2009. It is constantly challenging and pursuing progress in many areas of research. The doctorate and the masters degree students are working in a friendly atmosphere. Students enjoy athletic activities and other hobbies. The lively atmosphere of the lab makes it possible for the students to devote themselves to research and to enjoy school life.

■ **Recent research achievements ('22~'24)**

[1] WooHyun Kwon, Hyosup Won, Taeho Kim, Sejun Jeon, Soon-Won Kwon, Hail Song, Hanho Choi, Bong-Jin Kim, Huxian Jin, Jun-Gi Jo, Woosang Han, Gain Kim, Jinho Park, Hyeon-Min Bae, "A 26-Gb/s Framed-Pulsewidth Modulation Transceiver for Extended Reach Optical Links", IEEE Journal of Solid-State Circuits (JSSC), Feb. 2024.

[2] Youngmin Kim, Myeong-Gee Kim, Seok-Hwan Oh, Guil Jung, Hyeon-Jik Lee, Sang-Yun Kim, Hyuk-Sool Kwon, Sang-Il Choi, Hyeon-Min Bae, "Quantitative Assessment of Thyroid Nodules through Ultrasound Imaging Analysis", International Conference on Medical Image Computing & Computer Assisted Intervention (MICCAI), Oct. 2024. - (early accept, top 11%)

[3] Bumjun Koh, Sangseong Kim, Byungju Park, SeongKwon Yu, Liang Yuqing, Jimin Lee, Hyeon-Min Bae, "Classifying the Prefrontal Cortex Reasoning Process Using CLEVR Cognitive Tasks", fNIRS 2024, Oct. 2024.

<Professor Jaeil Baek's Lab.>

KAIST IP(Integrated Power) Lab

■ **Contact information**

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Lab. : E3-2 5226

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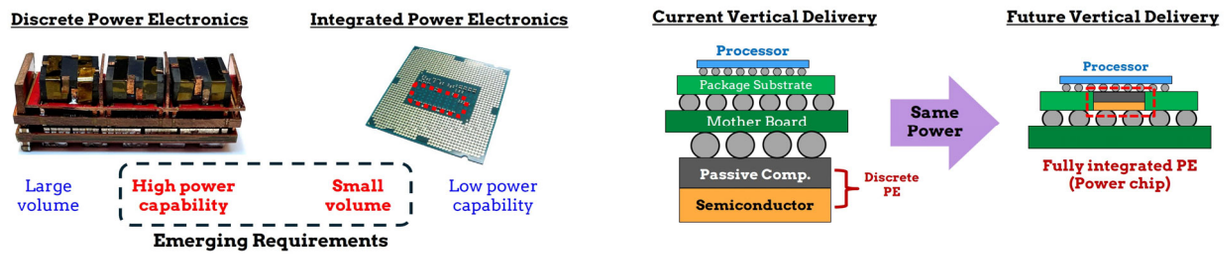
■ **Current state of the Lab. (in 2024 Fall Semester)**

New Faculty Member as of October 2024.

■ **Research Areas: High Performance Integrated Power Electronics**



Our research group is focused on innovations for high performance integrated power electronics. Traditional discrete power electronics can provide high power capability but limited by its large volume. On the other hand, PMIC and integrated power electronics are very small but limited by its low power capability. The main research area of our group is about how to develop smarter, greener, smaller, and higher-power integrated power electronics (or power chips) for emerging and future applications. The following are some of the key research areas we are primarily interested in:

☐ **Building Block**

- ✓ Circuit element: Magnetics
- ✓ Function blocks: Circuit & Control

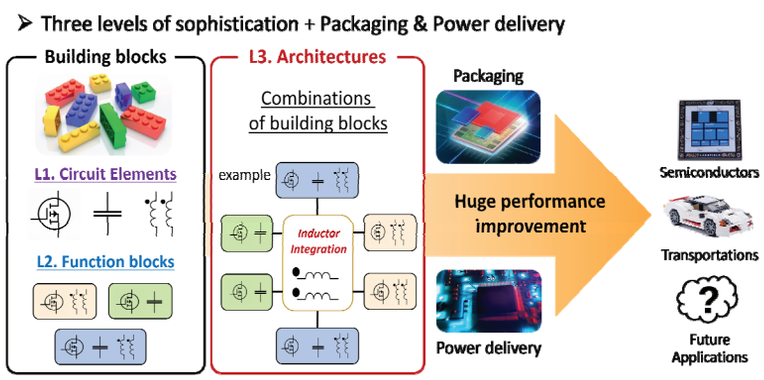
☐ **Architecture**

- ✓ Innovative combinations of building blocks

☐ **Packaging & Power Delivery**

☐ **Emerging & Future Applications**

- ✓ AI Semiconductors, Robot, Transportation, etc.



■ **Recommended courses & Career after graduation**

- **Recommended Courses**

Circuit theory, Electronics circuits, Power electronics

- **Career after graduation**

Academia, Industry, National lab

■ **Introduction to other activities besides research**

KAIST IP Lab is now open. There will be many exciting activities we can enjoy together. Let's make a lab culture together!

■ **Introduction to the Lab.**

We are looking for self-motivated students! Are you interested in power and energy crisis we are facing these days? Would you like to do lab activities more than just computer simulation? We are waiting for you!

■ **Recent research achievements ('22~'24)**

[1] Vertical Stacked LEGO-PoL CPU Voltage Regulator, **IEEE TPEL 2022 (First Prize Paper)**.

[2] MIPS: Multiphase Integrated Planar Symmetric Coupled Inductor for Ultrathin VRM, **IEEE TPEL 2023**.

[3] CoaxMIL 2.0 – Next Generation Coaxial Magnetic Integrated Inductors for Higher Efficiency Fully Integrated Voltage Regulator, **IEEE ECTC 2024**.

<Professor Youngchul Sung's Lab.>

SISReL
Smart Information Systems Research Lab

■ **Contact information**

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Lab. : ms.cho@kaist.ac.kr TEL : **042-350-5484**

Website : **https://sisrel.kaist.ac.kr**

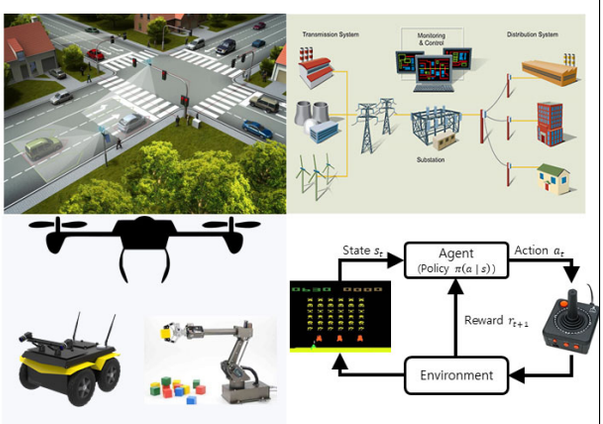
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 9 Master's Student: 4

■ **Research Areas**

▷ **Reinforcement Learning**

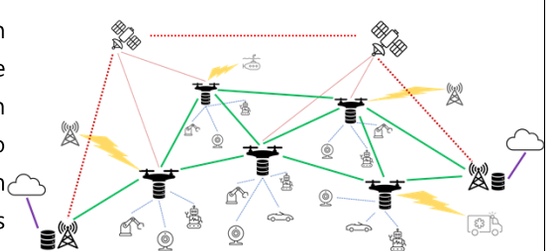
Statistical inference and machine learning are basic tools for making decision or prediction based on incomplete data. This field has been an important branch in systems area and has gained a recent interest in the era of big data and artificial intelligence. In this field, SISReL is investigating new possibilities and invention of efficient inference and machine learning algorithms based on sparsity, information geometry, statistical methods, and optimization tools. Currently, SISReL is focusing on reinforcement learning, which will be a major tool for AI robots, smart cities and autonomous vehicle, from various research perspectives such as



- multi-agent reinforcement learning / partially-observable Markov decision processes (POMDP)
- enhancing exploration / intrinsic reward design for sparse-reward reinforcement learning
- meta and multi-task reinforcement learning / domain adaptation / imitation learning / parellel learning

▷ **6G, Internet-of-Things, and Smart Machine Intelligence Systems:**

In this area, SISReL is conducting research on 6G and its fusion with internet-of-things and smart machine intelligence systems like connected vehicle from the perspective of real applications with extensive real world experience of the advisor. We are trying to come up with new algorithms, multi-access methods or system architectures with significant performance improvement for wireless communication networks.



■ **Recommended courses & Career after graduation**

We recommend interested students to take basic courses in mathematics such as *Analysis*, *Linear Algebra*, *Optimization Techniques,* and *Probability and Statistics*; and *machine learning related courses* such as Big Data and Reinforcement Learning. SISReL graduates are playing active roles in research and development activities as professors in academia, as researchers in national research institutes such as ETRI, ADD, NSRI, or as researchers in industry.

■ **Introduction to the Lab.**

The Smart Information Systems Research Lab. (SISReL) is a part of the School of Electrical Engineering and Graduate School of AI at KAIST, and headed by Professor Youngchul Sung. The research of SISReL focuses on signal processing, statistical inference, machine learning, reinforcement learning, and communication, with applications to internet-of-things, smart machine intelligence systems, and next generation communication systems.

■ **Introduction to other activities besides research**

We have a lab seminar to learn various basic theories every week. In addition, we exercise together for harmony and health.

■ **Recent research achievements ('22~'24)**

▷ Published ***14 papers/7 workshop papers*** in the ***top AI/ML conferences*** (NeurIPS, ICML, ICLR, AAAI, AAMAS)

▷ Published ***4 papers*** in SCI journals

<Professor Youngik Sohn's Lab.>

Quantum Device Lab

■ **Contact information**
Professor : Youngik Sohn (youngik.sohn@kaist.ac.kr)
Website : https://qdlab.kaist.ac.kr/

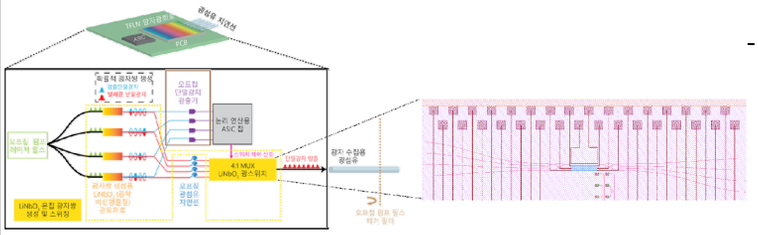
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 4 Master's Student: 8

■ **Research Areas**

- Application of Feed-forward: Deterministic Single photon source

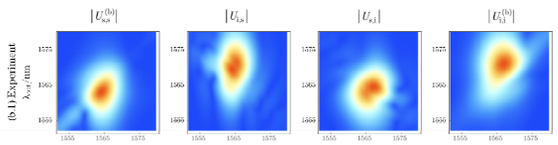
In Linear Optical Quantum Computing (LOQC), single photon sources are typically realized using pair-generation techniques such as SPDC or SFWM. These techniques rely on inherently probabilistic nonlinear optical processes. It's worth noting that the generation of the signal photon and idler photon is consistently pairwise, implying that the presence of a signal photon can be heralded through the detection of its corresponding idler photon.
However, the inherent probability of achieving pair-generation is fundamentally limited, with an upper bound of 1/4. As a consequence, feedforward-controlled multiplexing, which breaks upper bound of generation rate, becomes an essential component in these systems.
Multiplexor is basically an optical switch controlled with RF input. The probability of generation of multiplexed photon source is $P_0 = 1-(1-P_{pair})^n$. In the case of $P_{pair} = 1/4$ and n =16, total output probability $P_o \approx 0.99$.



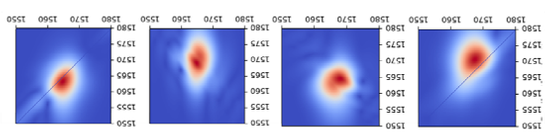
- *Multiplexing implementation : GMZI*
The multiplexing functionality was realized using the Generalized Mach-Zehnder Interferometer (GMZI). For a multiplexer with n inputs, only n active components of the GMZI are required for effective implementation.

- Nonlinear Quantum Photonics simulation

Producing a single photon source necessitates the utilization of photon pair generation through the parametric process, a manifestation of nonlinear quantum mechanics. For these process to be effective in diverse applications—such as quantum computing, quantum frequency conversion (QFC), and quantum communications—precise engineering of the photon pair generation process is imperative. A fundamental step in this engineering process is simulating the photon pair generation.



(Triginer et al. "Understanding High-Gain Twin-Beam Sources Using Cascaded Stimulated Emission", Phys. Rev. X (2020))



(Kim et al. "Simulation of integrated nonlinear quantum optics: from nonlinear interferometer to temporal walk-off compensator", in arXiv (2024))

We've developed a Python-based simulator capable of analyzing the nonlinear quantum processes involved in photon generation. It can model changes in laser spectrum, energy, waveguide geometry, and poling domain configurations. Unlike traditional methods relying on perturbation approximations, our tool offers exact solutions across both low and high pump gain regimes. The simulator's accuracy has been validated against actual experimental results.

■ **Recommended courses & Career after graduation**

- Electromagnetics, Quantum Optics, Quantum Computing, Optical Electronics, Nano-photonics
- You`ll earn various knowledge from theory to experiment in Quantum field. Based on your will, Youngik will support everything for you to get publications and become a leading researcher in this field from industry to academia.

■ **Introduction to other activities besides research**

Beyond research, we enjoy various outside-lab activities such as hiking and picnic, sometimes we do spots together like table tennis and badminton

■ **Introduction to the Lab.**

We are hiring students interested in exploring the world of quantum! Please contact Prof.Sohn to learn anything about quantum computing research. All inquiries are welcome.

■ **Recent research achievements ('22~'24)**

- Simulation of integrated nonlinear quantum optics: from nonlinear interferometer to temporal walk-off compensator(Seonghun Kim, Youngbin Kim et al, in arXiv)
- High-gain photon pair generation in a microring resonator with time-dependent non-perturbative effects (Youngbin Kim et al, in arXiv)

〈Professor Mincheol Shin's Lab.〉

Computational Nanoelectronics Laboratory
http://cnl.kaist.ac.kr

■ Contact information

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Website	http://cnl.kaist.ac.kr	

■ Current state of the Lab. (in 2024 Fall Semester)

PhD Students: 2 Master's Student: 4

■ Research Areas

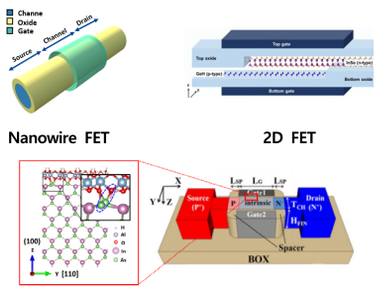
As the feature size of conventional planar metal-oxide-semiconductor field-effect transistors (FETs) shrinks into the nanometer regime, novel devices such as nanowire and tunnel FET have emerged as the next generation devices. The classical or semi-classical approach is no longer valid for the nano-sized devices so quantum-mechanical, atom-level treatment is required.

In our laboratory, we have been developing **simulators for advanced nano scaled logic devices** based on the quantum mechanical principles. Si-based as well as non-Si devices such as 2D materials and III-V compounds are being considered. To treat the devices in the atomistic level, density functional theory and the non-equilibrium Green's function method are employed to calculate the quantum charge transport.

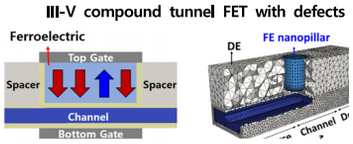
We have also studied **the next generation memory devices**, such as ferroelectric FET (FeFET) and magnetic random access memory (MRAM). For **FeFET**, we use in-house Phase-field-based simulator.

For an optimization of nanoscale devices, we have developed **machine learning(ML)-based device optimization framework** where TCAD simulator and Bayesian optimization algorithm are combined.

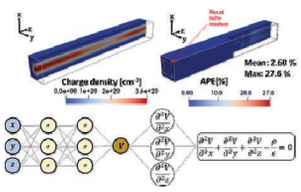
We are currently developing advanced transport models through **physics-informed neural networks** and more. Through this approach, we aim to construct advanced transport models and explore solutions to complex real-world problems by enhancing predictions and modeling.



III-V compound tunnel FET with defects



Fe-FET



ML-based device simulation/optimization

■ Recommended courses & Career after graduation

Prospective students should have good background knowledge on semiconductor physics and devices. Basic/advanced courses on the quantum mechanics, solid-state physics, and C language are also recommended to take. After graduation, they may continue their research career in universities or research institutes or work in semiconductor companies in Korea and overseas.

■ Introduction to other activities besides research

It is strongly encouraged that students set aside time for regular physical exercises. Besides research, it is emphasized that students acquire ability to develop and express their idea, thinking, opinions through reading, writing and presentation (scientific or non-scientific).

■ Introduction to the Lab.

Computational science/engineering is a new, a third way of doing research, besides the traditional way of doing research which is theory or experiment. Remarkable progress in the computer power and increasing needs for computation has led to the era of computational science/engineering. To meet the needs of the times, CNL provides its members with environments and experiences, which help them become the experts in semiconductor device physics and computational electronics. At the time of graduation, they are expected to be capable of handling all the semiconductor-device related issues that become more and more complex and ready to work both in industry and academia.

■ Recent research achievements (2021-2024)

[1] "A Novel Neural-Network Device Modeling based on Physics-informed Machine Learning", Bokyeom Kim and Mincheol Shin, IEEE Transactions on Electron Devices, vol. 70, no.11, 6021 - 6025, Nov. 2023.

[2] "Ferroelectric nanopillar field-effect transistors: Quantum transport simulations based on a three-dimensional phase-field", Hyeongu Lee, Yoon-suk Kim, and Mincheol Shin, Physical Review Applied, vol. 19, p. 054061, May. 2023

[3] "Efficient device simulations using density functional theory Hamiltonian and non-equilibrium Green's function: heterostructure mode space method and core charge approximation," Seonghyeok Jeon and Mincheol Shin, Journal of Computational Electronics, May 2023.

[4] "First-Principles-based Quantum Transport Simulations of Interfacial Point Defect Effects on InAs Nanowire Tunnel Field-Effect Transistors", H. Lee, et al., IEEE Transctions on Electron Devices, vol. 68, no. 11, pp. 5901 - 5907, Nov. 2021.

<Professor Seungwon shin's Lab.>

NS² Network and System Security Laboratory

■ **Contact information**

Professor : Seungwon shin TEL : 010-3259-5995

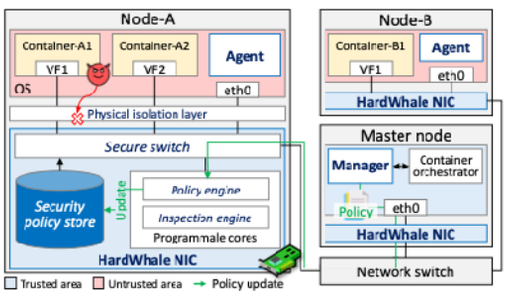
Lab. : Network and System Security Lab

Website : www.nss.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 13 Master's Student: 4

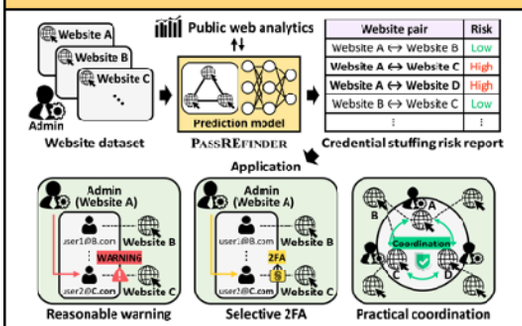
Enhancing the security of container-based cloud environments



[IEEE ICDCS 24] HardWhale

- **Goal**
  - Analyze all potential security threats in cloud environments
  - Devise robust yet performant security systems for enhancing the security of cloud environments
- **Approach**
  - Leverage a hardware-based robust and high-performance data plane to improve the performance and security of container networking architecture
  - Restrict the system access of individual containers based on optimized security policies created through environment and workload-aware analysis
  - Secure serverless functions using a hardware enclave equipped with fast function startup mechanisms

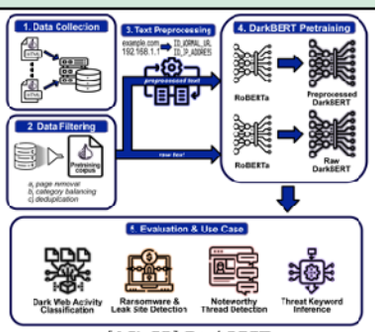
Applying data-driven approaches to cyber security domains



[IEEE S&P 24] PassREfinder

- **Goal**
  - Understand current and emerging attack trends
  - Devise security systems to detect cyber attacks
- **Approach**
  - Collect and analyze massive information on threats on the Web, aiming to discover threat intelligence
  - Design a graph-based system to capture complex relationships between users
  - Deploy AI frameworks build upon real-world data to preemptively evaluate the risks of cyber threats

Large language model security



[ACL 23] DarkBERT

- **Goal**
  - Apply LLMs to domains of interest related to security
  - Enhance data privacy when using individual user data for model pretraining
- **Approach**
  - Pretrain a transformer encoder-based language model using text from the Dark Web domain related to underground cybercriminal activities
  - Apply LLMs in a federated learning setting with modifications to the mixture-of-experts module to fit in a federated learning setting
  - Utilize LLMs to learn drug contexts through delexicalized distant supervision, aiming to identify illicit drug jargon in social media

■ **Recommended courses & Career after graduation**

Computer network, Operating system, System programming, and Machin learning

■ **Introduction to other activities besides research**

Yearly membership workshop Futsal club, and Monthly membership day

■ **Selected recent research achievements**

[NDSS 25] Tweezers: A Framework for Security Event Detection via Event Attribution-centric Tweet Embedding
[IEEE ICDCS 24] HardWhale: A Hardware-isolated Network Security Enforcement System for Cloud Environments
[NDSS 24] DRAINCLoG: Detecting Rouge Accounts with Illegally-obtained NFTs using Classifiers Learned on Graphs
[IEEE S&P 24] PassREfinder: Credential Stuffing Risk Prediction by Representing Password Reuse between Websites on a Graph
[IMC 23] Evolving Bots: The New Generation of Comment Bots and their Underlying Scam Campaigns in YouTube
[ACL 23] DarkBERT: A Language Model for the Dark Side of the Internet
[DAC 23] AVX Timing Side-Channel Attacks against Address Space Layout Randomization
[NDSS 23] Partitioning Ethereum without Eclipsing It

DT LAB

Semiconductor Design Technology

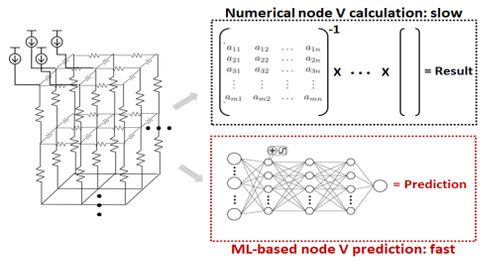
■ Contact information

Professor	**Email:** youngsoo@kaist.edu	**Tel:** 042-350-3479
Lab.	**Email:** sg.lee@kaist.ac.kr	**Tel:** 042-350-5479
Website	http://dtlab.kaist.ac.kr	

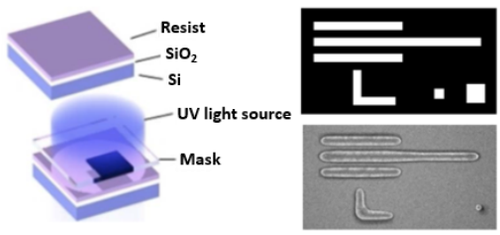
■ Current state of the Lab. (in 2024 Fall Semester)

Ph.D. Students: 5 Master's Student: 6

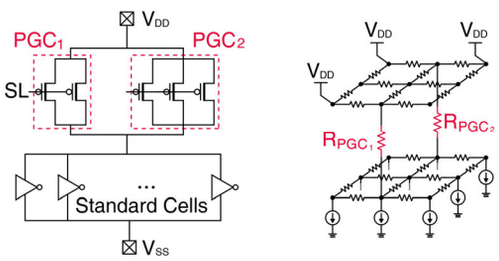
■ Research Areas



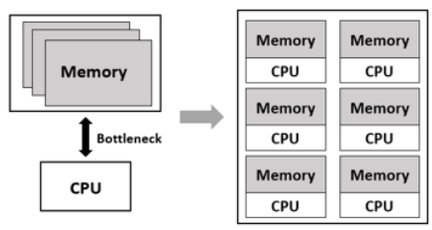
• **AI-EDA** Address challenges in electronic design automation (EDA) by using machine learning



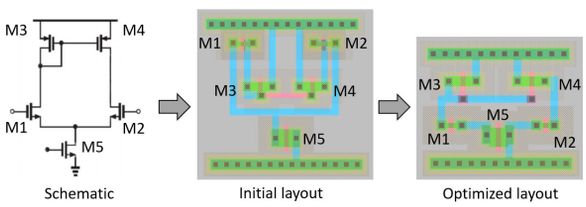
• **Computational Lithography** Correct and verify mask to prevent distorted patterning by diffraction on wafer



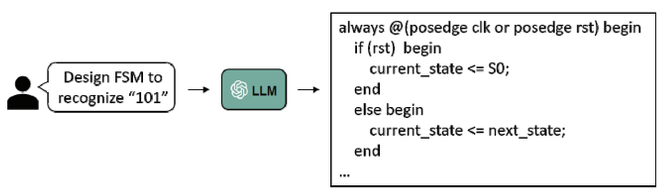
• **Low Power Design** Reduce leakage power by adding power gating cell (PGC) to cut off supply voltage



• **Processing-In Memory** Perform CPU operation in memory to reduce bottleneck between CPU and memory



• **Analog Layout Automation** Generate initial layout from schematic and optimize it while satisfying multiple specs



• **LLM-Aided EDA** Automate chip design using large language model (LLM) (e.g. verilog code generation, layout optimization)

■ Career after graduation

IBM, NVIDIA, Samsung Electronics, SK Hynix, LX Semicon, and EDA companies (Synopsys, Cadence, Siemens)

■ Recent research achievements (2018-2024)

- Ph.D. Outstanding Dissertation Award in 2023, 2016, 2012
- Best paper award (including nominate): ISOCC'24, TSM'22, TSM'21, ASP-DAC'20, GLSVLSI'20
- Prof. Shin has been elected as IEEE Fellow and KAIST ICT Endowed Chair
- Prof. Shin has won the science technology researcher of the month award (이달의 과학기술인상)

<Professor Hyunchul Shim's Lab.>

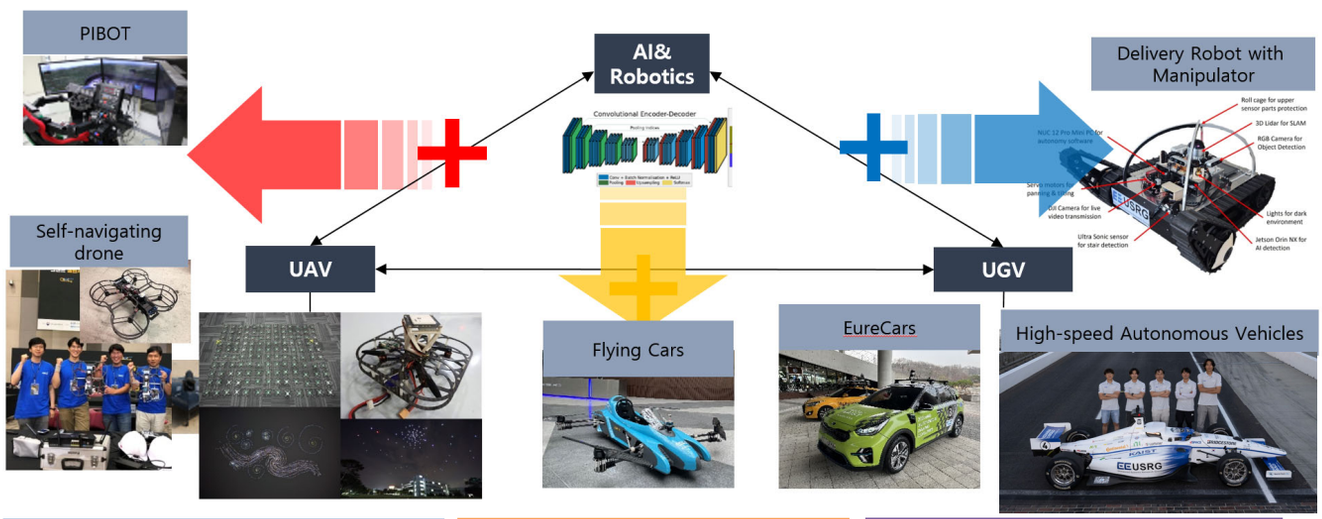
EE USRG
Unmanned Systems Research Group

■ **Contact information**
Professor : Hyunchul Shim TEL : 042-350-7445
Lab. : N1 #314
Website : http://unmanned.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 11 Master's Student: 11

■ **Research Areas**



UAVs	Fusion of Techs	Ground Vehicles
In-house fight controller Indoor SLAM using LiDAR Deep-learning bassed V-SLAM Anti-drone Tech Deep learning enabled Drones Korea RPAS Research Center	LLM-enabled pilot robot Logistics using drones and self-driving cars Multi-modal Vehicles Fully autonomous flying car Collaborative Drones and UGVs	VLM enabled UGVs In-house autonomous driving tech Fully Autonomous Racing Car based on Indy Car(~300km/h) Autonomous Four legged robots

■ **Introduction to the Lab.**

Our lab is committed to excellence in intelligent aerial and ground robotics research by combining the latest advances in robotics and artificial intelligence. We are dedicated to developing robots that operate in the real world. Our lab has worked on various research projects, including the development of autonomous indoor drones, self-driving cars, logistics robots, and, most recently, a humanoid robot capable of piloting general aviation airplanes simply by "°reading the manuals" using LLM technologies.

Our lab is well-funded and equipped, providing students with various opportunities to pursue AI and robotics research in real-world applications. We have 3 autonomous cars (including one Indy race car), 2 full-size aircraft, 3 ground station trucks, 1 DGX station, Optitrack, 200+ drones, and much more. Our alumni works at top Korean companies and Institutes such as Samsung, LG, Hyundai Motor Company, Naver, ETRI, KARI, ADD, and more.

