〈Professor Joonhyuk Kang's Laboratory〉

Advanced Radio Technology Lab

■ Contact information		
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■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 9 Master's Student: 8

■ **Research Areas**

The Advanced Radio Technology Laboratory (ART Lab) has researched the signal processing technology used in communication systems and various related technologies. In particular, we focused on multi-input multi-output (MIMO), massive MIMO, cognitive radio and etc. Furthermore, GPS-free localization and security issues at the physical layer are important parts of our research area. We also research innovative technologies to be used in the 5G wireless communication system. Specific research topics are given as follows.

- Multiple-input Multiple-output (MIMO) and Massive MIMO

MIMO uses multiple antennas for base stations and mobile users to increase the data rate and reliability. Recently, ART Lab has been working on energy efficient problems in Massive MIMO. Also, we investigate problems related to interference control, resource allocation, user scheduling and etc.

- Cognitive Radio (CR)

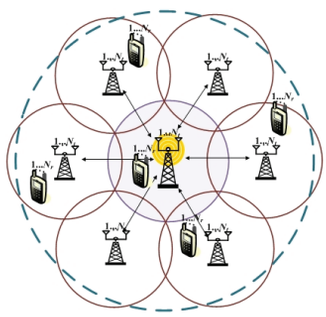
The CR is a representative technique that secondary user recognizes the wireless communication environment and communicates opportunistically. So, ART Lab is researching a spectrum sensing technique and allocating the resources for improving a user's transmission rate and spectral efficiency in CR network.

- Localization

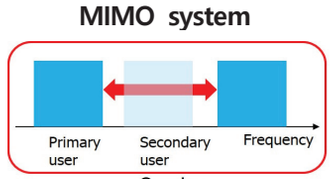
Localization is a technique for estimating the position of a mobile user. The ART Lab develops localization techniques for indoor and wartime conditions without using GPS. A localization algorithm with low complexity and high accuracy is also being researched.

- 5G Communication System

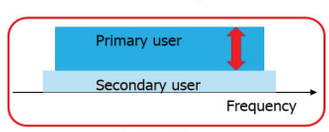
In recent years, ART Lab has been researching full-duplex, cloud radion access network (C-RAN) and mmWave system for the 5G communication system.



MIMO system



Overlay



Underlay

Cognitive radio

■ **Recommended courses & Career after graduation**

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

Career after graduation : A research institute (Agency for Defense Development (ADD), Electronics and Telecommunications Research Institute (ETRI), and major company (Samsung Electronics Co. KT Co. and etc.) in Korea.

■ **Introduction to other activities besides research**

ART lab promotes friendship among the students with various activities: birthday party, summer/winter workshop, spring/fall picnics and so on. Also, we have home-coming day annually and share alumni's experience for setting a goal and choosing a job after their graduation.

■ **Introduction to the Lab.**

All students in ART lab endeavor to be a leader in signal processing and wireless communication. So, our laboratory encourages students to research in an environment where members feel free to share their ideas. We have considerate professor's guidance and promote active cooperation among members. Also, by doing sports and many other events, we can spend our time in graduate school energetically. ART lab is open to who wants to research and study in a good environment with prospective students.

■ **Recent research achievements (2020-2022)**

[1] Projects : ETRI, ADD, Samsung Electronics Co., Ministry of Science, ICT and Future Planning, etc. (Currently doing 9 projects)

[2] Publications : Journal papers 17 / Conference papers 12 / Patents 13

⟨Professor Kyeongha Kwon⟩

THE KWON GROUP

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■ **Current state of the Lab. (in 2022 Fall Semester)**

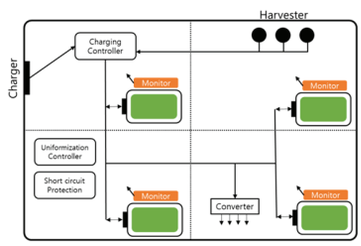
PhD Student: 2 Master's Student: 7

■ **Research Areas**

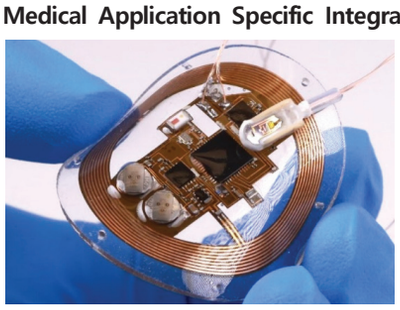
▷ **Battery Management System (BMS)**

For battery-powered devices and electric vehicles, an efficient battery management system is essential to guarantee safety and performance. We aim to design a BMS that can effectively control multi-stoage devices and monitor individual battery state. We also plan to expand our BMS research for IoT-level application.

BMS Platform



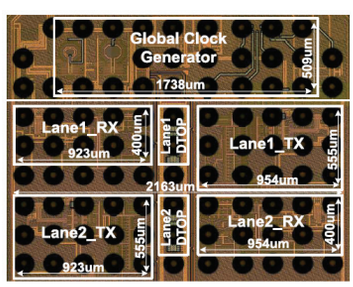
▷ **Medical Application Specific Integrated Circuits (M-ASIC)**



The need of biomedical treatment for various diseases, including Covid-19, is increasing in this worldwide aging society. Instead of using heavy health-checking machines in the hospital, we would like to facilitate real-time monitoring of our physical condition using small, wireless and low-power devices. We are currently working on flexible, skin-attachable systems that can sense various biosignals such as sweat & blood flow rate, wound healing state, CO_2 concentration from exhalation, etc.

▷ **High-Speed Transceivers**

When data is transferred through a medium, it suffers from distortion due to various reasons, resulting erroneous data at receiver. For high-speed communication, the impairment is severer and equalization is mandatory for acceptable signal integrity. Our research focuses on distortion compensation algorithms and their integration into transceiver ICs. Currently, we are investigating on equalizers for Processing-in-Memory (PIM) data link and optical networks.



■ **Recommended courses & Career after graduation**

Courses on circuits, signals and communcations are recommended. (EE201, EE304, EE372, EE403, EE202, EE303, EE321, etc) More information can be found on our website. Our research topics are related to and necessary in various areas. Potential careers after graduation include government-funded/private research institutes or companies related to IC design, medical devices, automobile, etc.

■ **Introduction to the Lab.**

Our lab has a horizontal organizational structure and lively work atmosphere. Also, lab members have friendly relationship. Beside, we regularly have group lunch/dinner and birthday celebrations. We often spend some time together playing sports, doing fun activities, etc. Also, we regularly hold or participate in workshops.

■ **Recent research achievements (2020-2022)**

"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) - Accepted (2022)

"Soft, wireless skin-interfaced mechano-acoustic sensors for real-time monitoring and patient feedback on respiratory and swallowing biomechanics" nature partner journal (npj) Digital Medicine (IF:15.357) - Accepted (2022)

"An on-skin platform for wireless monitoring of flow rate, cumulative loss and temperature of sweat in real time," Nature Electronics (IF:27.500), Mar. 2021.

⟨Professor Dae-Shik Kim's Lab⟩

Brain Reverse Engineering and Imaging Laboratory

■ Contact information

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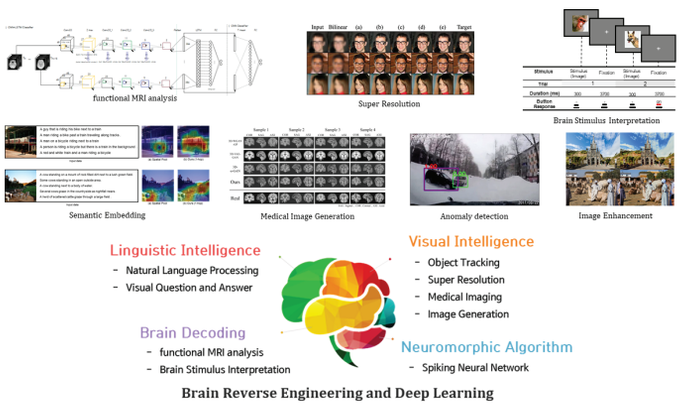
■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 9 Master's Student: 7

■ Research Areas



Brain Reverse Engineering and Deep Learning

Our laboratory aims to understand how the brain functions and use the knowledge to build an artificial brain close to human brain performance. In the Visual Intelligence group, we study computer vision, including image enhancement, image generation, domain adaptation, and medical imaging. Linguistic Intelligence group conducts research in natural language processing such as topic modeling and dialogue system. In the Brain Decoding group, we carry out research using fMRI and EEG to understand the brain, including studies on human emotion decoding and reconstruction of arm movement.

■ Recommended courses & Career after graduation

We recommend laboratory candidates to take Introduction to Brain IT and coursework in machine learning, information theory, and signal processing. We have Ph. D graduates (assistant professor at Kumoh National Institute of Technology, CTO at Omnious, etc.) and graduates with master's degree (Samsung Research, NCSOFT AI, Samsung DMC Lab, Lunit, LG, ETRI, SK Hynix, Hyundai Motors, UCL Wellcome Trust Centre for Neuroimaging, Ph. D candidates, CEO of Omnious and bHaptics, etc.).

■ Introduction to other activities besides research

Professor Dae-Shik Kim is currently serving as the director of SHINSEGAE I&C-KAIST AI Research Center and Kyobo/Dplanex-KAIST AI Center for Future of Insurance. In our Laboratory, we freely share and socialize cultural life such as MT, dining, sports and birthday parties.

■ 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, neuromorphic engineering and brain decoding, enriched by active collaboration with leading groups. Striving for excellence and innovation, we have entered the DARPA Robotics Challenge with the HUBO laboratory KAIST and dispatched our members for overseas research at Cambridge U.K, UCL, Leiden (Netherlands), EPFL (Switzerland), and Stanford. Alongside collaborating with top authorities in the industry and academia, we also nurture a venture spirit that has led to the establishment of successful venture startups such as Omnious and bHaptics.

■ Recent research achievements (2020-2022)

[1] M. Kim, F. Inglese, G. M. Steup-Beekman, T. W. Huizinga, J. d. Bresser, D. Kim, I. Ronen, MRI-based classification of neuropsychiatric systemic lupus erythematosus patients with self-supervised contrastive learning, ESMRMB2020 ONLINE, (Lightening Talk), Sep.30-Oct.2, 2020

[2] Wooyeong Cho, Sanghyeok Son, Dae-Shik Kim. "Weighted Multi-Kernel Prediction Network for Burst Image Super-Resolution", Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, pp. 404-413, June 19-25, 2021

[3] JungHyuk Im, Wooyeong Cho, Dae-Shik Kim. "Cross-Active Connection for Image-Text Multimodal Feature Fusion", International Conference on Applications of Natural Language to Information Systems. Springer, pp. 343-354, June 23-25, 2021

[4] Nahyun Kim*, Donggon Jang*, Sunhyeok Lee, Bomi Kim and Dae-Shik Kim, "Unsupervised Image Denoising with Frequency Domain Knowledge", the 32nd British Machine Vision Conference(BMVC) 2021, Online, Nov 22-25, 2021. (Oral presentation) *Equal contribution

[5] Bomi Kim*, Sunhyeok Lee*, Nahyun Kim, Donggon Jang and Dae-Shik Kim, "Learning Color Representations for Low-Light Image Enhancement", IEEE Winter Conference on Applications of Computer Vision, WACV 2022, Waikoloa, HI, USA, Jan 4-8, 2022. *Equal contribution

[6] Donggon Jang*, Sanhyeok Son*, and Dae-Shik Kim, "Strengthening the Transferability of Adversarial Examples Using Advanced Looking Ahead and Self-CutMix", Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops, CVPR 2022, New Oreleans, USA, June 19-24, 2022. *Equal contribution

[7] Gyeongdo Ham*, Ji-Man Yu*, Chungryeol Lee, Jae-Hyeok Lee, Joon-Kyu Han, Jin-Ki Kim, Donggon Jang, Nahyun Kim, Moon-Seok Kim, Sung Gap Im, Dae-Shik Kim, and Yang-Kyu Choi "A Multiple-State Ion Synaptic Transistor Applicable to Abnormal Car Detection with Transfer Learning", Advanced Intelligent Systems, Just accepted, *These authors equally contributed

⟨Professor John Dongjun Kim ⟩

Computer Systems and Network Lab	■ Contact information		
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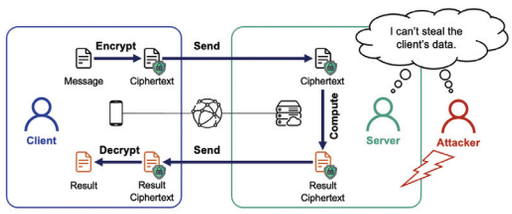
	Website	**https://icn.kaist.ac.kr**	

■ Current state of the Lab. (in 2022 Fall Semester)

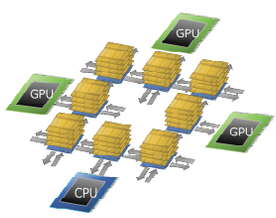
Postdoctoral Fellows : 0 PhD Students: 7 Master's Student: 5

■ Research Areas

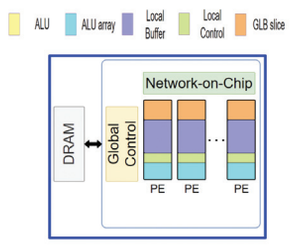
- **Computer and System Architecture for Deep Learning**
  - Scale-out interconnection networks
  - Efficient communication-centric architecture for accelerators
- **Memory-centric Network Architecture**
  - Memory-centric network architecture for machine learning
  - Processing-in-memory (PIM) Architectures
- **Architecture and Security**
  - Side-channel attacks in CPU and GPU
  - Fully homomorphic encryption (FHE)
- **Mobile System for Continuous Monitoring and Intervention**
  - Monitoring Itching condition
  - Language Development



Accelerating Fully Homomorphic Encryption



Scalable Memory-Centric Architecture / Processing-in-Memory



Deep Learning Accelerators

■ 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, Kangwoon 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 (2020-2022)

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

- MICRO'22 Networked SSD: Flash Memory Interconnection Network for High-Bandwidth SSD
- ISCA'22 Dynamic global adaptive routing in high-radix networks
- HPCA'21 Trident: A Hybrid Correlation-Collision GPU Cache Timing Attack for AES Key Recovery
- ISCA'21 Ghost Routing to Enable Oblivious Computation on Memory-centric Networks

⟨Professor Munchurl Kim ⟩

■ Contact information		
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Lab.	**LG hall (N24) 1106**	**Tel: 042-350-7519**
Website	**https://www.viclab.kaist.ac.kr/**	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 13 Master's Student: 9

■ **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.

Recently, our intensive works are in the fields of image/video super-resolution, frame interpolation, SDR-to-HDR inverse tone mapping, optical flow estimation, depth estimation, image deraining, image dehazing, video motion deblurring, neural radiance field (NeRF) learning of images and video, image in-painting, GAN-based restoration of old photos, PAN sharpening and super-resolution of satellite images, deep-learning-based image/video compression, learning-based perceptual video coding, detection and classification of Synthetic Aperture Radar (SAR) image targets as well as super-resolution of SAR images, etc.

■ **Recommended courses & Career after graduation**

DSP, Pattern recognition classes are recommended. In 2022, Dr. Kim will work as a Research Scientist at Adobe Research in San Jose, CA, USA. Dr. Sim will work as a Research Engineer at Qualcomm in San Diego, CA, USA. The others work as a researcher at Samsung, SKT, ETRI, and KARI.

■ **Introduction to other activities besides research**

We do too many activities with lab members. The activities include Manito, Lab Athletic Competition, and lab MT. In addition, every month, we plan a monthly lab activity(for fun).

■ **Introduction to the Lab & Recent research achievements (2020-2022)**

Our intensive research is in the field of all computer vision tasks. Our general mission is to be the best computer vision researcher. Our works have been accepted to CVPR(4), ICCV(1), ECCV(2), NIPS(1), ECCV(2), ICLR(1), AAAI(2) etc.

The contact mail address : woguq365@kaist.ac.kr

⟨Professor Min Jun Kim⟩

Research group for
Intelligent Robotic Systems
Intelligent Robotic Systems Lab

■ **Contact information**

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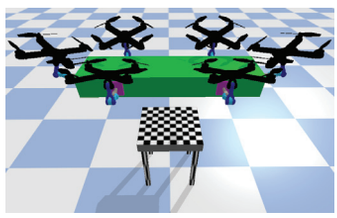
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 2 Master's Student: 4

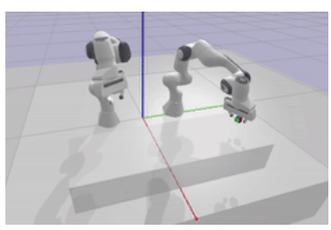
■ **Research Areas**

Physical Interaction with Aerial Manipulators



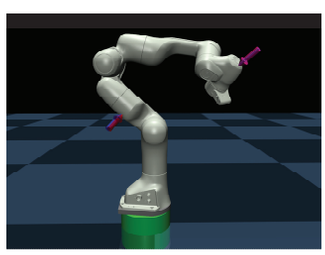
By mounting a manipulator on a multi-rotor, an aerial manipulator can perform active tasks through physical interaction. However, its application is limited due to the limited payload of the aerial manipulator and the coupling between the floating base and the manipulator. To this end, studies on the **collaboration of multiple aerial manipulators**, **fully-actuated multi-rotors**, and **trajectory optimization** have been conducted so that the aerial manipulator can interact with the environment stably.

Dual-arm Robot Intelligence



We are developing perception, planning, and control techniques for the intelligence of dual-arm robots. This includes skills such as: 1) **manipulation planning**, which allows the robot to plan where to grasp and place the unseen object, 2) **compliance control**, which allows both arms to safely interact with the environment, 3) **grasp detection**, which allows the robot to know which part of an object can be grasped using a deep vision network.

Model-based Robot Control & State Estimation



One of our primary research interests is the development of safe human-robot physical interactions. For this purpose, we conduct research on torque-controlled robots and state estimation techniques. The robot's **compliant motion behavior** is achieved through precise torque control. In addition, for **contact estimation**, proprioceptive sensors are used to estimate the contact points and forces.

■ **Recommended courses & Career after graduation**

Recommended courses: Control system engineering, Linear Systems, Nonlinear Control, Optimization Techniques, Machine learning	**Career:** The practical / theoretical experience gained in the robotics lab is applicable to a wide range of engineering careers (both academia and industry).

■ **Introduction to other activities besides research**

Our lab holds regular events such as outing, dinner parties, to maintain a strong bond between members. Also, there are private groups that share personal hobbies such as sports and cultural life.

■ **Introduction to the Lab.**

In our laboratory, students who are academically curious and full of self-motivation gather to create a synergistic effect in robotics research. The professor's kind advice and full research support are at the center of it. Our lab provides the best environment for students who want to study responsibly in an atmosphere of freedom.

■ **Recent research achievements (2020-2022)**

[1] J. Jeong, H. Mishra, C.Ott, and M. J. Kim, "A Memory-based SO(3) Parameterization: Theory and Application to 6D Impedance Control with Radially Unbounded Potential Function", ICRA 2022

[2] M. J. Kim, A. Werner, F. Loeffl, and C. Ott, "Passive Impedance Control of Robots with Viscoelastic Joints via Inner-loop Torque Control", IEEE T-RO

[3] C. Gabellieri, Y. Sarkisov, A. Coelho, L. Pallottino, K. Kondak, and M. J. Kim, "Compliance Control of Cable-Suspended Aerial Manipulator Using Hierarchical Control Framework", IROS 2020

<Professor Sangsik Kim's Lab.>

KAIST INTEGRATED METAPHOTONICS GROUP

■ **Contact information**

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■ **Current state of the Lab. (in 2022 Fall Semester)**

We just moved to KAIST! Join us as starting members!

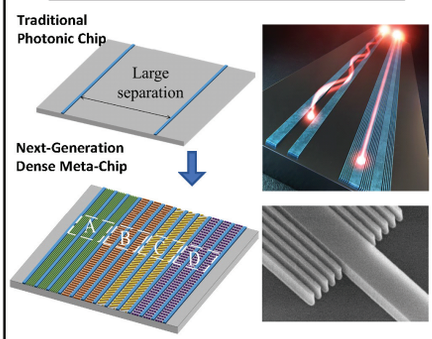
At KAIST: 0 postdocs, 0 PhD students, 0 Master's students

At Texas Tech: 4 PhD students, 1 Master's student (Alumni: 2 PhD, 2 MS, 2 BS)

■ **Research Areas**

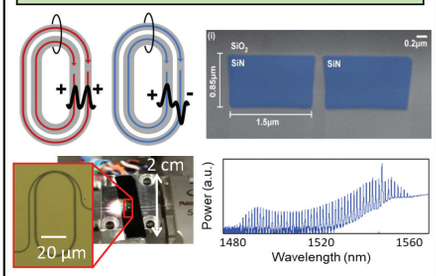
Integrated Nanophotonics	**I. Small device size ⇒ scalable & portable system**	**II. Efficient nonlinear & quantum processes**
	II. CMOS compatibility ⇒ mass production & low cost	**IV. Nanofabrication ⇒ alignment-free & stable operation**

On-Chip Metamaterials



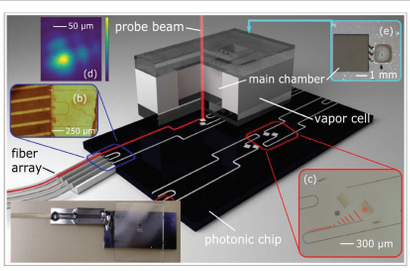
- High-density integration via metamaterials [2,4]
- Record-high coupling length (>1,000x) [4]
- Toward large-scale quantum/AI photonic chips

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: Optics & Electromagnetic courses (EE 555, EE 647, EE 666, EE 757)

Career after graduation: Integrated nanophotonics chips are versatile for both science and industry, allowing both academia and industry career paths. Representative national labs are ETRI, KIST, KRISS, NIST, and SNL; and industrial companies are Samsung, Intel, IBM, IMEC, ASML, NTT, Meta (Facebook), Keysight, Finisar, NeoPhotonics, AyarLabs, Voyant Photonics, Hyperlight, and others. Our recent 3 PhD alumni went to Intel (1 silicon photonics and 1 lithography team) and NeoPhotonics (design engineer), among multiple offers from the above companies. Their average salary is over 150K USD (>200M KRW).

■ **Introduction to other activities besides research**

Our group strongly supports activities other than research and is open to various options! Since we just started, the detailed activities are up to our new group members. At Texas Tech, we usually had a group BBQ or lunch each semester and happy hours (coffee breaks) when we needed photosynthesis.

■ **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. We just moved to KAIST from Texas Tech University (in Fall 2022), and we are excited about the prospect of working with brilliant students at KAIST EE. For more details, please visit the Q&A page in our group webpage and feel free to email at sangsik.kim@kaist.ac.kr

■ **Recent research achievements**

[1] (Exceptional Points) A. Yulaev*, **S. Kim***, *et al.*, ***Nature Nanotechnology*** 17, 583 (2022) (*equal contribution)
[2] (Metamaterials) M. Mia, S. Ahmed, I. Ahmed, Y. Lee, M. Qi, and **S. Kim**, ***Optica*** 7, 881 (2020)
[3] (Photonic/Atomic System) **S. Kim**, *et al.*, ***Light: Science & Applications*** 7, 72 (2018)
[4] (Metamaterials) S. Jahani*, **S. Kim***, *et al.*, ***Nature Communications*** 9, 1893 (2018) (*equal contribution)
[5] (Frequency Comb) **S. Kim**, *et al.*, ***Nature Communications*** 4, 1345 (2017)

⟨Professor Sanghyeon Kim's Lab.⟩

3D integrated opto-electronic device Laboratory	■ Contact information		
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	Lab.	**Email: mmb07@kaist.ac.kr**	**Tel: 7552**
	Website	**https://www.3doedl.com/**	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 12 Master's Student: 5

■ **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**

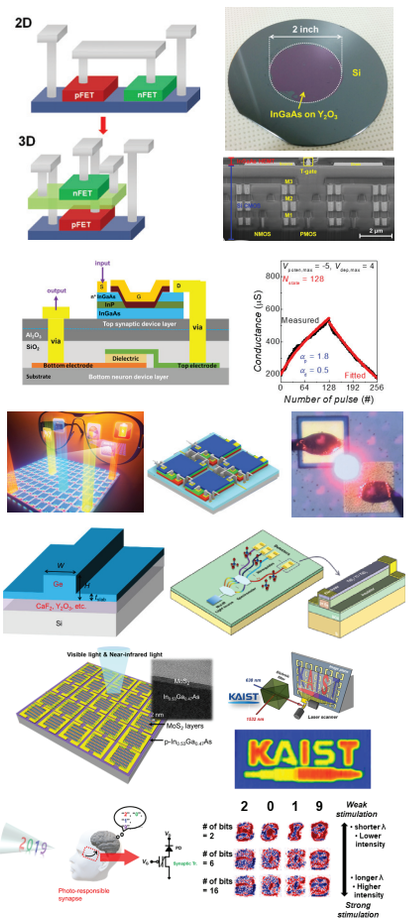
For ultra-small, but ultra-high resolution display, we are developing 3D stacked inorganic MicroLED display using wafer bonding and sequential device fabrication process.

▶ **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.

■ **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 (2020-2022)**

27 journal papers (some of them were featured as a cover article), 33 conference papers including flagship conferences (IEDM, VLSI, IMID, etc.)

⟨Professor Song Min Kim's Lab.⟩

Smile LAB

SMart and Mob**ILE** Systems (SMILE) Lab

■ Contact information		
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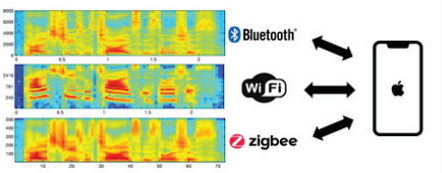
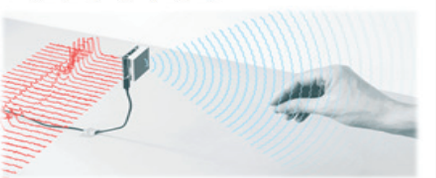
■ Current state of the Lab. (in 2022 Fall Semester)

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

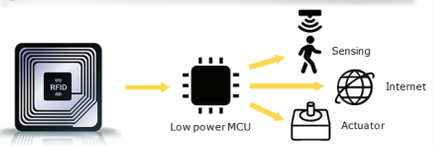
■ Research Areas



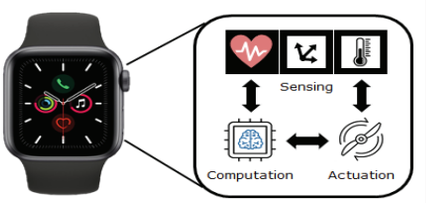
Cross-technology Communication: CTC is a new technology for direct communication among heterogeneous wireless devices (e.g., WiFi, Bluetooth) despite their incompatible physical-layers. CTC is a key to hyper-connectivity and cross-technology collaborations.



Millimeter Wave 5G/6G Wireless Network: With 100 Gbps speed, mmWave is a key to heavy-traffic future applications such as virtual and augmented reality. We aim at realizing such services while tackling the unique issues of mmWave (e.g., blockage and high attenuation). Our research targets to achieve high throughput, long distance and low power consumption by innovative hardware and network protocols.



Batteryless Internet of Things: IoT without batteries is critical for (1) massive and pervasive IoT deployment and (2) a greener world. We design systems and algorithms for extremely low-power IoT operated by power harvesters (e.g., Solar-cell, RF, vibration).



Artificial Intelligence of Things: AI (training + inference) on low-power and low-cost IoT systems is a vital component for sustainable smart homes and healthcare applications. To realize this, we design efficient AI embedded systems (e.g., wearables) and algorithms with minimum computation, actuation, and sensing overheads, while achieving high accuracy.

■ 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 mobile 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 (2018-2022)

Many top conference and premier journal papers: MobiCom, SenSys, MobiSys, ICDCS, INFOCOM, USENIX Security, TON, TCOMM, TMC, and TOSN. Until now, all students have published top conference papers within the first two years after joining, thanks to their hard-work. A student was nominated **MobiSys'22 Best Paper Award** (2/176), the second time in history from an Asian university, while 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)	■ Contact information		
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	LAb.	Email: syssec@kaist.ac.kr	Tel: 042-350-7430
	Website	http://syssec.kaist.ac.kr	

■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 16 Master's Student: 7

■ Research Areas

o Security of Drones, Self-Driving Cars, and Embedded Devices

Security of all layers of Cyber Physical Systems (CPSs) such as drones, self-driving cars and embedded devices is one of the major research pillars. We have shown that EMI injection on analog sensing circuits of can manipulate actuation (to stop pacemaker). This paper is known to be the 1st sensor security paper. Since then, we have been leading sensor security research. Examples include dropping drone using sound (by causing resonation in gyroscopic sensors), causing over- and under-infusion in medical infusion pumps, faking and disabling LIDAR used for self-driving cars, faking and disabling fire detection sensor, hijacking drones using GPS spoofing. We also investigate communication channels of frequency hopping drones. To support fuzzing without hardware, we show how one can emulate firmwares automatically. Currently, we are exploring more advanced anti-drone technologies as well as security of self-driving cars.

o Security of Cellular Technologies

We use 4G and 5G cellular networks everyday. We have shown that these cellular technologies are not secure. In terms of cellular security research, our lab is known to be #1 in the world.

- Security Testing: Cellular standard does not include security testing causing many implementation vulnerabilities. We have developed testing tools for VoLTE, LTE core networks and smartphone modems. Using these tools, we found and reported several hundred vulnerabilities of commercial smartphones and operating cellular networks in Korea and the US. We also investigate how one can diagnose performance bugs as well.
- Cellular Privacy: In 2012, we showed that 2G and 3G networks leak location information. In 2018, we showed that 4G also leaks location information. In 2022, we show that one can track which video a victim is watching.
- Voice phishing: In 2021, Korea lost 0.7 Billion USD due to voice phishing. We have received funding from Korean police to develop technologies for track, prevent, and mitigate voice phishing.

■ Recommended courses & Career after graduation

As SysSec lab works in broad area, any kind of expertise are welcomed. In general, strong computer system (e.g. networking, OS, security, etc.), theoretical (cryptography, mathematics, information theory, etc) or electrical engineering (circuits, wave, signal processing) skills are all welcomed.