■ **Recent research achievements ('22~'24)**

- 1st Place, Korean Army Dronebot Challenge (Sep. 20p24)
- Semifinalist and Most Improved Award, Indy Autonomous Challenge (USD50,000, Sep. 2024)
- KAIST Top 14 Research Areas: Defense Technology (Pilot Robot), 2024
- 2nd Place, MBZIRC Maritime Challenge, UAE (Feb 2024)
- Outstanding Paper Award, Korea Robotics Society Conference (KROC), Feb 2024
- 2nd Place, Hyundai Motor Autonomous Vehicle Competition (Oct 2023)
- 1st Place, Army Dronebot Challenge (2022)
- KAIST International Collaboration Award, Prof. Shim (Feb. 2022)

<Professor Heejin Ahn's Lab.>

Control and Intelligent Systems Laboratory

■ Contact information

Professor : Heejin Ahn TEL : 042-240-7471

Lab. : E3-2 3235 TEL : 042-350-7571

Website : https://cis.kaist.ac.kr/

■ Current state of the Lab. (in 2024 Fall Semester)

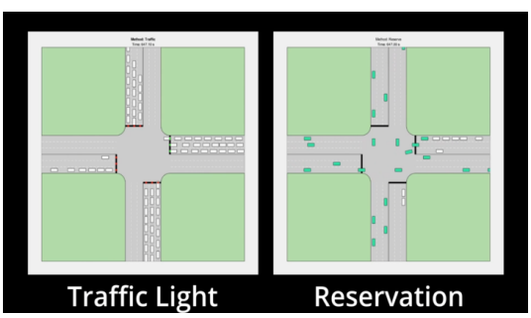
Postdoctoral Fellows : 1 PhD Students: 1 Master's Student: 10

■ Research Areas

1. **Motion/Behavior Planning**

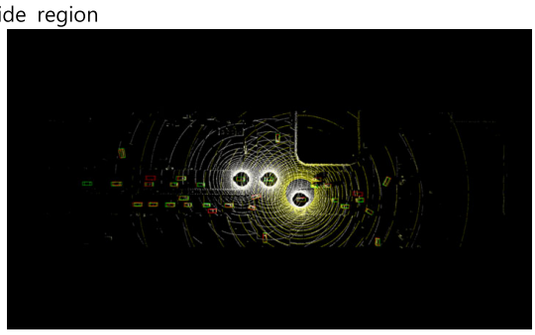
-We develop methods for safe and efficient multi-agent motion planning, focusing on intelligent transportation systems, especially at intersections, using optimization and machine learning.

-Altruistic lane-level route planning: a route optimization considering both minimizing (1) vehicle travel time from origin to destination and (2) traffic flow disturbance



2. **Collaborative Perception**

-Fusion with connected vehicle and infrastructure to detect wide region

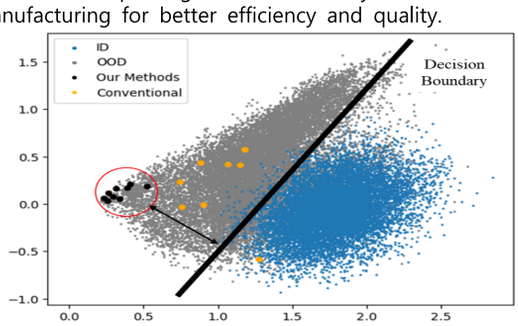


3. **Safe Control with Uncertain Perception**

-Trajectory planning ensures safe paths by accounting for uncertain movements of other agents. We use chance-constrained optimization with sampling-based or GMM methods to address uncertainty.

4. **Safe Control under Distribution shifts**

-This research develops techniques to enhance control system stability by quantifying uncertainties and detecting anomalies, improving DNN reliability in semiconductor manufacturing for better efficiency and quality.



5. **Smart City Project**

-Generating scaled-down components, such as a map, vehicles, and infrastructure, to validate various multi-agent techniques.

■ Recommended courses & Career after graduation

Recommended Courses : Linear Algebra, Differential equations, Optimization, Signal & Systems, Feedback Control, Machine Learning.

Career After Graduation : Academia, National Labs, Industries (e.g. Autonomous Vehicles)

■ Introduction to other activities besides research

Students are encouraged to participate in other activities, including national/international internships and exchange programs.

■ Introduction to the Lab.

Our lab focuses on advancing autonomous systems by developing innovative methods for safe motion planning and robust control under uncertainty. We optimize multi-agent behavior in intelligent transportation systems, enhance wide-area detection through collaborative perception, and ensure safe trajectories by accounting for uncertainties in agent movement.

We also contribute to smart city projects by validating multi-agent techniques within urban infrastructure models.

■ Recent research achievements ('22~'24)

1. Hyunchul Bae, Minhee Kang, Minwoo Song, and Heejin Ahn, "Rethinking the Role of Infrastructure in Collaborative Perception," European Conference on Computer Vision Workshop (ECCVW), 2024, To appear.
2. Y. Wang, E. Hansen, and H. Ahn, "Hierarchical planning for autonomous parking in dynamic environments," IEEE Transactions on Control Systems Technology, vol. 32, no. 4, pp. 1386-1398, July 2024.
3. Yoojin Choi, Minhee Kang, and Heejin Ahn, "Infrastructure-guided Optimal Spacing for Vehicles Approaching Intersections," In Proc. IEEE Intelligent Vehicles Symposium (IV), June 2024.
4. Beomjun Kim and Heejin Ahn, "Chance-Constrained Control with Imperfect Perception Modules," In Proc. American Control Conference (ACC), June 2023, pp. 2568-2573.
5. K. Ren, H. Ahn, and M. Kamgarpour, "Chance-constrained trajectory planning with multimodal environmental uncertainty," IEEE Control Systems Letters, vol. 7, pp. 13-18, June 2022. (Presented at IEEE Conference on Decision and Control)
6. Y. Ma, J. Guo, Y. Wang, A. Chakrabarty, H. Ahn, P. Orlik, and C. Lu, "Optimal dynamic transmission scheduling for wireless networked control systems," vol. 30, no. 6, IEEE Transactions on Control Systems Technology, Jan. 2022.

<Professor Kyounghoon Yang's Lab.>

High Speed Nano Electronics Laboratory

■ **Contact information**

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Lab. : E3-2, 1227 TEL : 042-350-5471

Website : http://hsnl.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 1 Master's Student: 0

■ **Research Areas**

● Quantum-effect High-speed Nanodevices/Integrated Circuits

A **resonant tunneling diode (RTD),** which is a semiconductor nonlinear diode with a double-barrier quantum-well structure for electrons to resonantly tunnel through, has been regarded as one of the most mature quantum-effect devices for practical low-power integrated circuit (IC) applications. The resonant tunneling diode (RTD) which is the fastest electronic device has inherent negative differential resistance (NDR), nonlinearity, and multifunctional/bistable characteristics, so it has been actively researched in signal sources, detectors, and mixed-signal circuits for various mmW and THz applications.

For upcoming THz applications and the development of THz monolithic integrated circuits (TMICs) using the RTD and high-speed **heterojunction bipolar transistor (HBT)** technologies, further optimization techniques based on the previously developed HBT technologies and their monolithic co-integration of RTDs with HBTs are highly required.

● Wide-bandgap High-power Semiconductor Devices

For power electronics application, the wide-bandgap semiconductors such as gallium nitride (GaN) and silicon carbide (SiC) have benefits of high breakdown voltage, lower on-resistance, and higher current. In particular, **GaN-based HEMTs are ideal for the next generation of high-frequency, high-power power electronics applications** because the GaN HEMTs generate a high concentration of two-dimensional electron gas (2-DEG) owing to the strong polarization difference and high conduction band offset at the interface and have on-resistance lower than SiC devices. Our current focus is on **enhancement-mode (E-mode) GaN HEMTs grown on Si substrate with Vds,max>150 V and Ids>25 A.** The enhanced GaN HEMT is safer and more energy efficient because the device is in the off state at zero bias.

● Nano-CMOS / III-V HEMT RF Device Modeling & mm-Wave IC Design

Mm-wave wireless T/R Front-end phased-array ICs have been developed at the frequencies ranging from 28GHz, 60GHz up to W-band (77GHz, 94GHz). With the increase of frequencies, it has been widely known that the resolution of beam-forming and the capacity for signal data rates are enhanced, which is a major research focus for the next-generation wireless system development. **The research on D-band (110-170GHz) RF-ICs** is in progress and **sub-THz bands (170-300GHz)** will be also pursued.

■ **Recommended courses**

► Basic Physical Electronics, Semiconductor Devices, Electronic Circuits, Microwave Engineering, etc.

■ **Career after graduation**

► Samsung Electronics/SK Hynix/ADD/ETRI/KIST/Academia

■ **Introduction to other activities besides research**

► Laboratory workshop & picnic / Casual group meetings with sandwich or coffee

■ **Introduction to the Lab.**

► HSNL is currently getting into the 2nd-phase of lab research activities, moving towards ***more integrated & converged co-research with other laboratories to develop mmW/THz Wireless Comm-Radar Core System IC/Modules*** from high-speed/high-frequency nano devices to full-scale IC/Systems based on enhanced mutual-lab collaboration, which will ***provide students with more in-depth & broader research opportunities from device to circuit & system levels.***

■ **Recent research achievements ('22~'24)**

[1] J.-H. Yoo, et al., "Single-power-supply compatible cryogenic $In_{0.8}Ga_{0.2}As$ quantum-well HEMTs with record combination of high-frequency and low-noise performance for quantum-computing applications," IEEE VLSI, 2024.

[2] W.-S. Park, et al., "Characterization of AlGaN/GaN HEMTs on 4-inch SiC substrate at Cryogenic temperature," CS MANTECH, 2024.

[3] I.-G. Lee, et al., "Improved thermal reliability in base contact of full 3-inch InP Double-HBTs with f_T and f_{max} in excess of 300 GHz," CS MANTECH, 2024.

[4] M, Park, et al., "200-mm Si CMOS Process-Compatible Integrated Passive Device Stack for Millimeter-Wave Monolithic 3-D Integration," IEEE TED, 2023.

[5] X, Yang et al., "Systematic characterization for RF small-signal parameter extraction of 28 nm FDSOI MOSFETs up to 110 GHz," Microelectronics Journal, 2023.

[6] K, Yang, "Status and Perspective of Resonant Tunneling Diode Technology for Future mm-Wave and Terahertz (THz) Electronics," CSW, 2023.

[7] X, Yang, et al., "RF characterization and small signal extraction of 28nm FDSOI MOSFETs up to 110GHz," IEEE APMC, 2022.

<Professor Youjip Won's Lab.>

OSLab
Operating Systems Laboratory

■ **Contact information**

Professor : ywon@kaist.ac.kr TEL : 042-350-7456
Lab. : TEL : 042-350-7613
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■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 8 Master's Student: 6

■ **Research Areas**

We hack.

1. Operating System Design

We overhaul the operating system kernel for performance and scalability under newly emerging hardware; manycore system, ultra-low-latency storage device and byte-addressable non-volatile memory. We redesign the memory management module, the filesystem, the block device layer and the storage device firmware for manycore and Ultra-low-latency storage device.

2. Bigdata system

We optimize the big-data storage engine such as MongoDB, Rocksdb and levelDB. The log-structured merge and graph DB lie at the core of the key-value management system. These data structures cannot well be used in large scale big data system due to its frequent storage interaction and flush overhead. Industry and academia altogether seek for a new solution to meet the demand from the big-data application.

3. Machine Learning System

The entire machine learning pipeline consists of data ingestion, data cleaning, data tagging, learning and inference. The current machine learning pipeline suffers from a fair amount of redundant data copies, the coarse grain CPU/graph scheduling, unnecessary synchronization among the heterogeneous GPU devices with widely different computing capability. As a system developer, we orchestrate the behaviors of the individual software components in the machine learning pipeline and eliminate all inefficiencies in the existing ML system.

■ **Recommended courses & Career after graduation**

- Recommended courses to join the group: C/C++, Data Structure and Algorithms, Operating Systems
- Career: Professor at academia, researcher at government funded research organization, system software developer at the software company such as Google, Facebook, at the smartphone manufacturers such as Samsung and LG, or at the semiconductor Industry such as Samsung and Intel

■ **Introduction to other activities besides research**

- Sports: The group members do lots of sporting activities together; including basket ball, swimming, running around campus, and going to the gym for workout a few times a week.
- Travel: Each student has the opportunity to attend international conferences a few times a year (USENIX FAST, USENIX ATC, EuroSys and etc.).
- Leisure: Once a month, the group members dine out and enjoy drinks together. We often visit an excellent beer pub near the KAIST campus to spend quality time.

■ **Introduction to the Lab.**

OSLab@KAIST is the world's leading research group at the forefront of operating system design for Flash storage and NVRAM. OSLab has been leading the IO stack optimization for the smartphone for several years. The techniques proposed by OSLab have been adopted by Google Android platform (Best Paper, USENIX ATC 2013). OSLab has also contributed numerous open-source tools that are widely utilized in Android research worldwide.

One of OSLab's significant achievements is their successful proposal of a new IO subsystem design for Flash storage, which provides separate support for ordering guarantees (Best Paper, USENIX FAST 2018). Separating the ordering guarantee from the durability guarantee has been a long-standing challenge in the systems research community for more than 50 years.

For passionate kernel developers and system hackers, OSLab offers an ideal environment to expand their limit and contribute to pioneering research.

■ **Recent research achievements ('20~'24)**

International journals: 0, International conferences: 13, Domestic journals: 1, Domestic conferences: 0

< Professor Kyoungsik Yu's Lab. >

<Integrated Nanophotonics Laboratory>

■ **Contact information**

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Lab.	**E3-3 #2302**	**Tel: 042-350-7515**
Website	**https://kaist-yu.notion.site**	

■ **Current state of the Lab. (in 2024 Fall Semester)**

PhD Students: 6 Integrated MS-PhD Student: 3 MS Students: 7

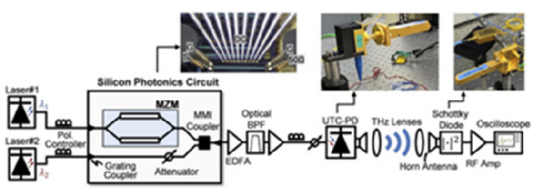
■ **Research Areas**

The Integrated Nanophotonics Laboratory is working on both fundamental aspects and practical applications of modern photonics / optoelectronics with special emphasis on integration techniques. Especially, we are interested in device-level integration of photonics / optoelectronics for 5G-optical data transmission, advanced information processing, display, smart sensor, and energy applications.

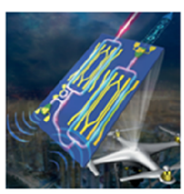
Integrated photonics

Silicon is the most well known material for electronics, but is also a promising optical medium at near-infrared wavelengths. By taking advantages of advanced fabrication and design techniques developed for electronic circuits, we can now design and build integrated photonic circuits that can complement and sometimes overcome the electronics in a number of cutting-edge applications, such as 'large-scale high-speed interconnects for chiplets', 'optical/wireless communication convergence for beyond 5G, photonic radar and terahertz era', 'high-precision time and frequency reference for quantum sensing', 'energy-efficient optical engines for large-scale information processing and quadratic optimization', and smart sensing – LiDAR (Light Detection And Ranging).

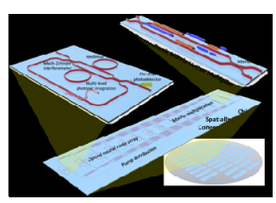
Integrated Photonic circuit



THZ Optical Data Transmission



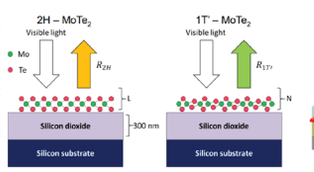
photonic Radar



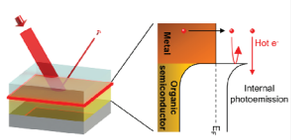
photonic Ising machine

Innovative photonic materials

In addition to conventional group IV semiconductors and III-V compound semiconductor materials, recent innovations in materials research have significantly broadened the scope of modern photonics / optoelectronics. Our group is interested in various emerging materials, such as 2D materials, hybrid materials, and metamaterials.



< 2D phase change material >



< Photodetectors >

■ **Recommended courses & Career after graduation**

We recommend wave- and device-related courses, such as electromagnetics, semiconductor physics, and optoelectronics. Our alumni members are currently working at universities (**Stanford, UC Berkeley, Toronto, Oxford**), national research institutes (**ETRI, ADD**), and industries (**Samsung, SK Hynix, and PsiQuantum**).

■ **Introduction to other activities besides research**

We have regular summer and winter retreats, and workshops with domestic & overseas conferences. We also regularly play soccer and badminton. These extracurricular activities are sometimes done with other laboratories with similar research interests.

■ **Introduction to the Lab.**

Our research group is generally interested in micro-/nano-photonics and optoelectronics, a highly interdisciplinary area with emerging applications in information processing and quantum technologies. Starting from micro-sized optical resonators to subwavelength-scale metamaterials, we cover a wide range of photonic/optoelectronic devices and systems.

■ **Recent research achievements (2024)**

[1] Rah, Yoonhyuk, et al. "Demonstration of spontaneous symmetry breaking in self-modulated ring resonators" Physical Review Research 6.1 **(2024)**

[2] Jin, Yeonghoon, et al. "Rigorous Determination of Dipole Orientation in Organic Thin Films Using Angle-Dependent Photoluminescence." The Journal of Physical Chemistry C 128.4 **(2024).**

[3] Younjae, Jeong et al. "Programmable photonic arrays based on microelectromechanical elements with femtowatt-level standby power consumption." Nature Photonics 17.12 **(2023).**

[4] Son, Gyeongho, et al. "Highly efficient broadband adiabatic mode transformation between single-mode fibers and silicon waveguides." Journal of Lightwave Technology **(2023).**

〈Professor Minsoo Rhu's Lab〉

Vertically Integrated Architecture (VIA) Research Group

■ Contact information

Professor : Bldg. N1, #809 TEL : 042-350-7547

Lab. : Bldg. N1, #818

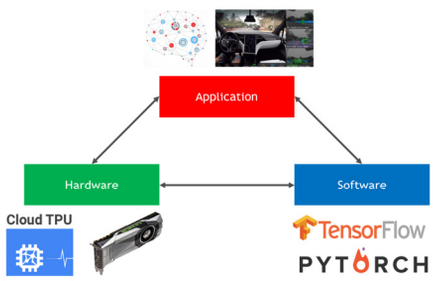
Website : https://sites.google.com/view/kaist-via

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 11 Master's Student: 7

■ Research Areas

Vertically Integrated Architecture (VIA) research group conducts research in the domain of computer architecture with a vertically integrated approach. By co-optimizing VLSI circuit technology, computer system architecture, and application & algorithms (with an emphasis on machine learning and computer vision), our research mission is to build high-performance computing platform for future "intelligent" systems that are programmable, robust, reliable, secure, and energy-efficient.



■ Recommended courses & Career after graduation

- Courses: computer architecture, data structures, system programming, digital logic design, compilers, operating systems, computer networks
- Careers: During your graduate studies, we strongly encourage you to take internships in the industry (preferably in bleeding-edge IT companies like Google, Facebook, NVIDIA, Samsung, Microsoft, and Intel) so that you get practical, hands-on experience within the electrical and computer engineering discipline.

■ Introduction to other activities besides research

Professor Rhu is a huge sports fan and encourages students to engage in extra-curricular activities as means to pursue a (mentally & physically) healthy graduate school life. We also encourage lab members to get together outside of the laboratory so that they maintain good social relationships with each other. There are frequent (un)official get-togethers and we plan on having regular team-building events during summer & winter breaks.

■ Introduction to the Lab.

Professor Minsoo Rhu has spent three years working at NVIDIA Research as a Senior Research Scientist. He worked in several domains within the computer system stack, including ASIC designs, computer system architecture, runtime systems, and application & workload characterization with an emphasis on machine learning (ML) and computer vision (CV). As such, our research mission is to train students to become computer system architects that understands *both* the hardware and software system, enabling you to optimize any target application (e.g., ML or CV) for the underlying computing stack. Our group is currently funded by several *research-oriented* projects, for instance, the ERC-AI (by National Research Foundation), Neural Processor Research Center (by Samsung Research), Samsung Future Research Funding and Incubation Center for Future Technology, and others.

■ Recent research achievements ('23~'24)

[1] Dongjae Lee, Bongjoon Hyun, Taehun Kim, and Minsoo Rhu, "PIM-MMU: A Memory Management Unit for Accelerating Data Transfers in Commercial PIM Systems," The 57th IEEE/ACM International Symposium on Microarchitecture (**MICRO-57**), Austin, TX, Nov. 2024

[2] Jehyeon Bang, Yujeong Choi, Myeongwoo Kim, Yongdeok Kim, and Minsoo Rhu, "vTrain: A Simulation Framework for Evaluating Cost-effective and Compute-optimal Large Language Model Training," The 57th IEEE/ACM International Symposium on Microarchitecture (**MICRO-57**), Austin, TX, Nov. 2024

[3] Yunjae Lee*, Hyeseong Kim*, and Minsoo Rhu, "PreSto: An In-Storage Data Preprocessing System for Training Recommendation Models," The 51st IEEE/ACM International Symposium on Computer Architecture (**ISCA-51**), Buenos Aires, Argentina, Jun. 2024

[4] Yujeong Choi, Jiin Kim, and Minsoo Rhu, "ElasticRec: A Microservice-based Model Serving Architecture Enabling Elastic Resource Scaling for Recommendation Models," The 51st IEEE/ACM International Symposium on Computer Architecture (**ISCA-51**), Buenos Aires, Argentina, Jun. 2024

[5] Juntaek Lim, Youngeun Kwon, Ranggi Hwang, Kiwan Maeng, Edward Suh, and Minsoo Rhu, "LazyDP: Co-Designing Algorithm-Software for Scalable Training of Differentially Private Recommendation Models," The 29th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (**ASPLOS-29**), San Diego, CA, Apr. 2024

[6] Bongjoon Hyun, Taehun Kim, Dongjae Lee, and Minsoo Rhu, "Pathfinding Future PIM Architectures by Demystifying a Commercial PIM Technology," The 30th IEEE International Symposium on High-Performance Computer Architecture (**HPCA-30**), Edinburgh, UK, Feb. 2024

[7] Ranggi Hwang*, Minhoo Kang*, Jiwon Lee, Dongyun Kam, Youngjoo Lee, and Minsoo Rhu, "GROW: A Row-Stationary Sparse-Dense GEMM Accelerator for Memory-Efficient Graph Convolutional Neural Networks," The 29th IEEE International Symposium on High-Performance Computer Architecture (**HPCA-29**), Montreal, Canada, Feb. 2023

<Professor Seunghyup Yoo's Lab.>

IOEL
Integrated Organic Electronics Lab

■ Contact information

Professor : syoo_ee@kaist.ac.kr TEL : 042-350-3483
Lab. : spark2473@kaist.ac.kr TEL : 042-350-5483
Website : https://www.ioel.kaist.ac.kr/

■ Current state of the Lab. (in 2024 Fall Semester)

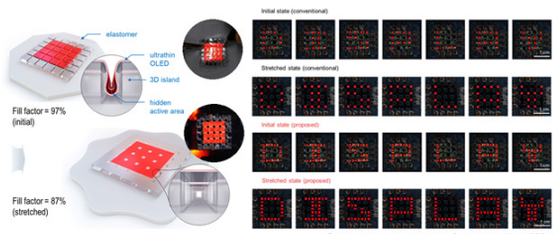
PhD Students: 11 Integrated MS/PhD Students: 2 Master's Student: 9

■ Research Areas

Organic Light-Emitting Diodes (OLED)

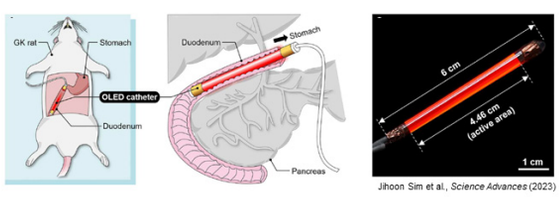
As future display panels and other applications, OLEDs are promising due to their advantages such as high color purity, applicability on versatile designs including flexible and transparent devices, and low power consumption.

- Highly efficient flexible and stretchable OLEDs



Donggyun Lee et al., *Nature Communications* (2024)

- OLEDs for phototherapy

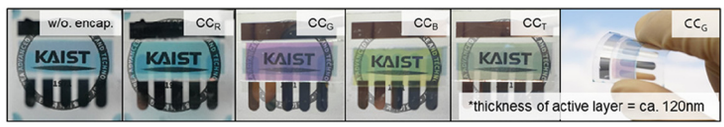


Jihoon Sim et al., *Science Advances* (2023)

Organic photovoltaics (OPV)

Significant advances are being made in the commercialization of solar cells for building-integrated and vehicle-integrated photovoltaics by developing flexible and semi-transparent characteristics of solar cells.

- Semitransparent and flexible OPVs



Hyunwoo Lee et.al., *Advanced Energy & Sustainability Research* (2020)

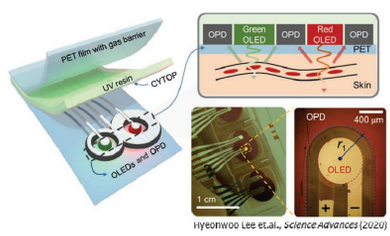
Organic electronic devices

State-of-the-art applications for future electronics including wearable/ patched devices require not only various functions but also diverse form factors.

- Organic thin-film transistors

Hanul Moon et.al., *Advanced Materials* (2014)

- Wearable sensors



Hyeonwoo Lee et.al., *Science Advances* (2020)

■ Recommended courses & Career after graduation

- Introduction to Physical Electronics (EE211)
- Semiconductor Devices (EE362)
- Organic Electronics (EE568)
- Display Engineering (EE563)

- Research and development field in electronics
- Academic fields

■ Introduction to other activities besides research

- IOEL encourages good interpersonal relationship through regular lab workshops, strawberry party, and exhilarating sports days held every semester

■ Introduction to the Lab.

Integrated Organic Electronics Lab (IOEL) focuses on developing novel device architectures and processes based on organic and other emerging semiconductors in the following areas: display & lighting, energy, and flexible low-cost electronics. Recent research trends no longer centralize on device performance enhancement, but focus more on the realization of various functionalities. For students with knowledge in electronics and great interest in interdisciplinary fields, we hope you will join IOEL and seize the chance to apply your electrical engineering skills to various areas.

■ Recent research achievements ('22~'24)

[1] Su-Bon Kim, et al., "3D height-alternant island arrays for stretchable OLEDs with high active area ratio and maximum strain." *Nature Communications*, 2024
[2] Donggyun Lee, et al., "Stretchable OLEDs based on a hidden active area for high fill factor and resolution compensation." *Nature Communications*, 2024
[3] Hyung Suk Kim, et al., "Understanding of complex spin up-conversion processes in charge-transfer-type organic molecules." *Nature Communications*, 2024
[4] Haechang Lee, et al., "Gradual Electrical-Double-Layer Modulation in Ion-Polymer Networks for Flexible Pressure Sensors with Wide Dynamic Range.", *Advanced Functional Materials*, 2024
[5] Jee Hoon Sim et al., "OLED catheters for inner-body phototherapy: A case of type 2 diabetes mellitus improved via duodenal photobiomodulation.", *Science Advances*, 2023
[6] Junho Kim, et al., "Toward Near-Foldable Surface Light Sources with Ultimate Efficiency: Ultrathin Substrates Embedded with Micron-Scale Inverted Lens Arrays.", *ACS Photonics*, 2023
[6] Palanisamy Rajakannu, et al., "Molecular Engineering for Shortening the Pt···Pt Distances in Pt(II) Dinuclear Complexes and Enhancing the Efficiencies of these Complexes for Application in Deep-Red and Near-IR OLEDs.", *Advanced Functional Materials,* 2023

<Professor Jaemin Yoo's Lab.>

Data AI Lab	■ Contact information			
	Professor	Jaemin Yoo	**Mail**	jaemin@kaist.ac.kr
	Website (Prof.)	https://jaeminyoo.github.io		
	Website (Lab.)	https://dai.kaist.ac.kr		

■ Current state of the Lab. (in Fall 2024)

3 Master's students and 12 undergraduate interns.

■ Research areas

1. Graph Neural Networks (GNNs)

- Graphs represent dynamic interactions between entities.
  - Social networks, molecular graphs, knowledge graphs, etc.

Q: *How can we make GNNs robust to real-world noise?*

Q: *How can we interpret or theoretically analyze GNN models?*

2. Machine Learning on Time Series

- Most time series data contain multiple correlated variables.
  - E.g., stock prices, traffic patterns, sensor data, etc.
- Some data have both spatial and temporal relationships.
- Some data have irregular observations over time.

Q: *How can we consider such diverse properties in ML models?*

3. Recommender Systems (RecSys)

- RecSys is everywhere: YouTube, NetFlix, Amazon, Coupang, etc.
- RecSys a popular application of GNNs and time series ML.
  - User history can be represented as a graph or a time series.

Q: *How can we improve RecSys performance with diverse views?*

4. Self-supervised Learning (SSL)

- SSL is the key component for large foundation models.
  - Since labeled data are insufficient for such heavy models.
- SSL is being studied for almost all tasks and applications.

Q: *How can we train ML models with insufficient data or labels?*

Q: *How can we improve SSL for GNNs, RecSys, or time series?*

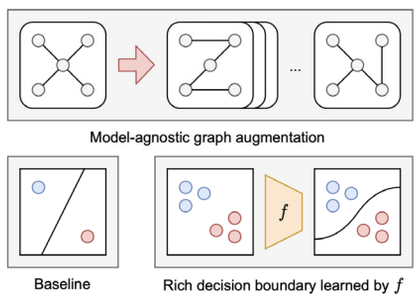


Fig 1. Graph augmentation

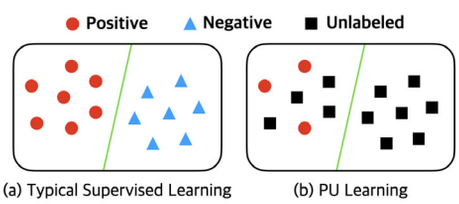


Fig 2. Positive-unlabeled learning

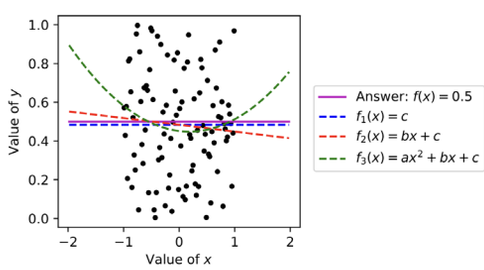


Fig 3. Strength of simplicity

■ Recommended courses & Career after graduation

- **Recommended courses:** Math (EE210, EE213), Machine Learning (EE331), Data Mining (EE412)
- **Career after graduation:** Software engineers, Data scientists, ML engineers, ML research scientists

■ Introduction to the Lab.

Our research group has started in August 2023 when Prof. Jaemin Yoo began to work as an Assistant Professor in KAIST EE. Our primary goal is to enhance the generalizability and practicality of machine learning algorithms for real-world challenges, covering a variety of data representations and applications.