Graduates are currently working for the academia (Sungkyunkwan Univ., Kansas State, Univ of Central Florida, Liberty Univ), research institute (Qualcomm research, Samsung Research, National Security Research Institute, Electronics and Telecommunication Research Institute), companies (Samsung, LG, Naver, SDS, Microsoft), and start-ups (Looxid Labs, Theori, Krust, S2W).

■ Introduction to other activities besides research

Attend one international conference participation per year on average. Frequent (un)official get-together's. Extra money through bug bounties.

■ Introduction to the Lab.

Professor Yongdae Kim has been working on security for nearly 30 years. (20 years as a professor = 10 years at KAIST + 10 years in Univ of Minnesota). His paper was cited nearly 10,000 times (the most cited security professor in Korea). His work is very well-known internationally. He has been invited to companies (e.g. Qualcomm, Microsoft, Google, Samsung, SKT), research labs and government to give a talk or consult. SysSec lab has students from both the School of Electrical and Electronics Engineering and the Graduate School of Information Security.

■ Recent research achievements (2020-2022)

- 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)
- Enabling the Large-Scale Emulation of Internet of Things Firmware With Heuristic Workarounds, IEEE Security & Privacy (IEEE S&P '21)
- BaseSpec: Comparative Analysis of Baseband Software and Cellular Specifications for L3 Protocols, Network and Distributed Systems Security Symposium (NDSS '21)
- FirmAE: Towards Large-Scale Emulation of IoT Firmware for Dynamic Analysis, Annual Computer Security Applications Conference (ACSAC '20)
- The System That Cried Wolf: Sensor Security Analysis of Wide-area Smoke Detectors for Critical Infrastructure, ACM Transactions on Privacy and Security (ACM TOPS' 20)

⟨Professor Yong-Hoon Kim's Lab.⟩

Atomic-Scale Devices Simulation Lab	■ Contact information		
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	Lab.	**Email:** dndhdrnl@kaist.ac.kr	**Tel: 042-350-7523/ 042-350-7623**
	Website	http://nanocore.kaist.ac.kr	

■ Current state of the Lab. (in 2022 Fall Semester)

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

■ Research Areas

1. Theory & Computation

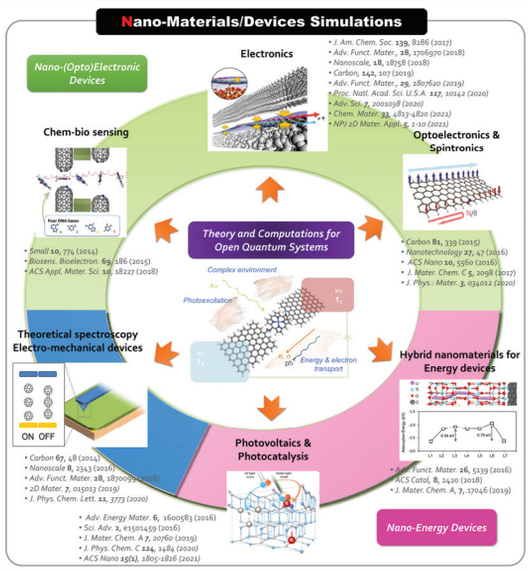
- physics of non-equilibrium open quantum systems
- novel 1st-principles & multiscale theory for quantum transport & optical excitation processes
- artificial intelligence (AI) & machine learning for technology computer aided design (TCAD) simulations

2. Functional Nano-Materials

- graphene, 2D materials, & heterostructures
- semiconductor & oxide quantum dots, wires, & wells
- hybrid halide perovskites & bio/organic materials

3. Next-Generation Nano-Devices

- "more Moore & more than Moore" devices (multi-value logic, neuromorphic computing, quantum computing)
- energy conversion & storage devices (solar cells, LED, electro/photocatalysis, supercapacitor)
- bio & electrochemical interfaces (chem-bio sensors)



■ Recommended courses & Career after graduation

- Lab members are expected to have strong interest in (1) advanced quantum/device physics, (2) high-performance/AI computing, & (3) next-generation TCAD
- In the past 5 years, 2 PhD graduates became permanent staff members in a National Lab (< 1 yr. after graduation); 1 postdoc was appointed as an associate professor in a leading Pakistanese university

■ Introduction to other activities besides research

- 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.

- According to *Nature* (http://nature.com/top100), among the top 100 most cited papers of all time in all fields, 12 of them are on density functional theory (DFT).
- Our group is leading the development of novel 1st-principles DFT, multiscale & AI nanodevice simulation formalism and softwares that can deal with quantum transport & optical excitations.
- This will have far-reaching implications for the understanding of the physics of non-equilibrium open quantum systems and the development of next-generation electronic/energy/bio-nanodevices.

■ Recent research achievements (2020-2022)

- *"Gate-versus defect-induced voltage drop and negative differential resistance in vertical graphene heterostructures"*, Npj Comput. Mater. (2022)
- *"An Optogenetics-Inspired Flexible van der Waals Optoelectronic Synapse and its Application to a Convolutional Neural Network"*, Adv. Mater. (2021)
- *"Origins of genuine Ohmic van der Waals contact between indium and MoS_2"*, NPJ 2D Mater. Appl. (2021)
- *"Multi-space excitation as an alternative to the Landauer picture for non-equilibrium quantum transport"*, Adv. Sci. (2020)
- *"Quasi-Fermi level splitting in nanoscale junctions from ab initio"*, Proc. Natl. Acad. Sci. U.S.A. (2020)

(18 papers of impact factor > 5 SCI journals in '20-'22; See http://nanocore.kaist.ac.kr for the full publication list)

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

〈Professor Lee-Sup Kim's Lab.〉

Multimedia VLSI Laboratory

■ Contact information		
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Website	http://mvlsi.kaist.ac.kr	

■ Current state of the Lab. (in 2022 Fall Semester)

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

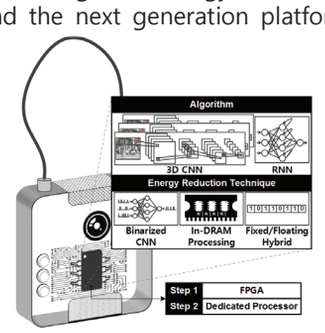
■ Research Areas

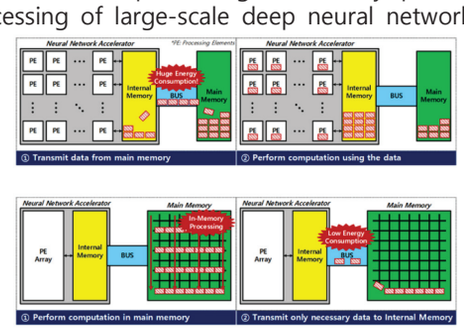
[Deep Learning & Neural Network Processor Design]

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
▷ 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. 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 (2021-2022)

[1] The most recognized journal: Seungkyu Choi, Jaekang Shin, Lee-Sup Kim, "A Deep Neural Network Training Architecture with Inference-aware Heterogeneous Data-type", IEEE Transactions on Computers, 2022

[2] The most recognized conference: , Jaekang Shin, Seungkyu Choi, Jongwoo Ra, Lee-Sup Kim, "Algorithm/Architecture Co-Design for Energy-Efficient Acceleration of Multi-Task DNN", IEEE/ACM Design Automation Conference , 2022

⟨Professor Joungho Kim's Lab.⟩

TERA
TeraByte Interconnection and Package Laboratory

■ **Contact information**

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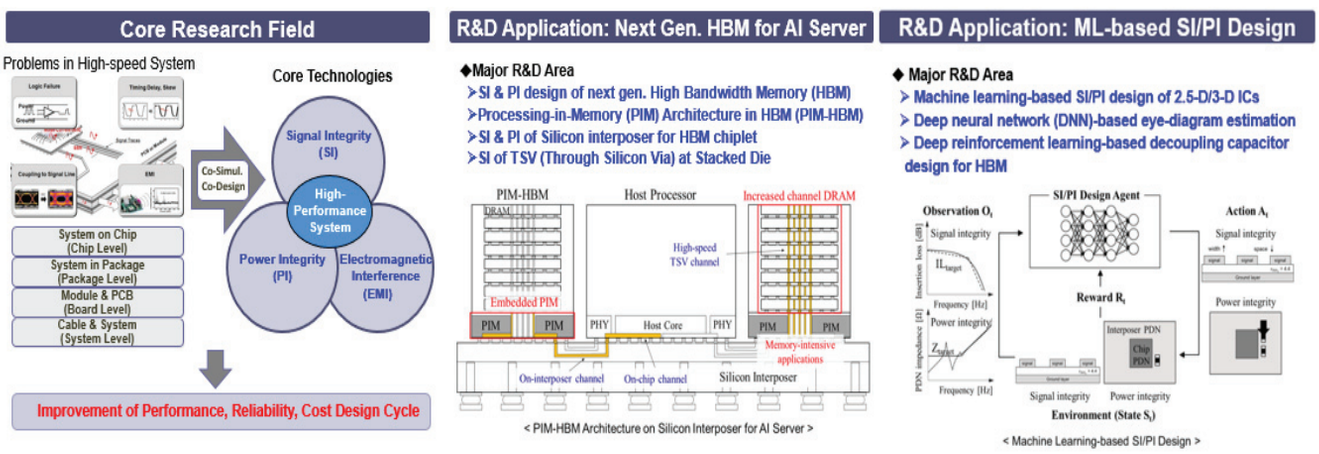
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 2 PhD Students: 11 Master's Student: 11

■ **Research Areas**



■ **Career after graduation**

◆ **Domestic Companies**

➢ **Samsung, SK Hynix, Hyundai motors, LG electronics, etc.**

◆ **International Companies**

➢ **Google, Apple, NVIDIA, Tesla, Intel, Qualcomm, Rambus, etc.**

■ **Introduction to other activities besides research**

Seminar in Silicon Valley, Workshop, Exercise

■ **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 (2019-2022)**

[1] Best Paper Award, Gapyeol Park and et al, ""Design and Measurement of a 28 GHz Glass Band Pass Filter based on Glass Interposers for 5G Applications," 2019 Electrical Design of Advanced Packaging and Systems (EDAPS)

[2] Best Paper Award, Kyunjune Son and et al, "Deep Reinforcement Learning-based Interconnection Design for 3D X-Point Array Structure Considering Signal Integrity" 2020 Electrical Design of Advanced Packaging and Systems (EDAPS)

[3] SCI Journal : 14 (2019~2022), Conference Paper : 62 (2019~2022)

<Professor Joo-Young Kim's Lab.>

CastLab

(Circuits, Architecture, Systems, Technology Lab)

■ **Contact information**

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Lab.	E3-2 #4209	**Tel:** N/A
Website	https://castlab.kaist.ac.kr	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 8 Master's Student: 13

■ **Research Areas**

1. Next Generation AI Processor

Machine Learning (ML) revolutionizes how computers handle cognitive tasks based on a massive amount of observed data. As more industries are adopting the technology, we are facing fast-growing demand for hardware support to enable faster and more energy-efficient processing. However, the latest hardware solutions are often limited to a few popular algorithms such as Multi-Layer Perceptron (MLP), Convolutional Neural Networks (CNN), and Recurrent Neural Networks (RNN). We will focus on hardware support for next-generation AI/ML scenarios such as unsupervised learning and reinforcement learning.

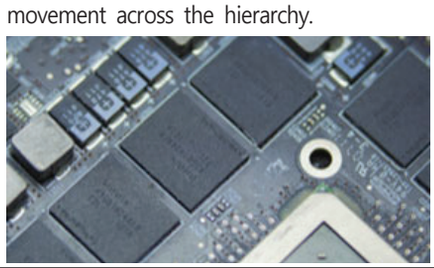
2. Datacenter SoC

Cloud computing is rapidly changing how enterprises run their services. Hardware specialization for a massive number of datacenter servers makes economic sense as its energy-saving effect will be magnified by the number of servers.

Although it is difficult to find dominant applications in datacenter, network and storage layers tend to have shared data processing pipelines across the workloads. We aim to develop a specialized system-on-chip that not only accelerates common network and storage processing but also provides direct paths between virtual machines and network and storage devices in datacenters.

3. Memory Centric Computing

Traditionally CPU is the center of the computing systems while a few layers of memory are built around it to feed the data. However, as compute unit gets much faster than memory unit with technology scaling, it is no longer the most time and energy-consuming part of the system. Instead, the cost of moving data to the locations where computations happen becomes the bottleneck. Memory centric model takes an opposite approach to traditional compute centric model to solve this expensive data movement problem: data stays in different storage levels, but the processing engines around them perform computations to avoid data movement across the hierarchy.



■ **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**

- You will have chances to work with various international research organizations such as Microsoft Research, IBM, University of Washington, etc. This can lead you to internship opportunity as well as full-time employment.
- You will get a modern workspace and various language skill development resources.

■ **Introduction to the Lab.**

Mission statement: 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 (2020~2022)**

Starting in 2019, we are making a history in advanced hardware design research! Please see latest publications below:

"DFX: A Low-latency Multi-FPGA Appliance for Accelerating Transformer-based Text Generation," MICRO, 2022
"A Dual-Mode Similarity Search Accelerator based on Embedding Compression for Online Cross-Modal Image-Text Retrieval," FCCM, 2022
"T-PIM: A 2.21-to-161.08TOPS/W Processing-In-Memory Accelerator for End-to-End On-Device Training," CICC, 2022
"Z-PIM: A Sparsity-Aware Processing-In-Memory Architecture with Fully-Variable Weight Bit-Precision for Energy-Efficient Deep Neural Networks," JSSC, 2021
"FIXAR: A Fixed-Point Deep Reinforcement Learning Platform with Quantization-Aware Training and Adaptive Parallelism," DAC, 2021

〈Professor. Junmo Kim 〉

Statistical Inference and Information Theory Lab (SIIT)	■ Contact information		
	Professor	Email: junmo.kim@kaist.ac.kr	
	Lab.	N1 214	
	Website	siit.kaist.ac.kr	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 28 Master's Student: 9

■ **Research Areas(RP: Recent Publication)**

Further information on publication is available on the laboratory website. (siit.kaist.ac.kr)

Continual Learning(RP: ECCV 2022)

Human Pose Estimation(RP: ICCV 2021)

Depth Estimation(RP: IROS 2022, AAAI 2021)

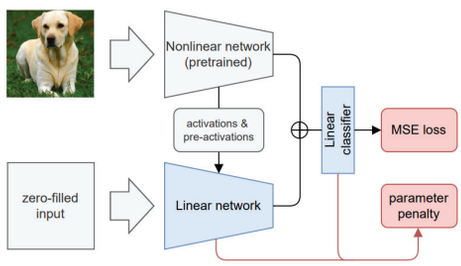
Representation Learning(RP: ECCV 2022)

Domain Adaptation/Generalization(RP: ICRA 2022)

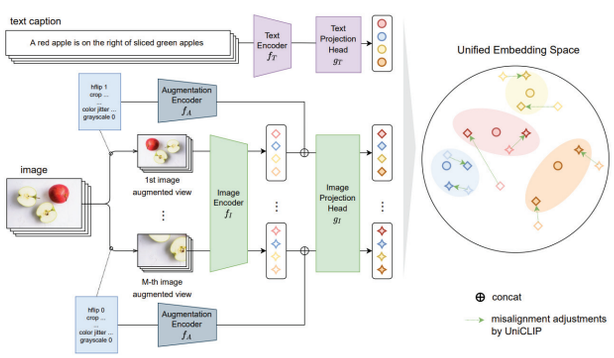
Hyper-parameter Tuning(RP: ECCV 2022)

Others

- Geneartive Model(RP: [Best Paper] CVPRW 2022)
- Point Cloud, 3D model(RP: ICCV 2021)
- Augmentation Strategy
- Deep Learning Theory(RP: ICCV 2021)
- Fairness



(Figure 1) Overview of DLCFT



(Figure 2) Overview of UniCLIP

■ **Recommended courses & Career after graduation**

Recommended courses:

Career after graduation(2020~): LG AI Research, SAIT, Samsung Research, NAVER CLOVA AI, etc.

■ **Introduction to other activities besides research**

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

■ **Introduction to the Lab.**

As many students are enrolled in our laboratory, various research topics are being conducted. Team meetings are held approximately every two weeks in the lab, and students are free to choose a team to attend according to the research topic they are interested in.

In addition, the lab is conducting projects with various companies, and incentives are paid according to the amount of participation in the project.

■ **Recent research achievements (2020-2022)**

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

2021: ICCV 3 , ICRA 1, CVPR 1, WACV 1, AAAI 3

2020: ICPR 2, ECCV 1, IROS 1, CVPR 2, AAAI 1(Oral)

〈Professor Changick Kim's Lab.〉

CILAB Computational Intelligence Laboratory

■ Contact information		
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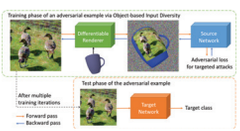
Lab.	Email:suminlee94@kaist.ac.kr	Tel: 042-350-7521
Website	https://cilabs.kaist.ac.kr/	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 15(full-time) / 9(part-time) Master's Student: 10

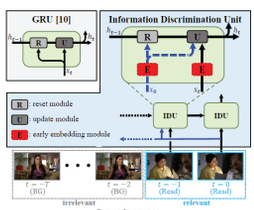
■ **Research Areas**

▶**Adversarial Attack & Defense**



- Protecting AI systems against malicious users who tries to fool the system.
- Creating adversarial perturbations exploited in real-world physical environments.

▶**Action Detection and Anticipation**

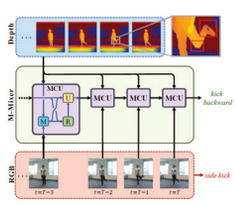


- Discriminating relevant actions for online action detection.
- Forecasting unseen future actions from the pseudo action labels obtained by online action detection.

▶**Image segmentation**

- Human face parsing & body part segmentation.
- Exploring diverse research topics (e,g, domain adaptive or few-shot segmentation).

▶**Video Understanding**



- Understanding actions in a video based on multiple modalities.
- Localizing an object of an action.

▶**Long-Tail Recognition**

- Resolving the data imbalance problem in machine learning
- Important for real world applications such as wild animal classification

▶**Short-term Weather Forecast**

- Predicting total precipitation image for Korean Peninsula
- Pesenting new Total Precipital Water (TPW) benchmark from the Geostationary Korea Multi-Purpose Satellite-2A

■ **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.

↑Homepage

■ **Recent research achievements (2012 - 2022)**

- **24** publications in top-tier conferences. (Total 118 publications including major conferences and SCI journals.)
- 7 awards in international conferences and challenges, 20 in domestic conferences.
- 11 international and domestic patents.

<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) hongbae2004@kaist.ac.kr

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

■ **Current state of the Lab. (in 2022 Fall Semester)**

Ph.D. Students : 13 Master/Ph.D.-Integrated Students: 1 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)**

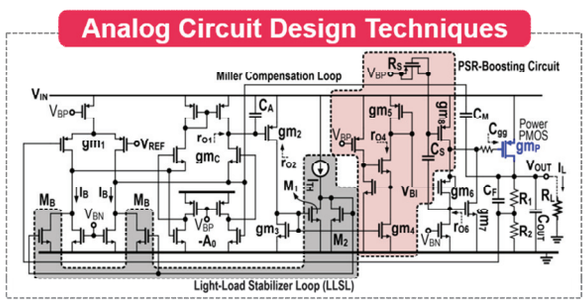
- Switch-mode DC-DC power converter using inductive, capacitive, and hybrid techniques
- Fully-monolithic high-speed switching PMIC for modern SoCs
- Energy-harvesting interface circuit and system
- Fast-response high-PSR low-dropout (LDO) regulator
- Battery charger and management circuit

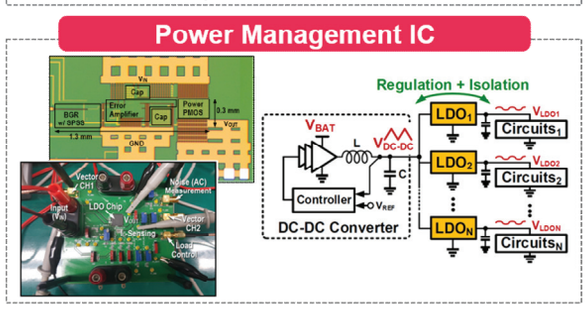
☐ **Display Driving Circuits and Systems**

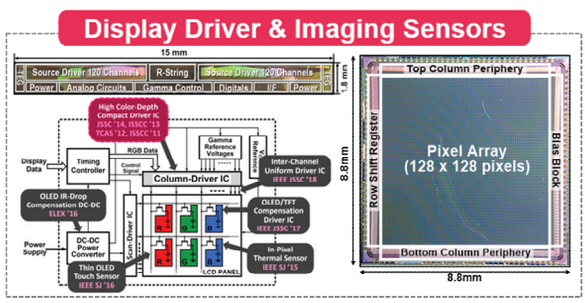
- High-resolution area-efficient digital-to-analog converter (DAC)
- OLED display driver with pixel-readout and active-compensation
- Low-power high-speed output driving buffer amplifier
- Fully-integrated system-on-wafer (SoW) for micro-LED displays
- Displays with touch-sensing functionality

☐ **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

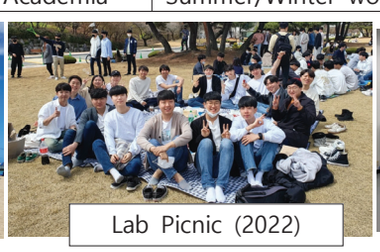
■ **Careers after graduation :** Samsung, LG, SK-Hynix, National Research Laboratory, Silicon-Valley, Academia

■ **Introduction to our laboratory**

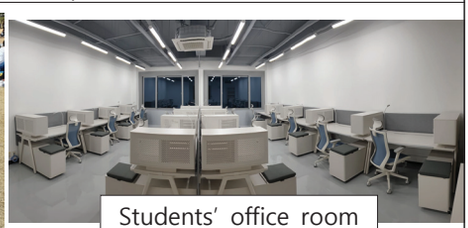
Young and active research environments, Horizontal peer relationship, 24-hours academic discussion, Opened and wide opportunities to attend international conference, Summer/Winter workshop, Refreshed clean office room

■ **Lab. Photo**

VLSI 2022 (Hawaii)



Lab Picnic (2022)



Students' office room

■ **Recent research achievements (2020~2022)**

Fully-integrated PMIC (JSSC 2022 & ISSCC 2022), TENG energy-harvesting (JSSC 2022 & ISSCC 2022), Ultra-fast amplifier (JSSC 2021 & ISSCC 2021), Touch sensor (JSSC 2021), ADC (ESSCIRC 2022), HV DC-DC (VLSI 2022), Fast-DVS PMIC (VLSI 2022), Fully-integrated PMIC (VLSI 2022), SIDO PMIC (VLSI 2022), Display driver (ISSCC 2022)

<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 2022 Fall Semester)**

PhD Students : 5 Master's Student : 4

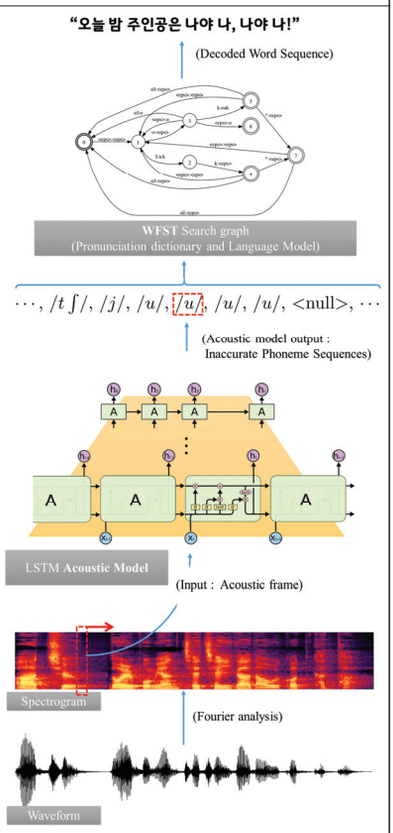
■ **Research Areas**

SSSCLAB has been researching pattern recognition based on machine learning and deep learning for speech and sound signals. In recent years, with the advance of smart devices, AI, IoT, etc., 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
Development of Speech Technology for Machine Learning Diagnosis of Cognitive-Affective Disorder Patients
Research on Unified Interactive Learning Schemes of End-to-End Speech Recognition and Synthesis based on Deep Learning of Speech Chain Mechanism
Development of Voicepishing Prevention Technology Based on Speech and Text Deep Learning

■ **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, VUNO, TmaxSoft, 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 10 Ph.D. and 26 Master graduates for 20 years.

■ **Recent research achievements ('21~'22)**

[1] Youngsik Eom, *et al.,* "Anti-Spoofing Using Transfer Learning with Variational Information Bottleneck" Interspeech2022.

[2] Myunghun Jung, *et al.,* "Asymmetric Proxy Loss for Multi-View AcousticWord Embeddings" Interspeech2022.

[3] Yeunju Choi, *et al.,* "Learning to Maximize Speech Quality Directly Using MOS Prediction for Neural Text-to-Speech" IEEE ACCESS, Vol. 10, pp. 52621-52629, May 2022.

<Professor Hoon Kim's Lab.>

PHOTONICS SYSTEMS RESEARCH LAB

■ Contact information

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Lab.	**Email: kihong94@kaist.ac.kr**	**T: 042-350-7633**
Website	**http://psrl.kaist.ac.kr**	

■ Current state of the Lab. (in 2022 Fall Semester)

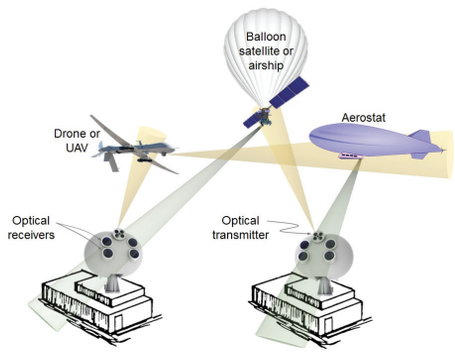
Research Professor : 1 Postdoctoral Fellows : 2 PhD Students: 11 Master's Student: 4

■ Research Areas

We have been focusing our research activities on various aspects of photonic systems/subsystems and related technologies, including free-space optical communications, high-capacity fiber-optic communication systems, broadband optical access systems, fiber-optic mobile fronthaul/backhaul systems, and lightwave subsystems since 2014.

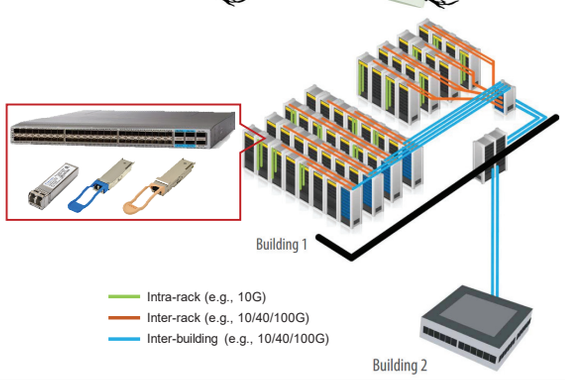
High-speed free-space optical transmission system

Due to the scarce resources of RF spectrum and growing demand for higher capacity, there is an increasing interest in the free-space optical communication (FSOC) system for commercial and military applications. For example, Google and Facebook have launched Project Loon and Aquila to extend internet connectivity to anywhere in the world by using FSOC-based balloons and drones, respectively. We are exploring the possibility of utilizing the FSOC technology for long-distance, high-capacity transmission.



Transmission technologies for data center

There are strong demands for connectivity inside datacenters and between datacenters, Datacenter is a house of computer systems with storage, each interconnected with one another. There are >1 million optical transceivers in a large datacenter, delivering tens of gigabit data per second. We are focusing on various cost-effective technologies for datacenter applications.



■ Recommended courses & Career after graduation

- Recommended courses: Digital Communications, Introduction to Optical Communication, Introduction to Optical Engineering, and Digital Signal Processing.
- Potential career paths after graduation include national research institutes, major companies, and academia.

■ Introduction to other activities besides research

We plan to have an annual retreat among our team members in winter. We are also going to have a sports day regularly with other lab members in KAIST working on photonics.

■ Introduction to the Lab.

- Photonics Systems Research lab was established in 2014. Under the supervision of Prof. Hoon Kim who has worked on photonics systems for 19 years in industry and academia including Bell Labs, Lucent Technologies, Samsung Electronics, and National University of Singapore, we research into the fundamental limits of various photonics systems as well as practical ways of implementing them. Prof. Kim is currently serving as a Editor of *Optics Communications* and Senior Editor of *IEEE Photonics Technology Letters.*
- We carry out academic exchange with international research institutes and universities and also attend top-notch international conferences such as Optical Fiber Communications and OptoElectronic Communication Conference.

■ Recent research achievements (2020-2022)

- International journal publications : 17, International conference presentations: 13.
- Best Student Paper Awards : PC 2021, COOC 2020, 2022.

〈Professor Yong Man Ro〉

IMAGE & VIDEO SYSTEMS Lab. since 1998
Empowered by Deep Learning

CARAI Center for Applied Research in Artificial Intelligence

Image and Video Systems Laboratory

Center for Applied Research in AI

■ **Contact information**

Professor	**Email: ymro@kaist.ac.kr**	**Tel: 042-350-3494**
Lab.	**ITC building (N1) #418**	**Tel: 042-350-8094**
Website	**http://ivylab.kaist.ac.kr**	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 15 (Full) 2 (Part) Master's Student: 6

■ **Research Areas**

Deep Learning Algorithm in Generic Image and Computer Vision Problems

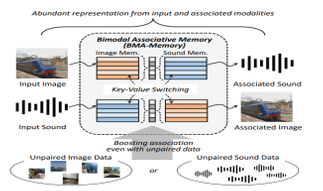
Image/video analysis is an important research subject in IVY Lab, where deep learning approach is our current research interest. We investigate various types of deep networks and devise novel network structures to extract and analyze image and video data. Current research works include adversarial robustness, representation learning for spatio-temporal dynamics in video, and object segmentation/detection/classification. A number of the lab research results have been published in international journals (IEEE TIP, IEEE TCSVT, etc.) and international conferences (CVPR, ICCV, ECCV, AAAI, ICASSP, etc.).