■ Recent research achievements (2021-2023)

- Yoo et al. "DSV: An Alignment Validation Loss for Self-supervised Outlier Model Selection." **ECML PKDD 2023.**
- Yoo et al. "Less is More: SlimG for Accurate, Robust, and Interpretable Graph Mining." **KDD 2023.**
- Yoo et al. "Accurate Node Feature Estimation with Structured Variational Graph Autoencoder." **KDD 2022.**
- Yoo et al. "Model-Agnostic Augmentation for Accurate Graph Classification." **TheWebConf 2022.**
- Yoo et al. "Accurate Graph-Based PU Learning without Class Prior." **ICDM 2021.**
- Yoo et al. "Accurate Multivariate Stock Movement Prediction via Data-Axis Transformer." **KDD 2021.**

<Professor Jong-Won Yu's Lab.>

RF System and Solution Lab

■ **Contact information**

Professor : drjwyu67@kaist.ac.kr TEL : 042-350-5478

Lab. : rfsslab@kaist.ac.kr Website : https://rfss.kaist.ac.kr

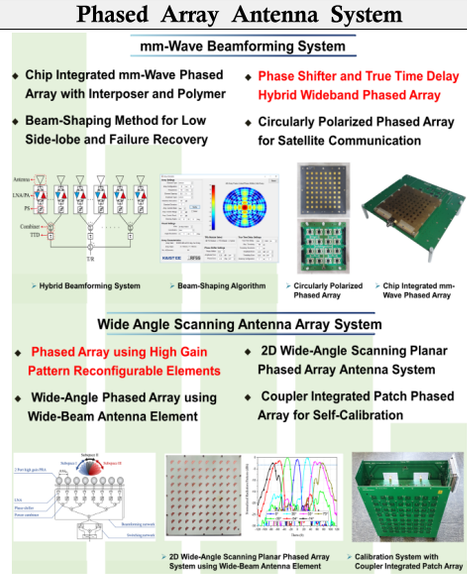
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 7+2 (part time) Master's Student: 8

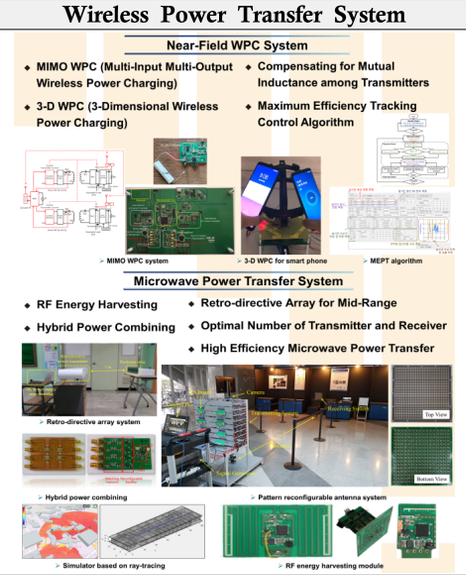
■ **Research Areas**

RF System Development

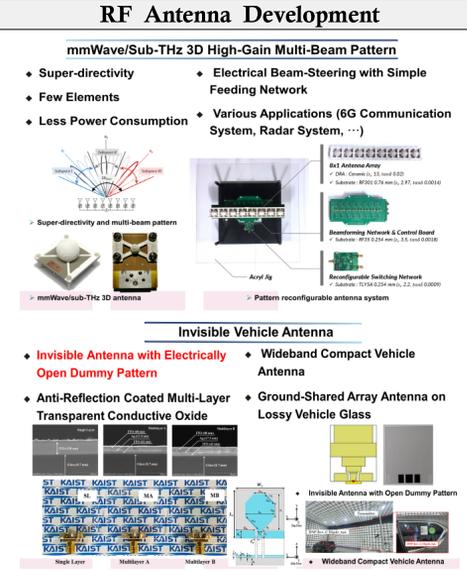
Phased Array Antenna System



Wireless Power Transfer System



RF Antenna Development



■ **Recommended courses & Career after graduation**

- Postdoctoral Courses
- Various Government-funded/Government-contributed Research Institute (ex. KISTEP, KRISS, KINS, ETRI, KRRI, ADD etc.)
- Various Major Company (ex. Samsung Electronics, LG Electronics etc.)

■ **Introduction to other activities besides research**

- Working out with other Lab or Running various programs once a month.

■ **Introduction to the Lab.**

For the next generation networks, we are trying to make it possible to have above characteristics of the RF systems more appropriate, more reliable, more efficient for the future wireless environment.

■ **Recent research achievements ('22~'24)**

- International Journal 17, International Conference 23, Award 16, Patent 11

<Professor Chang D. Yoo's Lab.>

U-AIM

■ Contact information

Professor : 유 창 동 e-mail: cd_yoo@kaist.ac.kr

Lab: U-Artificial Intelligence and Maching Learning (U-AIM)

e-mail : sunjae.yoon@kaist.ac.kr

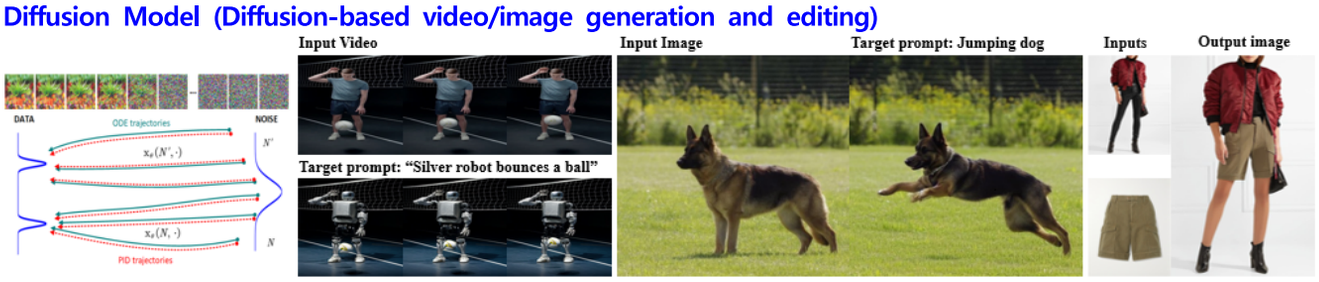
Website : https://sanctusfactory.com/u-aim/

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 13 Master's Student: 7

■ Research Areas

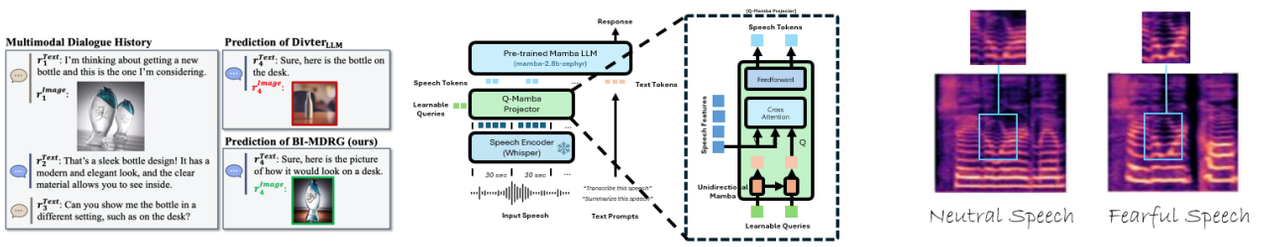
Diffusion Model (Diffusion-based video/image generation and editing)



(a) Single Step Diffusion (Ours) (b) Diffusion-based Video Editing (c) Diffusion-based Image Editing (d) Virtual try-on

Figure 1. Illustrations of (a) diffusion process and Its applications including (b) video editing, (c) image editing, and (d) virtual try-on

Large Language Model, Speech, and Audio Processing (LLM, RLHF, Multimodal Mamba, TTS)



(a) Context constancy in Dialogue LLM (b) Mamba-based Multimodal Processing (c) Universal Guidance for TTS models

Figure 2. Illustrations of (a) Context-consistent image generation(b) Multimodal processing (c) TTS Universal Guidance

Reinforcement Learning (Offline RL, VLM-based RL, Robot mainpulation)

(a) Reinforcement Learning (b) Reinforcement Learning with VLM (c) Robotic Manipulator

Figure 3. Illustrations of (a) Reinforcement Learning and (b) RL with VLM and (c) Robotic manipulator

■ Recommended courses & Alumni

Courses: Signal and System, Machine Learning, Deep Learning, Natural Language Processing, Computer Vision

Alumni: Prof (고려대, 중앙대), Google, Deepmind, Samsung, LG, KT, Qualcomm, Kakao brain, Naver, start-up companies

■ Introduction to other activities besides research

■ Recent research achievements ('22~'24 AI Publications:)

[1] 2024: 27 papers (ICML 2, ICLR 3, ECCV 4, IROS 2, ACL 1, AAAI 1, INTERSPEECH 1, ICASSP 4, CVPRW 1, ICPRAI 2, JSTSP 1, TMLR 1, Access 2)

[2] 2023: 20 papers (ICLR 2, ACL 4, ICCV 1, EMNLP 2, IROS 1, INTERSPEECH 1, ICASSP 1, TPAMI 1, Access 3, Advanced materials 1, Sensors 2)

[3] 2022: 22 papers (CVPR 2, ECCV 2, EMNLP 2, ICML 1, ACL 1, ICLR 1, AAAI 1, INTERSPEECH 1, ICASSP 1, Sensors 4, Access 5, Nano energy 1)

⟨Professor Hoi-Jun Yoo⟩

Semiconductor System Laboratory

■ Contact information		
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Website	**https://ssl.kaist.ac.kr**	

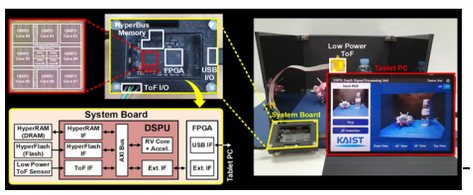
■ **Current state of the Lab. (in 2024 Fall Semester)**

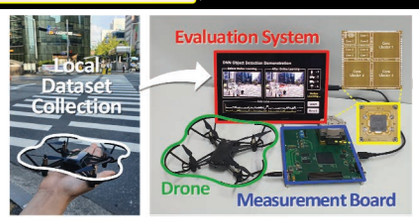
Postdoctoral Fellows : 4 PhD Students: 10 Master's Student: 18

■ **Research Areas**

Humanistic Intelligence System

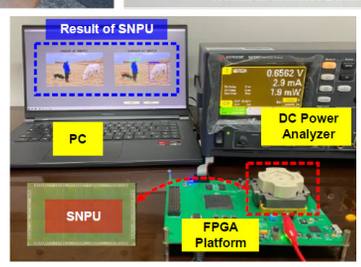
- Energy-Efficient Mobile DRL Training Processor
- World-First Floating-point Computing-in-Memory Architecture
- Multi-DNN Training Processor for Generative Adversarial Networks
- 3D Point Cloud-based Neural Network Processor
- CNN Super Resolution Processor for Full HD 60fps Video
- Mobile Neural 3D Rendering Processor
- eDRAM-based In-Memory-Computing Chip





Neuromorphic

- Always-on Face Recognition Spike Domain CNN Processor
- Neuromorphic Computing-in-Memory Processor
- Energy-efficient Analog-Digital Hybrid Computing Architecture
- Biological Neural Network System
- Complementary CNN/SNN Processor



■ **Recommended courses**

Circuit related courses (analog & digital), computer architecture, and digital systems will be helpful, but you can learn everything you need through OJT.

■ **Career after graduation**

Companies & research institutes all over the world (Apple, IBM, IMEC, Samsung, LG, etc.) or Universities (KAIST, UNIST, etc.)

■ **Introduction to other activities besides research**

In SSL, you will get a chance to explore international companies and research facilities like Samsung, IMEC, IME, Apple every year. Moreover, a joint workshop with Chinese (Tsinghua Univ.) and Japanese (Tokyo Univ.) universities is held every year. There are also lab workshops and parties with lab members.

■ **Introduction to the Lab**

Privilege of SSL Members

- Pride from world leading researches
- Business trip abroad average of 2 times per year
- Accepted to various international conferences/journals
- Project leading skills and presentation skills
- Semiconductor Chips with your name inscribed on

SSL Wants

- Who has passion to be the best
- Who wants to become a world leading engineer

Statue of SSL

- You can directly feel it at international conferences

■ **Recent research achievements (2020-2024)**

- Top class international conferences: **9** ISSCC / **14** S. VLSI / **12** HotChips papers presented
- Major international papers: **53** journal / **83** conference papers accepted
- Awards: 2022 AICAS best paper/demo award, 2022 CICC outstanding paper award, 2020 ISSCC Demo Award, 2020 Humantech Gold Prize, etc.

<2022 AICAS Demo Award> <2020 ISSCC Demo Award> <2020 Humantech Gold Prize>

<Professor Young-Gyu Yoon's Lab.>

Neuro-Instrumentation and Computational Analysis Lab

■ Contact information

Professor : ygyoon@kaist.ac.kr TEL : 7449
Lab. : nicalab@kaist.ac.kr TEL : 7549
Website : nica.kaist.ac.kr

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 5 Master's Student: 4

■ Research Areas

< Acquiring Big Data from Brain >

Imaging Brain Activity With genetic engineering, neurons can be modified to change their brightness as a function of the their activity (i.e., neurons "blink" as they fire) which makes the brain activity visible. The main challenge is to record the optical signals at a high spatiotemporal resolution and we develop optical imaging techniques to tackle this.

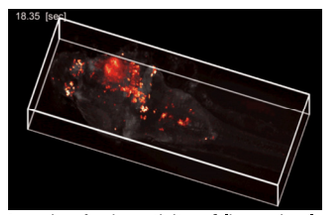
Computational Imaging The performance of imaging systems is impacted by a range of factors, including physics, biology, information theory, and the sampling theorem. To mitigate these limitations, we're utilizing computational imaging methods that leverage machine learning to predict more information from limited data.

Multiplexed Imaging Fluorescence microscopy is limited to imaging only four proteins simultaneously due to the broad emission spectra of fluorescent molecules. To surpass this limitation and visualize a larger number of proteins, we are developing multiplexed imaging technologies that use machine learning algorithms for blind signal separation.

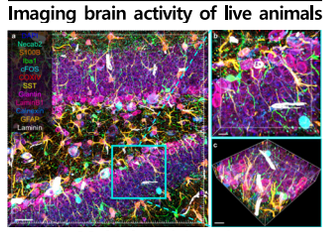
< Analyzing Big Data from Brain >

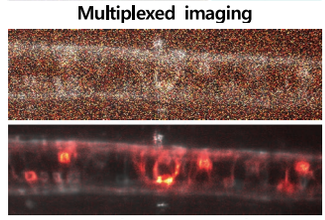
Neuro-image Processing State-of-the-art functional imaging methods generate more than a gigabyte of data per second, necessitating the development of automated analysis algorithms. We develop fast and scalable machine learning algorithms capable of processing such brain images without the need for labeled data.

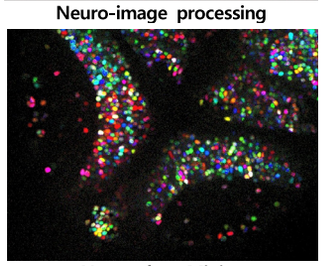
Neuro-data Mining Neural activity underlies many functions in our brain, but our understanding of the fundamental principles of neural signal processing remains limited. To gain greater insight, we apply computational methods to analyze brain activity data and quantify information flow, uncovering the functional connections between neurons. Our aim is to identify repeating patterns, discover local circuits that operate together, and extract synaptic strength information from brain activity, leading to a deeper understanding of the brain.



Imaging brain activity of live animals


Multiplexed imaging


Neuro-image processing


Neuro-data Mining

■ Recommended courses & Career after graduation

Recommended courses Signals and Systems (EE), Digital Signal Processing (EE), Machine Learning (CS), Linear Algebra (MA), Optics (PH), Biomedical Optics (ME), Biophotonics (BiS), Brain Science Fundamentals (BiS)

Career All experiences and knowledge acquired during the graduate study can be directly transferred and applied to many data scientist positions and biomedical jobs (both academia and industry).

■ Introduction to other activities besides research

NICA members communicates with each other through lab dinners and strawberry parties. Lab members maintain good relationships through outside activities on a regular basis.

■ Introduction to the Lab.

Our mission is to develop optical and computational technologies for brain and biomedical applications. More specifically, we think of a brain as a circuit that consists of neurons and devise new strategies to reverse engineer this circuit – through imaging/analyzing brain activity/structure. We are looking for the prospective students who are (a) self-motivated and (b) eager to explore new things.

■ Recent research achievements ('22~'24)

[1] Real-time self-supervised video processing with self-calibration on analog 1K reliable selector-less memristor array-based edge-computing platform, accepted for publication in ***Nature Electronics***, 2024.
[2] Statistically unbiased prediction enables accurate denoising of voltage imaging data, ***Nature Methods***, 2023. (featured on the cover of Nature Methods)
[3] Robust and efficient alignment of calcium imaging data through simultaneous low rank and sparse decomposition, ***WACV***, 2023.
[4] Three-dimensional fluorescence microscopy through virtual refocusing using a recursive light propagation network, ***Medical Image Analysis***, 2022.
[5] PICASSO allows ultra-multiplexed fluorescence imaging of spatially overlapping proteins without reference spectra measurements, ***Nature Communications***, 2022. (selected as KAIST Breakthroughs 2022)

<Professor Insu Yun's Lab.>

Hacking Lab

■ **Contact information**

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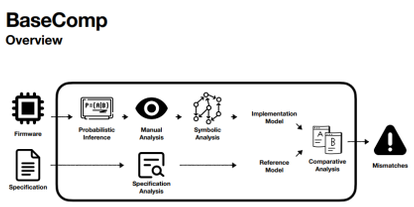
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 5 Master's Student: 6

■ **Research Areas:** Understanding hacking in a scientific manner!

Automatic bug finding:

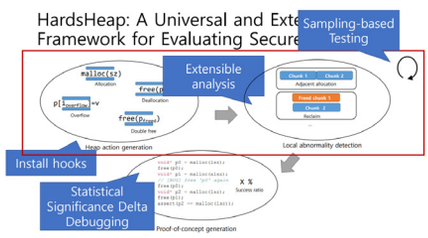
How do hackers find vulnerabilities?



BaseComp: A Comparative Analysis for Integrity Protection in Cellular Baseband Software (Security '23)

Automatic exploit generation:

How do hackers build exploits?



HardsHeap: A Universal and Extensible Framework for Evaluating Secure Allocators. (CCS '21)

Offensive research:

What do real hackers do?

Renderer RCE on both Google Chrome and Microsoft Edge (Pwn2Own 2024)

■ **Recent research achievements ('22~'24)**

40 ▼ KAIST		6.1	11
Faculty		*#.Pubs*	*Adj..#*
Sang Kil Cha	SECURITY,SE	3	0.8
Yongdae Kim	SECURITY	3	0.5
Sooel Son	SECURITY,WEB+IR,ML	3	0.9
Insu Yun	SECURITY	3	0.5
Jun Han 0001	MOBILE,SECURITY	2	0.5
Kihong Heo	SE,PL,SECURITY	2	0.6
Youngjin Kwon	OS,ARCH	2	0.4
Insik Shin	EMBEDDED,MOBILE,SECURITY	2	0.4

1st place (tie) in csranking.org (KAIST security research)

■ **Introduction to other activities besides research**

Hacking competition for fun & profit!

■ **News!**

- [03/22/2024] $145K from Pwn2Own 2024 (Google Chrome, Microsoft Edge)!
- [01/25/2024] $10K Bug Bounty from Google v8CTF!
- [10/25/2023] Got 2nd place in Cyber Security Challenge 2023!
- [10/04/2023] $67K Bug Bounty from Google kernelCTF!
- [07/17/2023] QSYM got a Frontiers of Science Award from ICSB!
- [06/06/2023] BaseComp is accepted to Usenix Security'23!
- [01/19/2023] $7K Bug Bounty from Google!
- [11/11/2022] QueryX is accepted to IEEE S&P'23!
- [11/04/2022] ScaleTrust is accepted to ToN'22!
- [06/11/2022] FuzzCoin is accepted to RAID'22!

■ **Recommended courses**

- EE209 Programming Structures for Electrical Engineering
- EE309: Advanced Programming Techniques for Electrical Engineering
- EE415: Introduction to Operating System
- EE517: Software Hacking Theory and Practice
- EE515: Security of Emerging Systems

■ **Career after graduation (3 Alumni)**

- Postdoc @ Georgia Tech (PhD)
- Security researcher @ S2W (MS)
- Security researcher @ 78ResearchLab (MS)

■ **Introduction to the Lab.**

Our lab is one of the best labs that study ***hacking.*** If you are interested in understanding and analyzing systems, finding vulnerabilities, and exploiting them, don't hesitate to contact us!

<Professor Jun-Bo Yoon's Lab.>

3DMNSL 3-DIMENSIONAL MICRO-NANO STRUCTURES LABORATORY

3D Micro-Nano Structures Laboratory

■ **Contact information**

Professor: Nanofab Center 513 (E19) TEL :042-350-3476

Lab.: Nanofab Center 523 (E19) TEL :042-350-5476

Website: http://MEMS.kr/

■ **Current state of the Lab. (in 2024 Fall Semester)**

PhD Students: 6 Master's Student: 4

■ **Research Areas**

▷We focus on the **high-performance 3-dimensional micro/nano-electro-mechanical systems (M/NEMS)**.

▷We research on **unique device-design, fabrication, and demonstration** technologies.

▷Based on our superior abilities in overall device-technology, we have developed the **world-best electrical devices, such as nano/micro-mechanical switches (DC/RF), nano-sensor devices and optical components.**

▷We have also **widen the research-field** into bio-sensor, health-care monitoring, energy harvesting devices and so on, **with lab members having various undergraduate majors (EE, ME, MSE, Chemistry, etc.)**

■ **Nano/micro-switch for DC & RF applications** ----------

Utilizing micro/nano-mechanical switches, we achieve zero leakage current and infinite sub-threshold swing. We're advancing high-performance switches to address CMOS transistor limitations, aiming to enhance **autonomous driving and space industry memory**, **advanced back end of line (BEOL) interconnects**, **circulator for quantum computing**, and **DC & RF applications**

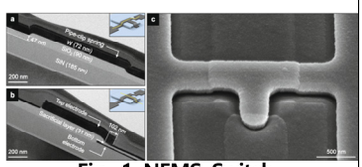


Fig. 1 NEMS Switch

■ **Commercial-Grade Reliable High-Performance Nano Devices** ----------

Utilizing our advanced large-area, high-resolution nano-fabrication techniques, we uncover groundbreaking phenomena, leading to the creation of high-performance **gas (chemical) sensors**, **pressure, strain and temperature (physical) sensors**, as well as **bolometer (optical)**, pivotal for Industry 4.0.

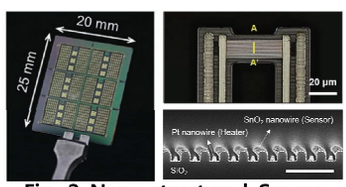


Fig. 2 Nano-structured Sensor

■ **Soft Electronics for Next-Generation Devices (Health Care, Human-Machine Interaction)** ----

Leveraging the advantages of nanostructures, we develop high-performance and highly reliable physical sensors, including **pressure, strain and temperature sensors**. By integrating circuitry, communication, and AI technologies, we design systems for applications in health monitoring and human-machine interaction.

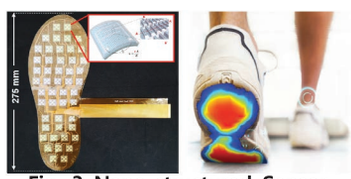


Fig. 3 Nano-structured Sensor

■ **Recommended courses & Career after graduation**

Semiconductor devices, integrated circuit devices, and MEMS in EE perspective are recommended.

So far, 25 PhDs and 47 MS degrees have been conferred. Many of our graduates have pursued careers in global industry leaders such as **Samsung, SAIT, Broadcom, SK Hynix, and LG**. Additionally, some have gone on to conduct postdoctoral research at esteemed institutions like **Northwestern, MIT, Purdue Johns Hopkins, and NIH**, and later secured positions at national research institutes (**KIST, ADD, KIMM, NIH**) and as professors (**Hanyang, Pusan National, SKKU**).

Quarterly Workshop :
- Summer: Pension
- Winter: Ski Resort
- Research Direction sharing

Annual Homecoming Day :
- Last homecoming day @ Japan ski resort

Leisure Activity :
- Enjoy sports regularly (Soccer, Bowling, running)

■ **Recent research achievements ('22~'24)**

– **In total, 110 international journals, 108 international conference, 38 international and 102 domestic patents.**

(Journals : Nature Nanotechnology, Nature Communcations, Advanced Materials, ACS Nano, Small etc.)

– **Awarded for our researches from IEEE, Samsung Electronics, Society of Micro and Nano Systems, and KAIST.**

– **Professor Jun-Bo Yoon wons 2023 KAIST Educator Award (윤준보 교수님 '2023 KAIST 교육자상' 수상).**

– **Selected as a 'Healthy Laboratory' by the Ministry of Science and ICT in 2021 (2021 건강한 연구실 선정)**

<Professor Chan-Hyun Youn's Lab.>

■ **Contact information**

Professor Office: E3-2, 3205 TEL : 010-6219-5674

Lab. : E3-2, 3211, 3206, 3204 TEL : 010-6676-7062

Website : ncl.kaist.ac.kr

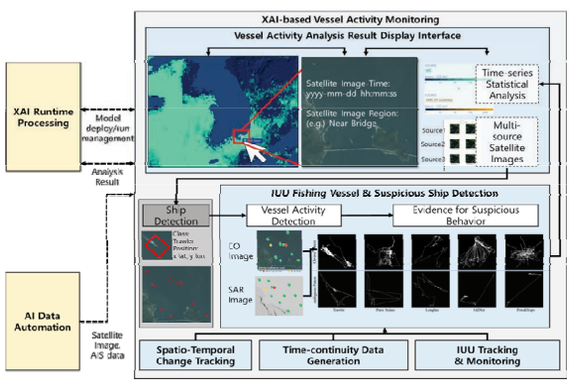
■ **Current state of the Lab. (in 2024 Fall Semester)**

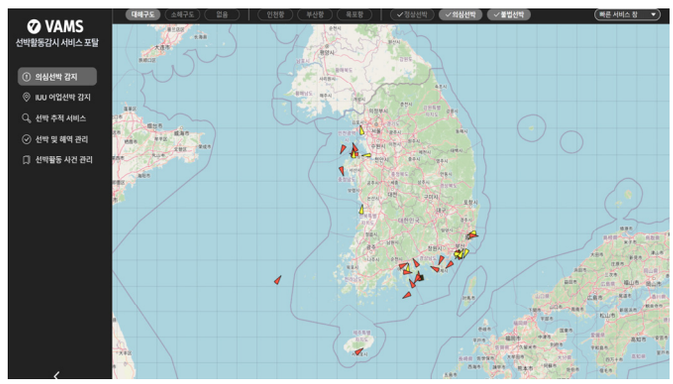
Postdoctoral Fellows : 1 PhD Students: 4 Master's Student: 2

■ **Research Areas (Detailed Description in ncl.kaist.ac.kr)**

- **Explainable AI-based Vessel Activity Monitoring for Korea Coast Guard Satellite Application (Korea Coast Guard)**

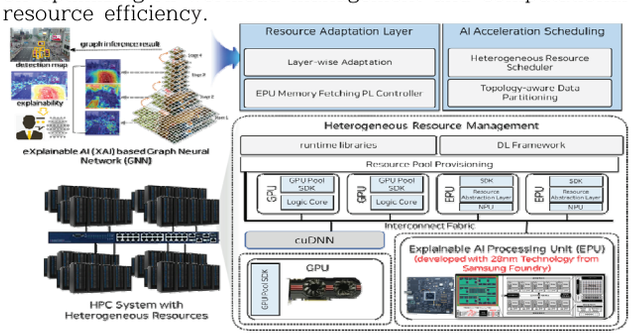
This project aims to provide explainable AI-based vessel activity monitoring service for Korea Coast Guard Satellite Application Project. The project includes runtime framework for maritime surveillance services that learn, deploy, and manage AI-based analysis models. It also performs service-specific analysis processing of real-time collected data and automates AI-based data management for new data that processes collected data by service.





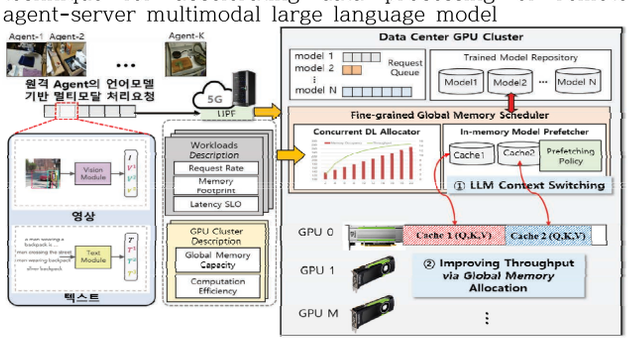
- **DL Acceleration Framework for Reconfigurable Datacenter (Samsung DS)**

Our research project aims to create an advanced DL acceleration framework tailored for datacenters, focusing on optimizing AI workload management and computational resource efficiency.



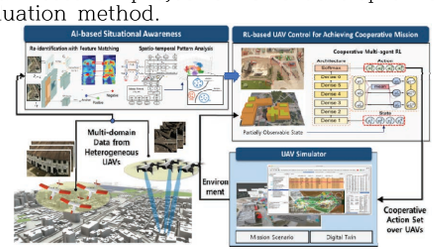
- **GPU Scheduling for Accelerating AI Application Services in 5G Edge-Cloud Computing Environment (Samsung Network)**

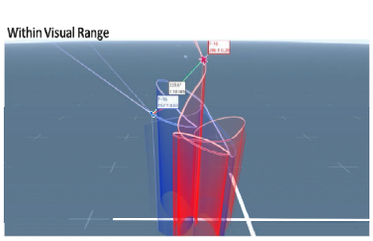
We have researched GPU workload management technique for accelerating data processing of remote agent-server multimodal large language model

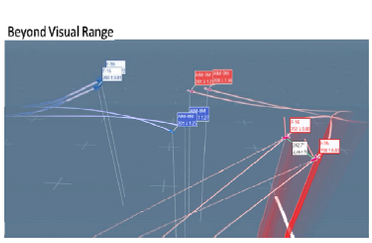


- **Reinforcement Learning-based Scheduling and AI Agent Evaluation**

Our research project aims to develop a Target Priority Scheduling Algorithm Based on Threat Analysis and AI Agent Evaluation method.







■ **Recommended courses & Career after graduation**

Samsung DS (Memory, SAIT, etc), Samsung Research, Naver, Hyundai, Toss, University Professor, and so on.

■ **Recent research achievements ('22~'24)**

AI Top Conference 3 Papers, SCI(E) Journal 9 Papers, and International Conference 8 Papers

(prof. kayoung.lee)

Low-dimensional Electron Systems Lab.