Multi-modal learning in Deep Learning

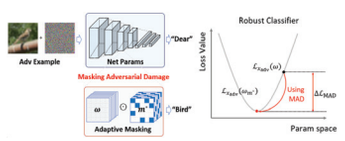
IVY Lab research the principle of multi-modal data analysis (video, audio, language, etc). Recently, we investigate the characteristic of multi-modal data, fusion method and adversarial robustness. Our research interests include adversarial robustness with multi-modal data (RGB, IR, Hyper-spectral, etc), multi-modal data relation/causality, and learning representation of multi-modal data.

Robust and Explainable Deep learning

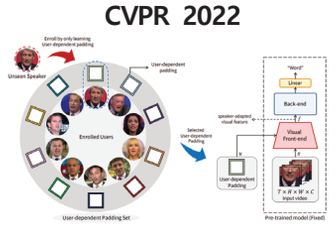
Current research interest on deep learning-based processing is to design robust networks and further disclose them for explanation, which are strongly demanded in the defense/security applications. Deep learning-based studies for attention network, adversarial learning, generative model, and explainable AI have been done on secure-required image data. Currently, we are conducting deep learning researches for analyzing robustness and interpretability of deep neural networks.



S. Lee *et al.* CVPR 2022



B. Lee and J. Kim *et al.* CVPR 2022



M. Kim *et al.* ECCV 2022

■ **Recommended courses & Career after graduation**

Recommended courses include probability, digital signal processing, machine learning, introduction to multimedia, image processing/computer vision, various programming courses. Graduates have jobs in various places such as professor, post-doc (EPFL: Lausanne, Switzerland, TUM: Munich, Germany), national research institutes (ETRI, ADD, KIST), and companies (Samsung, Hyundai, SKT, etc.)

■ **Introduction to other activities besides research**

IVY Lab regularly holds common activities such as mountain tracking, summer/winter MT, etc. Please see various activities in http://ivylab.kaist.ac.kr/base/Gallery/Gallery.php

■ **Introduction to the Lab.**

IVY laboratory is currently focusing on deep learning research. Our lab has achieved outstanding achievements such as this year's Science Prize (Association of Scientific Journalists), Best Paper Awards, and IT Mark. The researchers have strong bonds with each other, and they help/encourage each other while researching and living in an autonomous atmosphere with stable support. We also encourage students to have research experience in an international sense through visiting research with world-class research institutes (e.g., University of Toronto, Technical University of Munich, Ecole Polytechnique Federale de Lausanne, FAIR, Amazon, etc.) in our interesting research field.

■ **Recent research achievements (2020-2022)**

- We have published 142 SCI journal papers (SCI-indexed, referee peered), 333 International conference papers (referee peered). In the recent 3 years, 12 SCI journal papers (IEEE TIP, IEEE TCSVT, etc.) and 42 International conference papers (including 18 AI top tier conferences (CVPR, ICCV, ECCV, NeurIPS, AAAI, etc)) have been published.
Recent AI top tier publication: https://ivylab.kaist.ac.kr/base/Publication/toptier.php

⟨Professor Seung-Tak Ryu's Lab.⟩

MSICL
Mixed Signal Integrated Circuits Lab.

■ Contact information

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Lab.	**Email:** msicl@kaist.ac.kr	**Tel:** 042-350-7525
Website	https://msicl.kaist.ac.kr/	

■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 13 Master's Student: 8

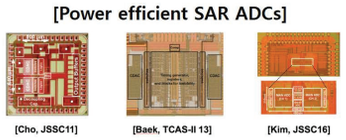
■ Research Areas

Our research is on Analog/Mixed-signal circuit design. The major research area is data converters, which convert analog signals to digital signals, or vice-versa (ADC/DAC). Digital circuits are popularly used for processing due to its advanced calculation power and reduced power consumption. As all the natural signals are analog, analog circuits became highly significant as we need to transfer the nature signal to digital systems for further processing. Therefore, the research on analog circuits and data converters are necessary with the development of circuit systems.

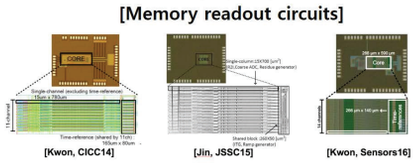
The current research includes the following:

- High-speed ADC (Time-Interleaved, SAR, Pipelined)
- High-resolution ADC (Delta-Sigma Modulator, Noise-Shaping SAR)
- Bio-sensor ADC (SAR, DSM)
- High-speed, high-resolution DAC (Current Steering DAC)
- Readout circuit for CMOS Image Sensor
- Readout circuit for Finger-print Sensor
- Synthesizable ADC (Synthesizable SAR)

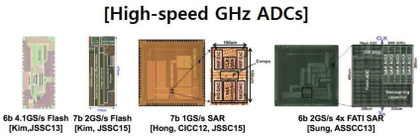
[Power efficient SAR ADCs]



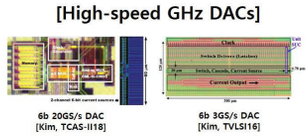
[Memory readout circuits]

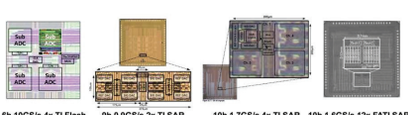


[High-speed GHz ADCs]

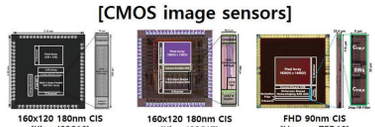


[High-speed GHz DACs]





[CMOS image sensors]



■ Recommended courses & Career after graduation

Recommended undergraduate courses are Electronic Circuits (EE304), Digital Electronic Circuits (EE372), and Analog Electronic Circuits (EE403), as the research deals with both analog circuits and digital circuits. Graduate courses related to our research includes Advanced Electronic Circuits (EE571) and Analog Integrated Circuits (EE676). After graduation, you can get a position in companies or researching-institutes related to semi-conductor design.

■ Introduction to other activities besides research

In order to encourage the friendship of group members, we have some events each season. In summer and winter, periodic workshops are held. There are some other outings such as strawberry party and end-of-the-year event. (Out of school activities are suspended due to COVID19). Besides, we celebrate each member's birthday, provide regular snacks in the lounge, and also provide midnight snacks.

Lunar New Year's Eve @EE Rooftop, KAIST

Summer MT @Sancheong-gu, Gyeongsangnam-do

■ Introduction to the Lab.

Our group is working on Analog/Mixed-signal circuit design, focusing on data converters and sensor read-outs. Since our research on circuit design deals with both analog and digital circuits, it would be a good chance to explore integrated circuit (IC) design. We hold various projects with companies and research institutes such as Samsung, Hynix, and ETRI. Due to these projects, the students will be able to have opportunities for chip fabrication.

■ Recent research achievements (2020-2022)

[1] Kent Edrian Lozada, "A 4th-Order Continuous-Time Delta-Sigma Modulator With Hybrid Noise-Coupling," TCAS-II 2022
[2] Kent Edrian Lozada, "A 4th-Order Continuous-Time Delta-Sigma Modulator With Hybrid Noise-Coupling," IEEE MWSCAS, 2022
[3] Dong-Jin Chang, "A Relative-Prime Rotation Based Fully On-Chip Background Skew Calibration for Time-Interleaved ADCs," VLSI, 2022.
[4] Dong-Ryeol Oh, "A 7-Bit Two-Step Flash ADC With Sample-and-Hold Sharing Technique," EEE, JSSC, 2022.
[5] Dong-Jin Chang, "MixedNet: Network Design Strategies For Cost-Effective Quantized CNNs," IEEE, Access, 2021.
[6] Dong-Jin Chang, "A 28-nm 10-b 2.2-GS/s 18.2-mW Relative-Prime Time-Interleaved Sub-ranging SAR ADC with On-Chip Background Skew Calibration," IEEE, JSSC, 2021.
[7] Ye-Dam Kim, "A 4th-Order CT I-DSM with Digital Noise Coupling and Input Pre-Conversion Method for Initialization," IEEE ASSCC, 2021.
[8] Seungyong Lim, "An Input-Buffer Embedding Dual-Residue Pipelined-SAR ADC with Nonbinary Capacitive Interpolation," IEEE ASSCC, 2021.
[9] Dong-Ryeol Oh, "An 8-Bit 1-GS/s Asynchronous Loop-Unrolled SAR-Flash ADC With Complementary Dynamic Amplifiers in 28-nm CMOS," JSSC 2020.
[10] Dong-Jin Chang, "Compact Mixed-Signal Convolutional Neural Network Using a Single Modular Neuron," TCAS-I 2020.
[11] Min-Jae Seo, "A Single-Supply CDAC-Based Buffer-Embedding SAR ADC with Skip-Reset Scheme having Inherent Chopping Capability," JSSC 2020.
[12] Dong-Ryeol Oh, "An 8b 1GS/s 2.55mW SAR-Flash ADC with Complementary Dynamic Amplifiers," VLSI 2020.

⟨Professor Hyun Myung⟩

	■ Contact information		
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	Lab.	Urban Robotics Lab	Tel: 042-350-7551
	Website	https://urobot.kaist.ac.kr/	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 22 Master's Student: 12

■ **Research Areas**

- Autonomous robot navigation (SLAM, Self-driving car, etc.)
- Machine learning & artificial intelligence
- Intelligent robots
- Monitoring & inspection for smart cities
- Environmental robotics
- Swarm robots

■ **Recommended courses & Career after graduation**

Recommended courses: EE381, EE581, EE585

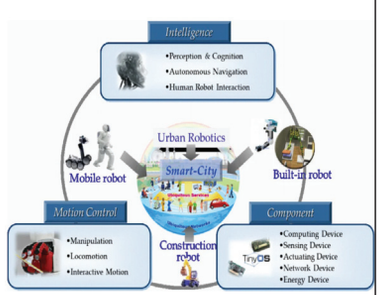
Career after graduation: Robotics researcher for gov. research institutes and industry (Samsung Elec., LG Elec., Hyundai Robotics, Naver labs, etc.); Professor in academia

■ **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, 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 (2020-2022)**

2022 (published paper: 27)

Seungwon Song, Hyungtae Lim, Alex Junho Lee, and Hyun Myung†, "DynaVINS: A Visual-Inertial SLAM for Dynamic Environments," IEEE RA-L (Robotics and Automation Letters), vol.7, no.4, pp.11523-11530, Oct. 2022. [DOI]

I Made Aswin Nahrendra, Christian Tirtawardhana, Byeongho Yu, EungChang Lee, and Hyun Myung†, "Retro-RL: Reinforcing Nominal Controller with Deep Reinforcement Learning for Tilting-Rotor Drones," IEEE RA-L (Robotics and Automation Letters), vol.7, no.4, pp.9004-9011, Oct. 2022. [DOI]

2021 (published paper: 51)

Hyunjun Lim, Jinwoo Jeon, and Hyun Myung†, "UV-SLAM: Unconstrained Line-based SLAM Using Vanishing Points for Structural Mapping," Accepted to IEEE RA-L, Dec. 2021 [arXiv]

Wooju Lee and Hyun Myung†, "Adversarial Attack for Asynchronous Event-based Data ," Accepted to AAAI 2022, Dec. 2021 [arXiv]

2020 (published paper: 35)

Hyungtae Lim, Hyeonjae Gil, and Hyun Myung†, "MSDPN: Monocular Depth Prediction with Partial Laser Observation using Multi-stage Neural Networks,," in Proc. IEEE/RSJ Int'l Conf. on Intelligent Robots and Systems (IROS), Las Vegas, USA (virtual), Oct. 2020.

Wonkeun Youn, Nak Yong Ko, Stephen Gadsden, and Hyun Myung†, "A Novel Multiple-Model Adaptive Kalman Filter for an Unknown Measurement Loss Probability," IEEE Trans. Instrumentation & Measurement, vol.70, pp.1-11, Sep. 2020. [DOI]

⟨Professor Gun-Woo Moon's Lab.⟩

KAIST Power Electronics Laboratory

■ Contact information		
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Lab.	**jaesangkim@kaist.ac.kr**	**Tel: 042-350-8075**
Website	**http://power.kaist.ac.kr**	

■ Current state of the Lab. (in 2022 Fall Semester)

PhD Students: 13 Integrated Master's/doctoral Student: 1 Master's Student: 5

■ Research Areas

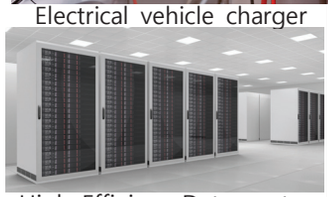
Electrical Vehicle Charger

Electrical vehicles essentially have rechargeble 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 Effieicny Data center

Battery Management System with Cell Balancing Circuit

To increase the battery power, individual battery cell is connected in series-parallel structure. 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 unbalances 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, Power electronics systems, Electromagnetics, control system

Career after graduation: Professors, Research institute, Company

■ 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 201 SCI journals, 279 international conferences, and 206 patents.

■ Recent research achievements (2019-2022)

International Journal (Total 21)

2021-2022 : 7. (IEEE Trans. Power Electronics [I.F : 6.663 / IEEE Trans. Industrial Electronics [I.F : 9.59])

2020 : 9. (IEEE Trans. Power Electronics [I.F : 6.373 / IEEE Trans. Industrial Electronics [I.F : 7.515])

2019 : 5. (IEEE Trans. Power Electronics [I.F : 7.224 / IEEE Trans. Industrial Electronics [I.F : 8.7])

International Conference (Total 16)

2021-2022 : 10. (ECCE Asia – Japan / ECCE Asia – Singapore)

2020 : **6.** (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 2019
[4] Korea Power Electronics Conference : 4 Best Paper

< Professor KyoungSoo Park's Lab.>

Networked and Distributed Computing Systems Lab

■ **Contact Info**

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Lab: ITC Building (N1-820) TEL: (+82) 042-350-7512

Homepage: https://www.ndsl.kaist.edu/

■ **Lab Members (2021 Fall):** Ph.D.: 3 M.S.: 2

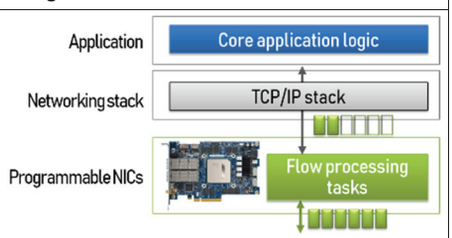
■ **Research Field**

We conduct research on new systems design that fundamentally improves the performance, security, availability, and reliability of networked computing systems, and we prove the effectiveness of new proposals through real-world system implementation and evaluation. Popular IT companies such as Google, Amazon, and Facebook, invest an enormous budget to develop networked and distributed system technologies for ultra-high availability and high performance. The importance of a technological breakthrough grows with the recent advent of low-latency and high-bandwidth services such as high-quality video streaming, AR/VR, and distributed deep learning. We deal with systems problems that occur when the applications operate in data centers, cloud environments or mobile networks, and we seek for novel approaches that may take advantage of recent hardware innovation.

■ **On-going Research Projects (2022)**

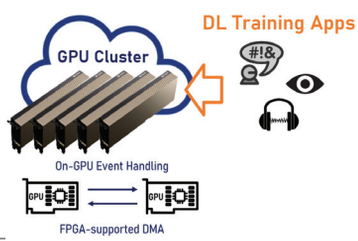
Accelerating Network Applications via SmartNICs

The Moore's law for CPU has ended, which would eventually stall the performance enhancement of network stacks in the face of ever-growing network bandwidth. This calls for a radically new approach that avoids the CPU-centric architecture. We exploit programmable network devices (such as SmartNIC or programmable switches) in designing a novel network stack architecture that draw the benefit from both worlds.



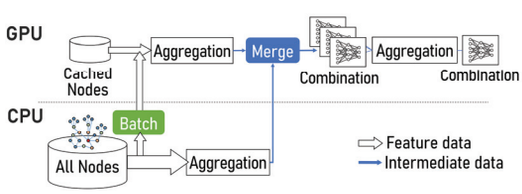
High-performance GPU-based Systems for Accelerating AI Applications

Deep learning (DL), as the key of modern artificial intelligence applications, requires a high-cost system that can process large amounts of computation in a short time. We conduct a number of research works that accelerate DL training or inference tasks by using many GPUs at the same time. For example, we develop a GPU resource management system that efficiently schedules GPU resources in a GPU cluster where multiple training tasks are executed simultaneously. We also develop technologies that accelerate the communication between GPUs by allowing them to handle communication events autonomously without CPU.



High-Performance Scalable Graph Neural Network Framework

Graph Neural Networks (GNNs) are increasingly popular for various prediction and recommendation tasks. Unfortunately, the graph datasets for practical GNN applications are often too large to fit into the memory of a single GPU, which requires long and frequent data loading from host memory. Our team is designing a new scalable framework that exploits heterogeneous near-data processors to mitigate the network overhead for data preparation.



■ **Recommended course and graduate career**

We recommend taking computer systems courses that provide background knowledge of system software such as Computer Networks, Operating Systems, Computer Architecture, and System Programming. Alumni of NDSL are working for top-notch IT companies such as SKT, Kakao, NHN, Google, Intel, Amazon, Microsoft, and Cisco Meraki. One of our alumni got recently hired as an assistant professor at Max Planck Institute (MPI) in Germany, one of the top schools in the world.

■ **Other Activities**

We support and encourage Ph.D. students to have internship at leading companies and research institutes (Intel, Microsoft Research, UC Berkeley / ICSI) for exchange with various academic people in the similar research fields. We also have fun together through regular workshops and ski trips.

■ **Lab Introduction**

We are more forced on high-impact research that can draw real change, rather than a sheer number of publications. Many of our research works are internationally well-recognized, and they are released as open source and have been followed up by academia (eg, CCP [SIGCOMM'18], Microboxes [SIGCOMM'18]) as well as by industry (Intel, Alibaba etc.).

■ **Representative Publications (2017 -)**

Most of the projects in the lab have been published at top-tier conferences and some have been honored by awards (mOS[NSDI'14] - Best paper award, mTCP[NSDI'14] – Community Award)

[1] Rearchitecting the TCP Stack for I/O-Offloaded Content Delivery [NSDI '23]
[2] Elastic Resource Sharing for Distributed Deep Learning [NSDI '21]
[3] AccelTCP: Accelerating Network Applications with Stateful TCP Offloading [NSDI '20]
[4] Hyperscan: A Fast Multi-pattern Regex Matcher for Modern CPUs [NSDI '19]
[5] mOS: A Reusable Networking Stack for Flow Monitoring Middleboxes [NSDI '17] ***(NSDI Best Paper Award)***
[6] APUNet: Revitalizing GPU as Packet Processing Accelerator [NSDI '17]

<Professor Seong-Ook Park's Lab.>

Microwave and Antenna Laboratory

■ Contact information

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LAB.	**Email: yoohjang@kaist.ac.kr**	**Tel: 010-8451-0028**
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■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 1, PhD Students: 12, Master's Student: 7

■ 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.

[Antenna Theory Analysis]

We theoretically and numerically analyze electromagnetic phenomena induced by new materials like nano-materials and metasurface to apply a novel antenna technology.

[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.

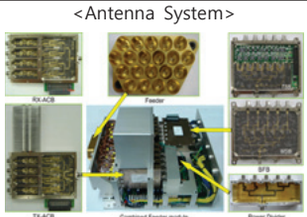
[Radar Surveillance System and Synthetic Aperture Radar(SAR)]

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.

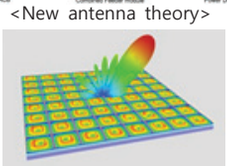
■ mm-wave antenna and SAR Radar Research Center, supported by MIST(2018 7. 1 ~ 2024.12.29)

The synthetic aperture radar(SAR) enables high-resolution, day-and-night, and weather-independent observation which enables to observe a particular location. Our research focuses on X/Ka-band antenna and SAR radar payload on a 50 kg microsatellite. Ultimately, we are going to apply the SAR data to AI and Deep Learning technologies to predict and monitor natural disasters.

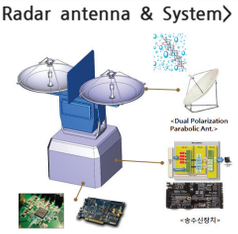
<Antenna System>



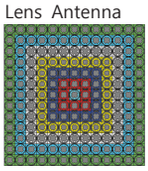
<New antenna theory>



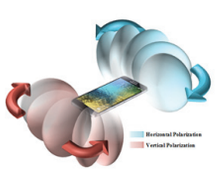
<Radar antenna & System>



Lens Antenna

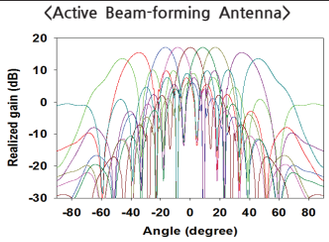


〈5G & 6G Beam-forming antenna 〉

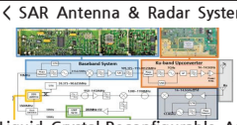


<SAR Radar Image>

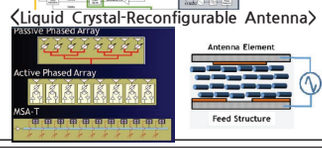
〈Active Beam-forming Antenna〉



〈 SAR Antenna & Radar System 〉



〈Liquid Crystal-Reconfigurable Antenna〉



■ Recommended courses & Career after graduation

Electromagnetics, Electronic Circuits, and Antenna are recommended for undergraduate courses.
For graduate courses, Electromagnetic Theory, Microwave Engineering, and Antenna Engineering are recommendable. After graduation, there are a wide range of career opportunities such as research institutes, University's professor, military institutes, & companies, *etc.*

■ 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 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 (2019~2022)

[1] International referred journal papers about 200, international conference papers about 160, domestic journals about 20, domestic conference about 50, and international/domestic patents of 28.
[2] IEEE AP-S, IEEE EMC Korea Chapter, ISAP 2019, and *etc*, best paper awards
[3] X-band Surveillance Radar System **:** Drone detection radar developed by Our lab (KAIST) was deployed and operated successfully at 2018 Pyeongchang Olympics.

⟨Professor YongKeun Park⟩

Biomedical optics Lab	■ Contact information		
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	Lab.	chunghalee@kaist.ac.kr	Tel: 2514
	Website	https://bmol.kaist.ac.kr	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 2 PhD Students: 9 Master's Student: 3

■ Research Areas

Biomedical Optics Laboratory is focused on developing novel optical methods based on interferometry, scattering and manipulation of light, for the purpose of (1) imaging biological and medical samples, (2) understanding the physics of diseases, and (3) diagnosing and treating the disease. Hosted by the Department of Physics and the KAIST Institute (KI), the lab is performing highly interdisciplinary research at the interface between technology development, basic biological studies and clinical applications.

The area of research is optics, holography, and biophysics. Prof. Park and colleagues have published +140 peer-reviewed papers with +11,000 citations, including 4 Nat Photon, 1 Nat Mat, 1 Nat Cell Bio, 4 Nat Comm, 1 Science Advances, 4 PRL, 6 PNAS papers. Two start-up companies with +70 employees have been created from his research (Tomocube,The.Wave.Talk).

- Quantitative phase imaging (e.g. holotomography, digital holographic microscopy): Park, YongKeun, Christian Depeursinge, and Gabriel Popescu. "Quantitative phase imaging in biomedicine."*Nature photonics*12.10 (2018): 578-589.
- Wavefront shaping (e.g. digital holographic display): Yu, Zhipeng, et al. "Wavefront shaping: A versatile tool to conquer multiple scattering in multidisciplinary fields."*The Innovation*3.5 (2022).
- Machine-learning based approaches for biomedicine: Jo, YoungJu, et al. "Quantitative phase imaging and artificial intelligence: a review."*IEEE Journal of Selected Topics in Quantum Electronics*25.1 (2018): 1-14.

■ **Recommended courses & Career after graduation**

Optics, Signals and Systems (recommended but not prerequisite)

■ **Introduction to other activities besides research**

n/a

■ **Introduction to the Lab.**

See: **https://bmol.kaist.ac.kr**

■ **Recent research achievements (2020-2022)**

Nature Materials, 2022; Nature Cell Biology, 2021; *PNAS*, 2021; *Nature Photonics*, 2021 *Nature Communications*, 2021; *eLife*, 2020

⟨Professor In-Cheol Park's Lab⟩

Integrated Computer Systems Laboratory

■ **Contact information**

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LAb.	**Email: hjjang@ics.kaist.ac.kr**	**Tel: 042-350-9884**
Website	**http://ics.kaist.ac.kr/**	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 2 Master's Student: 4

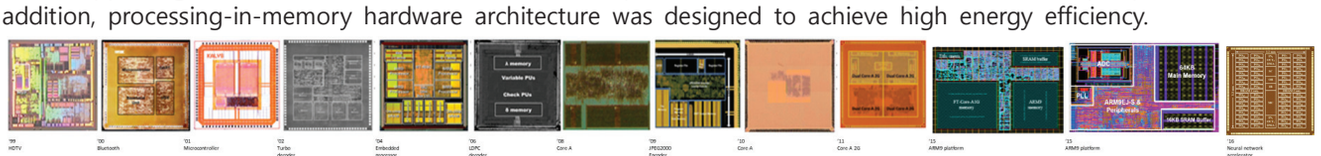
■ **Research Areas**

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, 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. Some members play the soccer, futsal, and so on.

■ **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 (2020-2022)**

[1] Jaewoong Choi, Byeong Yong Kong, and In-Cheol Park, "Retrain-less Weight Quantization for Multiplier-less Convolutional Neural Networks", IEEE Transactions on Circuits and Systems-I: Regular Papers, vol. 67, no. 3, pp. 972-982, Mar. 2020.

[2] Suchang Kim, Seungho Na, Byeong Yong Kong, Jaewoong Choi, and In-Cheol Park, "Real-time SSDLite Object Detection on FPGA", IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 29, no. 6, pp. 1192-1205, June 2021.

[3] Seongjin Lee, Sangsoo Park, Boseon Jang, and In-Cheol Park, "Multi-Mode QC-LDPC Decoding Architecture with Novel Memory Access Scheduling for 5G New-Radio Standard", IEEE Transactions on Circuits and Systems I: Regular Papers, vol. 69, no. 5, pp. 2035-2048, May 2022.

⟨Professor Hyuncheol Park's Lab.⟩

Laboratory for Information Transmission

■ **Contact information**

Professor	**email: hcpark@kaist.ac.kr**	**Tel: 042-350-7420**
Laboratory	**email: seongbae@kaist.ac.kr**	**Tel: 042-350-7520**
Website	**http://lit.kaist.ac.kr**	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows: 0 PhD Students: 8 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.

- **Beamforming scheme at mmWave and terahertz bands**
- **Massive MIMO systems with multi-numerology**
- **Meta/transfer learning for NAND flash memory system**
- **Simultaneous wireless information and power transmission (SWIPT) system**

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."

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

■ **Career after graduation**: The LIT has produced 21 Ph.Ds and 38 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. In particular, to reduce the risk of infection with COVID-19, ventilation is frequently implemented, and the density is lowered by distributing personnel in a way that respects each person's lifestyle.

■ **Recent research achievements (2020-2022)**

Publications: **19 International Journals, 12 International Conferences**

Awards: 2020 Best paper award (from KAIST EE Communication Division) for doctoral dissertation and The 10th S-oil Excellent Thesis Award: "User Scheduling and Beamforming Design for Millimeter Wave MIMO Communications"

Best paper award for KICS Summer 2020: "Experimental Study of Multiple-antenna Wireless Power Transfer Systems using USRP", The 28th SAMSUNG Human Tech Paper Award (1 Bronze prize and 1 Encouragement prize)

〈Professor Joonwoo Bae 〉

QIT@KAIST **Quantum Information Teory Lab**	■ **Contact information**		
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	Lab.	**E3-2 3215, 3216**	**Tel: 7646**
	Website	**https://sites.google.com/view/qitkaist/home**	

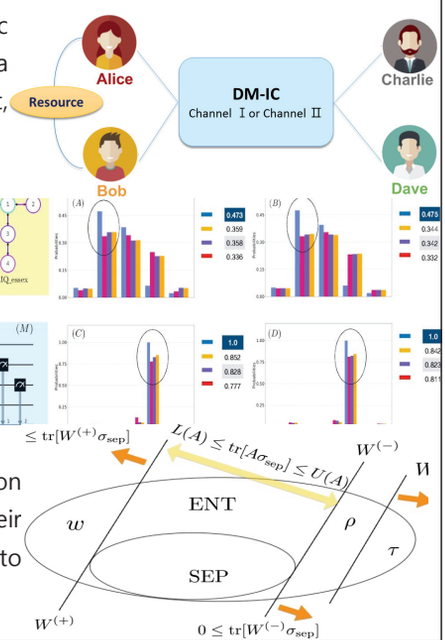
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 2 PhD Students: 8 Master's Student: 2

■ **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 curren quantum technolgoies, and also devote our effots 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.

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 (2020-2022)**

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

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

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

[4] A hybrid quantum-classical approach to mitigating measurement errors in quantum algorithms, Hyeokjea Kwon and Joonwoo Bae, IEEE Transactions on Computers, Vol 70 (9) 1401 (2021)

[5] Non-Local Network Coding in Interference Channels, Jiyoung Yun, Ashutosh Rai, and Joonwoo Bae, Physical Review Letters 125 150502 (2020).