■ Contact information	
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Lab.	Email: kleegroup@kaist.ac.kr
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■ Current state of the Lab. (in 2024 Fall Semester)

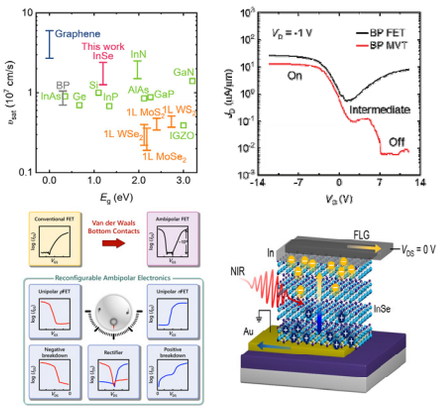
Postdoctoral Fellows : 0 PhD Students: 4 Master's Student: 6

■ Research Areas

Electrical Characterization of High-mobility Emerging Semiconductors:
- Transport spectroscopy; measurements of band structure information
- Electron transport and quantum phenomena in semiconductor nanostructures

Nanostructure Electronic/Optoelectronic Device Applications:
- High mobility transistors, steep-slope transistors, low-power tunneling electronics, multi-valued logics, electronic sensors, contact property optimization etc.

Vertical Electron Transport in Heterostructures Based on van der Waals Materials:
- Dynamic modulation of band alignment and tunneling properties
- Ballistic transport along the vertical direction in van der Waals materials
- Band modulation by Morie-induced superlattices



■ Recommended courses & Career after graduation

- Introduction to Physical Electronics, Semiconductor Devices, Semiconductor Nanostructures, Semiconductor IC Technology
- Academia: National research institutes and universities
- Industry: Semiconductor-related companies such as Samsung, SK Hynix, LG, LX Semicon, Intel, Apple, Micron, etc.

■ Introduction to other activities besides research

While not many group activities, individual freedom and hobbies are respected. Furthermore, the laboratory members have a positive relationship, fostering a friendly atmosphere.

■ Introduction to the Lab.

CMOS scaling is now running into the nanoscale regime, where quantum nature of electrons comes in. While the limits of silicon are being reached, data in electronic devices keep exponentially expanding. This requires further scaling, lowering power, and improving speed, which are exciting challenges to both academia and industry. Nanoscale materials and their heterostructures are therefore experiencing a burst of activities lately, producing diverse scientific and technological breakthroughs including interesting quantum phenomena. We perform vigorous research in electron transport in nanostructured electron systems. Our major research goals are (1) to understand fundamental electronic properties of emerging low-dimensional materials and their novel heterostructures, and (2) to realize unprecedented high-performance nanoscale device applications based on such basic study. Using advanced transport measurement techniques, we explore how electrons move and interact each other in nanostructured electron systems, and aim to broaden our fundamental understanding of emerging materials and physics. Our biggest motivation is curiosity, but we also have the ambition to bring unprecedented future computing with novel high speed and low power nanoelectronics.

■ Selected Publications

- Yongwook Seok, Hanbyeol Jang, YiTaek Choi, Yeonghyeon Ko, Minje Kim, Heungsoon Im, Kenji Watanabe, Takashi Taniguchi, Jae Hun Seol, Sang-Soo Chee, Junghyo Nah, and Kayoung Lee*, "High-field transport and high saturation velocity in multilayer indium selenide transistors," ACS Nano (**2024**).
  ** Highlighted on the cover.*
  ** Covered by 20 media outlets including Yonhap News, Herald Business, Newsis, and ETNews.*
- Jungi Song, Suyeon Lee, Yongwook Seok, Yeonghyeon Ko, Hanbyeol Jang, Kenji Watanabe, Takashi Taniguchi, and Kayoung Lee*, "Drain-induced multifunctional ambipolar electronics based on junctionless MoS2," ACS Nano (**2024**).
  ** Covered by 29 media outlets, including ChosunBiz, Yonhap News, Donga Science, and UPI Korea.*
- Hanbyeol Jang, Yumin Song, Yongwook Seok, Heungsoon Im, Tae Hyung Kim, Joo-Hyoung Lee, Yong-Hoon Kim, and Kayoung Lee*, "Zero power infrared sensing in 2D/3D-assembled heterogeneous graphene/In/InSe/Au," *Nanoscale* (**2022**).
- Hanbyeol Jang, Yongwook Seok, YiTaek Choi, Sang-Hoo Cho, Kenji Watanabe, Takashi Taniguchi, and Kayoung Lee*, "High performance near-infrared photodetectors based on surface-doped InSe," *Advanced Functional Materials* (**2021**).
  ** Highlighted in Hot Topic: Surfaces and Interfaces.*
- Sang-Soo Chee, Won-June Lee, Yong-Ryun Jo, Min Kyung Cho, DongWon Chun, Hionsuck Baik, Bong-Joong Kim, Myung-Han Yoon*, Kayoung Lee*, and Moon-Ho Ham*, "Atomic vacancy control and elemental substitution in a monolayer molybdenum disulfide for high performance optoelectronic device arrays," *Advanced Functional Materials* (**2020**).

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<Professor Donghwan Lee's Lab.>

Machine Decision Intelligence and Learning	■ **Contact information** Professor : donghwan@kaist.ac.kr TEL : 043-350-7462 Lab. : N1 314 TEL : 042-350-7562 Website : https://sites.google.com/site/donghwanleehome

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 5 Master's Student: 8

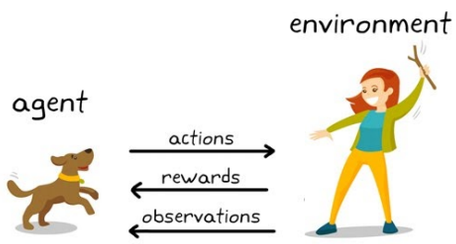
■ **Research Areas**

▶ Reinforcement learning

⇒ What is reinforcement learning? Algorithms to control unknown system by interacting with unknown environments

⇒ Applications: Covers broad area such as robot motion planning, self-driving car, general artificial intelligence, natural language processing, and chatbot

⇒ Our research directions: development of advanced reinforcement learning algorithms, theory and applications, such as robots and self-driving cars



▶ Other research areas:

Control theory and applications, machine learning algorithms, interplay among control, reinforcement learning, and optimization, optimization algorithms and theories.

■ **Recommended courses & Career after graduation**

Recommended courses: control system engineering, linear system, nonlinear system, optimal control, machine learning, reinforcement learning, probability theory, real analysis, measure theory

Career after graduation: national labs, start up, industry, silicon valley, academia

■ **Introduction to other activities besides research**

Domestic/International Conferences

Lab Seminar / Group Study

■ **Introduction to the Lab.**

Our research covers theory and application of control, machine learning, reinforcement learning, and interplay among them.

■ **Recent research achievements ('22~'24)**

Donghwan Lee,, "Lossless convexification and duality," Journal of the Franklin Institute, 2024

Donghwan Lee, Han-Dong Lim, and Do Wan Kim, "Continuous-time distributed dynamic programming for networked multi-agent Markov decision processes," IEEE ICCA2024, Iceland

Donghwan Lee, Han-Dong Lim, Jihoon Park, and Okyong Choi, "New versions of gradient temporal-difference learning," IEEE Transactions on Automatic Control, vol. 68, no. 8, 2023

Han-Dong Lim, Donghwan Lee, "Backstepping temporal-difference learning " ICLR2023, Kigali, Rwanda, May 1-5, 2023

Donghwan Lee, Jianghai Hu, and Niao He, "A discrete-time switching system analysis of Q-learning," SIAM Journal on Control and Optimization, vol. 61, no. 3, 2023

Donghwan Lee, "Convergence of dynamic programming on the semidefininte cone for discrete-time infinite-horizon LQR," IEEE Transactions on Automatic Control, vol. 67, no. 10, pp. 5661-5668, 2022

<Professor Sang-Gug Lee's Lab.>

NANO INTEGRATED CIRCUIT EXPERTISE

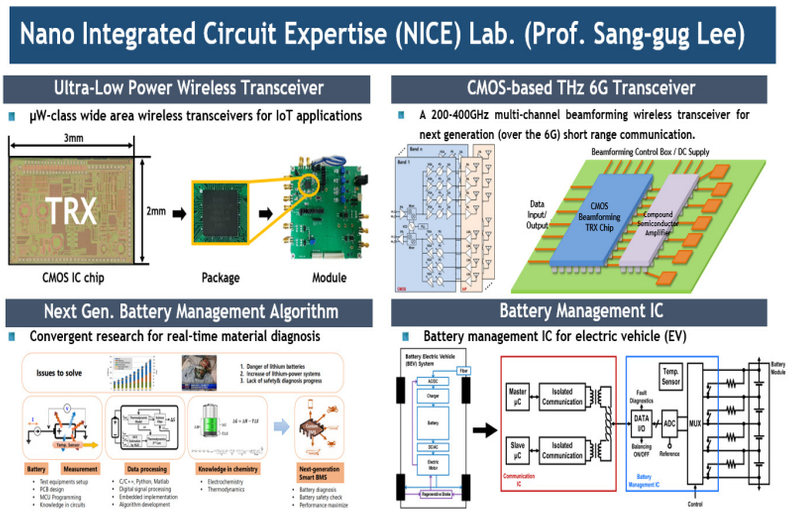
■ **Contact information**

Professor : Sang-Gug Lee TEL : 042-350-3491
Lab. : CHiPS Building (N24) TEL : 042-350-5491
Website : http://nice.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 10 Master's Student: 15

■ **Research Areas**



▶ **Ultra-Low Power (ULP) Wireless Communication Transceiver**

Developing energy-efficient transceivers for IoT and wearables, focusing on wake-up radios that activate only during communication, reducing standby power consumption. Includes RF energy harvesting and power-efficient oscillator designs for extended device battery life.

▶ **THz imaging system and transceiver for 6G communications**

Researching sub-THz transceivers for ultra-high data rates (100Gbps+) in 6G communications. Focused on efficient design of PAs, LNAs, mixers, and VCOs for high-performance transceiver systems and high-resolution imaging applications.

▶ **Battery Management Integrated Circuit (BMIC)**

Research focuses on designing DC-DC converters and analog front-end circuits for high-voltage battery systems. This includes power-efficient buck-boost DC-DC converter, monitoring of high-voltage battery parameters to optimize power efficiency, and robust circuits for safety operation.

▶ **Next Generation Battery Management Algorithm**

Developing real-time battery management algorithms to monitor thermodynamic and material states, improving safety and precision in electric vehicles and energy storage systems through predictive modeling and optimized charging cycles.

■ **Recommended courses & Career after graduation**

Recommended courses include Analog/RF/Digital Circuits, Communication Theory, Electromagnetics, Microwaves, Physical Electronics, and others as deemed necessary. Graduates can serve in companies, academia, government-funded research centers, and reputable national and international organizations.

■ **Introduction to other activities besides research**

NICE lab organize annual workshops as extra-curricular activities. Lab members engage regularly in sports and other occasional meet-ups to ensure a friendly and cheerful environment.

■ **Introduction to the Lab.**

Nano-Integrated Circuit Expertise (NICE) Lab provides its members a significant exposure to RF/Analog Circuits and Systems, and CMOS Integrated Circuits. Our expertise include circuits and systems for wireless communication, energy harvesting, imaging, and battery management. Our current research includes ULP long range wireless communication radio, THz Systems, and Battery Management IC and algorithm. Moreover, NICE lab fully supports its members for CMOS IC fabrication.

■ **Recent research achievements ('22~'24)**

[1] Byeong-Taek Moon, Hyun-Chul Park, Sang-Gug Lee. "A 281GHz, -1.5dBm Output-Power CMOS Signal Source Adopting a 46fsrms Jitter D-Band Cascaded Subharmonically Injection-Locked Sub-Sampling PLL with a 274MHz Reference" In 2024 IEEE International Solid-State Circuits Conference (ISSCC), February. 2024.

[2] Min Jae Jung, Sang-Gug Lee, Kyung-Sik Choi. "A new diagnostic indicator for lithium-ion batteries via electrochemical impedance spectroscopy: Harnessing the highest frequency peak in distribution of relaxation times" Journal of Power Sources, 2024.

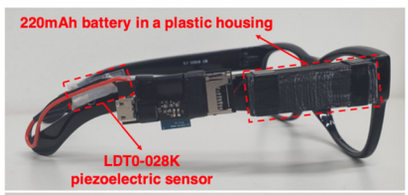
[3] Jeongwon Han, Won-Jong Choi, Young-Suk Son, Sang-Gug Lee. "ASIL-D and AEC-Q100 Grade 0 Compliant Automotive RC Oscillator with Farey Sequence-based Calibration" In 2024 IEEE Custom Integrated Circuits Conference (CICC), April. 2024.

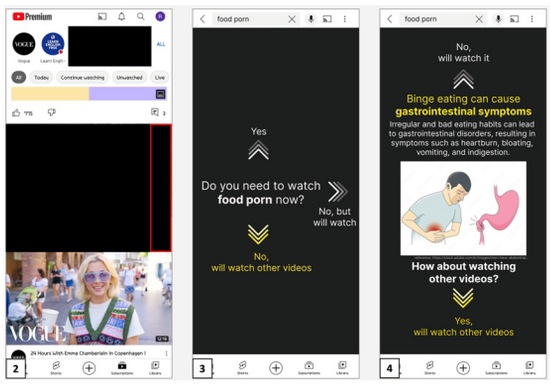
<Professor Sung-Ju Lee's Lab.>

■ **Contact information**
Professor : profsj@kaist.ac.kr TEL : 042-350-7413
Lab. : nmsl@kaist.ac.kr TEL : 042-350-7766
Website : https://nmsl.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**
Postdoctoral Fellows : 0 PhD Students: 7 Master's Student: 2

■ Research Areas
- Mobile computing (ubiquitous computing, mobile sensing, wearable computing, AR/VR)
- Mobile AI/ML (test time adaptation, domain adaptation, unsupervised learning, on-device ML, federated learning)
- Mobile Human-Computer Interaction (digital health and wellbeing, human/AI interaction, novel interaction methods)
- Wireless networking (networking for robots and drones, protocols for emerging spectrum, ML for networks)





■ **Recommended courses & Career after graduation**

• Recommended courses are: EE323 Computer Networks, EE331 Introduction to Machine Learning, EE415 Operating Systems and System Programming for Electrical Engineering.

• Career paths after graduation include (1) continuing studies in KAIST or overseas (e.g., MIT, University of Washington, Carnegie Mellon University), (2) working in tech giants (e.g. Google, Youtube, Amazon, Nokia Bell Labs, Naver, Samsung Electronics, SK), (3) pursuing an academic career as a professor (e.g., UNIST), (4) government research labs (e.g., Agency for Defence Development), and (5) start-ups.

■ **Introduction to other activities besides research**

• We have various leisure activities to refresh the atmosphere in the lab as well as to build solid companionship among lab members. Strawberry parties, birthday parties, playing board games, playing online games, pilates exercises, playing futsal are examples.

• Our lab also has study groups and workshops to improve the skills needed for professional careers (e.g., writing, presenting, relationship management).

• We also offer international internship opportunities to instututes such as Microsoft Research Asia, Nokia Bell-Labs Cambridge, Google, Cisco, MIT, CMU, Nanyang Technological University, and University of Buffalo.

■ **Introduction to the Lab.**

Networking and Mobile Systems Laboratory (NMSL) utilizes expertise in mobile computing, network systems, human-computer interactions, and machine learning to build innovative mobile services & applications. To enrich the quality of life of mobile users, we (i) identify challenging real-world problems, (ii) design novel solutions, protocols, algorithms, systems, applications, software, and interfaces, and (iii) build our solutions in working systems for practical validation and deployment. We are interested in interdisciplinary, high impact research, and seek collaboration with other academic research groups, industry and government worldwide.

■ **Recent research achievements ('22~'24)**

- Our lab has published in top international venues in mobile computing, machine learning, and human-computer interactions, such as NeurIPS, CVPR, EMNLP, MobiSys, MobiCom, CHI, CSCW, UbiComp, UIST, SenSys, IEEE INFOCOM, as well as Transactions on Mobile Computing.
- Our Research has won awards at ACM CHI, ACM CSCW, and ACM MobiSys.

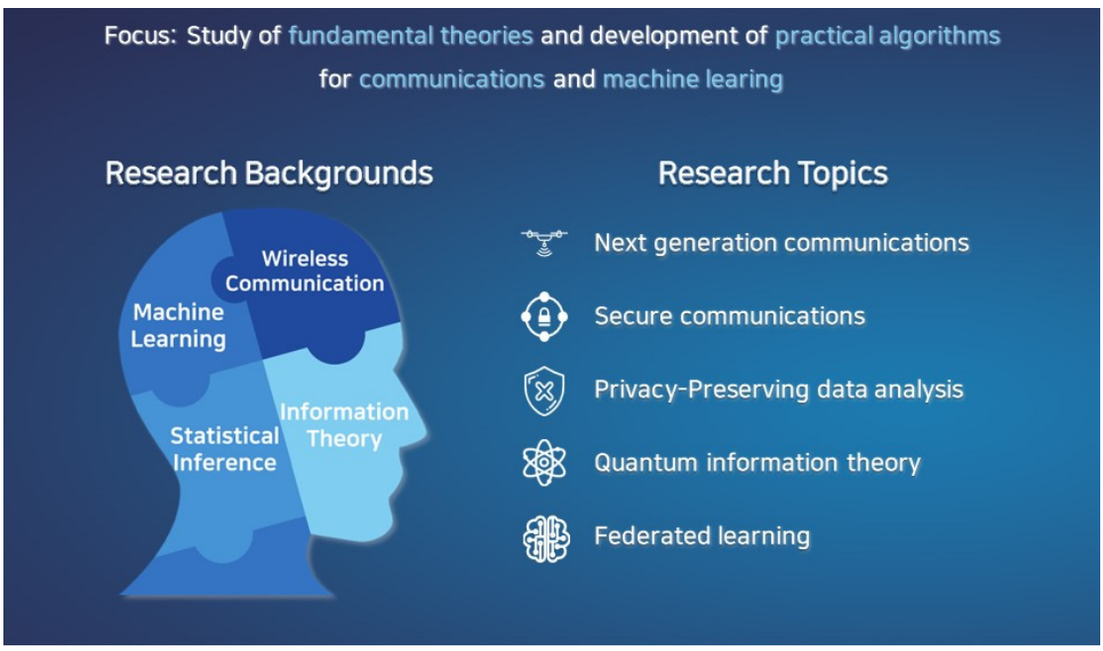
<Professor Si-Hyeon Lee's Lab>

InfoLab: Information and Communication Research Lab	■ **Contact information**		
	Professor	sihyeon@kaist.ac.kr	**Tel:** 042-350-7463
	Lab.	phy811@kaist.ac.kr	**Tel:** 042-350-7563
	Website	https://info-lab.kaist.ac.kr	

■ **Current state of the Lab. (in 2024 Fall Semester)**

PhD Students: 8 Master's Student: 5

■ **Research Areas**



Our lab is working both on the study of fundamental theories and on the development of practical schemes and algorithms for communication and machine learning. For the theoretical part, we are interested in the characterization of information-theoretic capacities and fundamental trade-offs for various communication and learning problems. For the practical part, we are interested in designing practical schemes for next-generation communications, improving the state-of-art machine learning algorithms such as federated learning.

■ **Career:** Communications and machine learning are highly demanded research areas in industry and academia.

■ **Introduction to the lab:** We welcome self-motivated and creative students, passionate about fundamental theories and developments of communication systems and machine learning algorithms.

■ **Recent research achievements**

Our lab published 31 SCI journal papers and 32 international conference papers, including several papers in IEEE TIFS (impact factor top 5%) and IEEE TIT (#1 in information theory).

Professor Ian Oakley's Lab>

WIT LAB
Wearable and Interactive Technology Lab

Contact information

Professor: Ian Oakley
Telephone: 010-4531-6693
Website : https://wit.kaist.ac.kr/

The current state of the Lab. (in 2024 Fall Semester)

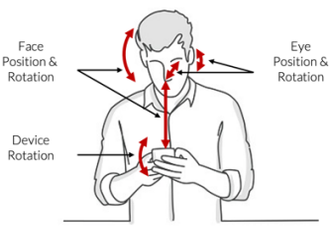
Postdoctoral Fellows : 0 PhD Students: 1 Master's Student: 0

Research Areas:

WIT Lab conducts research on Human-Computer Interaction (HCI). Specifically: Sensing and Input for AR and VR: Smartglasses are an emerging computational platform that demands new input forms based on sensing finger and body motions and gestures. WIT Lab designs, develops, and evaluates novel interactive technology in this space for critical use scenarios such as typing, selection or navigation.

Wearable Authentication: Wearable devices increasingly sense, store, or access sensitive user data or services relating to health, communications, or transactions. However, securing access to these devices poses new challenges regarding reliable entry of passcodes or the design of practical design and integration of biometric sensing. WIT lab develops novel systems and user studies behaviors during authentication to wearable devices.

Digital Phenotyping: Smart and wearable devices have unprecedented capabilities to monitor their wearers. WIT Lab explores the user of novel data (e.g., gaze or other physiological signals) generated by mobile and wearable devices to detect key affective states, such as the feelings experienced during social media use, and how these may contribute to mental health issues, such as depression. Wearables have the potential to track our mental health, as well as our physical health.



Recommended courses & Career after graduation

KAIST offers a world-class environment in which to study HCI, with a network of faculty engaged in and around core HCI topics (https://hci.kaist.ac.kr/) and courses across CS, ID, GSCT and EE. HCI offers many opportunities for future careers, with burgeoning opportunities in academia, strong demand from established industry research labs (e.g., Google, MS), and high relevance to many tech startups.

Introduction to other activities

Lab members can expect to attend top international and national HCI conferences and have regular lab social events (organized mainly around lunches) and periodic workshop trips. We are a new lab and open to ideas - join us and propose and/or organize your own events & social activities!

Introduction to the Lab.

WIT Lab was founded in August 2023. Grab an opportunity to join a rapidly growing lab as a founding member! We are recruiting! We're happy to speak to candidates interested in any area of HCI, but are currently focusing on sensing, input, and interaction design for wearable and augmented reality. Also, note that although we are a new lab, we are also a mature one - the lab builds on Professor Ian Oakley's 20+ years of experience as an HCI researcher and faculty member, so expect projects and publications to ramp up quickly. Come join us as we grow!

Recent research achievements ('21~'24)

We published six papers at ACM CHI and two papers at ACM IMWUT (Ubicomp). Come join our lab and contribute to top tier research in Human-Computer Interaction!

<Professor Jung-Yong Lee's Lab.>

Advanced Devices for Energy Conversion (ADEC) Lab

■ **Contact information**

Professor : jungyong.lee@kaist.ac.kr TEL : 010-9341-1834

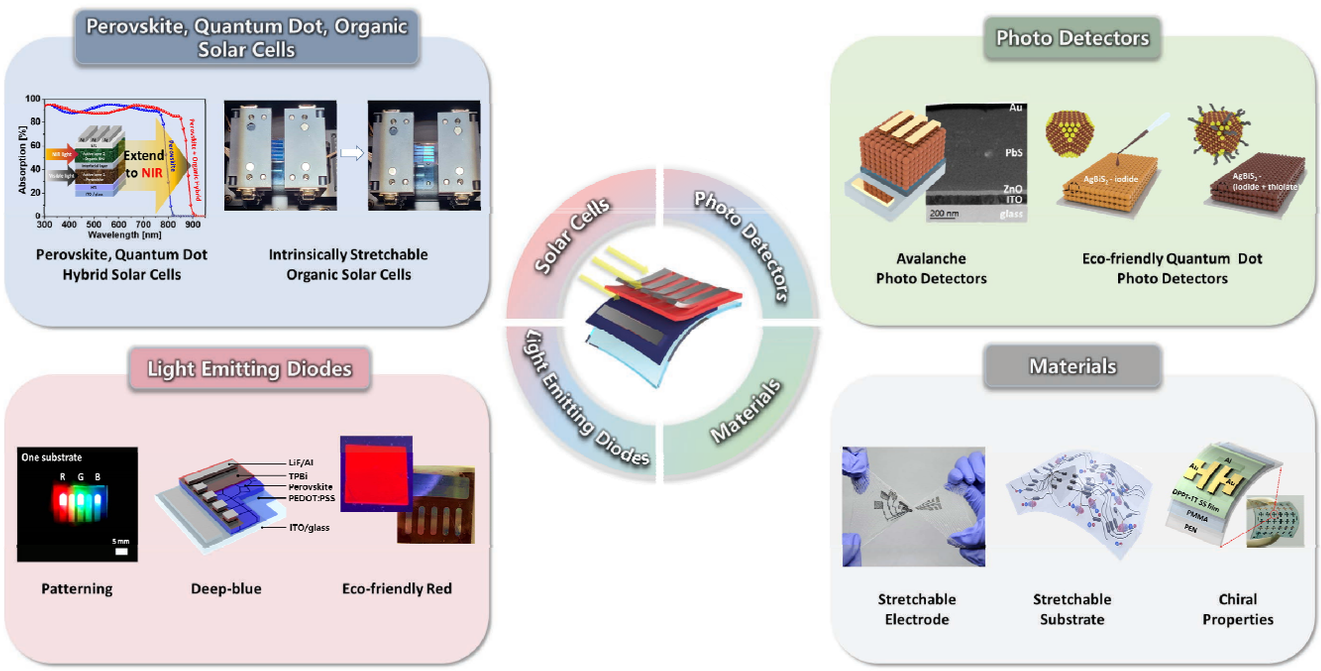
Lab. : seungbok@kaist.ac.kr TEL : 010-9260-9694

Website : https://adec.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 3 PhD Students: 7 Master's Student: 7

■ **Research Areas**



1. **Solar Cells** – Perovskite, Quantum Dot, Stretchable Organic Solar Cells
2. **Light Emitting Diodes** – Patterning, Deep-blue, and Eco-friendly Red LEDs
3. **Photo Detectors** – Avalanche and Eco-friendly Quantum Dot Photo Detectors
4. **Materials** – Stretchable electrode, substrate, and Chiral properties

■ **Recommended courses & Career after graduation**

Recommended courses : Introduction to Physical Electronics (EE211), Photovoltaic Power Generation (EE567), Introduction to Organic Electronics (EE568), Solid State Physics (EE661), Advanced Electromagnetic Theory I (PH507)

Career after graduation : Professors, postdoctoral researcher, researchers of national research labs, company (SAMSUNG, SK, LG electronics)

■ **Introduction to other activities besides research**

Exercise activity : Football, Basketball, Running, Weight training

Group teamwork : Team meeting (twice a week), dining together (more than twice a year)

■ **Introduction to the Lab.**

Advanced devices for energy conversion (ADEC) lab has been studying on the emerging optoelectronic devices since 2010. We will support your researches whatever your interests are and help you to set up an experimental environments. Also, we are happy to discuss research issues and other problems. If possible, we can create synergistic effect on our results as we collaborate together.

■ **Recent research achievements ('22~'24)**

[Highlight research]

* B. Kim et al., "Ultrahigh-gain colloidal quantum dot infrared photodetectors: Unraveling the potential of Avalanche charge multiplication" ***Nature Nanotechnology*** (2024)
* S. Lee et al., "Brightening deep-blue perovskite light-emitting diodes: A path to Rec. 2020", ***Science Advances*** (2024)

Journal articles (Total: 27) : 2022(6), 2023(11), 2024(10)

<Professor June-Koo Kevin Rhee's Lab.>

Quantum Information and Communications Lab

KAIST IT Research Center of Quantum Computing for AI

■ Contact information

Professor : June-Koo Kevin Rhee TEL : 042-350-7416
Lab. : Quantum Information and Communication Lab
Website : http://quic.kaist.ac.kr

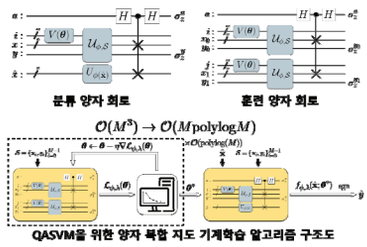
■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 3 Master's Student: 6

■ Research Areas

√ Quantum Approximate Support Vector Machine

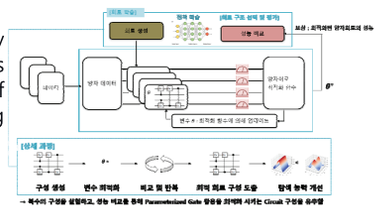
A kernel-based quantum classifier is the most practical and influential quantum machine learning technique for the hyper-linear classification of complex data. Variational Quantum Approximate Support Vector Machine (VQASVM) algorithm demonstrates empirical sub-quadratic run-time complexity with quantum operations feasible even in NISQ computers.
We experimented our algorithm with toy example dataset on cloud-based NISQ machines as a proof of concept. We also numerically investigated its performance on the standard Iris flower and MNIST datasets to confirm the practicality and scalability.



QASVM을 위한 양자 복합 지도 기계학습 알고리즘 구조도

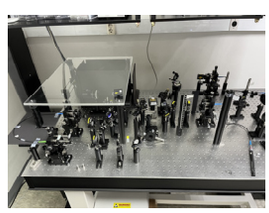
√ Ansatz Structure Search via Reinforcement Learning

Parameterized Quantum Circuit is quantum circuit which parameter can be optimized by Goal of Loss. Ansatz structure of quantum circuit is important task for many algorithms such as Variational Quantum Algorithm, Variational Quantum Eigensolver, cause result of algorithms changes via structure of ansatz. In this work, we used Reinforcement Learning to search optimal ansatz structure with various goals.



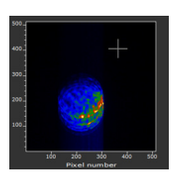
√ Satellite based Quantum Key Distribution (SQKD)

Since the successful demonstration of a satellite-based quantum key distribution (QKD) system by a research team from the University of Science and Technology of China (USTC) in 2017, the world has been fervently engaged in a competition to secure future technologies. South Korea is also actively conducting research related to this field, and we are conducting research specifically on entangled photon pair (EPP) sources, which is one of the essential technologies for achieving this project. In this research, we utilize optical experimental setups to observe and confirm phenomena that demonstrate quantum properties.



√ Quantum Ghost Imaging

The imaging technique allows the reconstruction of an image without directly detecting the photons that interact with the object. Despite a single photon from the signal not hitting the detector, the object can be obtained by utilizing the correlation between the detected signal and idler as the unique properties of the entanglement and non-locality of quantum mechanics.



■ Recommended courses & Career after graduation

Recommended courses are linear algebra, probability theory, quantum mechanics, information theory. Graduates have emancipated for various careers such as professors (Coventry U UK, IFSTTAR France), and researchers at major companies (Samsung, LIG Nex1, KT, ETRI, NSR).

■ Introduction to other activities besides research

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■ Introduction to the Lab.

Our lab is currently engaged in research focused on quantum communication and quantum computing algorithms with near-term applications. In particular, we're focusing on the fields of quantum machine learning and quantum chemistry(i.e. VQE) as part of the broader scope of variational quantum algorithms. We are also carrying out exciting experimental research in areas like quantum ghost imaging and quantum key distribution. If you're interested, feel free to reach out to our lab.

■ Recent research achievements ('22~'24)

- Junsang Oh, Jeongsik Cho, and June-Koo Kevin Rhee, Continuous-variable quantum key distribution with time-division dual-quadrature homodyne detection, Opt. Express 31, 30669-30681 (2023)
- Ryu, J.-Y.; Elala, E.; Rhee, J.-K.K. Quantum Graph Neural Network Models for Materials Search. Materials 2023 16, 4300.
- Park, S., Park, D.K. & Rhee, JK.K. Variational quantum approximate support vector machine with inference transfer. Sci Rep 13, 3288 (2023).
- Kim, JW., Cho, JS., Sacarelo, C. et al. Photon-counting statistics-based support vector machine with multi-mode photon illumination for quantum imaging. Sci Rep 12, 16594 (2022).

<Professor Hyunjoo. J. Lee's Lab.>

Brain/Bio Medical Microsystems Lab

■ **Contact information**
Professor : hyunjoo.lee@kaist.ac.kr TEL : 7436
Lab. : Electronics Building (E3-2) TEL : 7536
Website : https://bmm.kaist.ac.kr

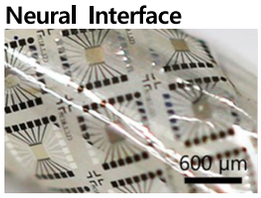
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 16 Master's Student: 7

■ **Research Areas**

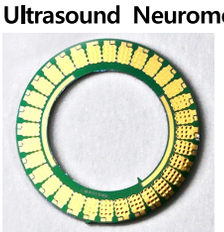
Our lab aims to develop novel systems for biomedical applications such as early detection of disease, therapeutics, and investigation of underlying mechanism of brain diseases. In specific, we focus on 1) developing Neural interface 2) developing Capacitive micromachined ultrasound transducer (CMUTs) for ultrasound neuromodulation, and 3) brain stimulation for neural circuits

Neural Interface



In order to provide chronic applications that offer long-term stability and precise measurements, flexible materials, such as those based on various polymers, are increasingly being integrated into the fabrication of microtechnologies. Multi-electrode arrays, also known as microelectrode arrays (MEAs), are one such field where flexible substrates are becoming critical components.

Ultrasound Neuromodulation



Capacitive micromachined ultrasound transducers (CMUTs) utilize traditional silicon-based microfabrication technologies to achieve highly configurable designs in a miniaturized package compatible with integrated circuits. A thin silicon membrane acts as the diaphragm for each micro-cell and a AC/DC voltage is applied across the vacuum cavity to deliver ultrasound pulses. Compared to conventional ultrasound transducers, CMUTs present numerous advantages such as easy fabrication of large arrays, large bandwidth, high sensitivity, and integration with various circuitry. In addition, CMUT arrays with various geometries and dimensions have been widely applied for biomedical ultrasound applications

Brain stimulation for neural circuits

We are exploring low intensity focused ultrasound as a new stimulation modality for treatment of brain/neurological diseases. A method currently used to treat degenerative brain diseases such as Parkinson's disease is to directly apply electrical, chemical, or light to the brain. Among them, ultrasound stimulation offers competitive advantages such as non-invasiveness, higher spatial resolution, and larger penetration depth. We are developing miniaturized flexible ultrasound transducers for small animal experiments as well as for clinical applications.

■ **Recommended courses & Career after graduation**

Recommended courses include fabrication, nano/bio electronics, and MEMS. Careers in semiconductor and medical industries as well as academia are possible.

■ **Introduction to other activities besides research**

Spring walk, Strawberry party, National teacher's day, Graduation party, and other many extra activities to accommodate friendship.

■ **Introduction to the Lab.**

Due to the interdisciplinary research field, our lab consists of a diverse group of students from different backgrounds such as electrical engineering, materials science, and chemistry.

■ **Recent research achievements ('22~'24)**

1. S. Kim†, Y. Jo†, G. H. Im, C. Lee, C. Oh, G. K, S.-G. Kim*, and H. J. Lee* (2023). Miniaturized MR-Compatible Ultrasound System for Real-Time Monitoring of Acoustic Effects in Mice using High-Resolution MRI. NeuroImage, 276.
2. Y. Kim†, E. Jang†, Y. Lee, C. Oh, K. Kim, G. Kook, M. K. Kim, M.-O. Lee, and H. J. Lee* (2023). Miniature Transparent Dopamine Sensor based on Nanosphere Lithography. Advanced Materials Technologies, 2300006.
3. G. Kook, Y. Jo, C. Oh, X. Liang, J. Kim, S.-M. Lee, S. Kim, J.-W. Choi, and H. J. Lee* (2023). Multifocal Skull-Compensated Transcranial Focused Ultrasound System for Neuromodulation Applications based on Acoustic Holography. Microsystems & Nanoengineering, 9 (45).
4. H. Kim†, S. Nam†, M. B. Durukan, H. E. Unalan, and H. J. Lee(2023). Self-Charging Dual-Modal Sensor for Glucose Monitoring Based on Piezoelectric Nanowire/Mircogel Hybrid Film. Advanced Functional Materials, 2308086
5. Y. Jo, S-M. Lee, T. Jung, G. Park, C. Lee, G.H. Im, S. Lee, J.S. Park, C. Oh, G. K, H. Kim, S. Kim, B.C. Lee, G.S.B. Suh, S-G. Kim, J. Kim*, H.J. Lee* (2022). General-Purpose Ultrasound Neuromodulation System for Chronic, Closed-loop Preclinical Studies in Freely Behaving Rodents. Advanced Science, 9 (34).
6. S. Nam†, H. Kim†, S.-M. Lee, M. B. Durukan, H. E. Unalan, and H. J. Lee* (2023). A Glucose-responsive Microgel-based Soft Etalon as an Epidermal Glucose Colorimetric Sensor, Sensors and Actuators B: Chemical (396)

<Professor Dong Eui Chang's Lab.>

KAIST EE
Ctrl Lab
Control Laboratory

■ Contact information

Professor	Email: dechang@kaist.ac.kr	Tel: 042-350-7440
Lab.	Room: 1110, N24	Tel: 042-350-7540
Website	https://control.kaist.ac.kr	

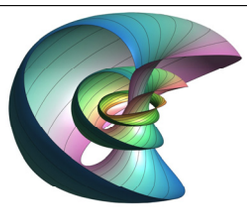
■ Current state of the Lab. (in 2024 Fall Semester)

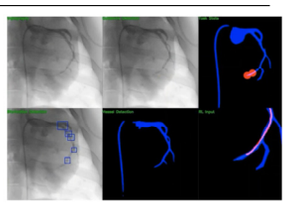
Postdoctoral Fellows : 1 PhD Students: 10 Master's Student: 7

■ Research Areas

■ Control theory and its application with AI

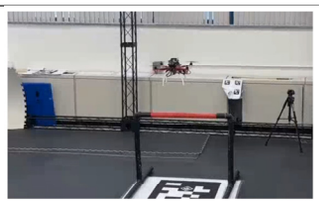
- We develop novel control theories for efficient and robust control and implement them on real systems.
- We develop automatic control algorithms that combine image processing AI and reinforcement learning.
- We develop numerical integration algorithms to faithfully preserve the values of conserved quantities such as energy during numerical integration.

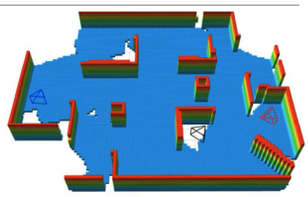

Drone control using S^1 fiber bundle


Automatic guidewire control using reinforcement learning

■ Autonomous flight drone

- We take a new approach to autonomous flight by applying control theory, deep learning and reinforcement learning.
- We combine AI-based perception and motion planning using reinforcement learning to accomplish missions.
- We implement developed control algorithm on real drone.

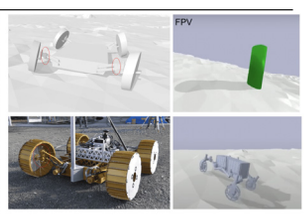

Autonomous flight drone for perching


Reinforcement learning-based swarm drone exploration

■ Robotics with AI

- We develop artificial intelligence technologies for various robotics fields.
- We develop a simulator for reinforcement learning as well as reinforcement learning algorithms for robust control.

State estimation and control for quadruped robots



Lunar rovor simulator for reinforcement learning

■ Recommended courses & Career after graduation

Research on control and robotics requires a strong background in mathematics, physics and computer science as well as electrical engineering. Recommended undergraduate courses are analysis, linear algebra, differential equations, optimization, signals and systems, feedback control, visions, and deep learning.

- Graduates can work in academia, national labs or companies.

■ Introduction to other activities besides research

There are no other activities done laboratory-wide other than research.

■ Introduction to the Lab.

Prof. Chang is an expert in control, and robotics. He takes students from various fields including electrical engineering, mechanical engineering, aerospace engineering, brain science, computer science, and mathematics, thus creating a synergistic and multi-disciplinary research environment in the laboratory. Prospective students are not expected to have been exposed to all these areas. Only industriousness is required of them.

■ Recent research achievements (2023-2024)

[1] H.-D. Jang, J.-H. Park, and D. E. Chang, "Particle Filter with Stable Embedding for State Estimation of the Rigid Body Attitude System on the Set of Unit Quaternions," in *2024 IEEE International Conference on Robotics and Automation (ICRA)*, 2024.

[2] J. H. Lee, J.-H. Park, and D. E. Chang, "FocoTrack: Multi Object Tracking by Focusing On Overlap at Low Frame Rate," in *2024 IEEE International Conference on Robotics and Automation (ICRA)*, 2024.

[3] J.-H. Park, S. Yoo, and D. E. Chang, "A New Paradigm for Dealing With Manifold Structures in Visual Inertial Odometry by Using Stable Embedding," *IEEE Transactions on Control Systems Technology*, 2024.

[4] D. E. Chang, "A New Bundle Picture for the Drone," *IEEE Transactions on Automatic Control*, 2023.

[5] J.-H. Park and D. E. Chang, "Unscented Kalman filter with stable embedding for simple, accurate, and computationally efficient state estimation of systems on manifolds in Euclidean space," *International Journal of Robust and Nonlinear Control*, 2023.

<Prof. Min Seok Jang's Lab>

JLAB NANO OPTICS

■ **Contacts**

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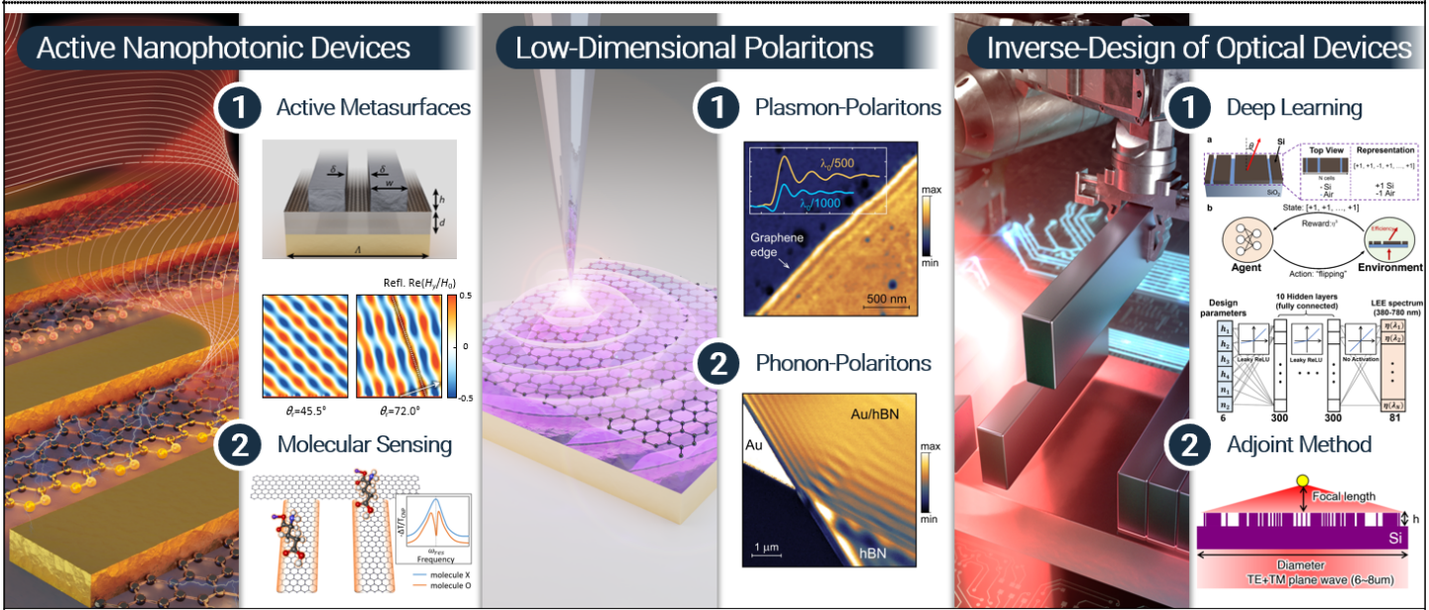
Lab : E3-2 #2222, #2232 TEL : 042-350-7539
Homepage : janglab.org
Email : jang.minseok@kaist.ac.kr

■ **Current member status (2024 Fall): 1 research professor, 1 post-doc, 10 PhD students, 8 MS students, 2 undergrads**

■ **Research Areas**

We understand the properties of light in ultra-small, subwavelength scales and develop technologies in the field of imaging, sensing, information processing, displays, and quantum computing



■ **Recommended courses and Potential career paths**

Theoretical research: To analyze and design photonic device functionalities, courses such as 'Electromagnetics' 'Quantum mechanics', and 'Fundamentals of photonics' are recommended.

Experimental research: The following courses 'Introductions to physical electronics', 'Semiconductor devices', 'Semiconductor IC technology', etc. are recommended to prepare oneself for fabrication of photonic devices.

There's a lot of demand for nanophotonics in both academia and industry, and diverse career paths are possible, whether it be researching in academia or working on display technologies at an industry.

■ **About our lab and prospective team members**

We are currently accepting graduate students who want a research experience in a lab. What we offer:

(1) Research along the **interface between science and engineering**: Understand the fundamentals behind physical phenomena, and apply it for engineering purposes.

(2) You can choose between theory/simulations or experiment, or both, depending on your aptitude or preferences.

(3) **Collaboration with other labs abroad** (Caltech, Harvard, Yale, UW Madison, EPFL, Southern Denmark Univ. (SDU))
Yale (Owen Miller): 3 graduate students visited for 6 months (from Nov. 2022 to Apr. 2023)
Caltech (Harry Atwater): 2 graduate students are visiting for 6 months (from Aug. 2024)
SDU (Asger Mortensen): 1 graduate student is is visiting for 6 months (from Jul. 2024)

Our lab prides in our friendly and horizontal lab culture and student-driven researches. We respect every student's own times and schedules, and provide an academic environment to study and research in at one's own needs.

* **About the PI**: I myself was a KAIST undergraduate, class of 2006, who took classes in the same rooms of KAIST and did internships and undergrad research programs, developing my skills as a researcher. I take as a top priority to lead a lab that's the most beneficial for our members, and will try my hardest in **helping students find the research topics of their interest** and **creating a non-authoritative lab atmosphere blooming with fruitful discussions**.

■ **Publications**

[1] "Electrostatic steering of thermal emission with active metasurface control of delocalized modes", Nature Communications (2024)
[2] "Graphene unlocks dispersion of topological polaritons", Nature Nanotechnology (2022).
[3] "Full 2π tunable phase modulation using avoided crossing of resonances", Nature Communications (2022s).
[4] "Near-field probing of image phonon-polaritons in hexagonal boron nitride on gold crystals", Science Advances (2022).
[5] "Real-space imaging of acoustic plasmons in large-area graphene grown by chemical vapor deposition", Nature Communications (2021).

<Professor Sanghun Jeon's Lab.>

ANTONIS Lab
Advanced Nano Technology based Opto, electronics & Integrated System Lab.

■ Contact information

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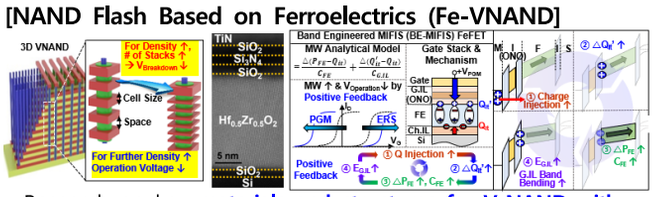
Website	https://antonis.kaist.ac.kr	

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 9 Master's Student: 17

■ Research Areas

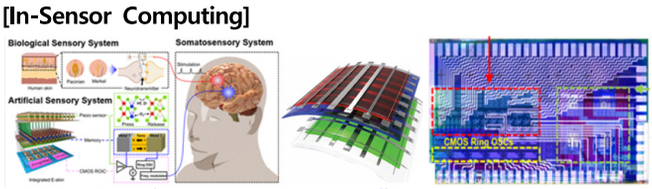
[NAND Flash Based on Ferroelectrics (Fe-VNAND)]



- Research on key **materials and structures for V-NAND with over 1000 layers** (KCHIPS 2023, 1000-layer NAND Project)
- Development and research of **MIFIS devices based on hafnia ferroelectrics** (KCHIPS 2023, 500-layer NAND Project)
- Research on **hybrid memory devices combining charge trapping and polarization switching principles** (Samsung, Flash Memory Project)
- Research on flash memory devices with a **negative capacitance-based insulator** (Samsung, Next-Generation Flash Project - Process Development)

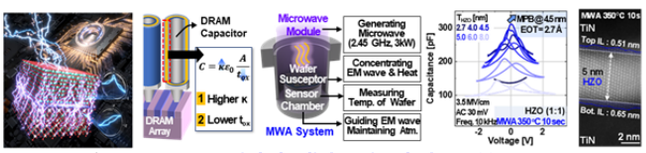
MW > 15V, Operating Voltage < 17V, Retention: 55°C/1 year, Verified on 24-layer NAND array

[In-Sensor Computing]



- Research on **low-temperature crystallization of nitride electrode-based dielectric films** (Samsung Project)
- Research on **semiconductor secondary battery** interfacing equipment and process platform technology (NNFC Project)
- Research on **high-sensitivity infrared image sensors** (Samsung Project)
- **I-CVD-based controlled dielectrics** for CMOS-compatible piezoelectric/pyroelectric thin-film materials (NRF Project)
- Research on **neuromorphic spatiotemporal tactile sensors using M3D platform** (NRF Project)

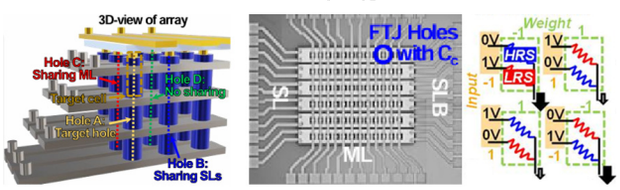
[High-k Dielectrics for Next-Generation DRAM Capacitors]



- Research on **DRAM High-k dielectrics below 10 nm process** (Hanyang University IRC Project)
- Research on **MPB High-k dielectrics based on hafnia ferroelectrics** (SAIT Project)
- Research on **High-k dielectrics based on ABO3 perovskites** (SAIT Project)
- Research on **crystallization techniques to minimize degradation of nitride-based dielectric films** (SAIT Project)

Dielectric constant > 60, leakage current density < 10^{-7} A/cm², crystallization temperature reduced to 200°C

[Ferroelectric Tunnel Junction (FTJ)]



- Development and research of **self-rectifying ferroelectric tunnel junction (FTJ) array devices** enabling high reliability and multi-level states (K-Chips 2024, FTJ Project)
- Research on **semiconductor technologies to overcome the limits of extreme scaling, extreme material properties, and heterogeneous integration** (H3) (Hanyang University IRC Project)

On/Off current ratio >5000, rectification ratio >10,000, operating voltage <2.5V, thin film thickness < 3.5nm, endurance > 10^{10} cycles, retention: 55°C/1 year, 3D FTJ array verified

■ Recommended courses & Career after graduation

◇ Recommended courses : Introduction to Physical Electronics, Semiconductor Devices, Semiconductor IC Technology
◇ Career : Semiconductor Industries and Institutes (Samsung, SK hynix, Qualcomm, NVIDIA, ETRI, etc.)

■ Introduction to other activities besides research

◇ Great Work Place (GWP) event : Wine seminar, LAB field trips
◇ Regular group meal
◇ Coffee time with LAB members
◇ Cultural activities : Bowling, laser tag, book club

■ Introduction to the Lab.

Our lab focuses on researching NAND Flash, DRAM, FTJ, and In-Sensor Computing utilizing ferroelectric materials.

■ Recent research achievements (최근 5개년)

Recent Papers and Research Achievements (Last 5 Years: Approximately 110 SCI Papers)

- NAND Flash Int. Elect. Dev. Meeting **(TBD IEDM 2023)**
- High performance FTJ, **IEEE Symp. VLSI Tech. & Circuit (2023)**
- FTJ based PUF, **IEEE J. Sol. Sta. Circuits (2023)**
- NC-based CIM device, **Adv. Funct. Mat. (2023)**
- Flash type CIM device, **IRPS (2023)**
- PIM device, **ACS Apl. Mat. Int. (2023)**
- M3D Sensor, **Nano Energy (2024)**
- NAND Flash, Int. Elect. Dev. Meeting **(IEDM 2022)**
- Super steep transistor, **ACS Appl. Mat. Int. (2022)**
- 1T-nC based majority functional logic, **IEEE EDL (2022)**
- Low EOT MPB, **ACS Appl. Mat. Int. (2022)**
- Microwave annealed low Temp. hafnia **ACS Appl. Mat. Int. (2022)**
- High performance & self rectifying FTJ, **(IEDM 2021)**
- Mechanism of FTJ, **ACS Nano (2024)**

Awards and Honors

- Awarded the 2022 Minister of Trade, Industry and Energy Commendation
- Received the 2013 Samsung Paper Champion Award
- Awarded the 2012 Samsung Infinite Exploration/Innovation Award
- Received the 2011 Samsung Best Paper Award
- Awarded the Samsung Electronics Innovation Award (2010-2011)

Publications, Conference Papers

- Approximately 200 SCI papers and 125 conference papers
- Presented a total of 19 papers at IEDM and VLSI Technology Symposium, the top conferences in the semiconductor device field
- In the past two years, presented 5 papers at IEDM, 3 at VLSI, 1 at IRPS, and participated in 9 HIPs

<Professor Myoungsoo Jung's Lab.>

Computer Architecture and Memory Systems Laboratory

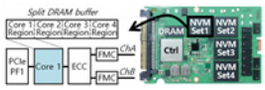
■ Contact information		
Professor	Email: m.jung@kaist.ac.kr	Tel: 042-350-7455
Lab.	Email: junhyeok@kaist.ac.kr	Tel: 042-350-7555
Website	http://camelab.org	

■ Research Areas

▶ CXL Hardware and Software co-solution

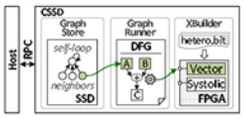
- Opening a new direction for memory disaggregation
- Ensuring direct accessible and high-performance capabilities

▶ Kernel & Storage Architecture



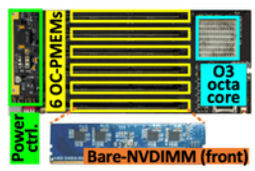
- High performance SSD architectures and firmware design
- In-memory processing and In-storage processing

▶ Machine Learning with Storage/SCM



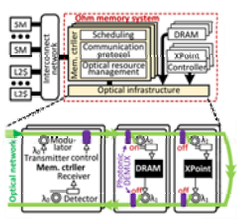
- Exploring ML algorithms to make system-related decisions
- Implementing hardware acceleration architectures using ML within Memory and storage

▶ Next Gen. Non-Volatile Memory (NVM)



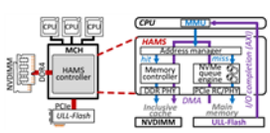
- Overcoming challenges of emerging NVMs such as RRAM and PRAM
- Architecting new platforms with byte-addressable NVMs

▶ Heterogeneous Computing



- Researching energy-efficient heterogeneous computing with diverse devices
- Remove data movement by aggressively integrating memory with hardware accelerator

▶ New Memory Computing



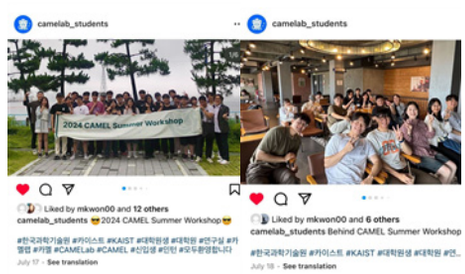
- New memory device design and implementation (e.g. Z-NAND, PRAM)
- Exploring a new territory to integrate new memory into domain specific accelerator

■ Recommended courses & Career after graduation

We recommend taking courses related to **operating systems (OS)**, **system programming**, **computer architecture, machine learning and field programmable gate array (FPGA)**. It would be better to have experiences with simulators or benchmark tools. Though all those courses and experiences listed above aren't mandatory. About career, based on your will, Dr. Jung will support everything for you to get publications and to become a leading researcher at from industry to faculty jobs.

■ Introduction to other activities besides research

We regard horizontal and active communications as important. So, we often have mealtimes and talking time together. Now, we are moving forward together encouraging each other. In addition, we sometimes visit abroad to attend top-tier academic conferences. If you're interested, check out our lab's instagram. :-) @camelab_members



Instagram

■ Introduction to the Lab.

Professor Jung has advised his students at UT Dallas, Yonsei Univ. and now KAIST under support and collaborations with U.S. government organizations, industries (Intel, Western Digital, Sandisk, Samsung, SK Hynix, Memray) and institutions (UIUC, Georgia tech). Our lab have published many papers to top-tier conferences and gotten attention in many presses. We continue to target top-tier conference publications in a perfect environment for research.

homepage

■ Recent research achievements (2012 - 2024)

- **46** publications in top-tier conferences. (Total 131 publications including major conferences and SCI journals.)
- Our system research is **ranked first** in Korea, according to the metrics-based system, CSRankings.
- 15 international articles, 181 domestic articles including **Korea major presses** and **Naver news headline**.
- 96 international and domestic patents.

<Professor Wanyeong Jung's Lab.>

Smart Energy-Efficient Design Laboratory

■ Contact information

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Lab. : seed@kaist.ac.kr TEL : 042-350-7559
Website : https://seed.kaist.ac.kr

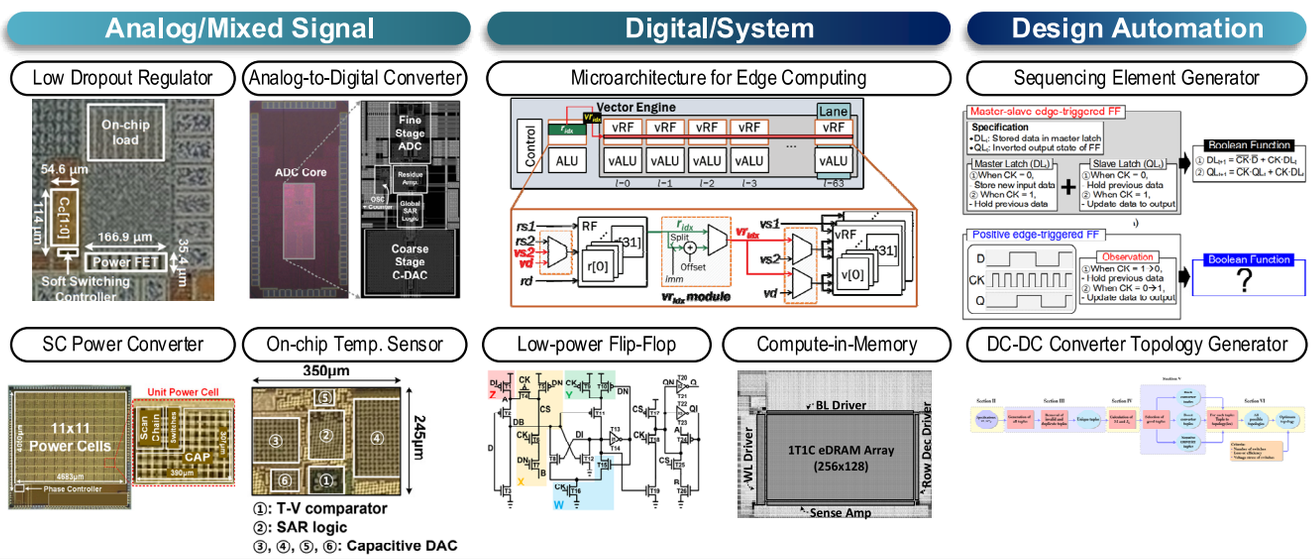
■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 11 Master's Student: 9

■ Research Areas

Our research group pioneers cutting-edge advancements from transistor-level to system-level circuit design.
We excel in analog/digital co-design, aiming to design circuits in a smarter and more energy-efficient way. Our research covers a wide range of areas such as op-amps, power management circuits, sensor interfaces, AI accelerators, and general-purpose processors. Through these works, we are dedicated to developing compact and cost-effective IoT platforms that are powerful and adoptable to modern technological demands.

▶ Our Works



■ Recommended courses & Career after graduation

Courses for analog and digital integrated circuits are strongly recommended. Basic English and programming skills are necessary. The career after graduation includes academia or industries related to circuit design.

■ Introduction to other activities besides research

Our group holds regular dinners and annual workshop. The group supports attendance at top international conferences in the field of integrated circuits such as ISSCC and VLSI-C, and other student-driven events and activities.

■ Introduction to the Lab.

Since 2019, our group has been working with graduate students and undergraduate students who are interested in IoT/low-power circuits and systems. Our lab offers a friendly atmosphere with various research opportunities and encourages creative approaches to research.

■ Recent research achievements (2024)

[1] "A Single/Dual-Output **Switched-Capacitor DC-DC Converter** with Geometrically Arranged Soft VCR Transitions", IEEE A-SSCC, 2024
[2] "A -60 to 145 °C, 216 fJ·K² Energy-Efficient **MOS-Based Temperature Sensor** Achieving 71.8 mK Resolution", IEEE A-SSCC, 2024
[3] "SeGen: **Automatic Topology Generator** for Sequencing Elements", ACM/IEEE ICCAD, 2024
[4] "A High-Resolution **Pipelined-SAR ADC** Using Cyclically Charged Floating Inverter Amplifier", IEEE JSSC, Jul. 2024 (invited)
[5] "A 0.6-1 V VIN Soft-Switching **Low Dropout Regulator** With 31.3 A/mm2 Current Density, 99.99% Current Efficiency, and 2.04 fs FoM", IEEE VLSI-C, 2024
[6] "VVIP: Versatile Vertical Indexing **Processor for Edge Computing**", ACM/IEEE DAC, 2024
[7] "A Redundant-Transition-Free and Contention-Free Change-Sensing **Flip-Flop**", IEEE TCAS-II, Mar.2024 (invited)

<Professor Jae-Woong Jeong's Lab.>

Bio-Integrated Electronics and Systems Laboratory

■ **Contact information**

Professor : Nanofab center (E19), Room 516

Lab. : Nanofab center (E19), Room 522

Website : http://jeongresearch.org

■ **Current state of the Lab. (in 2024 Spring Semester)**

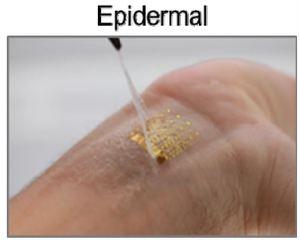
Postdoctoral Fellows : 2 PhD Students: 7 Master's Student: 10

■ **Research Areas**

Our mission is to invent the future generation "soft" bioelectronics and biomedical systems for advancing healthcare and biomedical research. Research areas in our group include design and fabrication of flexible/stretchable electronics, photonic microsystems, and microfluidic devices for various applications such as health/wellness monitoring, disease diagnosis and therapy, human-machine interfaces, and neuroscience.