[6] Channel Coding of a Quantum Measurement, S. Kechrimparis, et. al., IEEE Journal on Selected Areas in Communications, Vol 38, No 3, 439 (2020), Erratum IEEE JSAC Vol 38 No 5 980 (2020)

[7] Mirrored Entanglement Witnesses, J. Bae, D. Chruscinski, B. Hiesmayr, npj Quantum Information 6 15 (2020)

⟨Professor Hyeon-min Bae's Lab.⟩

NAIS Nanoscale Advanced Integrated Systems LAB

■ **Contact information**

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LAb.	**baelab@kaist.ac.kr**	**Tel: 042-350-5489**
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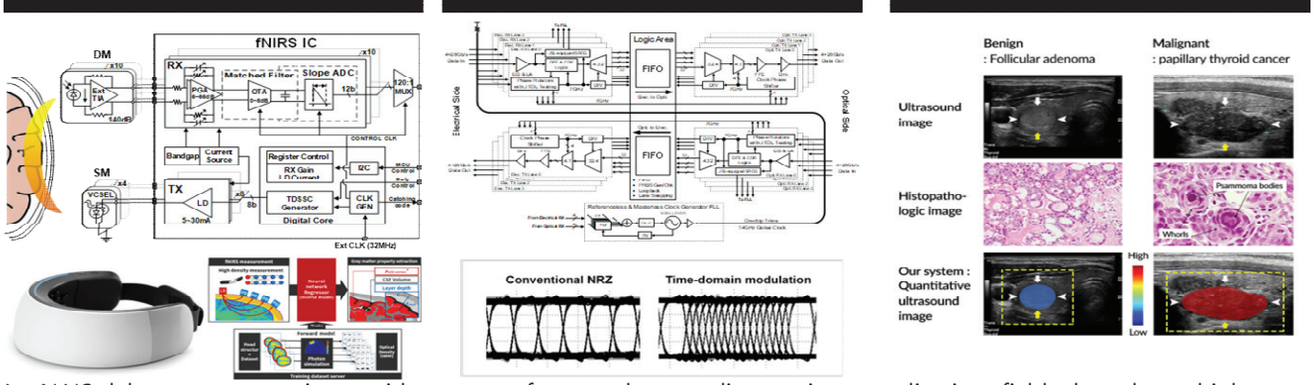
■ **Current state of the Lab. (in 2022 Fall Semester)**

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

■ **Research Areas**

fNIRS System | **High-Speed Circuit** | **Ultrasound System**



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, Poin2Tech, and Barreleye 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 carried out at NAIS lab.

■ **Introduction to other activities besides research**

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

■ **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 (2020-2022)**

[1] Hail Song et. al, "A 50Gb/s PAM-4 Bi-Directional Plastic Waveguide Link with Carrier Synchronization Using PI-Based Costas Loop", 2022 IEEE international Solid- State Circuits Conference (ISSCC), Feb. 2022.

[2] Seok-Hwan Oh, Myeong-Gee Kim, Youngmin Kim, Guil Jung, Hyuksool Kwon, Hyeon-Min Bae, "Sensor geometry generalization to untrained conditions in quantitative ultrasound imaging", International Conference on Medical Image Computing & Computer Assisted Intervention (MICCAI), Sept. 2022.

[3] Woohyun Kwon et al. "A 25.78125Gbps Bi-directional Transceiver with Framed-Pulsewidth Modulation (FPWM) for Extended Reach Optical Links in 28nm CMOS", 2022 IEEE Symposium on VLSI Technology and Circuits, June 2022.

<Professor Changho Suh's Lab.>

INFORMATION SYSTEMS LABORATORY (ISL)

■ **Contact Information**
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•Lab: N1 building #920 •TEL: 042-350-7529
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■ **Members • PhD students:** 3 • **Undergraduate students:** 2
■ **Alumni • Postdoctoral Fellow:** 1 (Professor at UW Madison) • **PhD/Master/Undergraduate:** 15 (Professor at Kwangwoon Univ, PhD students at MIT/UC-Berkeley/UIUC, Research scientists at Samsung, Lunit and Krafton)

■ **Research interests**

Our research agenda is to borrow tools of information theory, coding theory, optimization and statistics to address important issues that arise in modern AI systems. More broadly, we would like to establish information theory of any information systems, ranging from AI systems (e.g., search engine [4,7], recommender systems [5,6,10], autonomous driving [9,11]) to traditional systems like communication [1,3,8] (e.g., 4G-LTE and 5G) and distributed storage [2] (e.g., Google's data center and Meta's Hadoop file system). During past years, we have made progresses towards the agenda while working on many cross-disciplinary fields that span information theory, communication, coding theory, optimization to machine learning and deep learning. See below some of our recent contributions made along these directions.

	Research topics	Achievements and recognitions
1	Fairness in machine learning [1,2,3]	• Developed fair classifiers (e.g. fair AI judge and AI loan decision maker) • Won the **2022 Google Research Award** (collaboration with Google) [1] • Won the **2021 IEEE ITSoc James Massey Award** [2,3] • Top 10 KAIST Research Achievements of 2020
2	Driving in the matrix: Self driving via a video game [4]	• Deep-learning-based collision predictor using a game simulator (GTA V) • A paper published in AAAI (**oral presentation, rate = 6.48%**) [4] • 2018 KAIST Technology Innovation Award & JCCI Best Paper Award • Received the two-year grant from the **US Air Force** (2019.4 ~ 2021.3)
2	AI tutor: Recommender systems for education [7]	• Our algorithm commercialized (product app: SANTA TOEIC) • Received +₩50 billion investment (company: Riiid) • 2018 **IEIE/IEEE Joint Award** (given to the Best Young IT Engineer)
3	Recommender systems with social networks [6]	• Improves prior algorithms by an order of magnitude • Implemented in Kakao's recommender systems (news feed) • Relevant papers accepted in NeurIPS [6]
4	Real-time search engine [8,9]	• Speeds up Google's search engine (PageRank) by an order of magnitude • Relevant papers accepted in NeurIIPS/ICML [8,9] • **2016 IEIE Haedong Young Engineer Award, Bell Labs Prize finalist** [9]

■ **Intensive collaborations with prominent scholars in renowned institutes**
• **MIT:** Lizhong Zheng (fair machine learning) • **Stanford:** David Tse (network information theory)
• **UC Berkeley:** Kannan Ramchandran (general purpose AI) • **UW Madison:** Kangwook Lee (autonomous driving)
• **Univ of Minnesota:** Soheil Mohajer (recommender systems) • **National Univ of Singapore:** Vincent Tan (recommender systems)

■ **Recommended courses**
• EE202: Signals and systems • EE210: Probability and introductory random processes • MAS212: Linear algebra
• EE326: Introduction to information theory and coding • EE424: Introduction to optimization techniques

■ **Recommended books**
• C. Suh, "Convex optimization for machine learning" Now Publishers • C. Suh, "Communication principles for data science" Springer
• C. Suh, "Information theory for data science" Now Publishers • C. Suh, "Probability for information technology" Springer

■ **Our vision**

We pursue **strong students with fundamentals and practical skills**. If you wish to be an independent researcher who can do critical thinking with fundamentals and programming abilities, ISL is the right place. Prof. Suh offers weekly one-to-one meetings for each student, mentoring: (i) how to formulate research problems; (ii) how to address the problems; (iii) how to write papers in rigor and clarity; and (iv) give a highly organized presentation accessible to a broad audience in clarity.

■ **Selected publications (Google Scholar Citations: 6,189 as of Sep. 16 2022)**

[1] Y. Roh, K. Lee, S. Whang and C. Suh, "Sample selection for far and robust training," *NeurIPS*, Dec. 2021 (**2022 Google Research Award**).
[2] J. Cho, G. Hwang and C. Suh, "A fair classifier using kernel density estimation," *NeurIPS*, Dec. 2020 (**2021 IEEE ITSoc James Massey Research & Teaching Award for Young Scholars**).
[3] Y. Roh, K. Lee, S. Whang and C. Suh, "FR-Train:A mutual information-based approach to fair and robust training," *ICML*, July 2020.
[4] H. Kim, K. Lee, G. Hwang and C. Suh, "Crash to not crash: Learn to identify dangerous vehicles using a simulator," *AAAI*, 2019 (**oral presentation, US AF Grant**)
[5] C. Suh, J. Cho and D. Tse, "Two-way interference channel capacity: How to have the cake and eat it too," I*EEE Transactions on Information Theory*, June 2018 (cracked a **40+ year-old open problem in information theory**).
[6] K. Ahn, K. Lee, H. Cha and C. Suh, "Binary rating estimation with graph side information," *NeurIPS*, 2018 (collaboration with Kakao).
[7] K. Lee, J. Chung and C. Suh, "Large-scale and interpretable collaborative filtering for educational data," *KDD Workshop*, 2017 (**Our algorithm has been implemented in an online education platform, Santa TOEIC of Riiid**).
[8] M. Jang, S. Kim, C. Suh and S. Oh, "Optimal sample complexity of M-wise data for top-K ranking," *NeurIPS*, 2017.
[9] Y. Chen and C. Suh, "Spectral MLE: Top-K rank aggregation from pairwise comparisons," *ICML*, July 2015 (**IEIE Haedong Young Engineer, Bell Labs Prize finalist**).
[10] C. Suh and D. Tse, "Feedback capacity of the Gaussian interference channel to within 2 bits," *IEEE Transactions on Information Theory*, 2011(**2009 ISIT Best Student Paper Award; David Sakrison Memorial Prize from UC Berkeley EECS; 210 citations**).
[11] C. Suh and K. Ramchandran, "Exact-repair MDS code construction using interference alignment," *IEEE Transactions on Information Theory*, Mar. 2011 (**2010 ISIT Best Student Paper Award finalist; A customized version of our codes implemented in Meta's file system; 346 citations**)
[12] C. Suh, M. Ho and D. Tse, "Downlink interference alignment," *IEEE Transactions on Communications*, Sep. 2011 (won the **2013 IEEE Communications Society Stephen O. Rice Prize; 941 citations**).

〈Professor Youngchul Sung's Lab〉

SISReL
Smart Information Systems Research Lab

■ Contact information		
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■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 8 Master's Student: 6

■ 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 more 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 Introduction to 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 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. For example, we run or play badminton in the sports complex.

■ 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.

■ Recent research achievements (2020-2022)

▷ Published 7 papers / 4 workshop papers in the top AI/ML conferences (NeurIPS, ICML, ICLR, AAAI)

▷ Published 4 papers in SCI journals

▷ Samsung Humantech Paper Award (Silver) in the CS division

⟨Professor Youngik Sohn⟩

Quantum Device Lab

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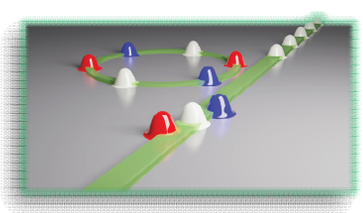
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 2 Master's Student: 6

■ **Research Areas**

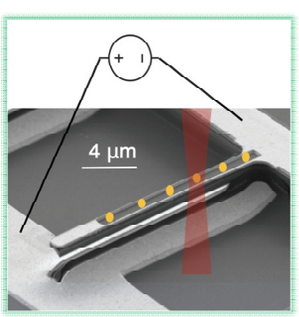


Quantum computing with integrated photonics

Quantum computing is a novel technology that is expected to become a game changer in the field of Chemistry, Material Science, Machine Learning for Artificial Intelligence.

However, building reliable hardware for fault-tolerant quantum computer is an extremely challenging task due to the fragile nature of quantum information. In our lab, we aim to build error-corrected, powerful quantum computer based on integrated photonics platform.

By combining optical circuit, superconducting electronics and RF amplifier altogether on a single integrated photonics platform, it is possible to realize the basic building block of a quantum computer.



Chip-scale quantum repeater for long distance entanglement

Having quantum mechanically pure entangled pair at a far distance is a key milestone pursued by many researchers all around the world. Based on our expertise in diamond color centers and nonlinear quantum photonics, we are working on realizing scalable quantum repeaters.

■ **Recommended courses & Career after graduation**

course: electromagnetics, quantum mechanics, solid-state physics, photonics, optics, fabrication

career: Research scientist or engineers for quantum technologies, Integrated photonics engineer

■ **Introduction to other activities besides research**

All of our members use motion desk! We care about your health and spirit more than anything else.

■ **Introduction to the Lab.**

We have a focused goal of building on-chip feedforward system, which is the most basic component for photonic quantum computer. Reliable, fault-tolerant quantum computer does not exist in the world yet! We want to become a pioneer who builds one.

■ **Recent research achievements (2018-2020)**

- First SCI journal paper produced from QDLAB (Koh et al. (2022))
- Pioneering MEMS fabrication for quantum emitter in diamond (Sohn et al. (2018))
- Proffessor Sohn is an early member of world's only quantum computing unicorn (PsiQuantum Corp)

⟨Professor Mincheol Shin's Lab.⟩

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

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LAb.	Email: cnl.kaist.lab@gmail.com	Tel: 042-350-7618
Website	http://cnl.kaist.ac.kr	

■ Current state of the Lab. (in 2022 Fall Semester)

PhD Students: 6 Master's Student: 4

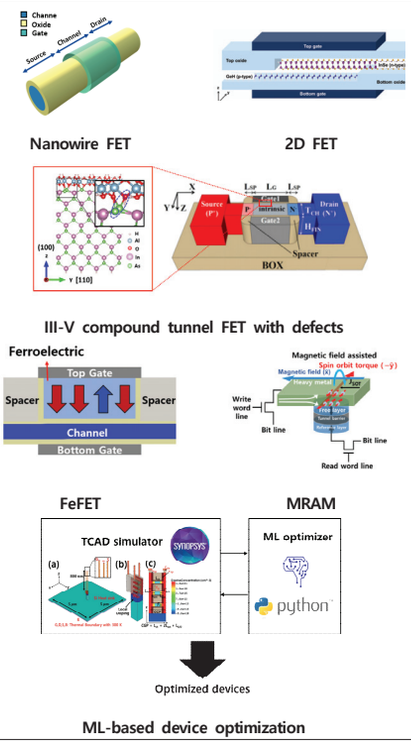
■ Research Areas

As the feature size of conventional planar metal-oxide- semiconductor field-effect transistors (FETs) shrinks into the nanometer regime, performance of the devices is degraded due to **short-channel effects** caused by weakened gate control. To overcome this, 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 **MRAM** we conduct micromagnetic simulations which are based on Landau-Lifshitz-Gilbert (LLG) equation.

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.



ML-based device 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 (2020-2022)

[1] DFT-NEGF Simulation Study of Co2FeAl-MgO-Co2FeAl Magnetic Tunnel Junctions Under Biaxial Strain", S. Noh, et al., IEEE Transactions on Magnetics, Vol. 58, No.5 , 2022.

[2] "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.

[3] "Bayesian Optimization of MOSFET Devices Using Effective Stopping Condition", B. Kim and M. Shin, IEEE Access, vol. 9, 108480-108494, Aug. 2021.

[4] "Atomistic Asymmetric Effect on the Performance of HfO2-based Ferroelectric Tunnel Junctions," J. Seo and M. Shin, Physical Review Applied, vol. 14, 054018, Nov. 2020.

⟨Professor Seungwon Shin⟩

Network and System Security (NSS) Lab	■ Contact information		
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	Lab.	N1 919	Tel: 7538
	Website	https://nss.kaist.ac.kr/	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 9 Master's Student: 4

■ **Research Areas**

1) Software-Defined Networking (SDN) / Network Function Virtualization (NFV)
2) Cyber Threat Intelligence (CTI)
3) Container Security
4) Blockchain Security

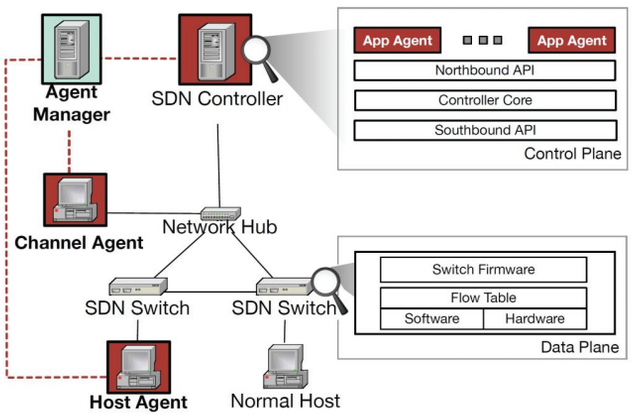

Figure 1. An Automated SDN Security Evaluation Framework.

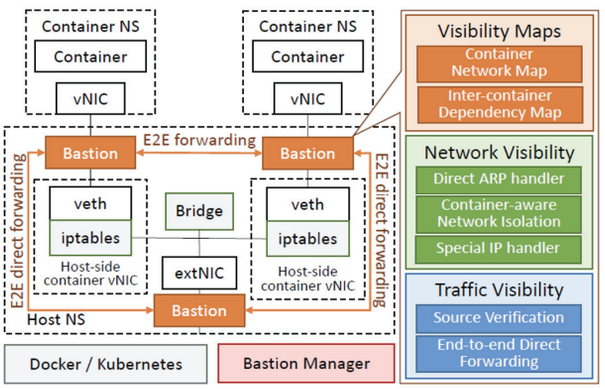

Figure 2. A Security Enforcement Network Stack for Container Networks.

■ **Recommended courses & Career after graduation**

Recommended courses: EE323 (Computer Network), EE312 (Computer Architecture)

Career after graduation: Our alumnis have recently employed as professors at several national universities and researchers at various national research institutes.

■ **Introduction to other activities besides research**

Our alumnis have founded S2W Inc, a leading company in the CTI field. Our lab members will have an opportunity for an internship program at S2W Inc.

■ **Introduction to the Lab.**

The NSS lab currently focuses on network and system security. In particular, we study a variety of topics including software defined network (SDN) security, embedded system and IoT using SDN, and web and mobile. We are now working on Design and Implementation of Innovative Security Services with SDN, SDN security evaluation project and analysis of the dark web environment. We also study cyber threat intelligence, container security, and blockc hain security.

■ **Recent research achievements (2020-2022)**

(NAACL 22) Shedding New Light on the Language of the Dark Web

(NDSS 22) EqualNet: A Secure and Practical Defense for Long-term Network Topology Obfuscation

(USENIX ATC 20) BASTION: A Security Enforcement Network Stack for Container Networks

⟨Professor Youngsoo Shin's Lab.⟩

DT LAB
Semiconductor Design Technology

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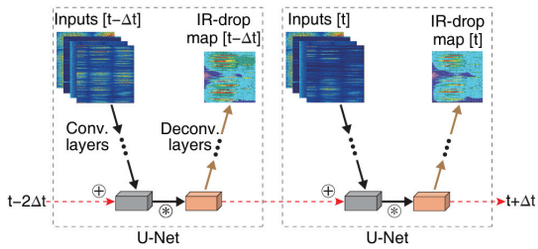
Website	http://dtlab.kaist.ac.kr	

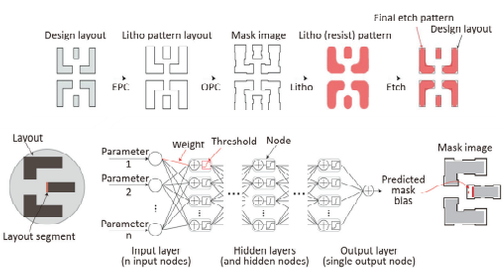
■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 5 Master's Student: 5

■ Research Areas

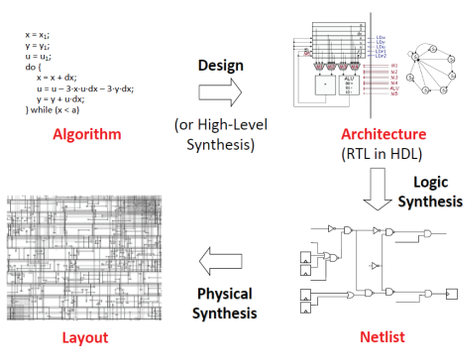
AI-EDA Physical design requires many iterations of optimization processes interleaved with manual efforts to gradually converge to the desired specifications. We adopted recent machine learning techniques (e.g. U-Net, GCN, bidirectional RNN) to propose effective approach to complex problems: IR drop analysis, ECO power optimization, clock tree estimation, wire length prediction.





Computational Lithography Chip manufacturing has always been limited by the ability to print small patterns cost-effectively. Particularly, the resolution limit of lithography process tend to dictate the manufacturing capability. Computational lithography is a set of algorithmic approach to enhance the resolution. The algorithms optimize each steps of lithography such as mask and source mask generation. We are currently studying how to apply machine learning algorithms to the optical proximity correction (OPC) and layout pattern synthesis.

VLSI Computer-Aided Design (CAD) Our research encompasses various aspects of VLSI Computer-Aided Design (CAD). Since the design process of modern VLSI chips is complicated, almost every stage is heavily dependent on sophisticated CAD tools. VLSI chips are produced in three major stages: functional design, CAD, and fabrication. The hardware description language (HDL) is converted into a layout through a series of CAD processes, such as logic synthesis, physical design, and verification. The development of CAD tools and algorithms realizes complex designs that could never be imagined in the past, and has geared up the entire semiconductor industry.



■ Recommended courses & Career after graduation

- Digital System (EE303) for undergraduate students
- CAD for VLSI (EE574) and Digital Integrated Circuit (EE678) for graduate students

Most alumni entered leading semiconductor (**IBM, NVIDIA, Samsung Electronics, SK Hynix, and LG Electronics**) and EDA (**Synopsys, Cadence**) companies.

■ Introduction to other activities besides research

- Internship opportunities in **IBM, Synopsys, Siemens, Cadence (USA), and IMEC (Belgium)**
  - Five PhD students had a chance to work abroad for the last few years
- Workshop for research sharing with Samsung
- Workshop twice a year (held in Jeju for this summer)
- Monthly social gatherings (coffee time, sports activities)

■ Introduction to the Lab.

We all pursue excellent achievement with mutual encouragement. We are conducting research closely related to up-to-date issues in semiconductor industry through cooperation with leading companies. We have **flexible working hours** and **stable fund**. Prof. Shin is always welcoming personal meeting for detailed discussion on research topic, and he enthusiastically supports and motivates students.

■ Recent research achievements (2018-2022)

- Consistent publications on top-class international journals (e.g. IEEE TCAD) and international conferences (e.g. DAC, ICCAD, ASPDAC, DATE).
- Received best paper award (TSM'21), innovative paper (NGL'22), nominated on the best paper (ASPDAC'20, GLSVLSI'20).
- Prof. Shin has lead international conference ASP-DAC 2018 as a General Chair.

⟨Professor David Hyunchul Shim⟩

EE USRG
Unmanned Systems Research Group

■ Contact information

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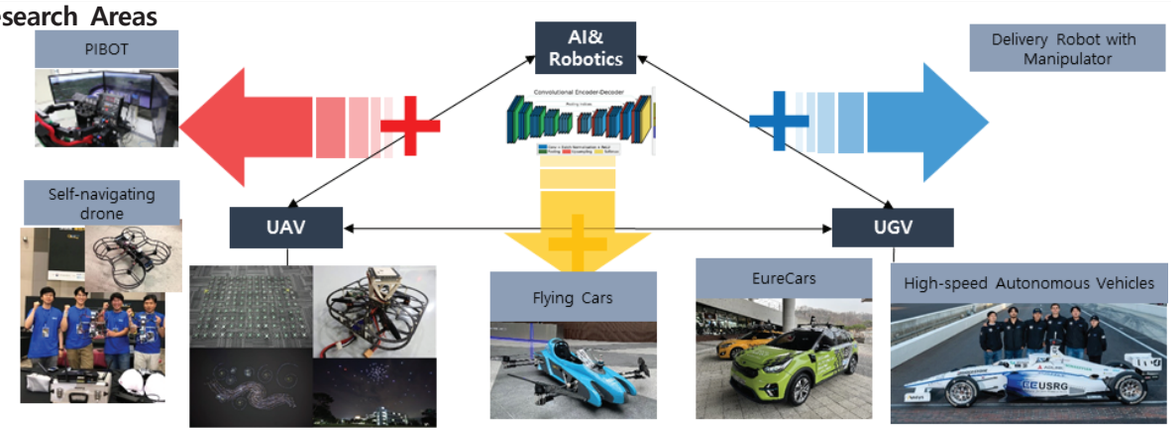
■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 10 Master's Student: 7

■ Research Areas



Autonomous Flight	Multidisciplinary Research	Autonomous Driving
In-house fight controller Drone swarms 3D SLAM based Indoor flight for DARPA Subterranean Challenge Anti-drone Tech Korea RPAS Research Center	Logistics using drones and self-driving cars Multi-modal Vehicles Fully autonomous flying car Automation of vehicles using Humanoid robots	In-house autonomous driving tech Deep learning-based sensing and decision making End-to-end Self-driving Delivery Robots Indy Autonomous Challenge

■ Recommended courses & Career after graduation

Our lab focuses on the research and development of robots that work in the real world. For this, we recommend backgrounds in robotics, control, computer vision, AI, and basic linux knowledges.

Our alumni have successfully moved into the following professional fields after graduation:

Foreign entities: NASA Jet Propulsion Laboratory(2), Cirrus Aircraft(1)

Private companies: LG Electronics(2), Naver Labs(1) and Hyundai Motors(3), etc.

National Institutes: ETRI, ADD, KARI, KETI. Academia: MIT (Ph.D.), TU Delft(Ph.D). a tenure-track professor.

■ Introduction to other activities besides research

We are committed to the excellency of intelligent aerial and ground robots research. We are participating in various drone and self-driving car related competitions such as AI Grand Challenge, Hyundai Motor Company, and most notably, Indy Autonomous Challenge.

■ Introduction to the Lab.

Our lab is very well-funded and equipped, and students will be given with all the opportunities to pursue cutting-edge AI&Robotics research. We have 4 autonomous cars (including one Indy race car), 2 full-size aircraft, 3 ground station trucks, 1 DGX station, Optitrack, 200+ drones, and much more.

■ Recent research achievements (2020-2022)

We won top prizes in AI Grand Challenge('20) and Hyundai Autonomous Vehicle Competition('21). Prof. Shim received Minister award from Ministry of Science and ICT('21), and. International Collaboration Award from KAIST('22).

⟨Professor Heejin Ahn's Lab.⟩

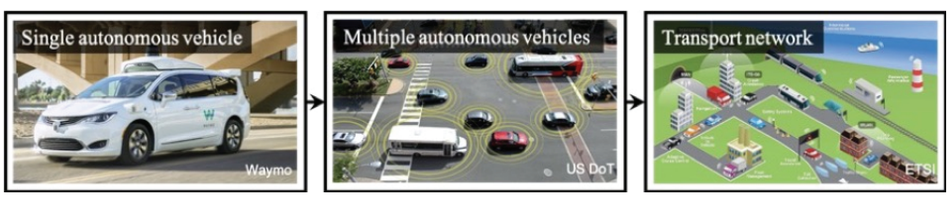
Control & Intelligent Systems Laboratory	■ Contact information		
	Professor	Email: heejin.ahn@kaist.ac.kr	Tel:
	Lab.	Room 3246, E3-2	Tel:
	Website		

■ **Current state of the Lab. (in 2022 Fall Semester)**

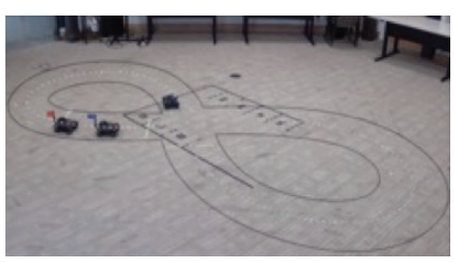
Postdoctoral Fellows : 0 PhD Students: 0 Master's Student: 1

■ **Research Areas**

Our lab aims to design control & decision-making algorithms for complex dynamical systems via integration of control theory with computer science. In particular, we use optimization, game theory, and machine learning to develop safe, robust, and efficient control systems.



We apply our control & decision-making algorithms to different areas of intelligent transportation systems, ranging from a single autonomous vehicle to multiple autonomous vehicles and to transport network. In addition to theoretical design and analysis of control systems, we put great emphasis on the validation of the theories through computer simulations and hardware tests.



■ **Recommended courses & Career after graduation**

Recommended courses: Linear algebra, differential equations, optimization, signals and systems, feedback control, machine learning

Career after graduation: Academia, industry (e.g., autonomous vehicles), national labs.

■ **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.**

We are hiring motivated graduate students! Student who want to study and perform research on control theory and its application are encouraged to apply.

■ **Recent research achievements (2020-2022)**

○ ***H. Ahn, C. Chen, I. M. Mitchell, and M. Kamgarpour, "Safe motion planning against multimodal distributions based on a scenario approach," IEEE Control Systems Letters, June 2021.***

○ ***H. Ahn, K. Berntorp, P. Inani, A. Ram, and S. Di Cairano, "Reachability-based decision making for autonomous driving: Theory and experiment," IEEE Transactions on Control Systems Technology, Sep. 2021.***

○ ***H. Ahn and A. Colombo, "Abstraction-based safety verification and control of cooperative vehicles at road intersections," IEEE Transactions on Automatic Control, Oct. 2020.***

⟨**Professor** Kyounghoon Yang's Lab (양경훈 교수 연구실)⟩

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 2022 Fall Semester)**

Postdoctoral Fellows : 0 Master/PhD Students: 1 & 1(Joint-Research)

■ **Research Areas**

● **Nano-CMOS RF Device Modeling**

► Device Modeling & Characterization of State-of-the-art RF-CMOS Technology

As the frequency goes higher, it is extremely important & challenging to predict the performance of nano devices because of increasing non-static physical & parasitic effects. Therefore, we have been performing ***novel device modeling & characterization studies for the State-of-the-art RF Nano-CMOS (28nm FD-SOI) technology*** up to 110 GHz for ***precise and effective RF IC designs for system applications.***

● **RF/Mm-Wave CMOS 5G/6G Communication/Radar IC Design**

► Mm-Wave/Sub-THz RF-CMOS ICs for 5G/6G Wireless Beam-forming Radar/Communication T/R Systems

Next generation 5G/6G mobile technology requires mmW/Sub-THz multi-input/multi-output (MIMO) phased-array integrated antennas & Transmitter/Receiver (T/R) systems at the frequencies ranging from 28GHz, 60GHz upto W-band (77GHz, 94GHz). With the upcoming needs for frequencies beyond these, ***the research on D-band (110-170GHz) & beyond RF-ICs for the phased-array T/R RF-CMOS ICs/MIMO-antennas/Package systems*** is under way as ***a Multi-year Project*** with collaboration of EE laboratories. The opportunities ***to encounter the State-of-the-art RF-CMOS Device & mmW-IC and Sytem Technologies*** will be given in this research activity.

● **Next-generation Nano-Quantum RTD Device & ICs**

► Development of THz(Tera-Hertz) & Beyond-CMOS Logic Devices for Upcoming THz Quantum Electronics

As a mature candidate for beyond-CMOS era, a quantum-effect nano device such as **a Resonant Tunneling Diode (RTD)** has been consistently developed in our laboratory. The physics-based modeling of RTD & design and fabrication of RTD analog/RF/digital ICs for THz-level frequency have been studied. The development of THz RTD devices & ICs can be ***an innovative next-generation compact and efficient THz multi-functional quantum electronics technology.***

■ **Recommended courses**

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

■ **Career after graduation**

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

■ **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*** **& high-speed/high-frequency nano devices to Full-scale IC/Systems** based on enhanced mutual-lab collaboration, which will ***provide the students with more in-depth & broader research opportunities from the integrated inter-laboratory research collaboration environment.***

■ **Recent research papers (2020-2022)**

[1] X. Yang et al., "RF Characterization & Small Signal Extraction of 28-nm FDSOI MOSFETs up to 110-GHz", IEEE APMC, 2022.

[2] J. Lee et al., "Area-Efficient Series-Connected Resonant Tunneling Diode Pair as Binary Neuron in Cellular Neural Network", IEEE EDL, 2020.

⟨Professor Youjip Won's Lab.⟩

OSLab Operating Systems Laboratory	■ Contact information		
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	LAB	Email:	Tel: 042-350-7656
		https://oslab.kaist.ac.kr	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 6 Master's Student: 9

■ **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; playing basket ball, running around campus, going to the gym for workout a few times a week.
- Travel: Each student is given the opportunity to attend the international conferences a few times a year (USENIX FAST, USENIX ATC, EUROSYS and etc.).
- Leisure: The group members go out for dinner and drinks often. There is an excellent beer pub nearby KAIST campus. We spend time together there frequently.

■ **Introduction to the Lab.**

OSLab@KAIST is world's leading research group widely known for its achievement in operating system design for Flash storage and NVRAM. OSLab has lead the IO stack optimization for the smartphone for years. The techniques proposed by OSLab are being used by Google Android platform (Best Paper, USENIX ATC 2013). A number of open source tools from OSLab are being used world-wide for Android research. They propose a new IO subsystem design for the Flash storage successfully providing the separate support for ordering guarantee (Best Paper, USENIX FAST 2018). Separating the ordering guarantee from the durability guarantee has been the outstanding issue in the systems research community for more than 50 years. For the avid kernel developer and system hacker, OSLab is the right place to expand one's limit.

■ **Recent research achievements (2020-2022)**

International journals: 0, International conferences: 10, 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 2022 Fall Semester)**

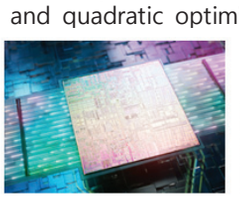
Postdoctoral Fellows : 0 PhD Students: 7 Integrated MS-PhD Student: 2 MS Students: 3

■ **Research Areas**

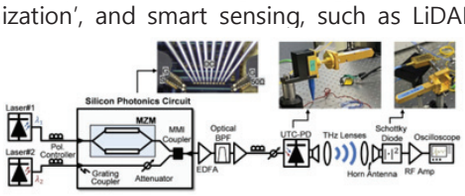
The Integrated Nanophotonics Laboratory is working on both fundamental aspects and practical applications of modern photonics and optoelectronics with special emphasis on integration techniques. We are especially interested in device- and circuit-level optoelectronic integration for 6G optical data transmission, advanced optical signal processing, and display applications.

Integrated photonics

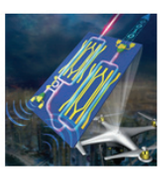
Silicon is the most well known material for electronics, but is also a promising optical medium at near-infrared wavelengths. By taking advantages of advanced fabrication and design techniques developed for electronic circuits, we can now design and build photonic integrated circuits that can complement and sometimes overcome the electronics in a number of cutting-edge applications, such as 'large-scale high-speed interconnects for chiplets', 'optical/wireless convergence for beyond 5G communications', '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, such as LiDAR.



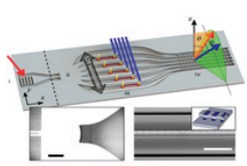
Intergrated photonic circuit



THz Optical Data Transmission



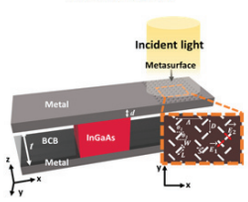
Photonic Radar



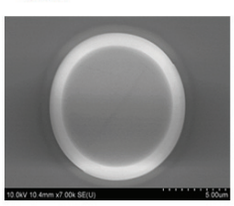
LiDAR

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 and optoelectronics. Our group is interested in various emerging materials, such as 2D materials, hybrid materials, and metamaterials.



<Nanophotonic-meta material>



<2D material resonator>

■ **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**).

■ **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/communication 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 (2021-2022)**

[1] "High-bandwidth InGaAs photodetectors heterogeneously integrated on silicon waveguides using optofluidic assembly." Laser & Photonics Reviews (**2022**).
[2] "A chemically-etched optical fiber tapers for adiabatic fundamental mode evolution over O-and C-Bands." Journal of Lightwave Technology (**2022**)
[3] "Coherent terahertz wireless communication using dual-parallel MZM-based silicon photonic integrated circuits" Optics Express (**2022**)
[4] "A review of optics-based methods for thickness and surface characterization of two-dimensional materials." Journal of Physics D: Applied Physics (**2021**).
[5] "Cascaded optical resonator-based programmable photonic integrated circuits." Optics Express (**2021**)

⟨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

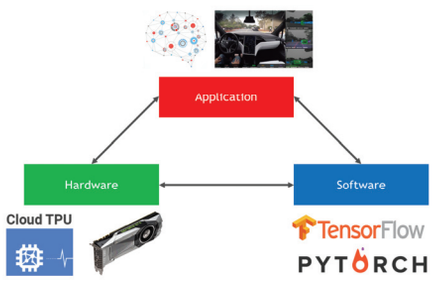
Website : https://sites.google.com/view/kaist-via

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 9 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 ('21~'22)**

[1] Beomsik Park, Ranggi Hwang, Dongho Yoon, Yoonhyuk Choi, and Minsoo Rhu, "DiVa: An Accelerator for Differentially Private Machine Learning," The 55th IEEE/ACM International Symposium on Microarchitecture (MICRO-55), Chicago, IL, Oct. 2022

[2] Yunjae Lee, Jinha Chung, and Minsoo Rhu, "SmartSAGE: Training Large-scale Graph Neural Networks using In-Storage Processing Architectures," The 49th IEEE/ACM International Symposium on Computer Architecture (ISCA-49), New York, NY, June 2022

[3] Youngeun Kwon and Minsoo Rhu, "Training Personalized Recommendation Systems from (GPU) Scratch: Look Forward not Backwards," The 49th IEEE/ACM International Symposium on Computer Architecture (ISCA-49), New York, NY, June 2022

[4] Youngeun Kwon, Yunjae Lee, and Minsoo Rhu, "Tensor Casting: Co-Designing Algorithm-Architecture for Personalized Recommendation Training," The 27th IEEE International Symposium on High-Performance Computer Architecture (HPCA-27), Seoul, South Korea, Feb. 2021

[5] Yujeong Choi, Yunseong Kim, and Minsoo Rhu, "LazyBatching: An SLA-aware Batching System for Cloud Machine Learning Inference," The 27th IEEE International Symposium on High-Performance Computer Architecture (HPCA-27), Seoul, South Korea, Feb. 2021

⟨Professor Seunghyup Yoo's Lab.⟩

IOEL
Integrated Organic Electronics Lab

■ Contact information

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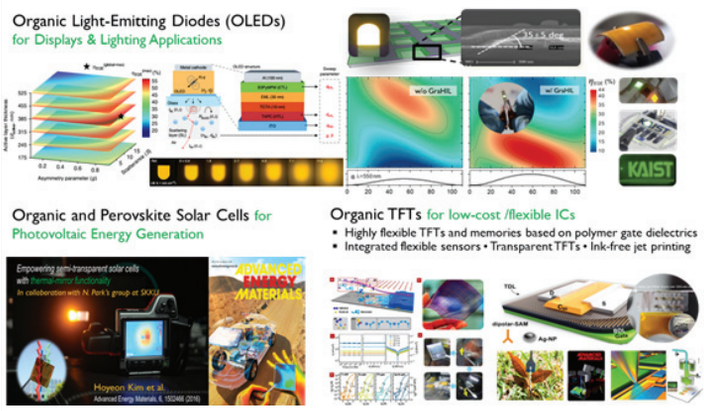
LAb.	Email: jhsim@kaist.ac.kr	Tel: 042-350-5483
Website	https://www.ioel.kaist.ac.kr/	

■ Current state of the Lab. (in 2022 Fall Semester)

PhD Students: 15 Master's Student: 4

■ Research Areas



Organic Light-Emitting Diodes (OLED) and their applications: As future display panels and solid-state lighting, 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. Our lab focuses on realizing flexible and efficient devices with various form-factors based on electrical and optical engineering. We have published several research papers in high-impact factor journals in recognition of these results, such as flexible and efficient devices based on dielectric-metal-dielectric and graphene electrodes, low-cost plastic OLEDs, transparent OLEDs, high-contrast-ratio OLEDs, etc.

Photovoltaics and their applications: Organic solar cells and perovskite solar cells have attracted considerable attention as a renewable and alternative energy source. IOEL is contributing to solar cell commercialization such as building-integrated photovoltaics and vehicle-integrated photovoltaics by developing flexible and semi-transparent characteristics of solar cells.

Devices for future electronics: State-of-the-art applications for future electronics including wearable / patched devices require not only various functions but also diverse form factors. Researches on thin film transistors and sensor devices are conducted with non-Si based semiconductors, such as organic semiconductors, 2D materials, and transparent metal-oxide semiconductors. Fields of interest are encouraged to be expanded, are currently focused on transparent thin film transistors, flexible organic memories, vertical transistors for high current drivability, organic sensors, solution-processed self-aligning nano-patterning techniques and organic vapor-jet printing techniques.

■ Recommended courses & Career after graduation

Recommended courses are Introduction to Physical Electronics (EE211) and Semiconductor Devices (EE362), Organic Electronics (EE568), and Display Engineering (EE563). After graduation, research institutes (national or company) and academic careers are possible.

■ Introduction to other activities besides research

IOEL promotes public relations by producing original researches through publishing journal papers and attending various domestic/foreign academic conferences or seminars. Also, we have lab workshops and sports days 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. To meet these requirements through devices with higher levels of integration and complicated systems, knowledge on electrical devices is highly necessary. For students with knowledge of 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 (2020-2022)

[1] SONG, Jinouk, et al. Organic light-emitting diodes: pushing toward the limits and beyond. ***Advanced Materials***, **2020**, 32.35: 1907539.

[2] KIM, Taehyun, et al. Realizing stretchable OLEDs: a hybrid platform based on rigid island arrays on a stress-relieving bilayer structure. ***Advanced Materials Technologies***, **2020**, 5.11: 2000494.

[3] KIM, Hyung Suk, et al. Enhancement of Reverse Intersystem Crossing in Charge-Transfer Molecule through Internal Heavy Atom Effect. ***Advanced Functional Materials***, **2021**, 31.50: 2104646.

[4] LEE, Jaeho, et al. Toward Ultra-Efficient OLEDs: Approaches Based on Low Refractive Index Materials. ***Advanced Optical Materials***, **2021**, 9.14: 2002182.

[5] LEE, Hyeonwoo, et al. Organic–Inorganic Hybrid Approach to Pulse Oximetry Sensors with Reliability and Low Power Consumption. ***ACS Photonics***, **2021**, 8.12: 3564-3572.

[6] LEE, Donggyun, et al. Realization of Flexible Ultraviolet Organic Light-Emitting Diodes: Key Design Issues. ***Advanced Photonics Research***, **2021**, 2.9: 2100108.

[7] YOO, Seunghyup; SONG, Youngjin; HAHN, Sangin. Ultralong persistent luminescence from carbon dots. ***Light: Science & Applications***, **2022**, 11.1: 1-2.

[8] SIM, Jee Hoon, et al. Simple and practical methods for utilizing parylene C film based on vertical deposition and laser patterning. ***Scientific Reports***, **2022**, 12.1: 1-8.

〈Professor Jong-Won Yu〉

RF System and Solution Lab

■ Contact information

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■ Current state of the Lab. (in 2022 Fall Semester)

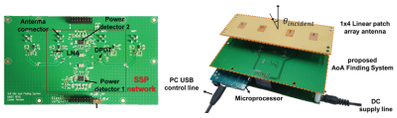
Postdoctoral Fellows : 0 PhD Students: 10+4 (part time) Master's Student: 4

■ Research Areas

RF System Development

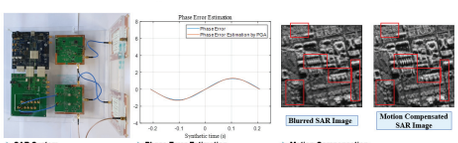
<Direction Finding System>

▶ Multiple Spacing Scheme, Few Antenna Elements, High Accuracy and Wide Coverage, Reduced Output Ports with Switched Six-Port Network



<SAR Motion Compensation Algorithm>

▶ Compact SAR System Design, Phase Error Estimation Method, Motion Compensation Algorithm, Compressive Sensing

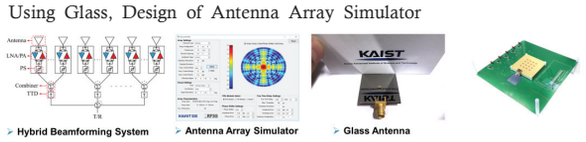


➢ SAR System ➢ Phase Error Estimation ➢ Motion Compensation

Phased Array Antenna System

<mmWave Beamforming System>

▶ Beam Squinting Frequency Dependency of Delay Circuits, Hybrid(PS/TTD) BeamformingArray, mmWavePhased Array Antenna Using Glass, Design of Antenna Array Simulator



➢ Hybrid Beamforming System ➢ Antenna Array Simulator ➢ Glass Antenna

<Wide Angle Scanning Antenna Array System>

▶ V2V Communication, Wide Beam Scanning Coverage in Phased Array, 8×8 Phased Array Antenna for Beamforming, Compact Calibration Algorithm

➢ Wide Angle Scanning System

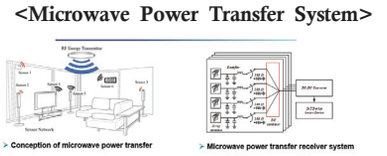
Wireless Power Transfer System

<Near-Field WPT System>

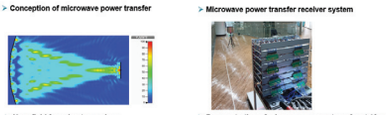
▶ 1:N Charging (Multi-Receiver Charging), Free-Positioning Charge, Assemble the Simple Receiver Module, Maximum Efficiency Tracking Control Scheme

➢ 1: N WPT for Smartphone ➢ WPT for AAA Battery

<Microwave Power Transfer System>



➢ Conception of microwave power transfer ➢ Microwave power transfer receiver system

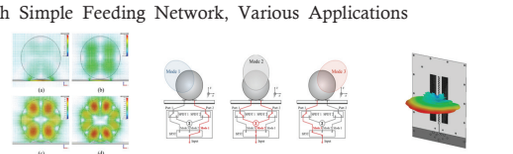


➢ Near-field focusing to receiver ➢ Demonstration of microwave power transfer at 10m

RF Antenna Development

<mmWave/Sub-THz 3D High-Gain Multi-Beam Pattern>

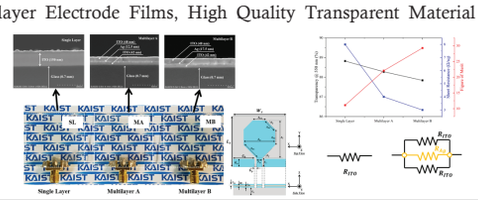
▶ Superdirectivity, Electrically Small Antenna, Electrical Beam-Steering with Simple Feeding Network, Various Applications



➢ High-Order TE Mode ➢ Pattern reconfigurable antenna system ➢ mmWave Automotive Radar antenna

<Invisible Antenna>

▶ Efficiency-Improved Material, Invisible Antenna Using ITO/Ag/ITO Multilayer Electrode Films, High Quality Transparent Material



■ 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 (2020-2022)

- International Journal 23, International Conference 11, Award 7, Patent 9

⟨Professor Chang Dong Yoo ‘s Lab.⟩

U-AIM

Artificial Intelligence & Machine Learning Lab

■ **Contact information**

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Lab.	duajeong@kaist.ac.kr	**Tel:**+82-42-350-5470
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■ **Current state of the Lab. (in 2022 Fall Semester)**

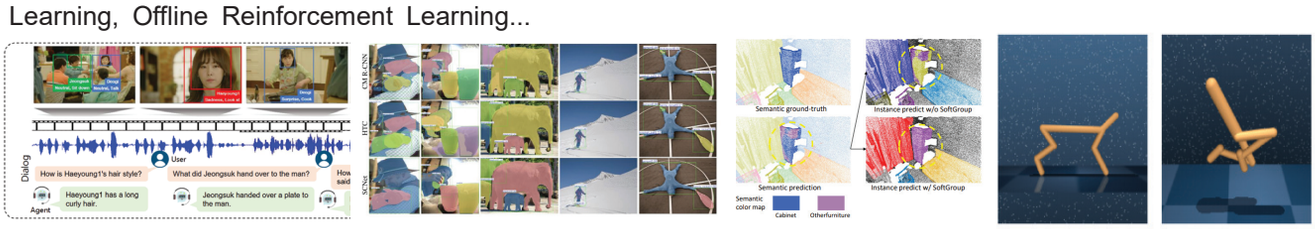
Postdoctoral Fellows : 0 PhD Students: 10 Master’s Student: 10

■ **Research Areas**

Image and Video Processing: Video Question Answering, Continual Learning, 2D and 3D understanding, Self-supervised learning, Video Scene Analysis, Video Caption, Scene Segmentation...

Audio Signal Processing: Speech Recognition, Blind Source Separation, Direction of Arrival estimation, Environment Sound Classification...

Reinforcement learning: Representation Learning for Reinforcement Learning, Meta Reinforcement Learning, Offline Reinforcement Learning...



■ **Recommended courses & Career after graduation**

Courses related to machine learning, deep learning, and probability & statistics are recommended. Some examples of courses are statistical Learning Theory, Advanced Deep Learning, Deep Learning for Computer Vision, and Neural network...

Graduates are evenly distributed across academia, industry, and research institutes. Notably, many graduates work for big companies in Korea and US.

■ **Introduction to other activities besides research**

(1) The happy hour is held every week for providing one hour of free food-eating and chit-chatting (2) Group tours are held every summer and winter to connect students together. (3) Dinners and hiking are held on some special occasion days.

■ **Introduction to the Lab.**

U-AIM is artificial intelligence and machine learning research lab. We develop and use various machine learning theories, novel machine learning/deep learning methods to process signals (such as image, text, speech, audio, video, EEG, and financial data) for longstanding and emerging applications. We are carrying out mid- to long-term projects with research institutes such as the government, ETRI, KT, Samsung Electronics, and LG Electronics.

■ **Recent research achievements (2020-2022)**

[1] Sunjae Yoon, et al "Selective Query-guided Debiasing for Video Corpus Moment Retrieval", ECCV 2022.

[2] Haeyong Kang, et al “Forget-free Continual Learning with Winning Subnetworks”, ICML 2022

[3] Thang Vu, et al "SoftGroup for 3D Instance Segmentation on Point Clouds" CVPR 2022, (Oral presentation)

[4] Trung Pham*, et al " Dual Temperature Helps Contrastive Learning without Many Negative Samples." , CVPR 2022

[5 Junghyun Lee, et al "Fast and Efficient MMD-based Fair PCA via Optimization over Stiefel Manifold." AAAI 2022.

⟨Professor Hoi-Jun Yoo ⟩

Semiconductor System Laboratory

■ Contact information		
Professor	hjyoo@kaist.ac.kr	Tel: 042-350-3468
Lab.	sslmaster@kaist.ac.kr	Tel: 042-350-8068
Website	https://ssl.kaist.ac.kr	

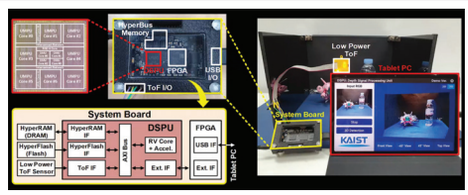
■ **Current state of the Lab. (in 2022 Fall Semester)**

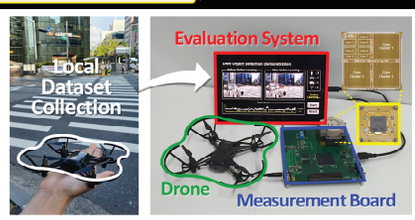
Postdoctoral Fellows : 0 PhD Students: 12 Master's Student: 7

■ **Research Areas**

Humanistic Intelligence System

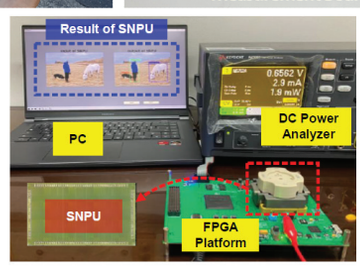
- Low-Power 3D Object Recognition Processor
- Energy-Efficient Mobile DRL Training Processor
- World-First Floating-point Computing-in-Memory Architecture
- Adaptive Fixed-point DNN Training Processor
- Multi-DNN Training Processor for Generative Adversarial Networks
- 3D Point Cloud-based Neural Network Processor
- CNN Super Resolution Processor for Full HD 60fps Video





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



■ **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 (2020-2022)**

- Top class international conferences: **3** ISSCC / **8** S. VLSI / **9** HotChips papers presented
- Major international papers: **38** journal / **42** 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 Giwan Yoon>

Terahertz Nano System Lab	■ Contact information		
	Professor	Email: gwyoon@kaist.ac.kr	Tel: 350-7411
	Lab.	E3-3 #2302	Tel: 350-7511
	Website	http://tnslab.modoo.at	

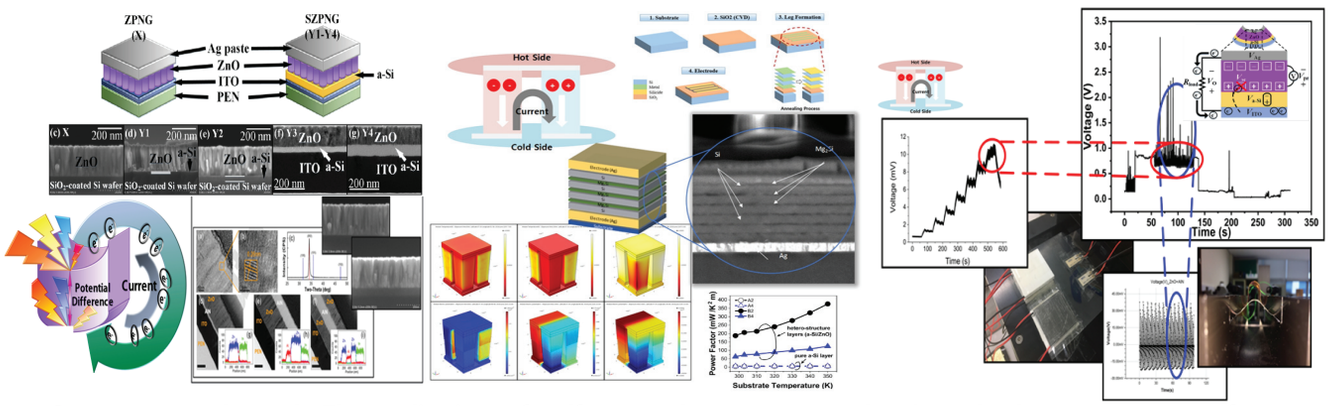
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 2 Master's Student: 1

■ **Research Areas**

- **1) Piezoelectric energy harvesting based on nanostructured thin films**
- **2) Thermoelectric energy harvesting based on nanostructured thin films**
- **3) Piezo-thermo hybrid energy harvesting for wearable/IoT applications**

Piezoelectric energy harvesting | **Thermoelectric energy harvesting** | **Hybrid energy harvesting**



★ **Current research goal: The realization of self-powered sensor networks through the convergence of energy harvesting devices and innovative sensor networks for wearable/IoT applications.**

■ **Recommended courses & Career after graduation**

- **Introduction to physical electronics, Semiconductor devices, Semiconductor integrated circuits etc. are recommended.**
- **Graduated students are working in universities, global electronics companies, national research institutes, etc.**

■ **Introduction to other activities besides research**

- **Frequently, a student gathering of refreshment is held at a decent place (e.g. italian restaurant) where meaningful discussions are interactively made on any issues or concerns related to lab research work as well as current technology development trends, etc.**

■ **Introduction to the Lab.**

Our research has focused on the development of high-efficiency energy harvesting devices based on novel nanostructured piezoelectric and/or thermoelectric thin films. Also, we are actively working to develop new kinds of piezo-thermo hybrid energy harvesting devices.

■ Recent research achievements (2020-2022)

[1] C Yoon et al., "Synergistic contribution of flexoelectricity and piezoelectricity towards a stretchable robust nanogenerator for wearable electronics", **Nano Energy**, 2022.

[2] Y Kim et al., "Anti-oxidation characteristics of Silicon Carbide coating layer for skutterudite thermoelectric modules",**Materials Chemistry and Physics,** 2021.

[3] C Yoon et al., "Enhanced output performance of sandwich-type ZnO piezoelectric nanogenerator with adhesive carbon tape", **Sensors and Actuators A: Physical,** 2021.

[4] B Jeon et al., "Realization of p-type ZnAgO:N thin films on flexible polyimide substrates through co-sputtering for wearable thermoelectric applications", **AIP Advances**, 2020.

[5] C Yoon et al., "Development of Al foil-based sandwich-type ZnO piezoelectric nanogenerators", **AIP Advances**, 2020.

[6] Y Kim et al., "Development of Indium-Tin Oxide Diffusion Barrier for Attaining High Reliability of Skutterudite Modules", **ACS Applied Energy Materials**, 2020.

⟨Professor Young-Gyu Yoon's Lab.⟩

Neuro-Instrumentation and Computational Analysis Lab

■ **Contact information**

Professor	**Email: ygyoon@kaist.ac.kr**	**Tel: 7449**
Lab.	**Email: nicalab@kaist.ac.kr**	**Tel: 7549**
Website	**nica.kaist.ac.kr**	

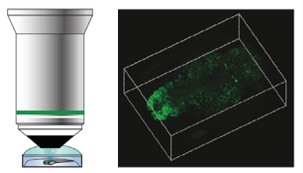
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 3 Master's Student: 4

■ **Research Areas**

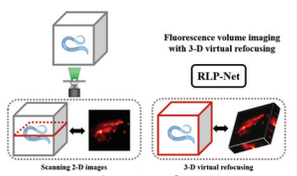
< Acquiring Big Data from Brain >

Imaging Brain Activity With genetic modification, the neurons can be modified to emit fluorescent light as a function of the brain activity (i.e., neurons "blink" as they fire) which makes the brain activity literally visible with an optical microscope. We develop and apply high-speed 3-D imaging techniques which will allow us to see how the neurons communicate.



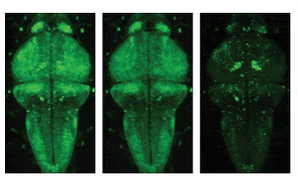
Imaging brain activity of live animals

Computational Imaging Performance of imaging system is limited by many factors including the laws of physics, biological constraints, information theory and sampling theorem. We develop computational imaging methods that combine imaging hardware and reconstruction algorithms (e.g., neural network) to overcome such limitations.



Virtual 3-D refocusing

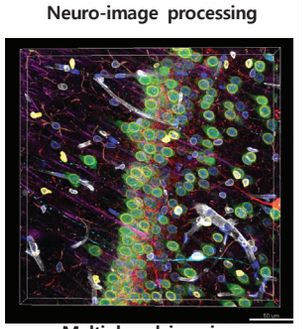
Multiplexed Imaging With fluorescence microscopy, only up to five proteins can be simultaneously imaged due to the wide emission spectra of fluorescent molecules. To image large number of proteins beyond this limit, we unify novel imaging methods based on signal processing algorithms.



Neuro-image processing

< Analyzing Big Data from Brain >

Neuro-image Processing State-of-the-art functional imaging methods can generate more than a gigabyte of data per second which necessitate the development of automated analysis algorithms. We develop fast and scalable AI algorithms that can process brain images without any labeled data.



Multiplexed imaging

Neuro-data Mining Neural activity is the basis of various operations in our brain, but our understanding of the fundamental principle of neural signal processing is very limited. We develop and apply computational methods to analyze the brain activity data to quantify how the information flows and reveal the functional connection among the neurons.

■ **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**

[1] Three-dimensional fluorescence microscopy through virtual refocusing using a recursive light propagation network, ***Medical Image Analysis***, 2022.

[1] PICASSO allows ultra-multiplexed fluorescence imaging of spatially overlapping proteins without reference spectra measurements, ***Nature Communications***, 2022.

[3] 3DM: Deep decomposition and deconvolution microscopy for rapid neural activity imaging, ***Optics Express***, 2021.

[4] Efficient Neural Network Approximation of Robust PCA for Automated Analysis of Calcium Imaging Data, ***MICCAI***, 2021.

[4] Sparse decomposition light-field microscopy for high speed imaging of neuronal activity, ***Optica***, 2020.

[5] Precision Calcium Imaging of Dense Neural Populations via a Cell-Body-Targeted Calcium Indicator, ***Neuron***, 2020.

[6] Robotic multidimensional directed evolution of proteins: development and application to fluorescent voltage reporters, ***Nature Chemical Biology***, 2018.

⟨Professor Insu Yun's Lab.⟩

Hacking Lab

■ Contact information		
Professor	Email: insuyun@kaist.ac.kr	Tel: 042-350-7469
Office	ITC Building (N1-812)	
Homepage	https://hacking.kaist.ac.kr	

■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 1 Master's Student: 4

■ Research Motivation

You may not be aware of it, but we are currently at war. This war is taking place within cyberspace, and we are constantly being attacked and defending ourselves. For example, we are experiencing attacks such as malware, ransomware, and voice phishing. To protect ourselves, we employ several tools such as Anti Virus (AV), firewalls, and IDS (Intrusion Detection Systems).

This cyber war has historically been managed by a small number of experts, what we call hackers; however, it is no longer practicable. These days, new technologies such as Internet of Things (IoT), cryptocurrencies, and artificial intelligence (AI) are developing far more quickly than in the past. Even though these new technologies may lead to new security vulnerabilities, these systems are too massive and complicated to analyze manually by human experts (i.e., hackers). To solve these issues, our KAIST Hacking Lab is creating practical technologies and systems that can automatically carry out high-level analysis like hackers.