"Wearable" Skin-like Electronics

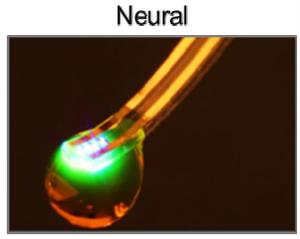
Epidermal



Conventional biomedical devices mounted on our body are rigid, bulky, and its mechanical properties do not match with the property of the human tissue. Based on flexible/stretchable electronics technologies, our group develops soft, flexible, and stretchable devices with diagnostic and therapeutic capabilities, which can be conformally wrapped on curvilinear-shaped skin. We are broadly interested in stretchy bio-integrated electronics that integrate multiple modalities (e.g. electronics, photonics, and microfluidics)

"Implantable" Soft Electronics

Neural



Implantable devices have been drawing significant attentions in biomedical research for continuous monitoring of force, pressure, temperature, and electrophysiological signals inside living subjects. Implantable electronic systems must be small in size, compatible with biological tissue, and sturdy enough to withstand the physical forces within the body. Our research focus is to develop soft, stretchable sensors and actuators that enable high spatiotemporal resolution recording and control; and that conform to the micro-geometry of 3-D tissue without creating damaging local stresses. Our particular interests are in implantable cardiac devices and wireless multifunctional neural probes for the brain.

"Transformative" Electronics

Transformative

Electronics capable of changing their shape, flexibility, and stretchability will enable versatile and accommodating systems for more diverse applications. Our group investigates design concepts, materials, physics, and manufacturing strategies that enable these reconfigurable electronic systems based on stimuli-responsive materials such as liquid metals. We are interested in developing this technology to create various transformative electronics for applications in wearables, implantables, sensing, robotics, and display.

■ **Recommended courses & Career after graduation**

Recommended courses: MEMS, micro/nanofabrication, circuit design, embedded systems, etc.

Potential career path:

Industry: Electronics, Semiconductor, Medical, etc.

Academia: Univ. Professors, Researchers at National Labs

■ **Introduction to other activities besides research**

We hold annual group party and workshop. In addition, we attend various international conferences including Transducers, MEMS, EMBC, MRS, BMES, etc.

■ **Introduction to the Lab.**

Our group works on multidisciplinary research, crossing the areas of EE, ME, BME, materials, and physics. We are actively collaborating with Washington Univ. School of Medicine, Georgia Tech, Yonsei University Medical School, etc.

■ **Recent research achievements ('22~'24)**

- ***Nature Communications, Advanced Materials*** (2021). ***Nature Biomedical Engineering, Nature Communications, Advanced Materials*** (2022). ***Nature Protocols, Nature Communications, Science Advances*** (2023).

[1] "Soft subdermal implant capable of wireless battery charging and programmable controls for applications in optogenetics." ***Nat. Commun.*** 12, 535 (2021).

[2] "Scalable and modular wireless-network infrastructure for large-scale behavioural neuroscience." ***Nat. Biomed. Eng.*** 6, 771–786 (2022).

[3] "Rapid meniscus-guided printing of stable semi-solid-state liquid metal microgranular-particle for soft electronics" ***Nat. Commun.*** 13, 2643 (2022).

[4] "Customizable, wireless and implantable neural probe design and fabrication via 3D printing" ***Nat. Protoc.*** 12, 219-237 (2023).

< Professor Joon Son Chung >

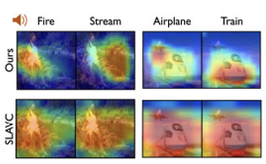
Multimodal AI Lab	■ Contact information		
	Professor	Email: joonsc@kaist.ac.kr	Tel: 042-350-2114
	Lab.	N24 #3102	
	Website	https://mmai.io	

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 7 + 9 (integrated) Master's Student: 7

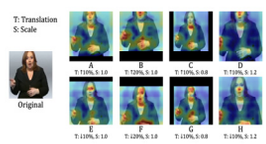
■ Research Areas

- **Sound Source Localization**



As humans have intuitive understanding of the direction of sound when perceiving visual scene. By focusing on cross-modal alignment of visual and auditory information and leveraging learning-based approach, we achieve high localization performance.

- **Sign Language and Gesture Recognition**

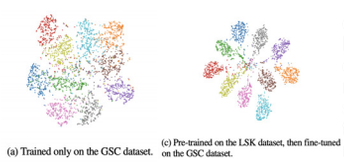


Sign language includes complex features to sufficiently understand the meaning. Therefore, we attempt to extract multiple features without the need for additional annotations. Our self-sufficient learning framework and thereby achieves the state-of-the-art performance.

- **Talking Face Generation**

Generating a talking face video plays a crucial role in human-computer interactions and can be applied to diverse fields. We construct a method that generates a natural-looking talking faces with fully controllable facial attributes and accurate lip synchronization

- **Keyword Spotting**



(a) Trained only on the GSC dataset. (c) Pre-trained on the LSK dataset, then fine-tuned on the GSC dataset.

We explore a task of discovering keywords spoken by humans. By leveraging user-defined keyword spotting and metric learning, we produce the state-of-the-art performance in the domain. We also propose a novel dataset corresponding to the task.

■ Recommended courses & Career after graduation

- Signals and Systems (EE202)
- Programming Structure for Electrical Engineering (EE209)
- Deep Learning for Computer Vision (EE488B)

■ Introduction to other activities besides research

Our Lab highly encourages social events including strawberry party, internal workshops, and sports. All lab members including foreign students and interns are open to active participation.




■ Introduction to the Lab.

Mutimodal AI (MMAI) Lab develops numerous ideas based on multi-modal data. With the help of Artificial Intelligence, we aim to solve various tasks by fundamental understanding of multi-modality, an extension of single modal approach such as vision only, and audio only. We focus on augmenting the performance of existing tasks by the multi-modal approach and exploring more in-depth researches based upon the combination of various information. Any motivated students in machine learning, visual, and auditory information are welcomed.

■ Recent research achievements (2024)

[1] J. Kim, H. Lee, K. Rho, J. Kim, J. S. Chung, "**EquiAV: Leveraging Equivariance for Audio-Visual Contrastive Learning**,'' International Conference on Maching Learning, 2024

[2] Y. Jang, J. Kim, J. Ahn, D. Kwak, H. Yang, Y. Ju, I. Kim, B. Kim, J. S. Chung, "**Faces that Speak: Jointly Synthesising Talking Face and Speech from Text**," IEEE Conference on Computer Vision and Pattern Recognition, 2024

[3] D. M. Argaw, S. Yoon, F. C. Heilbron, H. Deilamsalehy, T. Bui, Z. Wang, F. Dernoncourt, J. S. Chung, "**Scaling Up Video Summarization Pretraining with Large Language Models**," IEEE Conference on Computer Vision and Pattern Recognition, 2024

[4] J. Kim, J. Kim, J. S. Chung, "**Let There Be Sound: Reconstructing High Quality Speech from Silent Videos**," AAAI Conference on Artificial Intelligence, 2024

Inference and Information for Data Science (IIDS) Lab.

■ **Contact information**
Professor : ITC Building (N1) 206 TEL : 042-350-7441
Lab. : ITC Building (N1) 213 TEL : 042-350-7541
Website : http://iids.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**
PhD Students: 7 Master's Student: 5

■ **Research areas: Algorithms and theory for data science / Efficient deep learning and trustworthy AI.**

The goal of our research group is to provide a **theoretical and algorithmic framework** for data science and machine learning that can lead to efficient strategies for assessing, gathering, extracting, and exploiting information. In the era of big data, we want to fully utilize the large volumes and richness of data sets to efficiently infer the real-world phenomena behind the data. Information-theoretic concepts and tools are useful in data science, especially to establish fundamental limits and to explore trade-offs in extracting information from data sets. To deal with new challenges originated from practical concerns related AI systems, we also develop algorithms for data-efficient deep learning, and robust/trustworthy ML/AI systems.

■ **Recent research topics:**

- **Data-efficient deep learning:** storing and utilizing large datasets for training deep neural networks require high storage and computational costs. Our goal is to solve this challenge by finding techniques to select the most informative subset of the dataset or to acquire a summary of the dataset that can approximate the training with the entire datasets in a cost-efficient manner.

- **Robust and trustworthy machine learning:** we work on developing reliable machine learning methods to address practical issues in deploying deep learning systems such as out-of-distribution detection or test-time adaptation.
- **Algorithms and theory for data science:** we have worked on developing strategies to efficiently collect data from human annotators using crowdsourcing platforms and to extract useful information from high-dimensional data such as random graphs or matrices. We develop new algorithms and theoretically analyze these algorithms to provide not only efficient ways of processing data but to provide theoretical guarantees of the algorithms.

■ **Recommended courses & Career after graduation**

Recommended courses are probability, information theory, and machine learning. Mathematical background and/or programming skills would be helpful to start research in our lab. Data science and machine learning are rapidly emerging areas with many possible career opportunities both in industry and academia.

■ **Introduction to other activities besides research**

Students who would join our group can freely suggest ideas on group activities they would like to have. Prof. Hye Won Chung is willing to provide great support for students in our group and she tries to be available for students in meeting and discussing ideas.

■ **Introduction to the Lab.**

We are welcoming new students who are passionate in exploring interesting ideas in data science and machine learning. We encourage open discussions and collaborations in defining research problems and developing ideas.

■ **Recent research achievements (Year 2024)**

[1] BWS: Best Window Selection Based on Sample Scores for Data Pruning across Broad Ranges, ICML 2024
[2] SelMatch: Effectively Scaling Up Dataset Distillation via Selection-Based Initialization and Partial Updates by Trajectory Matching, ICML 2024
[3] Representation Norm Amplification for Out-of-Distribution Detection in Long-Tail Learning, TMLR 2024
[4] Exact Graph Matching in Correlated Gaussian-Attributed Erdos-Renyi Model, ISIT 2024
[5] Detection Problems in the Spiked Random Matrix Models, IEEE Trans. on Information Theory, 2024
[6] Asymptotic Normality of Log-Likelihood Ratio and Fundamental Limit of the Weak Detection for Spiked Wigner Matrices, Bernoulli, 2024
[7] A Worker-Task Specialization Model for Crowdsourcing: Efficient Inference and Fundamental Limits, IEEE Trans. on Information Theory 2024

<Professor Minkyu Je's Lab.>

IMPACT Lab
Integrated Microsystems Powered with Advanced Circuit Technology

■ **Contact information**

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Lab. : ygc980215@kaist.ac.kr TEL : 7637

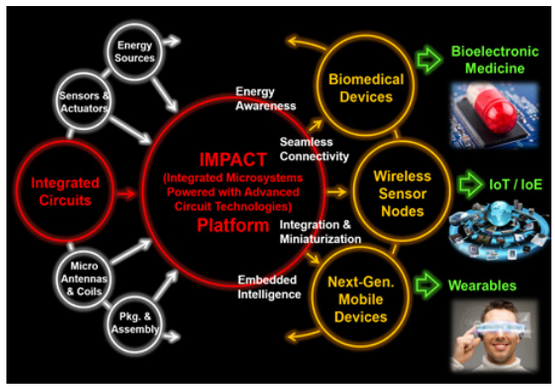
Website : impact.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 23 Master's Student: 20

■ Research Areas

The core technology of the research is analog, mixed-signal, and RF integrated circuit design techniques, especially focusing on intelligent sensor interface circuits and ultra low power wireless communication circuits.



▷ **Intelligent sensor interface**

The sensor interface circuit that works with the sensor is an essential component to acquire the information of the real physical world. It has to provide sufficient performance while consuming low power. In particular, we aim to develop an intelligent interface circuit that can compensate the deficiencies of the sensor and extract meaningful information even under imperfect conditions.

▷ **Ultra-low-power wireless communication**

Particularly, we are interested in the technology that realizes the short distance communication in the vicinity of the human body with high energy efficiency as well as the various circuit techniques for duty-cycling the wireless communication circuits which consume the most power in the wireless sensor microsystems as much as possible.

▷ **Microsystem convergence for emerging applications**

Based on this low-power integrated circuit technology, the extremely small and intelligent systems can be integrated for various applications expected to play an important role in the future. Especially, the miniaturized medical device that can be implanted inside a human body for therapeutics, brain research, and neuromodulation is the main application area. We are also interested in wearable devices which are expected to be the next generation mobile devices, and ultra low power wireless sensor nodes which are key to the implementation of the internet of things.

■ Recommended courses & Career after graduation

Courses on circuit and system design as well as wireless communication are recommended, which include circuit theory, electronic circuits, analog electronic circuits, digital electronic circuits, digital systems, digital signal processing, communication engineering, and radio engineering. After graduation, your career can be furthered at a variety of domestic and foreign companies, research institutes, or universities related to integrated circuit and microsystem design as well as research and development in the application areas of IoT, wearables, and medical devices.

■ Introduction to other activities besides research

The IMPACT lab. is fairly new in that we started in 2016 at KAIST. Therefore, the members can make an important contribution in forming the culture of the laboratory. The best possible support will be provided to create an environment in which the members can engage in research with pleasant passion, voluntary commitment, and open exchange, based on strong mutual trust. A variety of non-research activities are also being created in line with this.

■ Introduction to the Lab.

We are not just targeting to develop new circuit design techniques, but to create substantial achievement that can greatly affect our future lives, by working together with experts from diverse fields including sensor, energy, communication, packaging, as well as medical devices and IT applications through an international collaborative research network.

■ Recent research achievements (2024)

[1] A Two-Electrode Bio-Impedance Readout IC with Complex-Domain Noise-Correlated Baseline Cancellation Supporting Sinusoidal Excitation, in Proc. IEEE International Solid-State Circuits Conference (ISSCC), Feb. 2024.

[2] A Fully Integrated Dynamic-Voltage-Scaling Stimulator IC with Miniaturized Reconfigurable Supply Modulator and Channel Drivers for Cochlear Implants, in Proc. IEEE Custom Integrated Circuits Conference (CICC), Apr. 2024.

[3] A 5.7 kfps Fast Neural Electrical Impedance Tomography IC Based on Incremental Zoom Structure with Baseline Cancellation for Peripheral Nerve Monitoring Systems, in Proc. IEEE Symposium on VLSI Technology and Circuits (SOVC), Jun. 2024.

[4] An Intra-Body-Power-Transfer System Energized by an Electromagnetic Energy Harvester for Powering Wearable Sensor Nodes, in Proc. IEEE Symposium on VLSI Technology and Circuits (SOVC), Jun. 2024.

[5] A Δ-Based Spike Sorting SoC with End-to-End Implementation of Event-Driven Binary Autoencoder Neural Network in Analog CIM Achieving 94.54 % Accuracy and 3.11 μW/ch, in Proc. IEEE Symposium on VLSI Technology and Circuits (SOVC), Jun. 2024.

[6] A Fully Dynamic 1st-Order 1st-Order Δ-ΔΣ Modulator with a 468 mVpp Input Range for Electrical Impedance Tomography Systems, in Proc. IEEE Symposium on VLSI Technology and Circuits (SOVC), Jun. 2024.

<Professor Byung Jin Cho's Lab.>

NAND
Nanoelectronic And Neuromorphic Device Lab

■ **Contact information**

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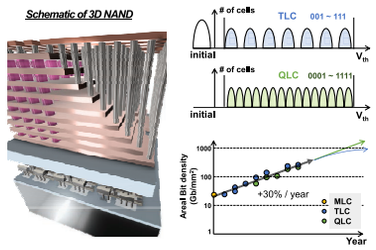
■ **Current state of the Lab. (in 2024 Fall Semester)**

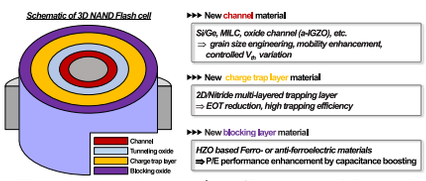
Postdoctoral Fellows : 0 PhD Students: 9 Master's Student: 7 Visiting Researcher: 4

■ **Research Areas**

3D NAND Flash

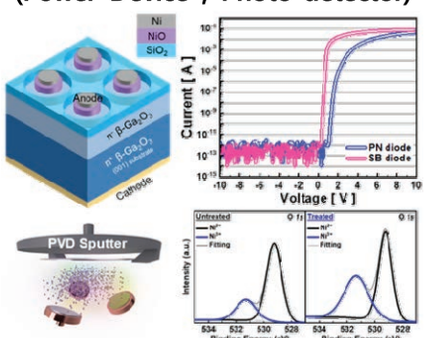


The rapid evolution of high-tech industry, including artificial intelligence, big data, autonomous driving, and cloud computing, is anticipated to drive a consistent demand for memory semiconductors, especially for **3D NAND technology**.



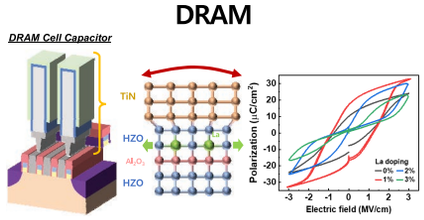
To maintain a leading position in the ever-competitive arena of 3D NAND technology, our laboratory actively has been researching for the next-generation **charge trap flash (CTF) technology**. This research area includes high-mobility channel materials, low-k interlayer dielectric (ILD), novel charge trap layer (CTL), new blocking layer and innovative cell structure.

WBG Oxide semiconductor device (Power Device , Photo-detector)

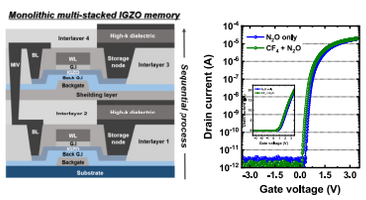


As Si-based devices has been facing various limitations, oxide semiconductors which can change the game of the semiconductor industry are emerging. Nickel oxide and Gallium oxide, which are type of **oxide semiconductors** featuring wide bandgap (**WBG**) characteristics, are getting attention as advanced channel materials for **power devices**, specifically diode**,** due to their capability of withstanding ultra-high voltage/current. In addition, oxide semiconductors can be used as optical devices (**photo-detector**) for detecting UV light with excellent photo-responsivity. Our laboratory are actively working on fabricating and developing power device and photo-detector based on WBG oxide semiconductor.

DRAM



Performance improvement of **DRAM cell capacitor** with conventional materials has reached its limit and people are seeking for new materials with high-k value and better leakage characteristic. Our research group is studying various methods to achieve the better performances utilizing ALD-$Hf_xZr_{1-x}O_2$ dielectrics for superior DRAM cell capacitor.



At the same time, to lead the low-power and high density 3D DRAM, we are researching the possibility of **Monolithic multi stacked 3D DRAM** with oxide semiconductor (e.g. IGZO) for the new channel material.

■ **Recommended courses & Career after graduation**

Our lab strongly recommends freshmen to take following courses: [EE211] Introduction to Physical Electronics, [EE362] Semiconductor Devices, [EE463] Semiconductor IC Technology, and so on. After graduation, graduates start their careers in domestic or foreign semiconductor companies (Samsung Electronics, SK Hynix, Lam Research, etc), research institutes, universities, and so on.

■ **Introduction to other activities besides research**

We regularly engage in sports activities such as futsal and badminton every week, and we actively interact with other labs. We also enjoy delicious meals together, and we hold events such as picnic, workshop, homecoming, and MT (membership training) every year.

■ **Introduction to the Lab.**

Our lab has world-class experience and various know-hows on traditional memory devices **(NAND and DRAM)** and advanced semiconductor devices **(Monolithic 3D integration and Oxide semiconductor based devices)**. Currently we are running 8 main projects funded by Samsung, SK hynix, and government agencies. Our research group published **301 journals** and presented in **363 conferences**. Professor thoroughly guides our research with his deep understanding on CMOS technology. Our lab has open and friendly atmosphere that students make interactive discussion about their research.

■ **Recent research achievements ('22~'24)**

Major International Conference (two VLSI – 2023, 2024)
19 SCI papers, 21 conference presentations, 13 patents

〈Professor SeongHwan Cho's Lab.〉

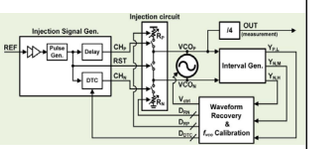
Cho's Circuits and Systems Laboratory (CCSLAB)	■ Contact information		
	Professor	Email: chosta@kaist.ac.kr	Tel: 042-350-3480
	Lab.	Nano-Fab Center 304	
	Website	https://ccs.kaist.ac.kr	

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows: 0 Ph.D. Students: 11 Master's Students: 7

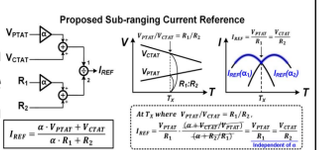
■ Research Areas

▷ High-speed analog, mixed-signal and RF circuits



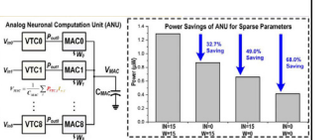
The high-speed analog, mixed-signal and RF circuits studied in our laboratory include clock generation, memory interface, and wireline transceiver. Representively, PLL is an essential analog and mixed-mode circuit which synthesizes system clock to the desired frequency for communication system. Recently, we are focusing on subharmonic injection locking technique for low-jitter clock multipliers applications.

▷ Low-power circuits for sensors



High performance PVT-insensitive sensors are one of our current research interests. In most applications, PVT variation degrades the performance of sensors. To relieve the trade-off between calibration cost and performance, we are currently focusing on developing related techniques for biomedical, automotive and industrial sensors.

▷ Machine learning and memory



Machine learning based on neural network has garnered great interest over the past decade as it has the potential to revolutionize various technologies for commercial and industrial use. In particular, we are interested to implement machine learning processor in analog circuit domain which is effective to achieve low-power and high-speed operation than digital domain.

■ Recommended courses & Career after graduation

Students are encouraged to take Circuit Theory, Electronic Circuits, Communication System, Introduction to Physical Electronics and Digital Signal Processing. Alumni are working with international major companies and research institutes such as DGIST, ETH Zurich, KAIST (Faculty), NVidia, Qualcomm, Broadcom, A*STAR, Samsung Electronics, Fairchild, MIT, Stanford, Univ. of Michigan, U. C. San Diego, MIT Sloan (MBA), and T. U. Delft.

■ Introduction to the Lab

Our group explores emerging technologies for high-performance communication and interference-tolerant sensors. Research focus is on the design of analog integrated circuits with multiple layers of system abstraction in mind, from algorithms and system architectures to circuit techniques and devices. Our main research area is wireline data interface, CMOS sensors, phase-locked loops (PLL), and low power circuit for machine learning. Recently we are also looking into power management circuit as well as reference generator.

■ Introduction to other activities besides research

We take annual/seasonal events such as strawberry party (spring season), ski camp and workshop to foster friendship. Also, members can have flexible vacation plan during the year to refresh and reinforce their motivation. We offer various opportunities to participate in international conferences.

■ Recent research achievements

[1] H. Choi, S.H. Cho, "A 7.5GHz Subharmonic Injection-Locked Clock Multiplier with a 62.5MHz Reference, -259.7dB FoMJ, and -56.6dBc Reference Spur," IEEE Int'l Solid-State Circuits Conference (ISSCC), 2024.

[2] P. Park, J. Lee, S.H. Cho, "A PVT-Insensitive Sub-Ranging Current Reference Achieving 11.4ppm/°C from -20°C to 125°C," IEEE Int'l Solid-State Circuits Conference (ISSCC), 2024.

[3]J. Oh, and S.H. Cho, "A 0.001-mm2, 1.15-11 GHz Background Quadrature Phase and Duty-Cycle Error Corrector Using a NAND-based Phase Detector in 28-nm CMOS", IEEE Solid State Circuits Letters, 2024.

[4] J. Seo, M. Seok, S.H. Cho, "A 44.2-TOPS/W CNN Process With Variation-Tolerant Analog Datapath and Variation Compensating Circuit", IEEE J. Solid-State Circuits, vol. 59, no. 5, 2024.

⟨Professor Kyung Cheol Choi⟩

Advanced Display and Nano Convergence Laboratory	■ Contact information		
	Professor	Email: kyungcc@kaist.ac.k	Tel: 042-350-3482
	Lab.	Device Innovation Facility (E3-3)	Tel: 042-350-5482
	Website	http://adnc.kaist.ac.kr	

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 14 Master's Student: 8

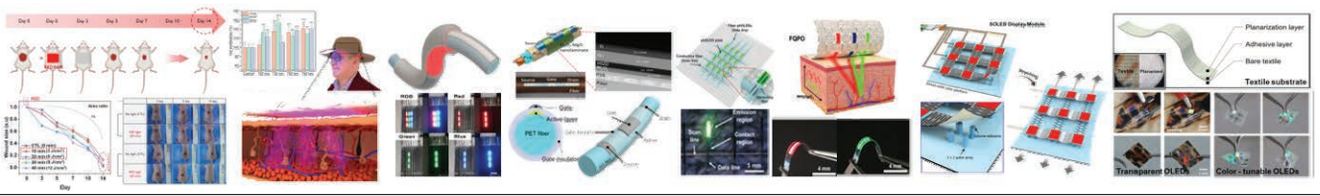
■ Research Areas

▶ **Transparent and Flexible display –** Fundamental researches on encapsulation, electrodes, and out-coupling enhancement methods applicable to transparent and flexible OLED displays.

▶ **Wearable and Stretchable display –** Various researches on display devices fabricated on textiles, such as fabric and fiber, used for truly wearable (wearing) and stretchable OLEDs are going on in the ADNC lab. Wearing textile displays are clothing-like wearable devices that can be used for fashion displays, IoT devices, and photo-therapeutic patches. Stretchable displays are beyond the curved and foldable displays and a strong candidate for future displays.

▶ **Bio and Medical applications (Photo-therapeutic by using display devices) -** Research on photo-therapeutic and cell & animal experiments (in-vitro & in-vivo) by using display devices used for medical tools, health-care is going on

▶ **Nanotechnology and nano-covergence –** New innovative technologies such as active metaphotonic color-imaging devices, oxide TFTs are also going on in ADNC Lab.



■ Recommended courses & Career after graduation

The lecture titled 'Display engineering' is recommended. A total of 54 people (as Ph.D. 35, M.S. 19) graduated from ADNC Lab. are working in university, corporations, and national institutes as professors and research engineers.

■ Introduction to other activities besides research

ADNC lab emphasizes team-work through various sports activities such as footsal, basketball, hiking and etc.

■ Introduction to the Lab.

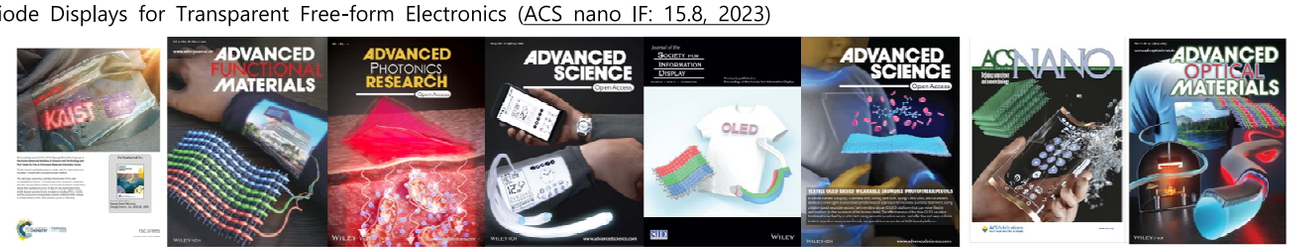
The ADNC lab conducts research on future technology of display devices. Until now, we have published 204 SCI papers, delivered 236 presentations in conferences, and filed 119 patents. ADNC lab had led the Center for Advanced Flexible Display Convergence (CAFDC), an 'Advanced Research Center Program' of the National Research Foundation of Korea (NRF) from 2007 to 2016. Since 2017, Our lab has been in charge of the important part in "Attachable Photo Therapeutics Center for e-Healthcare", a new Engineering Research Center (ERC) of NRF, which is funded until 2024. Professor Kyung Cheol Choi has been in charge of the LG Display-KAIST cooperation center from 2010 until now, and our laboratory hence has many opportunities for industry-academia cooperation with LG Display. From previous research on the world's most efficient PDP to current research on textile-based washable optoelectronic modules, we have reported numerous excellent results and have attracted attention from worldwide industries and various media. Students interested in future technologies should take note of our lab.

■ Recent research achievements (2022-2024)

19 SCI papers, 36 presentations in conference, 27 patents applied for or registered.

[Representative Journal papers]

- Graphene-enabled laser lift-off for ultrathin displays (Nature Communications IF: 14.7, 2024)
- Quantum-Dot Light-Emitting Fiber Toward All-In-One Clothing-Type Health Monitoring (ACS Nano IF: 15.8, 2024)
- **[Front Cover]** Highly Air-stable, Flexible, and Water-resistive 2D Titanium Carbide MXene-based RGB Organic Light Emitting Diode Displays for Transparent Free-form Electronics (ACS nano IF: 15.8, 2023)



⟨Professor Sung-Yool Choi's Lab.⟩

QMDL
QUANTUM MATERIALS & DEVICES LAB

■ Contact information

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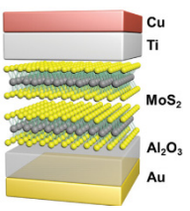
Lab. : School of Electrical Engineering (E3-2) 5232
KI Building (E4) C418

Professor	**Email:** sungyool.choi@kaist.ac.kr	**Tel:** 042-350-7427
Lab.	**Email:** kingkongdo@kaist.ac.kr	**Tel:** 042-350-7627
Website	qmdl.kaist.ac.kr	

■ Current state of the Lab. (in 2024 Fall Semester)

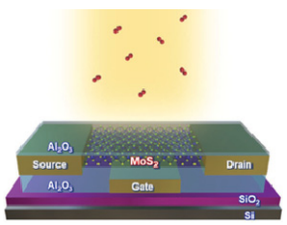
Research Professor: 1 Postdoctoral Fellows : 0 PhD Students: 10 Master's Student: 9

■ Research Areas



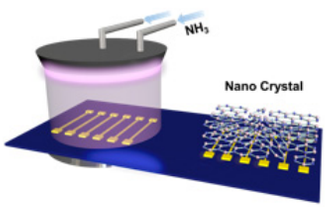
▸ Neuromorphic and Memristor Devices

- Our research focuses on studying and advancing innovative devices for memory, logic, and neuromorphic computing applications, including the next generation of in-memory computing and memristor-based neural network-mimicking devices.
- By employing advanced materials and structural engineering, we aim to enhance the performance of memristors as artificial synapses ans neurons, complemented by comprehensive device-to-system simulations for artificial neural networks.