■ On-going Research Projects

Advanced Automatic Exploit Generation. We are working on automating procedures that hackers create attack codes, which are called exploits. Recently, we have developed a new technique that can automatically analyze secure memory allocators, which are frequently used to enhance application security. Using this technique, we could discover several interesting behaviors and implementation flaws in these allocators, allowing us to automatically exploit them.

Automatic Vulnerability Finding. We are also studying methods for finding vulnerabilities automatically. In particular, we are interested in discovering serious security vulnerabilities in real-world applications such as browsers and operating systems. Due to their enormous complexity, a single approach cannot cover every vulnerability in these applications. Therefore, we are studying diverse bug finding techniques such as fuzzing or software verification to detect vulnerabilities in these applications.

Offensive Security Research for Real-world Applications. In order to understand hacking in detail, we are conducting offensive research on hacking. For example, in 2020, we successfully chained six vulnerabilities in Apple Safari and Mac OS and crafted the full-chain exploit. This exploit is extremely serious; it can achieve the victim's kernel privilege f he/she simply visits our website. We demonstrated this attack in an international hacking contest called Pwn2Own and received $70,000 prize. Currently, we are also conducting offensive research on international network equipment (e.g., routers) to discover and exploit their vulnerabilities.

■ Recommended courses & Career after graduation

We suggest you to take computer division courses related to system programming, operating systems, and security. After graduation, you can examine the security of systems, implement large-scale systems for security, and perform system security research. These skills are essential for many industries (e.g., Samsung) and laboratories (e.g., NSRI).

■ Introduction to other activities besides research

Our lab is currently at the starting stage. Nothing has been decided yet, and nothing has been confirmed. You can build our lab as you want. I am willing to support you actively if you have good ideas for our lab.

■ Recent research achievements (2021-)

- DoLTEst: In-depth Downlink Negative Testing Framework for LTE Devices (Security '22).
- HardsHeap: A Universal and Extensible Framework for Evaluating Secure Allocator (CCS'21)
- Preventing Use-After-Free Attacks with Fast Forward Allocation (Security'21)
- BaseSpec: Comparative Analysis of Baseband Software and Cellular Specifications for L3 Protocols (NDSS'21)

<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 2022 Fall Semester)**

Postdoctoral Fellows : 1 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), optical components, and nano-sensor devices**.

▷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**.

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

Through the micro/nano-mechanical switches, ideal switching characteristics such as no-leakage current and infinite sub-threshold swing can be achieved (**Fig. 1**), but the high operational voltage and low reliability still should be improved. We have been improving characteristics of the mechanical switch and trying to apply it into memory, logic & RF applications.

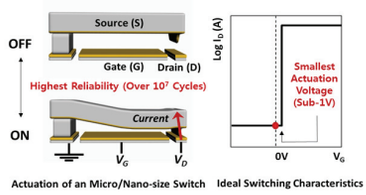


Fig. 1 Ideal mechanical-switch

■ **N/MEMS for Optical Components----------**

Based on our research experience on micro/nano fabrication, we make novel complex micro/nano-structures decorated optical films (**Fig. 2**). These films are for giving special abilities to display such as thinner feature, transparency, glass-free 3D and local dimming. We also developed micro-shutter for smart-window, AR and transparent OLED-display. Recently, we built a start-up company named MEMSLUX, and aim to see our technology being widely used in the near future.

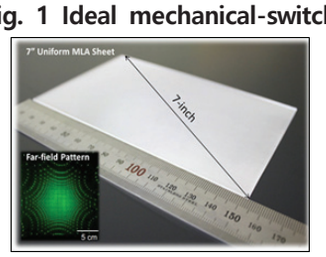


Fig. 2 Optical film for display

■ **Nano-sensor devices for future electronics----------**

To realize the industry 4.0, it is essential to fabricate high performance sensor devices in high-yield, reliable, and reproducible manners. Based on our large-area high-resolution and reproducible nano-fabrication technologies, we reliably explore unprecedented physical/chemical phenomena and apply them to develop high-performance optical, physical, tactile, bio, and optical sensor devices (**Fig. 3**).

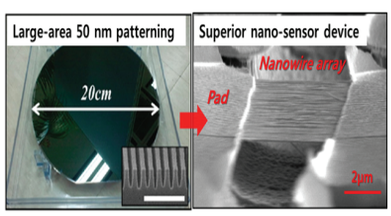


Fig. 3 Nano-structured sensor

■ **Recommended courses & Career after graduation**

Among EE courses, semiconductor devices, integrated circuit devices, and MEMS in EE perspective are recommended. Additionally, it is also recommended to have a basic understanding of physics and chemistry.

So far, 23 Ph.D. and 28 M.S. degrees have been conferred. Graduates have entered global leading industries such as Samsung, LG, SK Hynix, Broadcom, and also continue their research career as postdoctoral researchers in Northwestern, Massachusetts Institute of Technology(MIT), John`s Hopkins, and National Institutes of Health(NIH).

■ **Introduction of other activities besides research**

Annual Workshop :

- Present research results and future plan
- Enjoy winter sports

Homecoming Day :

- Share information with laboratory students and graduates

Leisure Activity :

- Enjoy sports regularly (Soccer, Bowling, Basketball)

■ **Recent research achievements**

▪ In total, 118 international journals, 111 international conference, 48 international and 111 domestic patents

– Nanolene (sole technology of 3DMNSL) - based Always-on gas sensor was broadcasted in 22 social media

– Journals : Nature Nanotechnology, Advanced Materials, ACS Nano, Nano Letters etc.

– Awarded by IEEE, Samsung Electronics, Society of Micro and Nano Systems, and KAIST (Awarded by "EE Device Division" as Best Paper Award, presented only to one person in the division)

〈Professor Chan-Hyun Youn's Lab〉

Network & Computing

■ Contact information		
Professor	**Email: chyoun@kaist.ac.kr**	**Tel: 042-350-3495**
Lab.	**Email: msjeon@kaist.ac.kr**	**Tel: 042-350-7261**
Website	**http://ncl.kaist.ac.kr**	

■ Current state of the Lab. (in 2022 Fall Semester)

Research Assistant Professor : 1 Ph.D Students: 10 Master's Student: 4

■ Research Areas

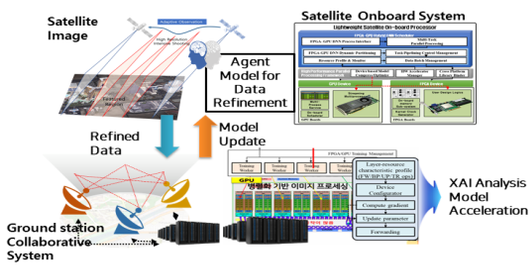


Fig 1. Explainable AI (XAI)-based Satellite Image Analysis Acceleration

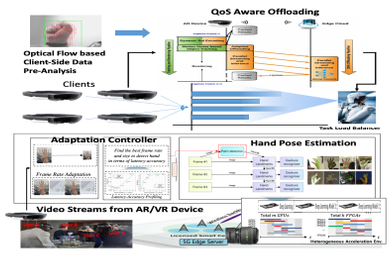


Fig 2. 5G based Low-latency Interaction Technology Development

1) Development of XAI-based Interactive Satellite Image Analysis and Accelerated Deep Learning Technology (ADD 미래도전기술) *(Fig 1.)*

- A collaborative system technology for satellite-to-ground control that combines satellite-on-board acceleration with resource management, and HPC systems for XAI acceleration processing
- Development of interactive deep learning system through XAI analysis

2) 5G based low-latency interaction technology development between device and edge-cloud environment (IITP 국책과제) *(Fig 2.)*

- Accelerate the multiple task processing VR/AR interaction with integrated information
- Offloading work to edge system and enabling parallel processing for low-latency and multi-tenant VR/AR interaction on heterogeneous hardware

3) GPU Scheduler Development for Acceleration of 5G-UPF Packet Processing (㈜삼성전자)

- Desing of pooled acceleration architecture for dynamic federation hierarchy and scalability
- Development of resource adaptation and DL pipeline scheduling

**Further projects and detail information of research areas are addressed in our homepage*

■ Recommended courses & Career after graduation

Recommended courses : EE331(Introduction to Machine Learning), EE324(Network Programming), EE424(Introduction to Optimization Techniques

Career after graduation : Our alumni are contributing in many ways such as being a Professor(Jeon-Buk, Prince Mugrin Univ.), Researcher(ETRI, Samsung, Bytedance), Cloud Engineer(Toss), etc.

■ Introduction to the Lab.

Our lab is "Network and Computings Lab" or NCL in short. We NCL people are researching computing systems, which is a crucial part of the AI driven 4'th industrial revolution. Specifically, we have research teams on **Acceleration System Design** for applications like Satellite Image Analysis, Medical Data Processing, and, Augmented Reality, **Large-scale Database & Computing cluster management** and **Hardware acceleration platform.** All of theses interesting topics are not mutually exclusive.

■ Recent research achievements (2020-2022)

[1] Dong-Ki Kang, Yun-Gi Ha, Limei Peng, Chan-Hyun Youn, "Cooperative Distributed GPU Power Capping for Deep Learning Clusters", IEEE Transactions on Industrial Electronics, Volume: 69, Issue: 7, (pp.7244 – 7254), July. 2022.
[2] Woo-Joong Kim and Chan-Hyun Youn "Cooperative Scheduling Schemes for Explainable DNN Acceleration in Satellite Image Analysis and Retraining",IEEE Transaction on Parallel and Distributed System Vol 33, Issue 7 (pp. 1605 – 1618), July. 2022.
[3] Minsu Jeon, Kyung-No Joo, Taewoo Kim, Seonghwan Kim, and Chan-Hyun Youn "FleX: A Flex Interconnected HPC System with Stochastic Load Balancing Scheme", IEEE Access, Vol 10 (pp.2169 – 3536), March. 2022.
[1] Kim, Heejae, et al. "An Alternating Training Method of Attention-Based Adapters for Visual Explanation of Multi-Domain Satellite Images." IEEE Access, Vol. 9, Apr. 2021.
[2] Joo, Kyung-No, and Chan-Hyun Youn. "Accelerating Distributed SGD With Group Hybrid Parallelism." IEEE Access, Vol. 9, Mar, 2021.
[3] Yang, Eunju, and Chan-Hyun Youn. "Individual Load Forecasting for Multi-Customers with Distribution-aware Temporal Pooling." IEEE INFOCOM, 2021.
[4] Kang, Dong-ki, et al. "Cooperative Distributed GPU Power Capping for Deep Learning Clusters." IEEE Transactions on Industrial Electronics, 2021.
[5] Lee, Changha, Seong-Hwan Kim, and Chan-Hyun Youn. "Cooperating Edge Cloud-Based Hybrid Online Learning for Accelerated Energy Data Stream Processing in Load Forecasting." IEEE Access, Vol. 8, Nov. 2020.

***Further detail information of publications are presented our homepage**

〈Professor Kayoung Lee's Lab.〉

Low-dimensional Electron Systems Lab	■ Contact information	
	Professor	**Email: kayoung.lee@kaist.ac.kr**
	LAb.	**Email: kleegroup@kaist.ac.kr**
	Website	**https://sites.google.com/view/quantum-materials**

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows: 0 PhD Students: 5 Master's Students: 2

■ **Research Areas**

Electrical Characterization of High-mobility Emerging Semiconductors:

- Transport spectroscopy; measurements of band structure information
- Electron transport and quantum phenomena in semiconductor nanostructures

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

Nanostructure Electronic/Optoelectronic Device Applications:

- High-performance field effect transistors; low power tunneling transistors; multi-valued logic devices; diodes, negative differential resistors, inverters; IR, vis light detectors etc.

■ **Recommended courses & Career after graduation**

- Semiconductor device physics, solid state physics, quantum mechanics, etc.
- Academia: national research institutes, universities / Industry: semiconductor-related companies such as Samsung, LG, SK Hynix, Intel, Apple

■ **Introduction to the Lab.**

Our major research goal is (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 transport 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 our study will also promote bringing unprecedented future computing with novel high speed and low power nanoelectronics.

■ **Recent research achievements (2018-2022)**

- 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 14, 3004 (2022).

- Sang-Hoo Cho, Hanbyeol Jang, Heungsoon Im, Donghyeon Lee, Je-Ho Lee, Kenji Watanabe, Takashi Taniguchi, Maeng-Je Seong, Byoung Hun Lee, and Kayoung Lee*, "Bias-controlled multi-functional transport properties of InSe/BP van der Waals heterostructures," Scientific Reports 11, 7843 (2021)

- Sanghyun Kim, Donghyeon Lee, Binbin Wang, Shangjie Yu, Kenji Watanabe, Takashi Taniguchi, Jonathan A. Fan, Jiamin Xue, and Kayoung Lee*, "Raman spectroscopic study of artificially twisted and non-twisted trilayer graphene," Applied Physics Letters 118, 133101 (2021)

- YiTaek Choi, Yongwook Seok, Hanbyeol Jang, Arvind Kumar, Kenji Watanabe, Takashi Taniguchi, Xuan Gao, and Kayoung Lee*, "Multiterminal transport measurements of multilayer InSe encapsulated by hBN," ACS Applied Electronic Materials 3, 163 (2021)

- 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 31, 2006788 (2021)

  ** Highlighted in Hot Topic: Surfaces and Interfaces*

- Sang-Soo Chee*, Hanbyeol Jang, Kayoung Lee, and Moon-Ho Ham*, "Substitutional fluorine doping of large-area molybdenum disulfide monolayer films for flexible inverter device arrays," ACS Applied Materials and Interfaces 12, 31804 (2020)

- Sang-Soo Chee, Joo-Hyoung Lee*, Kayoung Lee*, and Moon-Ho Ham*, "Defect-assisted contact property enhancement in a molybdenum disulfide monolayer," ACS Applied Materials and Interfaces 12, 4129 (2020)

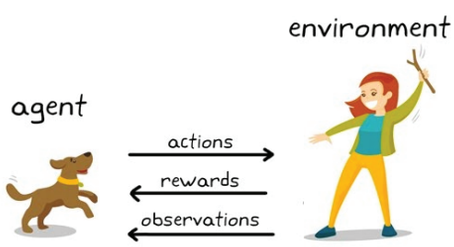
- Sang-Soo Chee, Won-June Lee, Yong-Ryun Jo, Min Kyung Cho, DongWon Chun, Hionsuck Baik, Bong-Joong Kim, Myung-Han Yoon*, Kayoung Lee*, and Moon-Ho Ham*, "Atomic vacancy control and elemental substitution in a monolayer molybdenum disulfide for high performance optoelectronic device arrays," Advanced Functional Materials 30, 1908147 (2020)

  ** Highlighted on the cover*

- Daehoon Park, Minje Kim, Sol Lee, Ick-Jae Yoon, Kayoung Lee, Min Hyung Lee, and Junghyo Nah, "Light-permeable air filter with self-polarized nylon-11 nanofibers for enhanced trapping of particulate matters," Advanced Materials Interfaces 6,1801832 (2019)

- Kayoung Lee*, En-Shao Liu, Takashi Taniguchi, Kenji Watanabe, and Junghyo Nah, "Interface states in bilayer graphene encapsulated by hexagonal boron nitride," ACS Applied Materials and Interfaces 10, 40985 (2018)

⟨Professor Donghwan's Lab.⟩

<table>
<tr><td rowspan="4">Machine Decision Intelligence and Learning Research Group</td><td colspan="3">■ Contact information</td></tr>
<tr><td>Professor</td><td>Email: donghwan@kaist.ac.kr</td><td>Tel: 043-350-7462</td></tr>
<tr><td>LAb.</td><td>Email:</td><td>Tel:</td></tr>
<tr><td>Website</td><td colspan="2">https://sites.google.com/site/donghwanleehome</td></tr>
<tr><td colspan="4">■ Current state of the Lab. (in 2022 Fall Semester)
Postdoctoral Fellows : 0 PhD Students: 0 Master's Student: 2</td></tr>
<tr><td colspan="4">■ 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.
 
</td></tr>
<tr><td colspan="4">■ 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</td></tr>
<tr><td colspan="4">■ Introduction to other activities besides research
Conferences and workshops</td></tr>
<tr><td colspan="4">■ Introduction to the Lab.
Our research covers theory and application of control, machine learning, reinforcement learning, and interplay among them.</td></tr>
<tr><td colspan="4">■ Recent research achievements (2018-2020)
Donghwan Lee and Niao He, ``A unified switching system perspective and convergence analysis of Q-learning algorithms,'' NeurIPS2020
Donghwan Lee and Niao He, "Target-based temporal difference learning," ICML2019, Long beach, CA, June 11-15, 2019.
Donghwan Lee, Niao He, Kamal Parameswaran, and Volkan Cevher, "Optimization for reinforcement learning: from single agent to cooperative agents," IEEE Transactions on Signal Processing Magazine.</td></tr>
</table>

<Professor Sang-Gug Lee's Lab.>

NANO INTEGRATED CIRCUIT EXPERTISE

■ **Contact information**

Professor	sgjlee@kaist.ac.kr	**042-350-3491**
Lab.	**E3-2 #2228**	**010-9132-8668**
Website	http://nice.kaist.ac.kr	

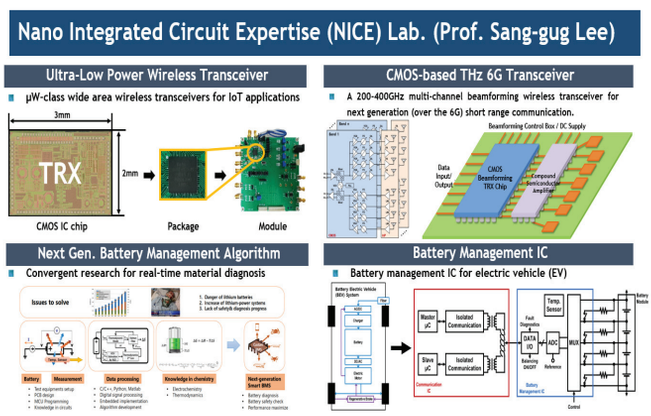
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows: 1 PhD Students: 12 Master's Student: 7

■ **Research Areas**

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

Wireless communications with minimum power dissipation is under spotlight with growing interest in IoT. For this purpose, NICE lab is actively working on ULP wireless and wake-up transceivers.



▶ THz Imaging System and Transceiver for 6G Communications

Imaging systems in sub-terahertz frequency domains and sub-terahertz circuits (PA, LNA, Mixer, VCO, etc.) achieve data rates up to 100Gbps for next-generation 6G communications.

▶ **Battery Management and Diagnosis Algorithm**

Battery management and diagnosis are crucial for battery performance and safety of battery-operated system. A next generation battery analysis technique that can diagnose various states of batteries in advance or real-time on battery management systems is developed for safer and more precise control.

▶ **Automotive Circuit Design**

An electric vehicle employs a battery management system (BMS) for the safe operation of batteries. The project develops a BMS having low cost, high efficiency, and reliable operation.

■ **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 conducts homecoming event annually to strengthen the bond between alumni and current students. Moreover, organize biannual 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 (2022)**

[1] Jeong-Il Seo et al. "A 95.1% Efficiency Hybrid Hysteretic Reconfigurable 3-Level Buck Converter with Improved Load Transient Response," IEEE Transactions on Power Electronics, July. 2022.

[2] Hyunki Jung et al. "CMOS Fractional-N Frequency Synthesizer for UHF RFID Reader Applications With Transformer-Based ISF Manipulation VCO," IEEE Transactions on Circuits and Systems II, June. 2022.

[3] Hyunki Jung et al. "Analysis and Design of Inductorless Transimpedance Amplifier Employing Nested Feedforward Noise-Canceling Amplifiers," IEEE Transactions on Microwave Theory and Techniques, June. 2022.

[4] Kyung-Sik Choi et al. "A 915 MHz IoT Transmitter Employing Frequency Tripler and Digitally Controlled Duty-Cycle/Phase Calibration," IEEE Journal of Solid-State Circuits, May. 2022.

[5] Young-Seok Noh et al. "A Reconfigurable DC-DC Converter for Maximum Thermoelectric Energy Harvesting in a Battery-Powered Duty-Cycling Wireless Sensor Node," IEEE Journal of Solid-State Circuits, March. 2022.

〈Professor Sung-Ju Lee's Lab.〉

■ **Contact information**

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

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows: 0 PhD Students: 9 Master's Students: 5

■ **Research Areas**

- Mobile computing (ubiquitous computing, mobile sensing, wearable computing, AR/VR)
- Mobile AI/ML (learning models for mobile conditions, mobile device ML training and inference, federated learning)
- Mobile Human-Computer Interaction (novel interaction methods, digital health and wellbeing, human/AI interaction)
- Wireless networking (networking for robots autonomous wireless network management, protocols for emerging spectrum)

■ **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, EE425 Wireless Networks, EE432 Digital Signal Processing.
- 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, Naver, Samsung Electronics, SK), (3) government research labs (e.g., Agency for Defense Development), and (4) 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 institutes such as Carnegie Mellon University, Microsoft Research Asia, Nokia Bell-Labs Cambridge, Nanyang Technological University, and University at 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 (2020-2022)**

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

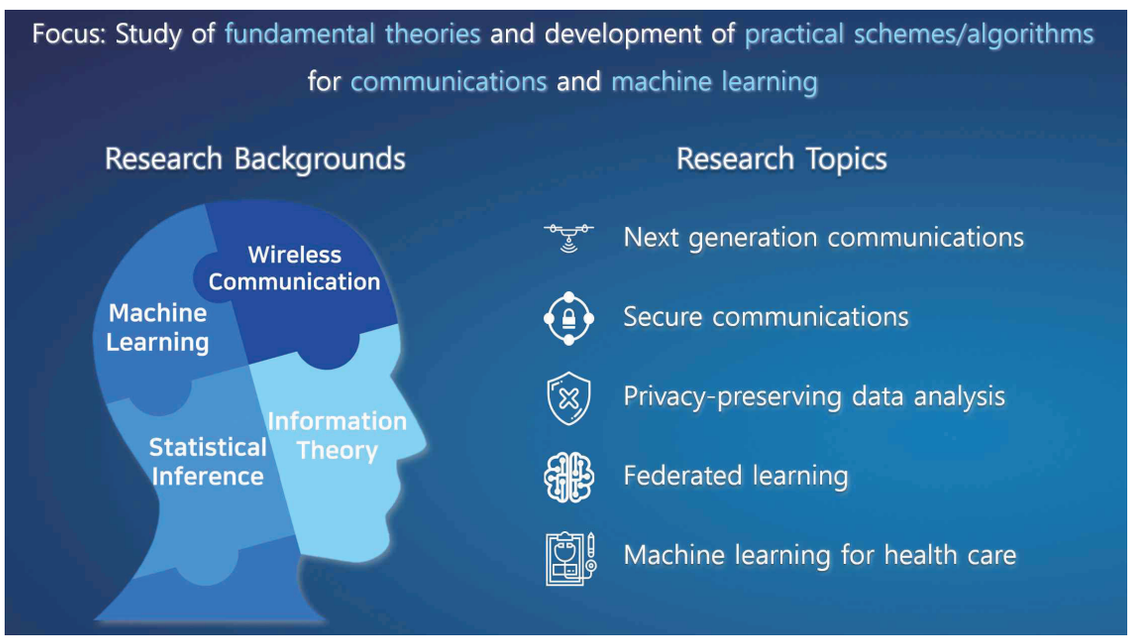
<Professor Si-Hyeon Lee's Lab>

InfoLab: Information and Communication Research Lab	■ Contact information		
	Professor	sihyeon@kaist.ac.kr	**Tel:** 042-350-7463
	Lab.	imhyun1209@kaist.ac.kr	**Tel:** 042-350-7563
	Website	https://sites.google.com/view/kaist-infolab	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 5 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, and developing machine-learning algorithms for various applications such as communication, health care, and NAND flash memory.

■ **Career after graduation**

Communications and machine learning technologies are highly demanded research areas both in industry and academia.

■ **Introduction to the Lab.**

InfoLab started in 2017 at POSTECH and moved to KAIST in 2020. We welcome students who are passionate about fundamental theories and developments of communication systems and machine learning algorithms.

■ **Recent research achievements**

Our lab published 22 SCI journal papers and 26 international conference papers, including several papers in IEEE Trans. Information Forensics and Security (impact factor top 5%) and IEEE Trans. Information Theory (#1 in information theory).

⟨Professor Jung-Yong Lee⟩

Advanced devices for Energy Conversion Lab	■ Contact information		
	Professor	Email: jungyong.lee@kaist.ac.kr	Tel: 010-9341-1834
	Lab.	Jihwan-joe@kiast.ac.kr	Tel: 010-2124-7330
	Website	http://adec.dsso.kr	

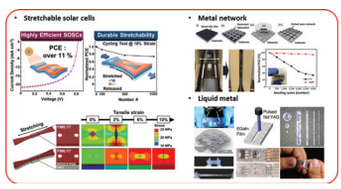
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 3 PhD Students: 11 Master's Student: 5

■ **Research Areas**

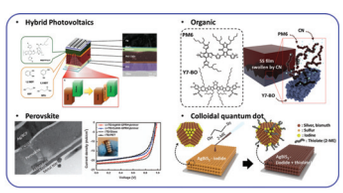
1. Promising electrode technology & stretchable optoelectronic device engineering

For realizing wearable devices, outstanding performance in stretchable optoelectronic devices is required. We investigate novel stretchable and transparent electrode including silver nanonetwork, InGa-based liquid metal and hybrid electrodes. Furthermore, we perform the structural engineering for efficient stretchable optoelectronic devices.



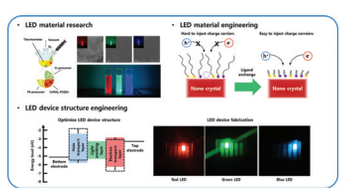
2. High efficient emerging optoelectronic devices

Although emerging optoelectronic materials including organic molecule, quantum dot and perovskite are beneficial to photovoltaic devices including solar cell, LED and photodetector, more efforts are required for commercialization. We study structural engineering for achieving high performance and leading in the emerging field of optoelectronics.



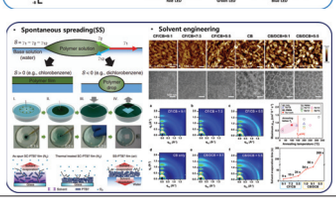
3. Next-generation light-emitting diodes and displays

Electronic devices are essential equipment for people today and provide a lot of useful information for their lives. An efficient way to convey tons of information from electronic devices is through displays. Therefore, for a clearer and more efficient display, advanced light-emitting diodes are needed necessarily. In our group, we research about synthesis and modification of materials, and optimization of device structure for advanced next-generation LEDs.



4. Thin film morphology engineering

We investigate the thin film morphology using various techniques such as spontaneous spreading (SS), water floating and solvent engineering. These researches open up to propose the scientific origins for efficient charge transfer.



■ **Recommended courses & Career after graduation**

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

Career after graduation : Professor, Postdoctoral researcher, Researchers of national research center, Company (SAMSUNG, LG electronics)

■ **Introduction to other activities besides research**

Exercise activity : Football, Basketball, Badminton

Group teamwork : Team meating (once every two weeks), dining together (more than twice of year)

■ **Introduction to the Lab.**

Advanced devices for energy conversion (ADEC) lab has been studied on the emerging optoelectronic devices since 2010. We will support your researches whatever you interest and help you to set up an experimental environments. Also, we are happy to time to discuss research issues and other problems. If possible, we can create synergistic effect on our results as we collaborate together.

■ **Recent research achievements (2020-2022)**

[1] C. Kim et al., "Highly Efficient (>9%) Lead-Free AgBiS2 Colloidal Nanocrystal/Organic Hybrid Solar Cells," Nature Energy, 4, 969 (2020)

Journal articles (Total: 21) : 2020(11), 2021(6), 2022(4)

⟨Professor June-Koo Rhee's Lab.⟩

Quantum Information and Communications Lab

KAIST IT Research Center of Quantum Computing for AI

■ Contact information

Professor	Email: EE building E3-2 3208	Tel: 042-350-7416
LAb.	Email: EE building E3-2 3217	Tel: 042-350-7516
Website	http://quic.kaist.ac.kr	

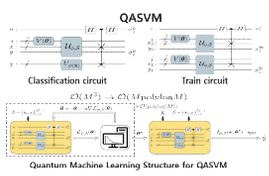
■ Current state of the Lab. (in 2022 Fall Semester)

PhD Students: 4 Master's Student: 5

■ Research Areas

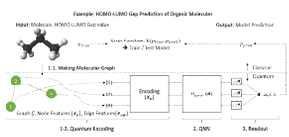
√ Quantum Approximated Support Vector Machine (QASVM)

Quantum Support Vector Machine (QSVM) algorithm has exponential advantage in calculation via Classical-SVM. However, QSVM requires quantum machine without error. Also, Quantum Kernel Estimation (QKE) algorithm is applicable to Noise Intermediate Scale Quantum (NISQ) device with shallow depth circuit, but requires high calculation time. In this work, we suggest Quantum Approximated Support Vector Machine (QASVM) algorithm, uses shallow depth quantum circuit and fast calculation than classical SVM, by using Swap Test Classifier (STC).



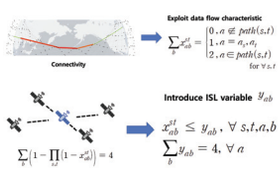
√ Quantum Machine Learning of Graph Data

Hilbert space of quantum state is exponentially large with number of qubits. Also, we can travel part of this large space by Parameterized Quantum Circuit (PQC), which use only small number of quantum gates. In this work, we analyze molecules by Quantum Graph Neural Network (QGNN), which is useful for graph data, with properties of molecule, and get faster calculation than classical algorithm



√ Low Earth Orbit Satellite Network Optimization Using Quantum Annealer

In general, finding optimal path for graph or networks is regarded as NP-hard problem. This network finding problem can be changed as Quadratic Unconstrained Binary Optimization (QUBO) problem. Also, QUBO can be solved faster than classical algorithm by Quantum Annealing. In this work, we research method that change problem to QUBO, and also suggest proper Quantum Annealing model for this problem.



■ 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

The Lab. actively encourages activities such as Leisure sports for membership among the member of the Lab. The members periodically play table tennis, badminton, bowling as well as workshops held twice in the year.

■ Introduction to the Lab.

Quantum Information and Communications (QuIC) Group with a vision to foster researches and educations of quantum computing and communications, as well as internet and communications, was founded in 2005. QuIC is currently working on researches seeking the first discovery of new ideas and the first implementation of new technologies in the area of quantum information and computing.