▸ Electronics based on 2D Materials

- By conducting core technologies compatible with 2D semiconductors—such as precise doping, defect passivation, and material transfer—we are able to meticulously fine-tune transistor performance.
- Furthermore, we also utilize intensive pulsed light (IPL) technology to improve the performance of transistors and synthesize different materials.
- By developing low-power integrated circuits based on two-dimensional semiconductors, we aspire to implement TFT arrays within flexible display backplanes.
- We are also focused on creating advanced optical devices for sensor applications, utilizing two-dimensional materials with diverse bandgaps.



▸Synthesis & Process for 2D or Novel nanomaterials

- Our laboratory employs a diverse array of advanced technologies for the synthesis of semiconductor transition metal dichalcogenides (TMDs) including metallic graphene, molybdenum disulfide (MoS_2), and insulating hexagonal boron nitride (h-BN).
- In addition to traditional chemical vapor deposition (CVD) methods, we are exploring innovative synthesis techniques such as organometallic chemical vapor deposition (MOCVD) and atomic layer deposition (ALD) to transcend the limitations associated with conventional processes.

■ Recommended courses & Career after graduation

We encourage you to take following courses.

- Introduction to Physical Electronics (EE211)
- Semiconductor Devices (EE362)
- Semiconductor IC Technology (EE463)

As of 2024, 7 QMDL alumni hold university professorships, 2 are conducting research at ETRI and KIMM, and 29 are employed by companies such as Samsung Electronics and SK hynix.

■ Introduction to other activities besides research

We develop our research through lively discussions between seniors and juniors in a casual atmosphere. We also invite alumni to present their research and conduct workshops once a semester. In addition, there are many opportunities to attend national and international conferences. Annual events include a strawberry party in April and a year-end party in December.

■ Introduction of the Lab.

Quantum Materials and Devices Lab (QMDL) is focusing on the molecular-scale materials and devices for the next-generation IT-ET-BT convergence technology, spanning the electronics and photonics applications. Our vision of research is "**creative researches to change the world**". All research members can choose creative research topics based on the above-mentioned topics considering students' opinions. **QMDL is mainly supervising GRC (Graphene/2D Materials Research Center), CAMD^3 (Center for Advanced Materials Discovery towards 3D Display), and KAIST-Hansol Center for Advanced Materials and Devices**. Individual member can have opportunities to perform in-depth study by cooperating with other members to achieve outstanding performance.

KAIST GRC 그래핀/2D소재 연구센터
GRC (Since 2012)

KAIST CAMD^3 디스플레이 미래소재 연구센터
CAMD^3 (Since 2016)

KAIST-Hansol Center (Since 2022)

■ Recent research achievements ('22~'24)

Neuromorphic and Memristor Devices

1. Adv. Sci. 11(23), 2308847 (2024)
2. Adv. Funct. Mater. 34, 2305136 (2024)
3. Small. 19, 2300223 (2023)
4. Mater. Horiz. 10, 2035-2046 (2023)
5. Adv. Mater. 35, 2300023 (2023)[Inside Front Cover]
6. Adv. Intell. Syst. 4, 2200177 (2022)
7. Adv. Intell. Syst. 4, 2200018 (2022) [Front Cover]

Electronics based on 2D Materials

1. ACS Appl. Mater. Interfaces. 16(33), 43849 (2024)
2. Nanoscale, Advance Article (2024) (Online published)
3. Small. 20, 2305143 (2024)
4. ACS Photonics. 10, 3027 (2023)
5. ACS Nano. 17, 9262 (2023)
6. Adv. Electron. Mater. 8, 2101325 (2022)

Synthesis & Process for 2D or Novel nanomaterials

1. Adv. Mater. 35, 2305222 (2023) [Supplementary Cover]
2. Adv. Mater. Interfaces. 10, 2300135 (2023)
3. ACS Appl. Nano. Mater. 6, 8981 (2023)
4. ACS Appl. Mater. Interfaces. 14, 43907 (2022)
5. Chem 8, 1014 (2022) [Front Cover]

<Professor Shinhyun Choi's Lab.>

ENTIS (Emerging Nanoelectronic Technology and Integrated Systems) Lab.

■ **Contact information**

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Lab. : E3-2 Room 5215 TEL : +82-42-350-7650

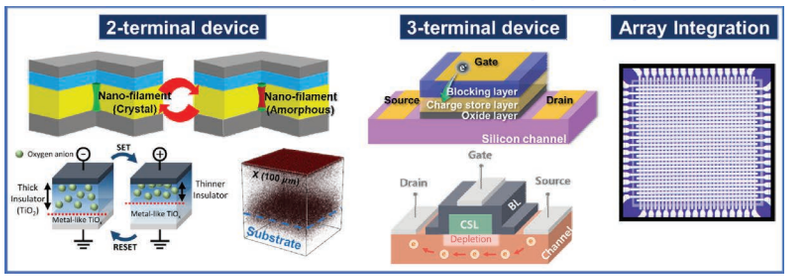
Website : www.shinhyunlab.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 11 Master's Student: 6

■ **Research Areas**

<Fabricating Emerging Nano Technology Device>

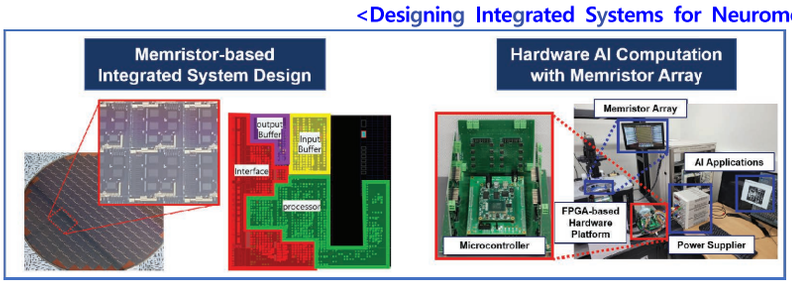


Our research team designs, fabricates and evaluates emerging nanoelectronic devices including:

1) **2-terminal devices (RRAM, PCRAM, etc)**
2) **3-terminal field-effect transistor (FET)**
3) **Array integration of emerging devices.**

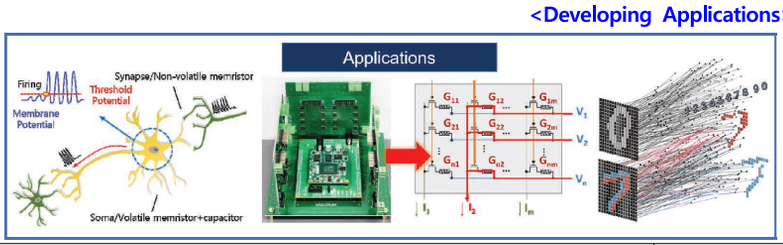
Our devices have garnered attention as possible candidates for various applications, such as neuromorphic computing, new memory technologies and logic devices.

<Designing Integrated Systems for Neuromorphic Computing>



By utilizing emerging device-based computing systems, **our team is working on demonstration of fully integrated systems from artificial neurons to artificial synapses.** Furthermore, we are also working on emerging device-based hardware such as digital/analog peripheral circuits controllers and software development for AI.

<Developing Applications>



Our team is focusing on **how to accurately implement AI inference and learning with low energy consumption using emerging devices.** Another focus of us is how to use applications that can be efficient by utilizing our devices about images, sequence data, security, medical diagnosis and etc.

■ **Recommended courses & Career after graduation**

The major pre-requisites are knowledge in semiconductor device physics, fabrication, and neural networks. However, students majoring CS or circuit are also welcome. Our goal is to help students become key members of academia and industry on a global scale.

■ **Introduction to other activities besides research**

The lab holds annual group parties and joint workshops for perspective collaboration. We also attend international conferences, including MRS, IEDM, and Memrisys. Additionally, we plan to have regular outdoor activities, such as soccer, badminton, and table tennis (participation is not mandatory).

■ **Introduction to the Lab.**

Our research group works on a wide range of multidisciplinary areas, including material sciences, device physics, circuits, and neural network algorithms. This allows students engage in various fields beyond device area. We actively collaborate with both universities and industry partners, providing opportunities for students to be involved in cutting-edge research projects.

■ **Representative recent research achievements ('22~'24)**

- H. Jeong*, S. Han*, S. Park, T. Kim, J. Bae, T. Jang, Y. Cho, S Seo, H. Jeong, S. Park, T. Park, J. Oh, J. Park, D. Jeon, I. Kwon, Y. Yoon†, S. Choi†, ***Nature Electronics*** Accepted (2024).
- S. Park*, S. Hong*, S. Sung, D. Kim, S. Seo, H. Jeong, T. Park, W. Cho, J. Kim, and S. Choi†, Phase-change memory via a phase-changeable self-confined nano-filament, ***Nature*** 628, 293–298 (2024)
- J. Bae*, C. Kwon*, S. Park, H. Jeong, T. Park, T. Jang, Y. Cho, S. Kim†, and S. Choi†, Tunable ion energy barrier modulation through aliovalent halide doping for reliable and dynamic memristive neuromorphic systems, ***Science Advances*** 10, 23 (2024)
- S. Seo*, B. Kim*, D. Kim*, S. Park*, T. R. Kim, J. Park, H. Jeong, S. Park, T. Park, H. Shin, M. Kim, Y. Choi, and S. Choi†, The gate injection-based field-effect synapse transistor with linear conductance update for online training, ***Nature Communications*** 13, 6431 (2022)
- S. Park*, H. Jeong*, J. Park*, J. Bae, and S. Choi†, Experimental demonstration of highly reliable dynamic memristor for artificial neuron and neuromorphic computing, ***Nature Communications,*** 13, 2888 (2022)
- S. Choi*, S. Park*, S. Seo, and S. Choi†, Reliable multilevel memristive neuromorphic devices based on amorphous matrix via quasi-1D filament confinement and buffer layer, ***Science Advances***, 8, 3 (2022)

<Professor Yang-Kyu Choi's Lab.>

Nano-Oriented Bio-Electronics Lab

■ **Contact information**

Professor : yangkyu@kaist.ac.kr TEL : 042-350-3477

Lab. : sjh224@kaist.ac.kr TEL : 042-350-5477

Website : https://nobel.kaist.ac.kr

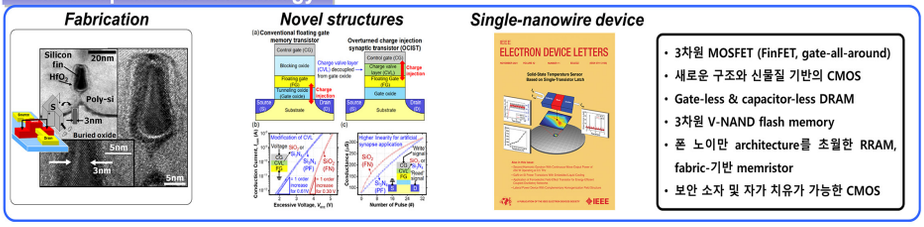
■ **Current state of the Lab. (in 2024 Fall Semester)**

PhD Students: 9 Master's Student: 12

■ **Research Areas**

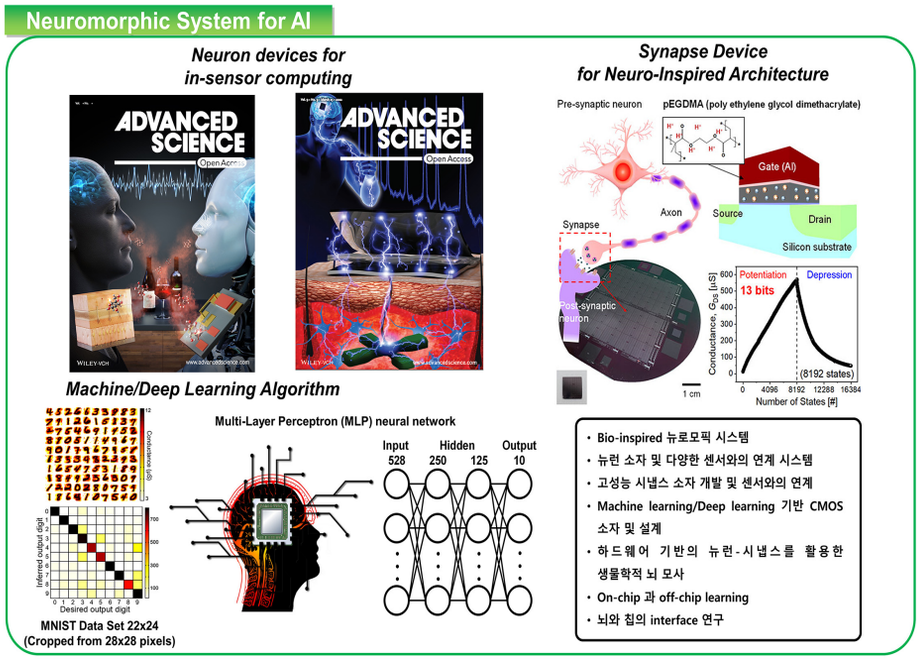
World Top CMOS Technology

연구실적: SCI 논문 419 편, 국제학회 129 편



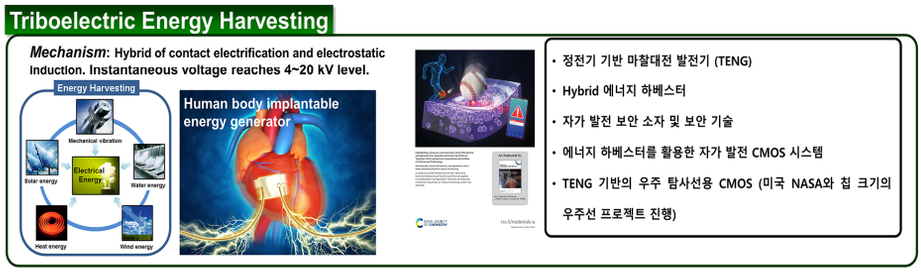
- 3차원 MOSFET (FinFET, gate-all-around)
- 새로운 구조와 신물질 기반의 CMOS
- Gate-less & capacitor-less DRAM
- 3차원 V-NAND flash memory
- 폰 노이만 architecture를 초월한 RRAM, fabric-기반 memristor
- 보안 소자 및 자가 치유가 가능한 CMOS

Neuromorphic System for AI



- Bio-inspired 뉴로모픽 시스템
- 뉴런 소자 및 다양한 센서와의 연계 시스템
- 고성능 시냅스 소자 개발 및 센서와의 연계
- Machine learning/Deep learning 기반 CMOS 소자 및 설계
- 하드웨어 기반의 뉴런-시냅스를 활용한 생물학적 뇌 모사
- On-chip 과 off-chip learning
- 뇌와 칩의 interface 연구

Triboelectric Energy Harvesting



- 정전기 기반 마찰대전 발전기 (TENG)
- Hybrid 에너지 하베스터
- 자가 발전 보안 소자 및 보안 기술
- 에너지 하베스터를 활용한 자가 발전 CMOS 시스템
- TENG 기반의 우주 탐사선용 CMOS (미국 NASA와 칩 크기의 우주선 프로젝트 진행)

■ **Recommended courses & Career after graduation**

NASA (3), SK Hynix (16), Samsung electronics (29), Professor (11), KIST (1), Intel (2), ETC.

■ **Introduction to other activities besides research**

Various social activities including sports

■ **Introduction to the Lab.** Our laboratory have friendly atmosphere with high-quality research facilities and know-hows. Students have various research field, and we try to think more creatively with deep, enthusiastic discussions.

■ **Recent research achievements ('22~'24)**

Five cover images, 59 SCI papers including high-impact journals (Science advances, Advanced materials, and etc.)

<Professor Jung-Woo Choi's Lab.>

Smart Sound Systems Lab

■ **Contact information**

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Website : https://sound.kaist.ac.kr

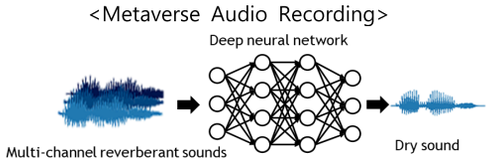
■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 5 Master's Student: 6

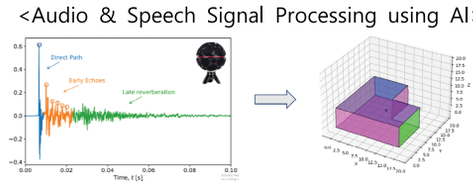
■ **Research Areas**

Smart Sound System Laboratory pursues **better understanding** and **rendering of spatial audio** through **AI-based technologies** and **audio signal processing**. We study audio signal processing, AI-based audio scene analysis, diagnosis, and audio generation models to realize truly immersive audio experience. Our research topics cover Metaverse Audio (virtual reality, augmented reality, extended reality audio), and Auditory Scene Analysis such as Speech Enhancement and Separation, Direction-of-Arrival estimation, Room Impulse Response estimation, Room Geometry Inference. Sound-based Anomaly Detection and Fault Diagnosis is another major research topic in our Lab.

<Metaverse Audio Recording>



<Audio & Speech Signal Processing using AI>



<Room shape inference from sound>

[Highlights]
- SOTA in DNN-based Multichannel Speech Enhancement [DeFTAN-II]
- 7th place, in 2023 DCASE Sound Event Detection & Localization
- Inventor of Personal Audio Technology for Automotive Vehicles

[Theories]
- Audio signal processing, Multichannel signal processing
- Sound propagation, Spatial perception of sound
- Anomaly detection, out-of-distribution detection

[Applications]
- Audio Metaverse, Audio AR/VR/XR
- Speech Enhancement and Separation, DoA Estimation using DNN
- Sound-based Environmental Parameter Generation and Estimation
- Beamforming, Sound Event Localization and Detection, Target Sound Extraction
- Intelligent Audio System with Environmental Awareness
- Machine Anomaly Detection and Fault Diagnosis with AI

■ **Recommended courses & Career after graduation**

We recommend signal processing based courses (EE202 Signals and systems, EE432 Digital Signal Processing) and deep learning-related courses (AI504 Programming for AI). After graduation, you can further develop your career in industries & academic areas (such as Meta Reality Labs, Samsung Research, ETRI, Naver). You can also work in a wide range of fields.

■ **Introduction to other activities besides research**

Lab members frequently engage in football, badminton, board game, etc. Through the organization of yearly membership training workshops and field trips, we actively facilitate the cultivation of camaraderie among members. Our laboratory fosters a regulation-free environment, striving to empower our members' creativity and self-motivation.

■ **Introduction to the Lab.**

The field of intelligent audio signal processing is a multidisciplinary field that enables the blending of signal processing technologies with machine-learning approaches, sound propagation theories, and insights into human sound perception. The driving force of the lab is the spirit of embracing challenges to explore new ideas guided by a profound intuition for signal processing. Collaborative research on top-notch immersive audio technology is underway, with the support of consistent funding, in partnership with KISTI, ETRI, and Samsung Electronics.

■ **Recent research achievements ('22~'24) (visit https://sound.kaist.ac.kr for full list of publications)**

- D. Lee, and J-W. Choi, "DeFTAN-AA: Array Geometry Agnostic Multichannel Speech Enhancement," Interspeech, Kos, Greece, Sep. 2024.
- S. Choi, and J-W. Choi, "Noisy-ArcMix: Additive Noisy Angular Margin Loss Combined With Mixup Anomalous Sound Detection," ICASSP, Seoul, Korea, Apr. 2024.
- Y. Shul, and J-W. Choi, "CST-FORMER: Transformer with Channel-Spectro-Temporal Attention for Sound Event Localization and ICASSP, Seoul, Korea, Apr. 2024.

⟨Professor Jun Kyun Choi⟩

MediaNET LAB
Media Network Laboratory
Media Network Laboratory

■ Contact information		
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Lab.	**T244, Truth Hall, Munji Campus**	**Tel: +82-42-350-8059**
Website	**https://sites.google.com/view/mnlabkaist/home**	

■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 2 PhD Students: 4 Master's Student: 2

■ Research Areas

- **Study on improving IoT efficiency and data reliability**
  - A sensor testbed for collecting data and applying research
  - Data tagging technology for efficient preprocessing of IoT data
  - Data Loss Recovery Techniques for Improving IoT Data Integrity
  - Data transmission control technology for energy efficiency
- **Study on Energy trade / saving / prediction model research**
  - Energy trading system using Game Theory and Optimization Theory
  - EV charging optimization with battery characteristics and degradation
  - Power energy estimation/forecasting model with data analysis and learning
- **Study on trust provisioning technology based ICT environment**
  - Data transaction modeling and individual reliability analysis in personal information trading environment
  - Evaluation of an entity's trustworthiness based on Personal Information Protection Law

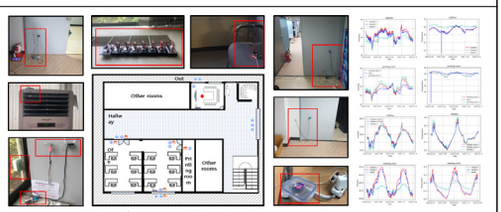

Fig. Sensor Testbed and collected data

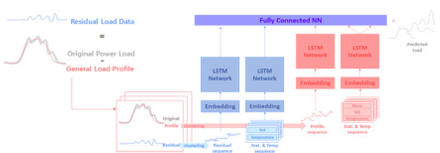

Fig. Electricity load forecasting model with users' characteristics considered

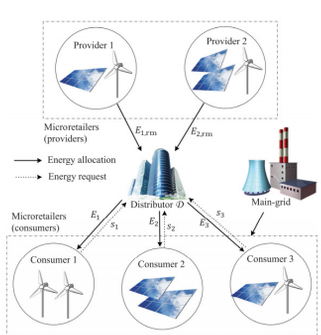

Fig. 1. System model for a contribution-based control of energy allocation in microgrid infrastructures.

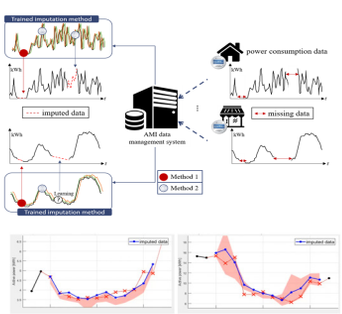

Fig. System model and examples of data interpolation

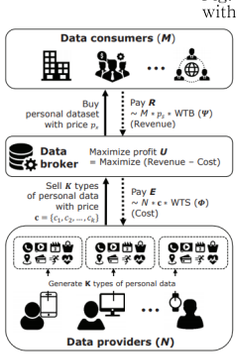

Fig. 1. The proposed personal data trading model with multiple types in the IoT data market

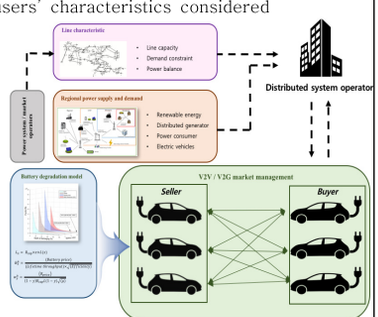

Fig. System model for charging electrical vehicle considering battery characteristics and wearout

■ Recommended courses

(1) Mathematical basics such as probability and statistics, optimization theory (2) Learning subjects such as learning theory and data processing (3) Communication and Network Basic Courses, including Communication and Information Theory and Introduction to Network

■ Career after graduation

As of 2024, 28 PhD graduates (Professor, Samsung Electronics, ETRI, etc.) and 46 masters (PhD., Naver, ADD, etc.) have been trained to nurture outstanding talents. Recent graduates' careers are widely distributed in the government-funded research institutes (ETRI, ADD, etc.), large corporations (Samsung Electronics, LG Electronics), and telecommunication companies (SKT, KT, LGU +).

■ Introduction to other activities besides research

There are many opportunities to attend many meetings other than research purposes, such as attending ITU-T and IETF standardization activities and participating in hackathon events. Each year, students have the opportunity to visit CES, attend conferences, and organize various group events for fellowship in the lab.

■ Introduction to the Lab

Our lab's greatest advantage is the atmosphere of freedom. Once a month, students held a casual meeting to gather our opinions and decide on all kinds of issues of the lab. The professor respects the opinions and rights of the students and actively reflects all matters decided at the student meetings. As various studies are conducted, the desired research topic can be freely selected from related fields in the lab. Our lab regularly held lab seminar to cooperate with each other and share comments on one's research. In addition, some graduates are working as professors in other colleges continuously give help to advise the students in our lab, which is beneficial to get various perspectives of the experts in different fields.

■ Recent research achievements (2022-2024)

SCI International Journal: 18; International Conference: 3; Patent Registration: 35

Prof. Junil Choi
Intelligent Communication Systems Lab.

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Lab. : N1 717 TEL : 350-7660
Website : www.icl.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 2 PhD Students: 10 Master's Student: 8

■ **Research Areas**

[MmWave Massive MIMO]

Millimeter-wave (mmWave) massive multiple-input multiple-output (MIMO) systems operate at 30~300 GHz with many antennas at transceivers. This technology enables large antenna arrays in small form factors, making it popular for 5G and future wireless communications.

[Reconfigurable Intelligent Surface]

RIS is a large 2D meta-material surface with controllable passive scattering elements. It can alter electromagnetic properties of incident signals to improve communication channels. RIS is particularly valuable for mmWave systems, which suffer from high path loss and blockage.

Research areas include: Joint active and passive beamforming, channel estimation of reflected signals, and multi-RIS deployment

[Non-Terrestrial Networks]

These networks use space-based systems for data, voice, and multimedia transmission. They offer high-speed, reliable, and wide-coverage communication, revolutionizing global connectivity.

[ML-based Communication]

Machine learning approaches in wireless communication systems are promising for 6G and beyond. They can discover linear or nonlinear characteristics from data, applicable to complex wireless systems.

Applications include: Near-optimal channel estimation and symbol detection using deep neural networks and over-the-air federated learning systems

■ **Recommended courses**

[MAS] Introduction to Algebra, [EE210] Probability Introductory Random Process, [EE202] Signal and System, [EE321] Communication Engineering

■ **Career after graduation**

Qualcomm, Samsung, ETRI, etc

■ **Introduction to other activities besides research**

Please visit our website (icl.kaist.ac.kr), where our various activities including are posted.

■ **Introduction to the Lab.**

Our laboratory focuses on designing state-of-the-art communication techniques for 5G/6G systems. We aim to support the commercialization of key 5G/6G services. Our primary interest lies in physical layer design, involving mathematical analysis and simulation experiments.

Professor Junil Choi provides strong support for student research. Team members are open to collaborative studies within the lab. We welcome inquiries from interested individuals.

■ **Recent research achievements ('22~'24)**

31 journal papers and 12 conference papers are accepted or published.

Students received multiple awards in various societies.

〈Professor Jinseok Choi's Lab.〉

SIC-X LAB.
Signal, Information, and Communications for everything

■ **Contact information**

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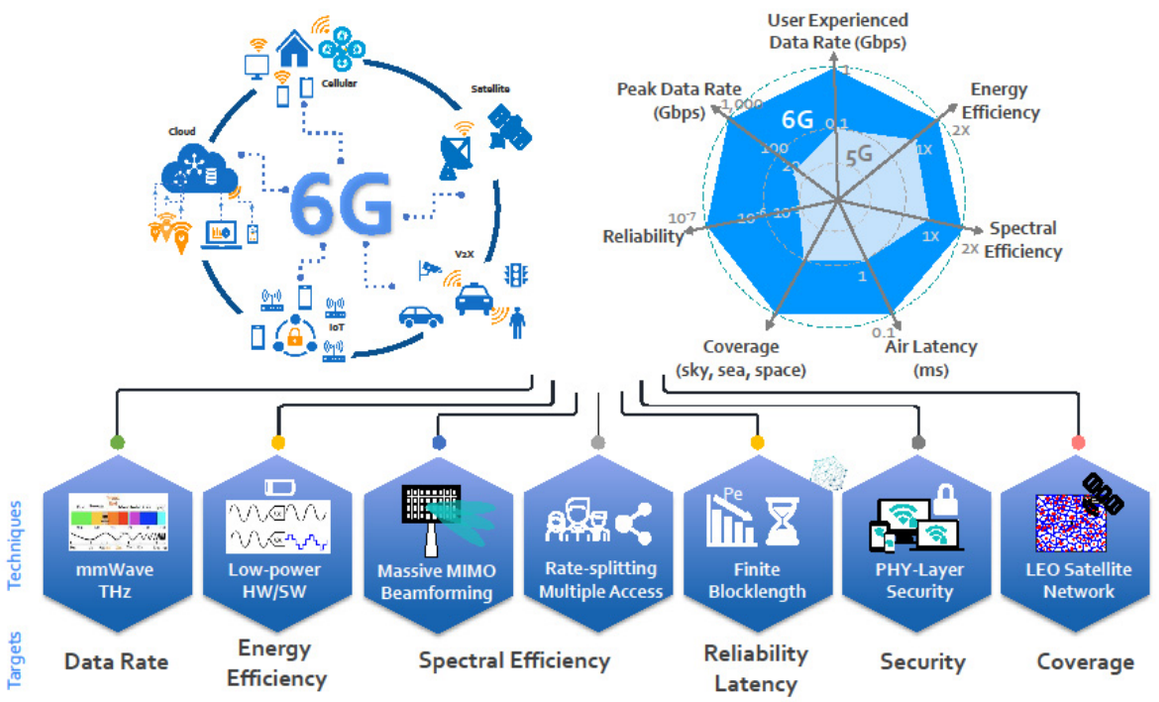
Website	**https://sic-x.kaist.ac.kr**	

■ **Current state of the Lab. (in 2023 Fall Semester)**

Postdoctoral Fellows: 0 Ph.D. Students: 4 Master's Students: 4

■ **Research Areas**



Our current research directions include, but not limited to: energy efficient MIMO system design, information security, IoT communications, satellite communications, next generation multiple access, and machine learning for communications.

■ **Recommended courses & Career after graduation**

- Linear algebra, Probability and stochastic processes, Information theory, Wireless communications, Optimization, Algorithms, and Machine learning
- Graduates of SIC-X lab. are playing roles in research activities as professors in academia
- Qualcomm, Samsung, SKT, KT, ETRI, ADD, KRIT, etc. as researchers in industry

■ **Introduction to the Lab**

Our lab is Signal, Information, and Communications laboratory (SIC-X LAB.).
Our primary research interest is to develop and analyze future wireless systems (beyond 5G and 6G) with communication theory, information theory, signal processing, convex optimization, and machine learning.
SIC-X LAB. Openings: SIC-X LAB. is now seeking prospective interns who are highly motivated for research and interested in 6G communications and machine learning algorithms. If you have any interest, please contact us.

■ **Introduction to other activities besides research**

- International and domestic conference participation
- Athletic competition
- Regular dining out

■ **Recent research achievements**

2021~2024: 17 Top journal (TWC, TCOM, etc.) papers and 13 flagship conference (ICC, WCNC, etc.) papers

<Professor Jeongseok Ha's Lab.>

CoCoA

Coding and Communications Lab

■ **Contact information**
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Lab : **Email** welcome2cocoa@kaist.ac.kr
Tel 042-350-7524
Website : http://cocoa.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**
PhD Students: 9 Master's Student: 2

■ **Research Areas**

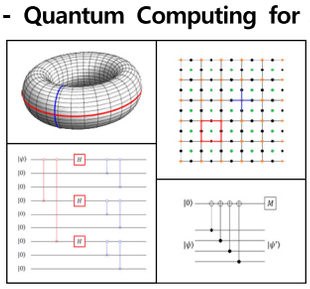
- Error-Correction-Codes with Machine Learning for 6G Communication Systems and Data Storage

Error-correction codes (ECCs) protect information from noisy environments. ECCs are an essential part of digital communications and are used in countless real-world applications. CoCoA Lab studies theoretical aspects of advanced ECCs like low-density-parity-check and polar codes. Recently, we are developing smart ECC solutions for data-centric computing devices and 6G wireless, optical, and space communication systems under the support of LG electronics, Samsung electronics, Institute of Information & communications Technology Planning & evaluation (IITP), and the National Research Foundation (NRF) of Korea.

- Wireless Communications with Machine Learning for 6G Communication Systems

CoCoA Lab is studying innovative machine-learning-based solutions for the 6th generation of wireless systems. In particular, we have been investigating wireless communication for 6G communication systems, including Low Earth Orbit (LEO) satellite communication systems, covert communication systems, Non-orthogonal multiple access (NOMA), and cell-free massive Multiple-input and multiple-output (MIMO) systems. Additionally, we have conducted research in the field of secure communication, with a particular emphasis on physical layer security: a promising secure communication scheme that doesn't rely on encryption. Our research is supported by the Korea Research Institute for defense Technology planning and advancement (KRIT).

- Quantum Computing for Artificial Intelligence



Artificial Intelligence (AI) is advancing rapidly, but it is expected to encounter limitations due to the slow growth of computing power. To solve this problem, quantum computers have been extensively studied. CoCoA Lab conducts research on quantum communication, information theory, as well as quantum-error-correction codes that are essential techniques for realizing quantum computers. We are currently working with the National Research Foundation (NRF).

■ **Recommended courses & Career after graduation**
Recommended courses include introduction to information theory and coding, communication engineering, and basic probabilities. Graduates of CoCoA Lab have excelled in schools and leading information technology companies such as Samsung Electronics, LG CTO, SK-Hynix, etc.

■ **Introduction to other activities besides research**
CoCoA Lab regularly conducts social activities in addition to research activities. Strawberry festivals, sports, and various other activities are organized to unite members of CoCoA Lab.

■ **Introduction to the Lab.**
CoCoA Lab, led by Prof. Jeongseok Ha, seeks to develop theories and applications of state-of-the-art error-correcting codes and wireless communications. Our research interests include machine learning-based smart error-correcting codes, wireless communication systems, and quantum communication. Research is supported by various institutes and companies such as LG Electronics, ETRI, NRF, ITRC, IITP, and KRIT. CoCoA has a very friendly lab atmosphere and we welcome everyone interested in our research topics.

■ **Recent research achievements ('22~'24)**
International Journals: 12, International Conferences: 4, International Patents: 3, Domestic Patents: 7

[1] H. Jung, I. Ali and J. Ha, "Convolutional Neural Decoder for Surface Codes," IEEE Transactions on Quantum Engineering, accepted, 2024
[2] J. Park, H. Yeom, S. Yun and J. Ha, "Downlink Cell-Free Massive MIMO With Pilot Contamination," IEEE Transactions on Vehicular Technology, vol. 73, no. 1, pp. 1412-1417, Jan. 2024
[3] I. Ali, and J. Ha, "Partial Spatial Coupling of LDPC Codes: Reducing the Gap to Capacity by Improving the Rate," IEEE Transactions on Communications, vol. 71, no. 12, pp. 6898-6913, Dec. 2023

⟨Professor Dongsu Han⟩

Intelligent Network Architecture and Distributed Systems Lab.	■ Contact information		
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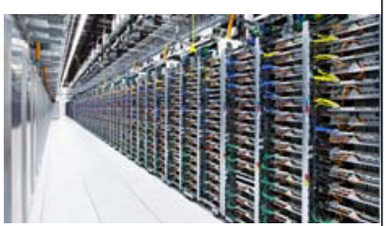
	Lab.	Email: inalab@kaist.ac.kr	Tel: 7631
	Website	https://ina.kaist.ac.kr	

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 5 Master's Student: 4

■ **Research Areas**



With more diverse applications and its requirements, we design/implement (1) the distributed system where such applications can be operated efficiently, and (2) the new possibility created with more interconnected computers.

Cloud infrastructure: Currently, many applications and its infrastructure become more complex with advanced features. This trends will continue as technology advances. Accordingly, we are making network/cloud infrastructure more intelligent.

Why cloud and distributed systems?: Cloud and distributed system is the key to realize computer's infinite possibility. You can reflect your vision into the software technology. New systems create new worlds and the new worlds require new systems. For example, big-data processing system becomes the infrastructure extracting "knowledge" from the raw data such as Google Search. Moreover, you can make current systems more efficient. For example, if mobile OS like Android can predict network performance in real time to show the YouTube video, it can reduce the delay to play the video, which create additional market value.

■ **Recent research topics**

- **Systems for AI:** Optimizing the use of GPU resources and network bandwidth in hyper-scale training environment
- **AI for Systems:** Microservice auto-scaling study, Accelerate DNA sequencing using the learned index
- **AI + Video:** How will Deep Learning Change Internet Video Delivery? Adaptive streaming + neural super-resolution
- **Cloud computing and Big data processing:** Resource allocation for cloud infrastructure, optimization with Big Data.
- **Internet-scale content distribution:** Software-defined content distribution, QoE inferencing and optimization, diagnosis.
- **Future Internet architecture:** Evolvable congestion control, evolvable service model, incremental deployment over IP.

■ **Recommended courses & Career after graduation**

We offer comfortable and active environment where you can discuss freely with other people including professor. We strongly recommend and support collaboration with other laboratories and intern experience from the industry. We are trying to establish the environment where each individual's advantage can make grater synergy. We support student's self-improvement, sports activities, extracurricular activities to provide best research environment to the students.

We recommend you to take Computer Networks, Network Programming, System Programming, Operating System, Data Structure, and Discrete Structure courses. You will have ability to design, implement, and manage the new systems required in the future. You will experience a new world with new software systems and introduce them to the public. You will be a great software architect required by many industries and laboratories predicting and leading the new technology trend.

■ **Introduction to other activities besides research**

We offer comfortable and active environment where you can discuss freely with other people including professor. We strongly recommend and support collaboration with other laboratories and intern experience from the industry. We are trying to establish the environment where each individual's advantage can make grater synergy. We support student's self-improvement, sports activities, extracurricular activities to provide best research environment to the students.

■ **Introduction to the Lab.**

INA research group pursues innovative ideas in/for Internet services and applications, cloud infrastructure, and systems that support artificial intelligence. We identify and anticipate new problems that arise from the evolution of Internet-/Cloud-based services and the development of new hardware, provide novel solutions for challenging problems in the real-world, design and implement the solutions in a way that reaches out for real-world impact.

■ **Recent research achievements (2023-2024)**

Top research group at ACM SIGCOMM and USENIX NSDI in Korea (published 15 papers in the past 10 years)

- TopFull: An Adaptive Top-Down Overload Control for SLO-Oriented Microservices [SIGCOMM 2024]
- Accelerating Model Training in Multi-cluster Environments with Consumer-grade GPUs [SIGCOMM 2024]
- Scaling Beyond the GPU Memory Limit for Large Mixture-of-Experts Model Training [ICML 2024]
- AccelIR: Task-aware Image Compression for Accelerating Neural Restoration [CVPR 2023]
- FlexPass: A Case for Flexible Credit-based Transport for Datacenter Networks [EuroSys 2023]

<Professor SooJean Han's Lab.>

Autonomous Control of Stochastic Systems (ACSS)

■ **Contact information**

Professor : SooJean Han TEL : 042-350-7474

Lab. : ACSS Mobile : 010-4868-7883

Website : acss.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**

7 MS, 5 research interns

■ **Research Areas**

control systems, stochastic processes, machine learning

■ **Recommended courses & Career after graduation**

*coding background: Python, MATLAB.

*course background: calculus, ODEs, linear algebra, introductory machine learning, basic probability.

*[Bonus] coding background: C++, ROS, working on GPUs.

*[Bonus] course background: any control theory / control engineering course.

*[Bonus] hardware background: robots/drones, motion capture system.

Bonus backgrounds are not strictly required. Self-motivation and a determination to learn new skills are more important.

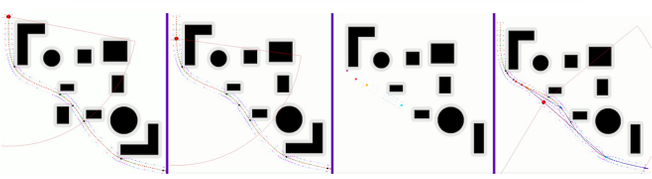
■ **Introduction to other activities besides research**

We engage in various activities with all lab members, such as group dinners, movie outings, strawberry parties, Teacher's Day celebrations, and futsal tournaments. We are open to other events as well!

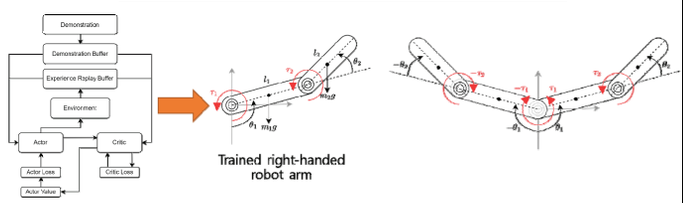
■ **Introduction to the Lab.**

We develop intelligent and efficient methods for control, estimation, and decision-making of stochastic systems by learning patterns. Our main applications include autonomous vehicles, multi-agent robotics, and distributed sensor networks.

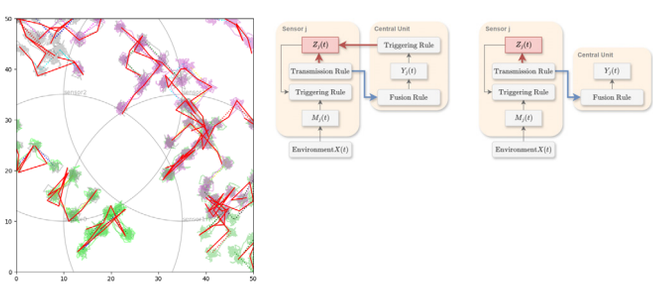
Path Replanning in Nonstationary Environments.



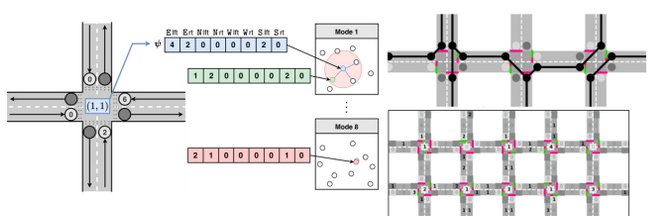
Data-Efficient AI by Learning Symmetries.



Multisensor Fusion via Feedback Distributed Data-Gathering.



Augmented Replay Memory Traffic Congestion Control.



<For more, please visit ACSS webpage at acss.kaist.ac.kr>

■ **Recent research achievements ('22~'24)**

* Chodhary, Octavian, Han. "Efficient Replay Memory Architectures in Multi-Agent Reinforcement Learning for Traffic Congestion Control." To Appear IEEE Intelligent Transportation Systems Conference (ITSC), Jul 2024.

* Han, Kim, Choo. "A Stochastic Robust Adaptive Systems Level Approach to Stabilizing Large-Scale Uncertain Markovian Jump Linear Systems." To Appear, IEEE Conference on Decision and Control (CDC), Sep 2024.

*Han, Chung, Gustafson, "Congestion Control of Vehicle Traffic Networks by Learning Structural and Temporal Patterns." Learning for Dynamics and Control Conference (L4DC), Jun 2023.

* Han, Chung, Doyle, "Predictive Control of Linear Discrete-Time Markovian Jump Systems by Learning Recurrent Patterns." Automatica, May 2023.

<For more, please visit personal homepage at soojean.github.io>.

<Professor Insu Han's Lab.>

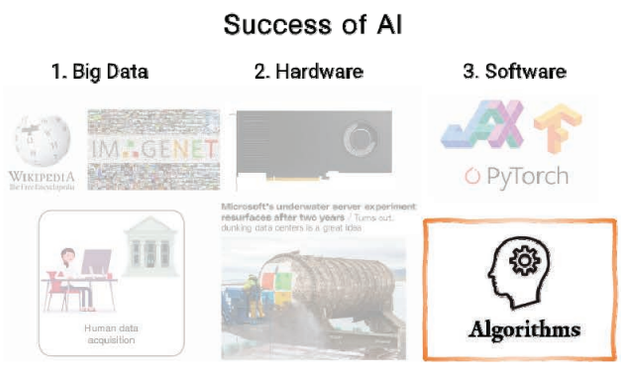
Flexible Machine Learning Algorithm Lab

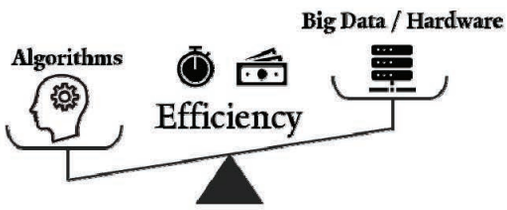
■ **Contact information**
Professor : Insu Han TEL : 7477
Lab. : Flexible ML Algorithm Lab TEL :
Website : flexml.kaist.ac.kr

■ **Current state of the Lab. (in 2024 Fall Semester)**
Postdoctoral Fellows : 0 PhD Students: 0 Master's Student: 0

■ **Research Areas**

Our research group focuses on developing scalable algorithms for large-scale machine learning problems, combining practical efficiency with rigorous theoretical analysis. We tackle challenges at the forefront of AI and machine learning, aiming to improve the performance and applicability of cutting-edge models and techniques.





Several research directions are

1. Efficient LLM inference with Cache Quantization

2. Fast Diffusion Transformer reducing redundant Self-attention

3. Optimal sampling for reconstructing spherical functions in high dimensions

■ **Recommended courses & Career after graduation**

- **Programming (EE209, EE309, CS101, CS109, etc)**
- **Data structure and algorithm (EE205, CS206, CS300, etc)**
- **Machine learning (EE331, EE412, EE424, CS475, etc)**
- **Mathematics (EE210, MS250, MS350, MS355, MS365, etc)**
- **Industrial experiences before/after graduate school**

■ **Introduction to other activities besides research**

- **Physical activities that achieve progressive goals, such as hiking, cycling, swimming**

■ **Introduction to the Lab.**

Established in September 2024, the lab offers you mentorship from highly motivated young professor working on cutting-edge researches, and the unique opportunity to become one of the first alumni of the group.

■ **Recent research achievements ('22~'24)**

- ClusterGen: Token Generation in Sublinear Time and Memory, Under Review, 2024
- QJL: 1-Bit Quantized JL Transform for KV Cache Quantization with Zero Overhead, Under Review, 2024
- Cell2Sentence: Teaching Large Language Models the Language of Biology, ICML 2024
- HyperAttention: Long-context Attention in Near-Linear Time, ICLR 2024
- Near Optimal Reconstruction of Spherical Harmonic Expansions, NeurIPS 2023
- KDEformer: Accelerating Transformers via Kernel Density Estimation, ICML 2023
- Fast Neural Kernel Embeddings for General Activations, NeurIPS 2022
- Scalable MCMC Sampling for Nonsymmetric Determinantal Point Processes, ICML 2022
- Random Gegenbauer Features for Scalable Kernel Methods, ICML 2022

<Professor Hamza Kurt's Lab.>

Metaphotonics Research Laboratory

■ **Contact information**
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Lab. :jaeyong21.kim@kaist.ac.kr (김재용) TEL: 010-3068-3510
Website : https://kurtresearch.com

■ **Current state of the Lab. (in 2024 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 7 Master's Student: 3 Undergraduate Student: 3

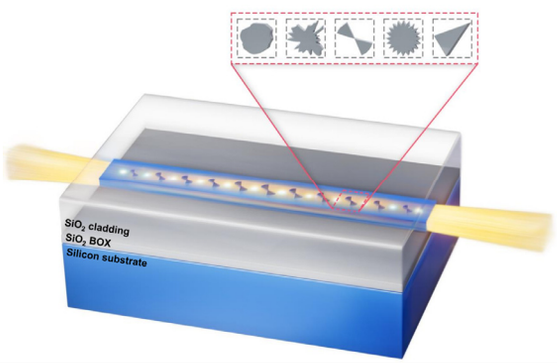
■ **Research Areas**

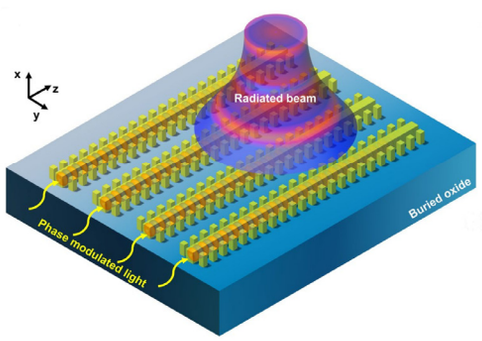
1. Optical Neural Networks: An optical neural network (ONN) is a physical realization of an artificial neural network with conventional (and usually discrete) optical components. We are interested in implementation of ONN with integrated photonic elements designed by utilizing advanced optimization methods. Processing data all optically in analog domain holds huge potential to alleviate the full potential of machine learning with photonics

.

2. Integrated Photonics, Silicon Photonics: Inverse and AI assisted designs and fabrication of nano-photonics and silicon photonic devices. The interaction of light with nanostructures that have variations in the refractive index on the order wavelength or sub-wavelength generates so many rich physical concepts that cannot be easily observed in conventional medium. At this stage, it becomes very crucial to have powerful numerical techniques assisted with AI tools to explore the tremendous novelties of meta-photonics domain for LiDAR and optical computing and programmable photonics applications.

3. Flat optics and meta-surfaces in imaging and display (AR and VR): Recently, meta-surfaces have been identified as promising optical elements in the modulation of the phase, amplitude and polarization of light within a subwavelength thickness. Compared to the bulky, conventional optical elements that use phase accumulation to manipulate light along curved optical paths, two-dimensional meta-surfaces composed of engineerednanostructured antennas arrays allow the realization of the manipulation of light on a flat surface.





■ **Recommended courses & Career after graduation**

Basic level background in "Electromagnetics, Fundamentals of Photonics, and Optics". The academic career is one option. The candidate can also work as a researcher in the R&D departments of private sectors such as Intel, Samsung, Apple, IBM, and Google. There are many examples of such career paths. Interested candidates may contact to the PI and lab representative

■ **Introduction to other activities besides research**

Participation in the international conferences (CLEO, SPIE, APC), being part of the professional societies and their activities (OSA, IEEE), holding social events (hiking, group dining, sport activities), short term scientific visits to our collaborators in different countries (such as US, Spain, Australia, Switzerland, Denmark).

■ **Introduction to the Lab.**

We conduct fundamental as well as applied research with an interdisciplinary nature covering Engineering and Science. We have published 140 papers in highly prestigious journals. The number of conference proceedings and papers is more than 150.

■ **Recent research achievements ('22~'24) The scientific outcome between 2018-2024 is the publication of total 56 journal articles. Selected articles are given below:**

1. "Semi-supervised learning leveraging denoising diffusion probabilistic models for the characterization of nanophotonic devices," Laser Photon. Rev. 2300998 (2024).

2. "Deep neural network-based phase calibration in integrated optical phased arrays." Sci. Rep. 13, 19929 (2023).

3. "Inverse design of Si-based high-performance vertical emitting metagrating coupler on 220 nm silicon-on-insulator platform," Photonics Research 11 (6), 897 (2023).

4. "Experimental demonstration of inverse-designed silicon integrated photonic power splitters," Nanophotonics 11 (20), 4581 (2022).

<Professor Songcheol Hong's Lab.>

WEIS
Wave Embedded Integrated Systems

■ Contact information

Professor : schong1234@kaist.ac.kr TEL : 042-350-3449
Lab. : KI Building A303 TEL : N/A
Website : https://weis.kaist.ac.kr

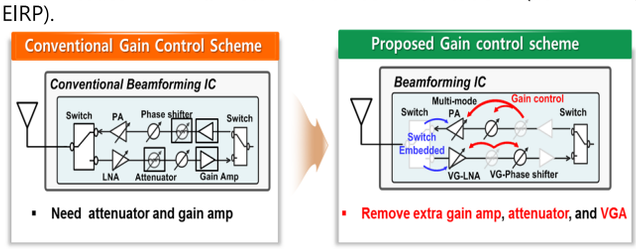
■ Current state of the Lab. (in 2024 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 2 Master's Student: 1

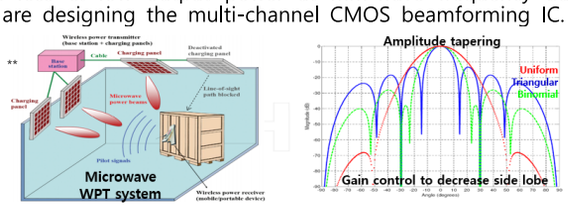
■ Research Areas

● Beamforming IC WIreless Power transfer for 5G communication

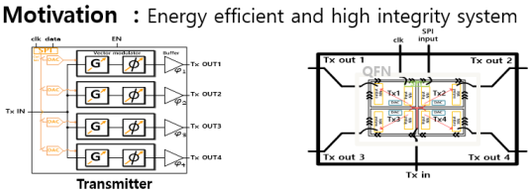
We are studying about 5G communication system. 5G communication system is targeting to increase bandwidth using millimeter wave frequency band(<110 GHz). There are some issues in millimeter wave communication (Low Rx P, EIRP).



Beamforming is the technology that can overcome the high path loss & low output power at mm-wave frequency band. We are designing the multi-channel CMOS beamforming IC.



A. Motivation : Energy efficient and high integrity system



B. Application: Mobile device charging system

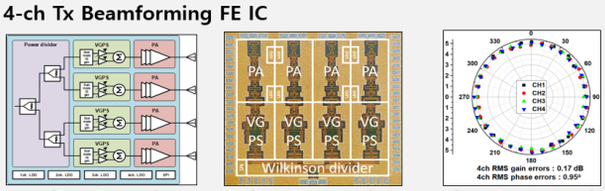
● Radar Transceivers

We are also interested in radar transceivers, which forms of RFID, automotive radar, motion sensor, military radar, and so on. To detect distance and velocity of the target with high resolution and accuracy in those applications, it includes the concepts of ultra wideband, reconfigurable, small size, low power.

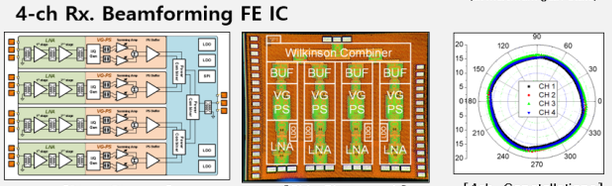
1) 60 GHz Radar

A. Applications : Sensing & 6G communications for future mobility, Indoor sensing for smart home & smart building

4-ch Tx Beamforming FE IC

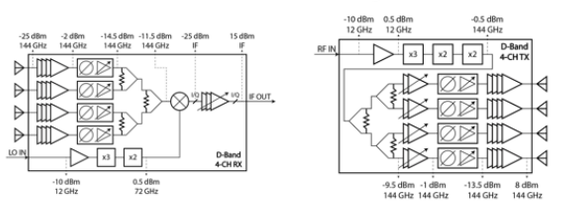


4-ch Rx. Beamforming FE IC



2) 144 GHz Radar

A. D-Band Rx/Tx 4 Channel Beamforming IC



■ Recommended courses & Career after graduation

Electronic circuit and RF engineering courses are recommended for undergraduate students to design RF circuits. Digital signal processing are also helpful for radar processing. Most of WEIS graduate find work at Samsung, Hynix, Qualcomm or national laboratory such as ETRI or ADD. There are many alumni employed as a professor after taking post-doctor course abroad.

■ Introduction to other activities besides research

we go trip (MT) or climb mountain 2~3 times annually. When we have something to celebrate, such as graduation, we have a meal together. Sometimes, we do sports activities such as soccer and basketball. We also have running crew, so people who want to improve physical strength, have chance to run with members.

■ Introduction to the Lab.

We are making new horizon of Sensor System on a Chip and Future RF transceivers. Sensor system includes microwave and millimeter wave radars, which will be prevail in the future in the forms of RFIDs, robot range finders, sensor networks, and etc. The future transceivers include the concepts of ultra wideband, digital RF, reconfigurable, low power.

■ Recent research achievements ('22~'24)

[1] J. Yoo and S. Hong, "Highly Efficient Differential Frequency Doubler With Output Resistance Boosting Feedback," in IEEE Journal of Solid-State Circuits, vol. 59, no. 2, pp. 414-423, Feb. 2024.
[2] C. So, E. -T. Sung and S. Hong, "A V-Band Four-Channel Phased Array Transmitter Front-End With 0.7° Phase Step and 20 dB Gain Dynamic Range," in IEEE Transactions on Microwave Theory and Techniques, vol. 72, no. 5, pp. 2799-2808, May 2024.
[3] K. Han and S. Hong, "Range-Angle Decoupling Technique Using Wavelength-Dependent Beamforming for High-Resolution MIMO Radar," in IEEE Transactions on Microwave Theory and Techniques, vol. 72, no. 7, pp. 4269-4277, July 2024.

⟨Professor Steven Euijong Whang's Lab⟩

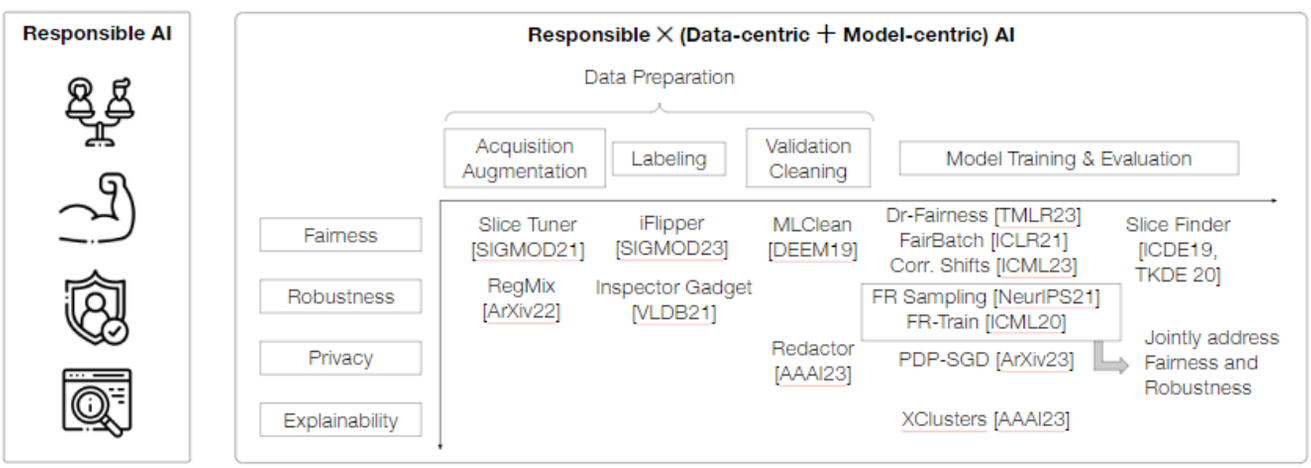
Data Intelligence Lab	■ Contact information	
	Professor	Email: swhang@kaist.ac.kr Tel: 042-350-7443
	Website	https://stevenwhang.com

■ **Current state of the Lab (in 2024 Fall Semester)**

Postdoctoral Fellows: 0 PhD Students: 7 Master's Students: 3

■ **Research Areas**

Software 2.0 is a fundamental shift in software engineering where machine learning is prevalent and data becomes a first-class citizen, on par with code. The goal of the Data Intelligence Lab is to pioneer the inevitable trend of Responsible/Trustworthy AI, Data-centric AI, and Big Data – AI Integration. We are especially interested in solving fairness, robustness, privacy, and explainability challenges in machine learning from the data.



■ **Recommended courses & Career after graduation**

Recommended courses: Discrete mathematics, data structures, algorithms, databases, data mining, probability theory, linear algebra, convex optimization, and machine learning. **Career after graduation:** Students will be trained to be world-class researchers and have career opportunities both in industry and academia.

■ **Introduction to other activities besides research**

Students are encouraged to participate in extracurricular activities. For example, the professor likes swimming and is an alum of the KAIST swimming team KAORI. Our lab will also have regular social events.

■ **Introduction to the Lab**

The Data Intelligence Lab solves important problems in Data-centric AI and Responsible AI. We are funded by Google Research, Microsoft Research, Samsung Electronics, SK Hynix, the National Research Foundation of Korea (AI ERC), and the Institute of Information & communications Technology Planning & Evaluation (IITP) among others. Our lab has 8 PhD and 4 Masters students with internship experiences at Google DeepMind & Youtube and NVIDIA Research.

Steven Euijong Whang is an associate professor at KAIST EE and AI. Previously he was a Research Scientist at Google Research and co-developed the data infrastructure of the TensorFlow Extended (TFX) machine learning platform. Steven received his Ph.D. in computer science in 2012 from Stanford University. He received a Google AI Focused Research Award (2018, the first in Asia) and was a Kwon Oh-Hyun Endowed Chair Professor (2020-2023).

■ **Recent research achievements ('22~'24)**

[1] S. Hwang, M. Kim, S. Whang, "RC-Mixup: A Data Augmentation Strategy against Noisy Data for Regression Tasks", KDD 2024

[2] Y. Roh et al., "LEVI: Generalizable Fine-tuning via Layer-wise Ensemble of Different Views", ICML 2024

[3] K. Tae, H. Zhang, J. Park, K. Rong, S. Whang, "Falcon: Fair Active Learning using Multi-armed Bandits", VLDB 2024

[4] M. Kim, S. Hwang, S. Whang, "Quilt: Robust Data Segment Selection against Concept Drifts", AAAI 2024

[5] S. Whang, Y. Roh, H. Song, and J. Lee, "Data Collection and Quality Challenges in Deep Learning: A Data-Centric AI Perspective", VLDB Journal, 2023.

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