■ Recent research achievements (2020-2022)

[1] Blank, Carsten, D.K Park, J-K.K. Rhee and F. Petruccione, "Quantum classifier with tailored quantum kernel", npj Quantum Information, 2020

[2] Trong Duong, Sang T. Truong, Minh Tam, Bao Bach, Ju-Young Ryu, June-Koo Kevin Rhee, "Quantum Neural Architecture Search with Quantum Circuits Metric and Bayesian Optimization", ICML, 2022

〈Professor Hyunjoo. J Lee 〉

Brain/Bio Medical Microsystems Lab	■ Contact information		
	Professor	Email: 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 2022 Fall Semester)**

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

■ **Research Areas**

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. Multifunctional probes that can simultaneously deliver stimulants and monitor neural circuits offer a promising approach to investigating the complexities of the brain.

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. CMUTs for ultrasound neuromodulation have demonstrated motor response in freely moving mice, as well as neuronal stimulation in vitro.

Biomedical Sensors

- Developing portable, miniaturized, and sensitive chemical and epidermal sensor is essential for home healthcare and workplace safety. A capacitive micromachined ultrasound transducer (CMUT), a MEMS-based resonator that detects chemicals through the mass-loading mechanism, is suitable for the miniaturized chemical sensor systems.

■ **Recommended courses & Career after graduation**

EE211 Introduction to Physical Electronics, EE305 Introduction to Electronics Design Lab.,

EE362 Semiconductor Devices

■ **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.**

Using microsystem fabrication technology to solve brain and bio medical problems.

■ **Recent research achievements (2020-2022)**

1. Lee, T., Jung, J., Lee, S. M., Park, J., Park, J. H., Paik, K. W., & Lee, H. J. (2022). FPCB as an Acoustic Matching Layer for 1D Linear Ultrasound Transducer Arrays. Sensors, 22(15), 5557.

2. Lee, S. M., Lee, T., Kim, H., Jo, Y., Kim, M. G., Kim, S., ... & Lee, H. J. (2021). Calcium-modified silk patch as a next-generation ultrasound coupling medium. ACS Applied Materials & Interfaces, 13(47), 55827-55839.

3. Kim, S., Jo, Y., Kook, G., Pasquinelli, C., Kim, H., Kim, K., ... & Lee, H. J. (2021). Transcranial focused ultrasound stimulation with high spatial resolution. Brain Stimulation, 14(2), 290-300.

4. Seo, J. W., Kim, K., Seo, K. W., Kim, M. K., Jeong, S., Kim, H., ... & Lee, H. J. (2020). Artifact-free 2D mapping of neural activity in vivo through transparent gold nanonetwork array. Advanced Functional Materials, 30(34), 2000896.

5. Kook, G., Jeong, S., Kim, M. K., Lee, S., Choi, N., & Lee, H. J. (2020). Fabrication of highly dense silk fibroin biomemristor array and its resistive switching characteristics. Advanced Materials Technologies, 5(4), 1900991.

⟨Professor Dong Eui Chang's Lab.⟩

KAIST EE Ctrl Lab

Control Laboratory

■ **Contact information**

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■ **Current state of the Lab. (in 2022 Fall Semester)**

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

■ **Research Areas**

We carry out research on control theory and artificial intelligence, and apply it to robotics systems such as drones, robots, and medical devices. The main tools used for our research include deep learning, Lyapunov theory, differential geometry, and optimization. We aim to build a system that enables robots to perform missions in real environments.

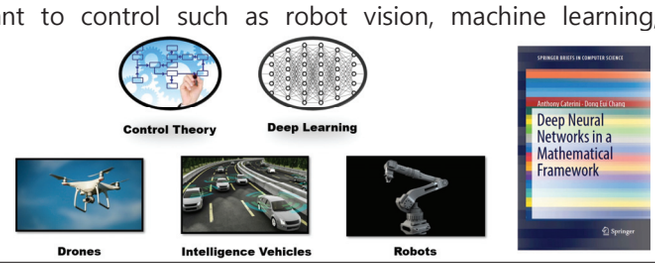
■ **Current Research Topics and Projects**

■ **Control and Robotics**

- Control of drones: We develop novel control algorithms for drone control and implement them on real drone systems.
- Feedback integrators: We develop numerical integration algorithms to faithfully preserve the values of conserved quantities such as energy during numerical integration. The results are not only interesting by themselves but also applicable to control theory and deep learning.
- Control of robots: We work on subjects relevant to control such as robot vision, machine learning, etc.

■ **Artificial Intelligence**

- We take a new approach to deep learning theory by applying control theory, differential geometry and advanced algebra, thus setting a higher stage for deep learning.
- We also work on 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 (2020-2022)**

[1] A New Bundle Picture for the Drone, IEEE TAC, 2022.
[2] Feedback Gradient Descent: Efficient and Stable Optimization with Orthogonality for DNNs, AAAI, 2022.
[3] Model-free Unsupervised Anomaly Detection of a General Robotic System Using a Stacked LSTM and Its Application to a Fixed-wing Unmanned Aerial Vehicle, IROS, 2022
[4] Sim-to-Real Transfer of Image-Based Autonomous Guidewire Navigation Trained by Deep Deterministic Policy Gradient with Behavior Cloning for Fast Learning, IROS, 2022
[5] Globally exponentially convergent observer for the rigid body system on SE(3),CDC, 2022
[6] Transversely Stable Extended Kalman Filters for Systems on Manifolds in Euclidean Spaces, Journal of Dynamic Systems, Measurement, and Control, 2021.
[7] Robust Navigation for Racing Drones based on Imitation Learning and Modularization, ICRA, 2021.
[8] Globally Exponentially Convergent Continuous Observers for Velocity Bias and State for Invariant Kinematic Systems on Matrix Lie Groups, IEEE TAC, 2021.
[9] Transversely Stable Extended Kalman Filter for Systems on Manifolds in Euclidean Spaces, Journal of Dynamic Systems, Measurement, and Control, 2021.
[10] Invariant extended Kalman filter on matrix Lie groups, Automatica, 2020.
[11] Discrete-time invariant extended Kalman filter on matrix Lie groups, International Journal of Robust and Nonlinear Control, 2020.

<Prof. Min Seok Jang's Lab>

Nano Optics Lab

■ **Contacts**

PI : E3-2 #2221 TEL : 042-350-7439
Lab : E3-2 #2222, #2232 TEL : 042-350-7539
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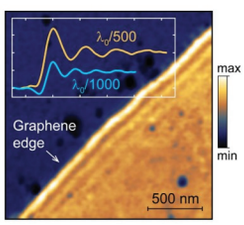
Email : jang.minseok@kaist.ac.kr

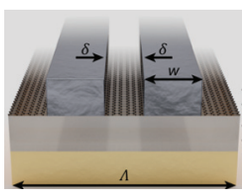
■ **Current member status (2022 Fall): # of Post-docs: 2, PhD: 8, Masters: 1, Undergraduates: 5**

■ **Research Areas**

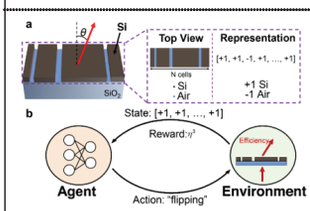
We understand the properties of light in ultra-small, subwavelength scales and develop technologies which manipulates them to suit our needs.



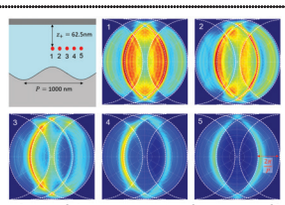
Plasmonic nanostructures: Free space photons and electrons in the metal interact at the metal's interface and light gets concentrated into very small volumes. Recent advancements with graphene (instead of metal) have yielded light concentration to a greater degree. Such phenomena opens up possibilities of ultrafast and microscopic photonic switches and mid-infrared sensors and sources.



Metasurfaces: Using nanoarray structures that are smaller than the wavelength of light, artificial materials called metasurfaces with novel optical properties constitute one of the main pillars of the field of nanophotonics. Using these metasurfaces, we are currently developing wavefront tuning technologies with spatial resolutions smaller than the wavelength scale.



Computation photonics: Because the need for nano structures with specific/optimized functionalities is increasing, our team is working on inverse design methodologies utilizing various optimization schemes like genetic algorithms and neural networks



Displays: The goal is to analyze the light distribution inside OLED components and minimize light losses. Furthermore, we are working on adapting OLED devices for virtual/augmented reality displays which require ultra-high-def resolutions.

■ **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 undergrads who want a research experience in a lab. What we offer:

(1) Research along t**he 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.

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. Also, having very recently graduated from graduate school, I understand very well the difficulties and problems graduate students go through. 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] "Near-field probing of image phonon-polaritons in hexagonal boron nitride on gold crystals", Science Advances (2022).

[2] "Full 2π tunable phase modulation using avoided crossing of resonances", Nature Communications (2022).

[3] "Real-space imaging of acoustic plasmons in large-area graphene grown by chemical vapor deposition", Nature Communications (2021).

[4] "Complete complex amplitude modulation with electronically tunable graphene plasmonic metamolecules," ACS Nano (2020). **[Front Cover]**

[5] "Self-stabilizing laser sails based on optical metasurfaces," ACS Photonics (2019).

〈Professor Sanghun Jeon's Lab.〉

ANTONIS Lab
Advanced Nano Technology based Opto, electronics & Integrated System Lab.

■ Contact information

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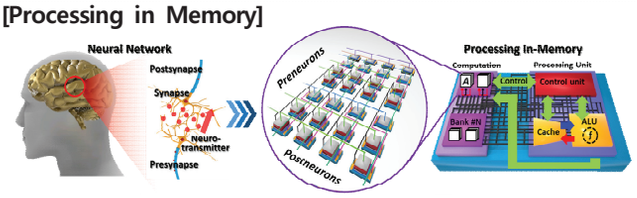
■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 8 Master's Student: 6

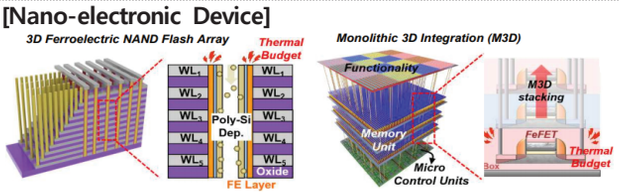
■ Research Areas

[Processing in Memory]



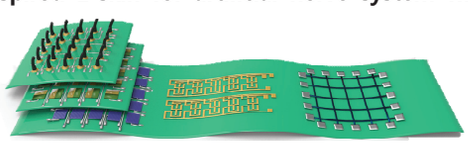
Processing in memory is a next-generation computing architecture beyond the conventional von Neumann computing architecture, and FeFET has been widely studied as a promising computational memory device based on their fast operation speed, high reliability and C-MOS compatibility. Antonis lab is actively conducting various research to develop an optimal FeFET for performing multiply and accumulation (MAC) operations, which is the most primary calculations in machine learning. In detail, we are introducing key approaches covering material and device architecture to overcome current technological issues. Moreover, using various computing logic, we are demonstrating the FeFET-PIM array with a high energy efficiency, which is evaluated by the system-level simulation.

[Nano-electronic Device]



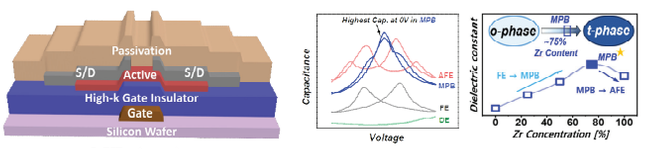
Recently, in the semiconductor industry, device structures that enable vertical stacking of transistor layers are considered as promising solution of device scaling-down limitations. In particular, monolithic 3D (M3D) integration can vertically arrange contacts between stacked layers in a narrow area, enabling high-density devices fabrication and reducing power consumption in global wiring compared to traditional 3D ICs. Therefore, it is a key technology for implementing next-generation computing architectures such as processing in memory. Antonis lab is actively conducting various researches to develop M3D integrated devices of oxide channel-based thin film transistors including hafnia ferroelectrics.

[Bio-inspired E-skin for artificial nerve system with M3D]



We are currently working on a ferroelectric Hf-Zr-O (HZO) based artificial nerve system. Ferroelectric is well-known material with an interesting behavior that can retain its electrical dipole characteristics even after removing the external field. Also, all ferroelectric material has pyroelectric and piezoelectric properties that respond to heat and pressure respectively. In comparison with lead-zirconium-titanium-oxide (PZT) which is widely used conventional ferroelectric material, HZO has no lead component and was able to use at nm scale. We hope that the approaches in our laboratory can be widely adopted in various industrial fields such as electronic skin for humanoid robots, health-care monitoring systems, and advanced prosthetic devices.

[High-k gate insulator for oxide TFT for display]



In recent years, high-performance TFT for high speed operation has been required to realize large-area, and high-resolution displays. In this regard, high-k gate insulator with relatively high thickness (~100 nm) is required for display backplane. But there are some bottleneck for realized formation of thick, high-k dielectrics with ALD process, which is long time process, and limitation of dielectric constants below ε_r~35. Therefore, a new approach is required for the formation of thick, high-k dielectrics. In our lab, we are conducting research on improving leakage current and on current (I_{ON}) by using HfO2-based ferroelectric as the gate insulator of oxide TFTs. In addition, research on integrateing FeTFT devices is being conducted with various TFT characteristics measurements.

■ 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 the research and development of functional oxide electronics ranging from materials, process and devices for nano-electronics, intelligent semiconductor, IOT sensor and display applications. Our research in materials science aspect is mainly focused on ferroelectrics and oxide semiconductor. Based on this, we are currently developing various semiconductor devices such as DRAM, NAND Flash and X-point memory. Also with this, we are also exploring futuristic semiconductor device including processing-in-memory, logic-in-memory and neuromorphic device to turn them into reality.

■ Recent research achievements (2020-2022)

[1] Goh, Youngin, et al. "High Performance and Self-rectifying Hafnia-based Ferroelectric Tunnel Junction for Neuromorphic Computing and TCAM Applications." IEDM, 2021.

[2] Kim, Giuk, et al. "Design Guidelines of Thermally Stable Hafnia Ferroelectrics for the Fabrication of 3D Memory Devices." IEDM, 2022. (just accepted)

〈Professor Myoungsoo Jung's Lab.〉

Computer Architecture and Memory Systems Laboratory

■ Contact information		
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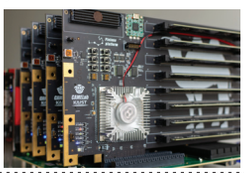
Lab.	Email: kukdh1@kaist.ac.kr	Tel: 042-350-7555
Website	http://camelab.org	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 10 Master's Student: 3

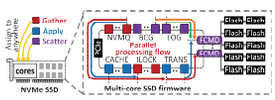
■ **Research Areas**

▶CXL Hardware and Software co-solution with real



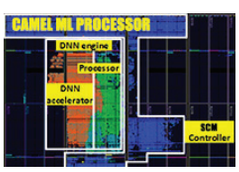
- Opening a new direction for memory disaggregation
- Ensuring direct accessible and high-performance capabilities

▶kernel & Storage Architecture



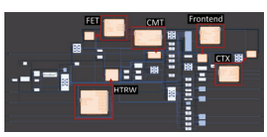
- High performance SSD architectures and firmware design
- In-memory processing and In-storage processing

▶Machine Learning with Storage/SCM



- Exploring ML algorithms to make system-related decisions
- Implementing hardware acceleration architectures using ML within Memory and storage subsystems

▶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 controller implementation (e.g. Z-NAND, PRAM)
- Exploring a new territory to integrate new memory into domain specific accelerator and fully hardware automated FPGA storage subsystems

■ **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 - 2022)**

- **39** publications in top-tier conferences. (Total 111 publications including major conferences and SCI journals.)
- Our system research is **ranked first** in Korea, according to the metrics-based system, CSRankings.
- 11 international articles, 65 domestic articles including **Korea major presses** and **Naver news headline**.
- 32 international and domestic patents.

⟨Professor Wanyeong Jung's Lab.⟩

Smart Energy-Efficient Design Laboratory

■ Contact information

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Lab.	**Email: seed@kaist.ac.kr**	**Tel: 042-350-7559**
Website	**https://seed.kaist.ac.kr**	

■ Current state of the Lab. (in 2022 Fall Semester)

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

■ Research Areas

▶ Autonomous Power Management for Self-Powered Devices

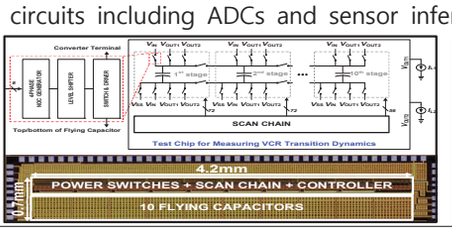
Improving efficiency in energy harvesting and power management is essential to extend overall system operating time. The group has developed efficient switched-capacitor (SC) DC-DC converters for energy harvesting and power management. The group is also exploring inductive/hybrid DC-DC converters, multi-phase/multi-output converters, linear regulators, and their applications including fine-grained DVFS and design co-optimization with load circuits.

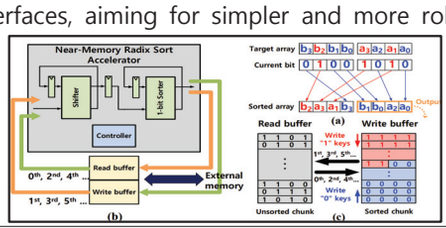
▶ Machine Learning on Edge Devices

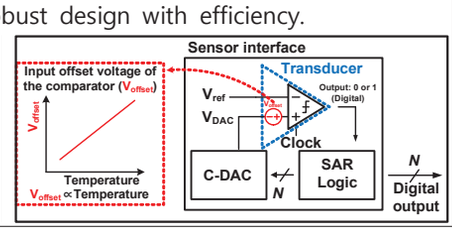
Machine learning allows us to make a unified data processing accelerator that can be widely used in many applications and devices regardless of data type and purpose. The needs for machine learning are growing fast in many types of mobile devices and systems, but it is difficult to find an architecture with high efficiency and flexibility. The PI has developed a general inference accelerator for various types of CNN networks, and the group is now extending the research area to digital building blocks, computer architecture, near/in-memory computing with analog computation, and algorithm. The group is also trying to apply machine learning to circuit design process itself, to automate some time-consuming design steps.

▶ Energy-Efficient Sensors in Advanced Technologies

Sensor interfaces are difficult to scale down because of noise, process variations, and the reduction of output swing and intrinsic gain in advanced processes. The PI applied principles for digital circuits to analog designs so that they fully benefit from process scaling and are easily combined with other digital-oriented techniques. While trying to extend the application of this new approach among others, the group has developed many analog circuits including ADCs and sensor inferfaces, aiming for simpler and more robust design with efficiency.







■ Introduction to other activities besides research

The lab holds group dinners (on a monthly basis) 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.

The PI joined KAIST in August 2019. The group is pretty new and now actively looking for graduate students and undergrad interns who are interested in IoT / low-power circuits and systems.

■ Recent research achievements (2021-2022)

[1] J. Kim, et. al., "A −50 to 130 °C, 38.69 pJ/conv Fully Integrated SAR Temperature Sensor Based on Direct Temperature-Voltage Comparison," *IEEE A-SSCC,* 2022. (Accepted) [2] J. Cho, et. al., "A Near-Memory Radix Sort Accelerator with Parallel 1-bit Sorter," *IEEE FCCM,* 2022. [3] D. Jang, et. al., "Techniques for Analyzing and Reducing Voltage Conversion Ratio Transition Losses of Capacitive DC –DC Converters for Fast-DVS-Enabled Systems," *IEEE TPEL,* March 2021.

<Professor Jae-Woong Jeong's Lab.>

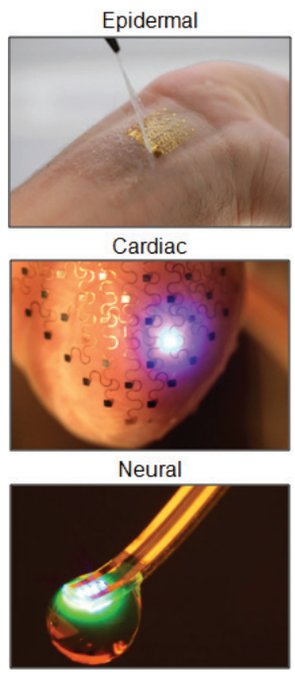
Bio-Integrated Electronics and Systems Laboratory

■ **Contact information**
Professor : Nanofab center (E19), Room 516
Lab. : Nanofab center (E19), Room 522
Website : http://jeongresearch.org

■ **Current state of the Lab. (in 2022 Fall Semester)**
Postdoctoral Fellows : 0 PhD Students: 8 Master's Student: 5

■ **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

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

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.

■ **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 ('21~'22)**

- ***Nature Communications*** (2021). ***Nature Biomedical Engineering, Nature Communications*** (2022).

[1] "Design Strategy for Transformative Electronic System toward Rapid, Bidirectional Stiffness Tuning using Graphene and Flexible Thermoelectric Device Interfaces." ***Advanced Materials*** 33, 2007239 (2021).

[2] "Soft subdermal implant capable of wireless battery charging and programmable controls for applications in optogenetics." ***Nat Commun*** 12, 535 (2021).

[3] "Scalable and modular wireless-network infrastructure for large-scale behavioural neuroscience." ***Nat. Biomed. Eng*** 6, 771–786 (2022).

[4] "Rapid meniscus-guided printing of stable semi-solid-state liquid metal microgranular-particle for soft electronics" ***Nat Commun*** (preprint) (2022)

〈Professor Soog nog whi g〉u

Multimodal Artificial Intelligence Lab	■ Contact information		
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	Lab.	Room 3102, N24	Tel:
	Website	https://mm.kaist.ac.kr	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 2 Master's Student: 8

■ **Research Areas**

Our research area lies at the intersection of speech, vision and language. We will solve interesting human-centered problems using one or more of these modalities, such as speech and action recognition. The following are some ideas, but feel free to bring new topics!

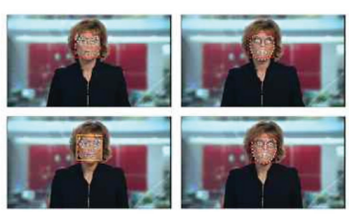
Multimodal Representation Learning

We learn representations using natural co-occurrences in the world, such as an image of a violin and the sound of someone playing violin.

Speech and Speaker recognition

We develop state-of-the-art speech and speaker recognition models, which are in high demand for many machine learning-based products.

Multimodal Speech Recognition



We make use of additional information such as gestures and lip motion to aid the performance of speech recognition in noisy environments.

Gesture and Action Recognition

We learn from time sequence data, such as spontaneous gestures, action classification and sign language recognition.

Machine Learning

We are interested in many other areas of ML, including but not limited to domain adaptation, adversarial AI and few shot learning.

■ **Recommended courses & Career after graduation**

Recommended courses include Introduction to Multimedia, Introduction to Machine Learning, Computer Vision, Speech Recognition Systems, Digital Signal Processing.

■ **Introduction to other activities besides research**

I will encourage exchange of information and collaboration between all members of the group.

■ **Introduction to the Lab.**

We are a new lab looking for enthusiastic researchers. The PI will endeavor to provide best possible research environment for all of our members.

■ **Recent research achievements (2020-2022)**

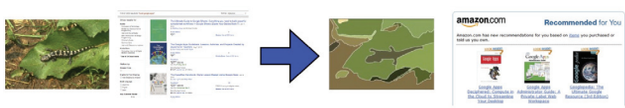
Inference and Information for Data Science (IIDS) Lab.

■ **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 2022 Fall Semester)**
PhD Students: 8 Master's Student: 3

■ **Research areas:** Data science, statistical inference, information theory, and machine learning.

The goal of our research group is to provide a theoretical and algorithmic framework for information science 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 in engineering information processors for big data, we also need new techniques and concepts beyond the classical information-theoretic solutions.



Raw Data Useful Information

Our research focus is on developing a theoretical framework for data science that copes with practical concerns such as timeliness in decision making, efficient usage of limited sensing resources, and computational efficiency in data processing. We develop algorithms for data acquisition and information recovery problems and provide performance guarantees for these algorithms by using tools from probability theory, information theory, and stochastic analysis.

■ **Recent research topics:**

- **Optimal data acquisition:** design sensing patterns to generate useful data with minimum resources from noisy sensors or by using crowdsourcing platforms
- **Value-centered bit data processing:** design principles to correctly assess the value of information and develop information extraction strategies for big data processing based on the quantified value of information

■ **Recommended courses & career after graduation**

Recommended courses are probability, information theory, statistical inference, and machine learning. Mathematical background (in probability, statistics, or analysis) and/or programming skills (e.g., Python, C++, or MATLAB) would be helpful to start research in our lab. Data science is a rapidly emerging area 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 statistical inference. We encourage open discussions and collaborations in defining research problems and developing ideas.

■ **Recent research achievements ('21~'22)**

Prof. Hye Won Chung completed her Ph.D in 2014 at MIT and joined KAIST as an assistant professor in June, 2017.

[1] Weak Detection in the Spiked Wigner Model, IEEE Trans. on Information Theory 2022.
[2] A Generalized Worker-Task Specialization Model for Crowdsourcing: Optimal Limits and Algorithm, ISIT 2022.
[3] Self-Diagnosing GAN: Diagnosing Underrepresented Samples in Generative Adversarial Networks, NeurIPS 2021.
[4] Detection of Signal in the Spiked Rectangular Model, ICML 2021.
[5] Binary Classification with XOR Queries: Fundamental Limits and An Efficient Algorithm, IEEE Transactions on Information Theory, 2021.
[6] Crowdsourced Labelling for Worker-Task Specialization Model, ISIT 2021.

<Professor Minkyu Je's Lab.>

IMPACT Lab
Integrated Microsystems Powered with Advanced Circuit Technology

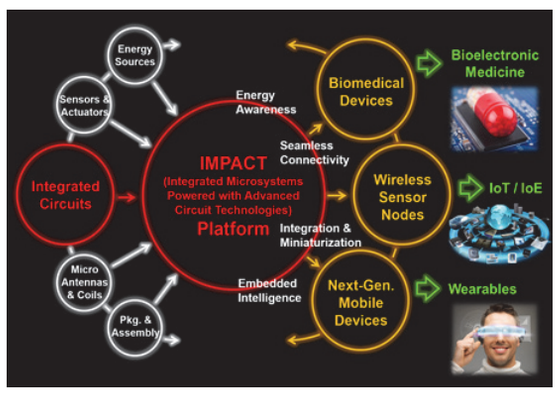
■ Contact information

Professor	Email: mkje@kaist.ac.kr	Tel: 7437
LAb.	Email: chinig@kaist.ac.kr	Tel: 7637
Website	impact.kaist.ac.kr	

■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 2 PhD Students: 28 Master's Student: 10

■ 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 just two years ago 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 (2021-2022)

[1] "A Wide-Dynamic-Range Neural-Recording IC With Automatic-Gain-Controlled AFE and CT Dynamic-Zoom Delta-Sigma ADC for Saturation-Free Closed-Loop Neural Interfaces," IEEE Journal of Solid-State Circuits (JSSC), 2022.

[2] "A 96.5%-Power-Efficiency Hybrid Buck-Boost Photovoltaic Energy Harvester Employing Adaptive FOCV MPPT Control for >98% MPPT Efficiency Across a 10,000x Dynamic Range," IEEE Symposium on VLSI Circuits (SOVC), 2022.

[3] "A 600mV$_{PP}$-Input-Range 94.5dB-SNDR NS-SAR-Nested DSM with 4th-Order Truncation-Error Shaping and Input-Impedance Boosting for Biosignal Acquisition," IEEE Symposium on VLSI Circuits, 2022.

[4] "A Frequency-Splitting-Based Wireless Power and Data Transfer IC for Neural Prostheses with Simultaneous 115mW Power and 2.5Mb/s Forward Data Delivery," International Solid-State Circuits Conference (ISSCC), 2021.

[5] "An Energy-Replenishing Ultrasound Pulser with 0.25CV2f Dynamic Power Consumption," International Solid-State Circuits Conference (ISSCC) , 2021.

⟨Professor Byung Jin Cho's Lab.⟩

NAND
Nanoelectronic And Neuromorphic Device Lab

■ Contact information

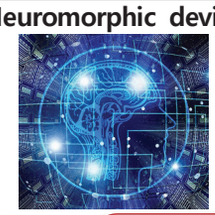
Professor	Email: elebjcho81@kaist.ac.kr	Tel:042-350-3485
Lab.	Email: seongho0809@kaist.ac.kr	Tel:042-350-5485
Website	nand.kaist.ac.kr	

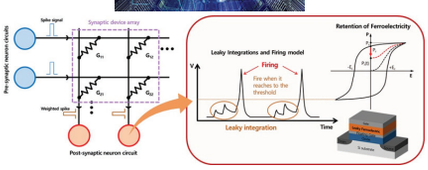
■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 5 Master's Student: 11

■ Research Areas

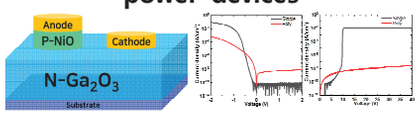
Neuromorphic device



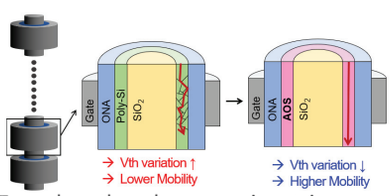


Neuromorphic computing inspired by the low-power operation of the human brain was newly suggested. Ferroelectric devices (MFS /MFIS /MFMIS FeFET, FTJs, etc.) are one of the main candidates that can be used as synaptic devices and neuron circuits because of their manifold functionality, CMOS compatibility. **Leaky-FeFET** shows accumulation and firing operations with leaky characteristics, so it is free from using bulk and complex components such as capacitors, comparators, and amplifiers. Therefore, high integration density, low-cost fabrication process, and low-power operation can be achieved from the SNN system.from the SNN system.

Oxide semiconductor based power devices

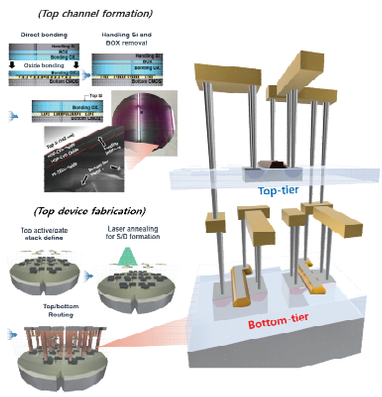


Oxide semiconductor based power devices(PN diode/BJT/Thyristor etc.) are expected to be a game-changing technology in the future. Using wide band gap(WBG) oxide materials, we can realize extremely high breakdown voltage(V_{br}) and low on-resistance(R_{on}) characteristics compared with conventional Si/SiC based power devices.



To solve the decrease in string current of 3D NAND with stacking height, we suggested the new channel material, **amorphous oxide semiconductor**(AOS). Using AOS channel, we can fabricate the flash memory device with higher mobility and less Vth variation compared to poly-Si channel. (**3D flash memory**)

Monolithic 3D



As technical node has been reduced, RC delay arising from overall interconnect seriously. 3D Integrated Circuit (3D IC), structurally changed can dramatically reduce the global interconnect and footprint. **Monolithic 3D (M3D)**, which sequentially fabricates top channel and devices after bottom CMOS circuits are defined, is advantageous in terms of Via density and power reduction. Low-temperature SOI bonding technique and green nanosecond (ns) laser annealing successfully demonstrated M3D integration.

■ 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

Sports activities such as basketball, soccer, and baseball are held once a week to improve physical strength. We are seeking to harmonize the lab by holding regular MT or picnic every year. After COVID-19 calms down, it will be activated again.

■ Introduction to the Lab.

Our lab has world-class experience and various know-hows on traditional semiconductor devices (MOSFET, DRAM, NAND) and advanced semiconductor devices (Monolithic 3D, Oxide FET, neuromorphic device). Currently we are running 9 main projects funded by Samsung, SK hynix, and government agencies. Our lab published 283 journals and presented in 331 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 (2020-2022)

Major International Conferences (one VLSI 2020, two IEDM 2020)

29 SCI papers, 10 conference presentation, 17 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**	**Tel: 042-879-9926**
Website	**https://ccs.kaist.ac.kr**	

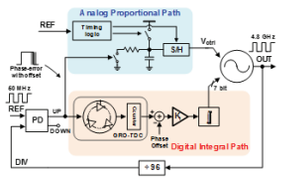
■ Current state of the Lab. (in 2022 Fall Semester)

PhD Students: 9 Master's Student: 4

■ Research Areas

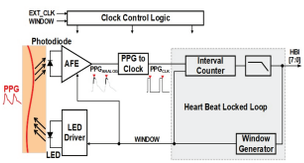
▷ High Speed Analog Circuits

The high speed analog 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 V-band(40-75GHz) and W-band(75-110GHz) PLLs for RADAR applications.



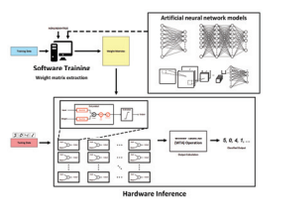
▷ PVT-invariant Sensors

High performance PVT-invariant 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, environmental and automotive sensors



▷ Machine Learning Processors

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 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.

■ Introduction to the Lab.

Our group explores emerging technologies for high-performance communication and bio-medical/environment 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 analog interface for medical and CMOS sensors, phase-locked loops (PLL), analog-to-digital converters (ADCs). Recently we are also looking into high-performance circuits for machine learning as well as health care using wearable devices.

■ Recent research achievements (2020-2022)

[1] J.-O. Seo, M. Seok, S.H. Cho, "ARCHON: A 332.7TOPS/W 5b Variation-Tolerant Analog CNN Processor Featuring Analog Neuronal Computation Unit and Analog Memory" IEEE International Solid-State Circuits Conference (ISSCC), 2022.

[2] Y. Jung, S. Lee, H. Kim, S.H. Cho, "A Supply-Noise-Induced Jitter-Cancelling Clock Distribution Network for LPDDR5 Mobile DRAM featuring a 2nd-order Adaptive Filter" IEEE International Solid-State Circuits Conference (ISSCC), 2022.

[3] N. Koo, H. Kim, and S.H. Cho. "A 43.3uW Biopotential Amplifier With Tolerance to Common-Mode Interference of 18Vpp and T-CMRR of 105 dB in 180-nm CMOS." IEEE Journal of Solid-State Circuits, 2022.

[4] S. Park, J-H. Seol, L. Xu, S.H. Cho, D. Sylvester, and D. Blaauw, "A 43 nW, 32 kHz, A 43 nW, 32 kHz, ±4.2 ppm Piecewise Linear Temperature-Compensated Crystal Oscillator With ΔΣ-Modulated Load Capacitance", IEEE J. Solid-State Circuits, vol. 57, no. 4, 2022.

⟨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 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 16 Master's Student: 5

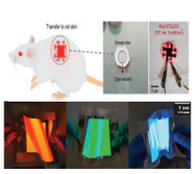
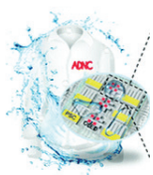
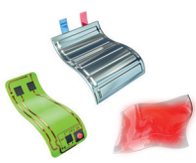
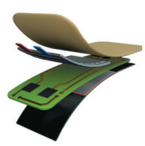
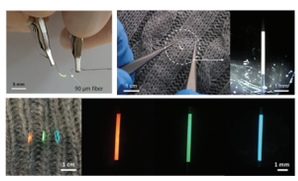
■ Research Areas

▶ **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 50 people (as Ph.D. 32, M.S. 18) 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 195 SCI papers, delivered 225 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 (2020-2022)

18 SCI papers, 32 presentations in conference, 24 patents applied for or registered.

[Representative Journal papers]

- **[Inside Front Cover]** High-Performance and Reliable White Organic Light-Emitting Fibers for Truly Wearable Textile Displays (*Advanced Science* IF: 17.52, 2022)
- **[Front Cover]** Bright-Multicolor, Highly Efficient, and Addressable Phosphorescent Organic Light-Emitting Fibers: Toward Wearable Textile Information Displays, (*Advanced Functional Materials* IF: 19.98 , 2021)
- **[Back Cover]** Organic Light-Emitting Diodes: Pushing toward the Limits and Beyond (*Advanced materials* IF: 32.086, 2020)
- Parallel-Stacked Flexible Organic Light-Emitting Diodes for Wearable Photodynamic Therapeutics and Color-Tunable Optoelectronics (*ACS nano* IF: 18.23, 2020)
- Two-Dimensionally Stretchable Organic Light-Emitting Diode with Elastic Pillar Arrays for Stress Relief(*Nano Letters* IF:12.262)

⟨Professor Sung-Yool Choi's Lab.⟩

QMDL
QUANTUM MATERIALS & DEVICES LAB

■ Contact information

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Lab. : Device Innovation Faculty (E3-3) 2302
KI Building (E4) C418

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Lab.	**Email:** solbaestar@kaist.ac.kr	**Tel:** 042-350-7627
Website	qmdl.kaist.ac.kr	

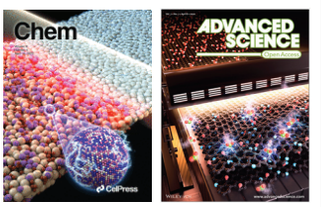
■ Current state of the Lab. (in 2022 Fall Semester)

Research Professor: 1 Postdoctoral Fellows : 0 PhD Students: 5 Master's Student: 12

■ Research Areas

▸ Synthesis of 2D Material and Process Development

- Our lab possesses various skills for the synthesis of metallic graphene, semiconducting TMDs (transition metal dichalcogenides) such as MoS_2, and insulating hexagonal boron nitride
- Besides conventional CVD processes, novel synthetic approaches such as MOCVD (metal organic chemical vapor deposition), and ALD (atomic layer deposition) have been studied to overcome the existing process limitations.
- Development of novel 2D material process techniques such as doping, defect healing and transfer
- Additionally, various materials synthesis and engineering methods using IPL (intense pulsed light) are being developed.



▸ 2D Materials Applications

- Research on applications based on materials growth, processes, and device fabrications of 2D materials
- Graphene based electrodes for transparent electrodes and doping techniques for luminance efficiency improvement using atomically thin and high electron mobility of graphene
- Utilization of 2D semiconducting materials for TFT array channels in backplane for displays
- Development of low-power integrated circuits based on 2D materials
- Optical devices using various bandgap 2D materials for sensor applications

▸ Neuromorphic and Memristor Devices

- Study of novel memristor devices for memory and logic applications
- Research on next generation computing enabling in-memory-computing
- Development of memristor-based synaptic devices for neuromorphic computing
- Materials and structural engineering to improve the performance of memristors as artificial synapses
- With various memristors, device-to-system simulation performed for artificial neural network

■ Recommended courses & Career after graduation

We encourage you to take following courses.

- Introduction to Physical Electronics (EE211)
- Semiconductor Devices (EE362)
- Semiconductor IC Technology (EE463)

QMDL alumni are studying abroad, working for a research institute or semiconductor companies such as Samsung Electronics and SK Hynix.

■ Introduction of other activities besides research

We take a coffee break after lunch in a daily routine, and play team sports such as futsal and basketball once in a week. Besides, a lot of chances are provided to attend domestic and international conferences. As annual events, we have a strawberry party in April and 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. Freedom of time management is guaranteed for self-regulating and creative researches. Especially, **QMDL is mainly supervising GRC (Graphene/2D Materials Research Center) and CAMD^3 (Center for Advanced Materials Discovery towards 3D Display)**. 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)

■ Recent research achievements ('19~'22)

2D Material Synthesis & Process Development

1. Chem 8, 1014 (2022) [Front Cover]
2. ACS Appl. Mater. Interfaces 13, 50497 (2021)
3. Adv. Mater. 1907166 (2020)
4. Adv. Sci. 7, 1903318 (2020) [Inside Back Cover]
5. Adv. Fuct. Mater. 29, 1807550 (2019)
6. Sci. Rep. 9, 1199 (2019)

Electronic & Optoelectronic Devices based on 2D Materials

1. Adv. Electron. Mater. 8, 2101325 (2022)
2. Adv. Mater. Technol. 2100494 (2021)
3. Nano Res. 14, 1305 (2021)
4. Nano Lett. 20, 5741 (2020)
5. Adv. Electron. Mater. 2000091 (2020) [Front Cover]
6. Adv. Opt. Mater. 8, 1901519 (2020)
7. ACS Appl. Mater. Interfaces 12, 5106 (2020)
8. ACS Appl. Mater. Interfaces 12, 4749 (2020)

Neuromorphic and Memristor Devices

1. Adv. Intell. Syst. (2022) (Accept)
2. Adv. Intell. Syst. 4, 2200018 (2022) [Front Cover]
3. Sci. Adv. 7(32), eabg8836 (2021)
4. Nanoscale 12, 14301 (2020) [Inside Front Cover]
5. Adv. Mater. 31, 1806663 (2019)
6. Nano Lett. 19, 839 (2019)

〈Professor Shinhyun Choi 〉

ENTIS (Emerging Nano Technology and Integrated System) Lab

ENTIS

■ Contact information

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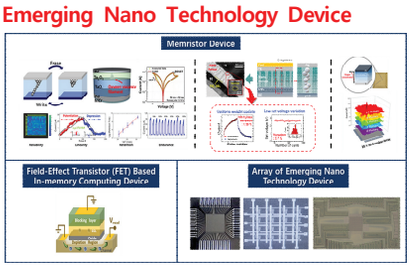
■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 4 Master's Student: 8

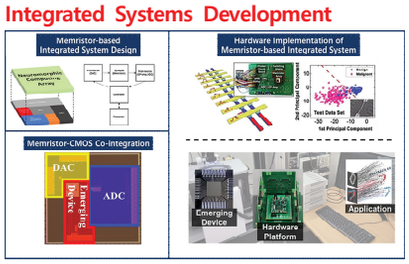
■ Research Areas

Emerging Nano Technology Device



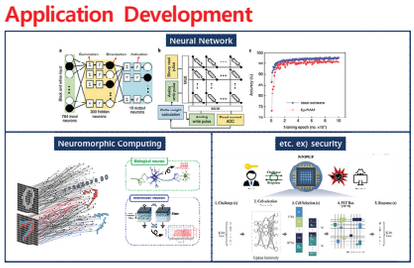
Our research team (ENTIS) design, fabricate and evaluate emerging nanoelectronic devices such as 1) 2-terminal devices (memristors, also called RRAMs or resistive switching devices), 2) 3-terminal field-effect transistor (FET) based devices and etc. Our emerging devices have attracted tremendous attention as possible candidates for many applications such as neuromorphic computing hardware, next-generation memory cells, logic applications, and security applications.

Integrated Systems Development



Our team focuses on the integration of intelligent systems from input sensors to computing units. 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 domain-specific architectures (DSA) utilizing our device, by designing the framework using hardware such as digital and analog peripheral circuits and controllers, and software development for artificial intelligence.

Application Development



Our team is focusing on how to accurately implement artificial intelligence inference and learning with low energy consumption using a neuromorphic computing system based on emerging devices. Another focus of our team is how to use applications that can be efficient by utilizing our devices about images, sequence data, security, medical diagnosis and etc. Several parameters, such as accuracy, heat dissipation, and power consumption, are being analyzed by both simulation and experiment for certain applications.

■ Recommended courses & Career after graduation

Major pre-requisites are Semiconductor device physics, Fabrication, Neural networks. However, other students who have CS and circuit background are also welcome. The students can be in academia and industry as a core member world-wide.

■ 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, etc. We also plan to have regular outdoor activities, such as soccer, basketball, hiking and so on.

■ Introduction to the Lab.

The group works on multi-disciplinary research areas including material sciences, device physics, circuits and neural network algorithms. Therefore, our group is able to give students a chance to participate in various fields besides device area. We will have lots of collaboration from Universities and Industries.

■ Recent research achievements (2020-2022)

S. Park*, H. Jeong*, J. Park*, J.Bae, 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, S. Choi, Reliable multilevel memristive neuromorphic devices based on amorphous matrix via quasi-1D filament confinement and buffer layer, ***Science Advances***, 8, 3 (2022)

J. Park, Y. Lee, H. Jeong, S. Choi, Neural Network Physically Unclonable Function: A Trainable Physically Unclonable Function System with Unassailability against Deep Learning Attacks Using Memristor Array, ***Advanced Intelligent Systems*** 3 (11) , 210011 (2021)

〈Professor Yang-Kyu Choi 〉

Nano-Oriented Bio-Electronics Lab	■ Contact information		
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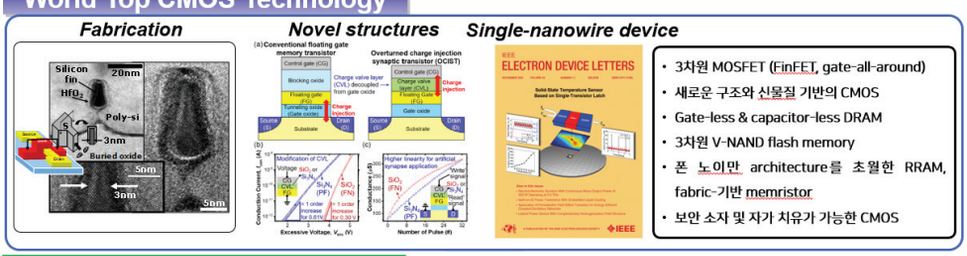
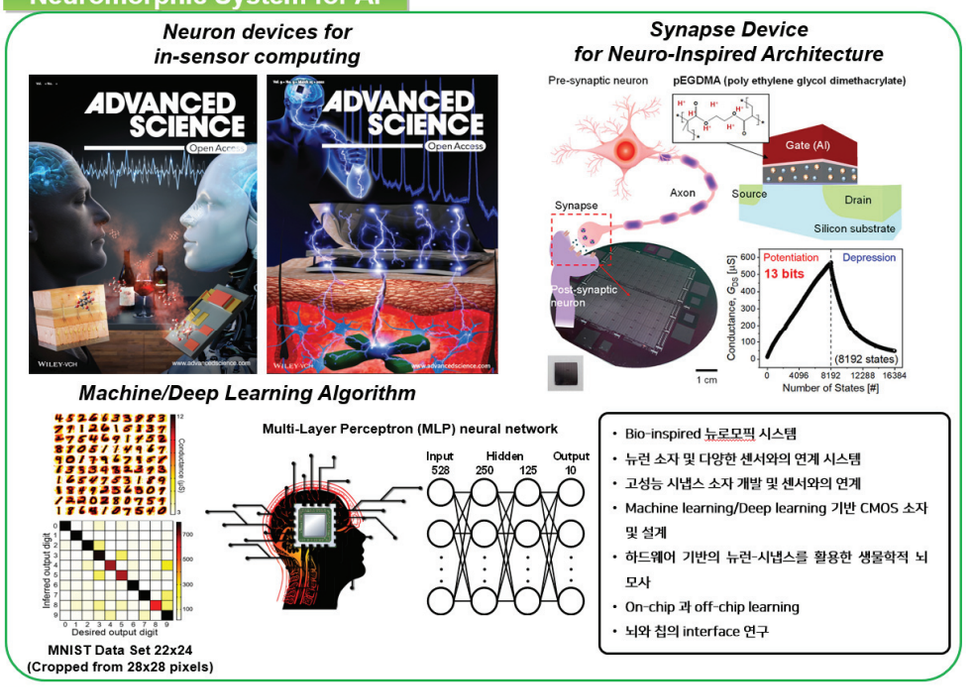
	Lab.	Email: dokim@nobelab.kaist.ac.kr	Tel: 042-350-5477
	Website	https://sites.google.com/view/nobelab/home	

■ **Current state of the Lab. (in 2022 Fall Semester)** - PhD Students: 7 Master's Student: 7

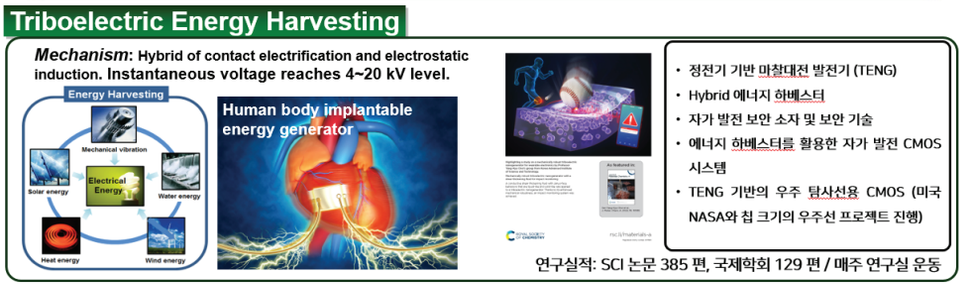
World Top CMOS Technology



Neuromorphic System for AI



Triboelectric Energy Harvesting



■ **Recommended courses & Career after graduation**

NASA (3), SK Hynix (14), Samsung electronics (28), Professor (10), KIST (1), Intel (2), ETC.

■ **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 (2020-2022)**

Four cover images, 60 SCI papers including high-impact journals (Science advances, etc.)

Our research were frequently highlighted in YTN Science, KBS, Etc.

〈Professor Jaehyouk Choi's Lab.〉

Integrated Circuits and Systems Lab

■ **Contact information**

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Website	**icsl.kaist.ac.kr**	

■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows: 0 PhD Students: 10 Master's Students: 5

■ **Research Areas**

▶ **High-performance wireless transceivers for mm-W-band 5G and beyond-5G systems**

Wireless transceiver ICs for cellular communications that can support ultra-wideband data communications in the millimeter high-frequency band are the core of the 5G system. Since 5G systems are being commercialized based on "interoperability" with 4G LTE, it is essential for 5G chips to simultaneously support existing bands as well as new millimeter bands. This study aims to research and develop 5G cellular communication ICs that can obtain unique global market competitiveness. Based on the technology acquired in 5G research, we plan to study Beyond 5G and 6G over the next 10 years.

▶ **Ultra-low-jitter high-frequency clock generation and distribution for high-performance SoC and memory**

Among oscillator structures that are the core circuits of high frequency signal generators, ring oscillators have a high degree of integration, so it is suitable for use in SoC and memory systems where density is important, but noise performance, which is significantly inferior to the LC structure, has been a problem. So, it has been impossible for ring oscillators to be used in 5G communication and SerDes system requiring ultra-low jitter. The LC structure, on the other hand, has excellent jitter performance but has a problem of occupying a large silicon area. Increasingly the range of clock signals required by semiconductor systems, the use of multiple LC oscillators leads to significant increases in silicon area and manufacturing costs. This study aims to study the ultra-miniature, ultra-low noise signal generators that can fundamentally overcome the dilemma between ring and LC oscillators

▶ **Self-sustaining multi-purpose environment IoT platforms**

The ultimate future for IoT is a hyper-connected world where various sensors are widely deployed in nature, and many of these sensors collect and deliver small pieces of information that are easy to miss. The key to future IoT sensor technology is self-powering. Thus, the key is to design ultra-low-power circuits that collect energy from various environmental elements, manage power and batteries based on them, and measure, collect and transmit target signals. This study aims to develop a self-powered multi-mode environment IoT sensor platform.

■ **Recommended courses & Career after graduation**

Recommended courses: Circuit Theory, Electronic Circuits, Analog Electronic Circuits

Career after graduation: IC designer in global companies, Researcher in international research institutes, Instructor in universities

■ **Introduction to other activities besides research**

Group sports (basketball, badminton, etc), Movie night, Team trip, Board games

Global company internship (Qualcomm, Samsung, Intel, etc)

Participation in international conferences (ISSCC, VLSI Symposium)

■ **Introduction to the Lab.**

ICSL is the group pursuing world-class research in analog, mixed, and RFIC fields in a family-like atmosphere. We research together, study together, play together, thereby growing together as a researcher equipped with both research ability and sociability.

■ **Recent research achievements (2019-2022)**

23 Publications (10 ISSCC, 1 VLSI Symp., 1 ESSCIRC, 9 JSSC)

- **Recent Publications**

[1] S. Park, et al., "A 97fsrms-Jitter and 68-Multiplication Factor, 8.16GHz Ring-Oscillator Injection-Locked ClockMultiplier with Power-Gating Injection-Locking and Background Multi-Functional Digital Calibrator," ***IEEE ISSCC***, 2022.

[2] C. Hwang, et al., "A 188fsrms-Jitter and –243dB-FoMjitter 5.2GHz-Ring-DCO-Based Fractional-N Digital PLL with a 1/8 DTC-Range Reduction Technique Using a Quadruple-Timing-Margin Phase Selector," ***IEEE ISSCC***, 2022.

[3] H. Park, et al., "A Low-Jitter Ring-DCO-Based Fractional-N Digital PLL with a 1/8 DTC-Range-Reduction Technique Using a Quadruple-Timing-Margin Phase Selector," ***IEEE JSSC***, early access.

<Professor. Jung-Woo Choi's Lab.>

Smart Sound Systems Laboratory

■ **Contact information**

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Lab. : N24 LG Innovation Hall 2103 TEL : +82-42-350-7535

Website : https://www.sound.kaist.ac.kr/

■ **Current state of the Lab. (in 2022 Fall Semester)** Ph. D. Students (5) Master Student (4)

■ **Research Areas**

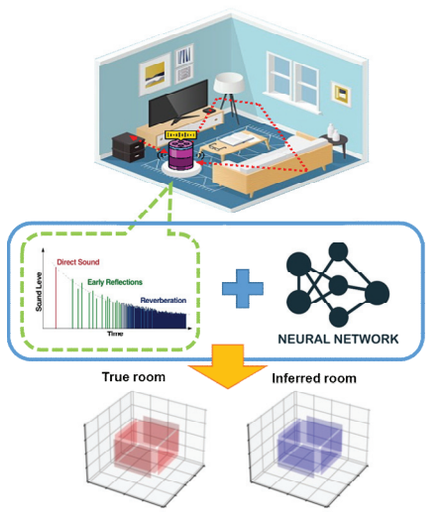
The smart sound system laboratory has been doing research on audio metaverse, sound field control, and AI-based smart sound systems through acoustic and audio signal processing. We study signal processing, sound field control techniques to control the shapes of physical waves (synthesis) or to extract useful information (analysis). Recently, new approaches to sound problems are adapted through deep learning. Our research topics based on DNN for metaverse and VR/AR applications include the speech enhancement and separation, DoA estimation, RIR generation, room geometry inference using RIR. In addition, DNN based machine sound anomaly detection and fault diagnosis are included. Also, there is research such as Spatial Audio Implementation using HRTF and BRIR.

[Theory]

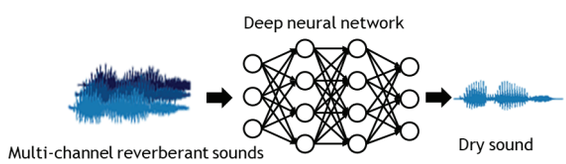
- Acoustics, Wave propagation
- Array signal processing
- Machine learning, Deep learning

[Applications]

- Audio Metaverse, Audio AR/VR
- Speech Enhancement and separation, DoA Estimation using DNN
- Sound-based environmental parameter generation and estimation (RIR, Room geometry, user location, real-time auralization, etc.)
- Beamforming, Sound source localization, Underwater Imaging
- Intelligent audio system with environmental awareness
- Machine anomaoy detection and fault diagnosis with AI



<Room Geometry Inference using DNN>



<Audio morphing using DNN>

■ **Recommended courses & Career after graduation**

We recommend signal processing based courses (Signals and systems / DSP), sound / vibration based courses (Acoustics / Array signal processing theory), and Deep learning courses. After graduation, you can further develop your career in IT related companies & research centers and sound & vibration control industries through research on sound and audio signal processing. You can also work in a wide range of fields, including Electric / Defense science, etc.

■ **Introduction to other activities besides research**

Lab members regularly do yoga, play ping-pong, and learn to play musical instruments. By holding workshops with various subjects, we share our knowledge and promote fellowship.

■ **Introduction to the Lab.**

The field of sound and vibration control is a multidisciplinary field that facilitates the integration of signal processing technologies with traditional technologies in communication / mechanical / aviation fields. The most important thing in the lab is the spirit of challenge to explore new fields without fear based on a strong theoretical foundation. Our laboratory pursuits regulation-free life to encourage creativity and self-motivation of members. Research on high-quality immersive technology for metaverse applications is being developed. 'Machine condition diagnosis with AI is being developed under the contract with LG electronics and Korean Atomic Energy Research Institute (KAERI). Also, spatial sound for True Wireless Stereo is being developed with Samsung electronics, and a virtual sound environment reproduction task for VR is being conducted with Korea Electronics and Telecommunications Research Institute (ETRI).

■ **Recent research achievements ('21~'22)**

[1] "Multiarray Eigenbeam-ESPRIT for 3D Sound Source Localization with Multiple Spherical Microphone Arrays", IEEE/ACM Transactions on Audio, Speech, and Language Processing, 2022.

[2] "Inter-channel Conv -TasNet for source-agnostic multichannel audio enhancement", 2022, InterNoise2022, Glasgow, Scotland, 21-24 August, 2022.

[3] "Generation of a Near-field Sound Zone Using Broadside Differential Array", 2021 Immersive and 3D Audio : from Architecture to Automotive (I3DA), Bologna, Italy, 8-10 September, 2021.

[4] "Iterative Echo Labeling Algorithm With Convex Hull Expansion for Room Geometry Estimation," IEEE/ACM Transactions on Audio, Speech, and Language Processing, Vol. 29, pp 1463-1478, May 2021.

[5] "Direction-of-arrival estimation with blind surface impedance compensation for spherical microphone array," Journal of the Acoustical Society of America (JASA), Vol. 1, July 2021.

⟨Professor Jun Kyun Choi⟩

MediaNET LAB
Media Network Laboratory
Media Network Laboratory

■ **Contact information**

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■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 2 PhD Students: 11 Master's Student: 0

■ **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

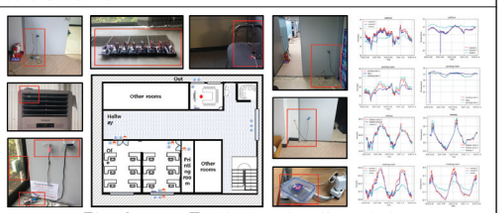

Fig. Sensor Testbed and collected data

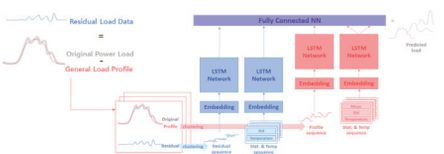

Fig. Electricity load forecasting model with users' characteristics considered

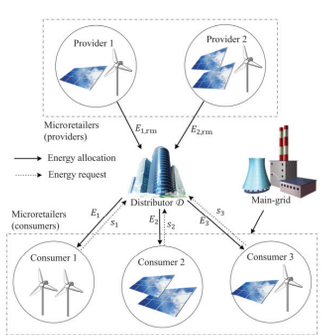

Fig. 1. System model for a contribution-based control of energy allocation in microgrid infrastructures.

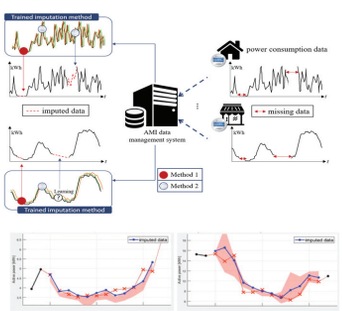

Fig. System model and examples of data interpolation

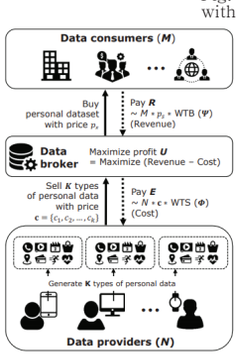

Fig. 1. The proposed personal data trading model with multiple types in the IoT data market

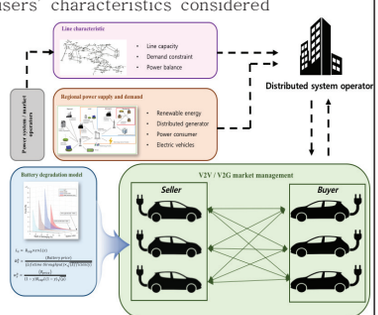

Fig. System model for charging electrical vehicle considering battery characteristics and wearout

■ **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 2022, 18 PhD graduates (Professor, Samsung Electronics, ETRI, etc.) and 45 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 (2020-2022)**

SCI International Journal: 15; International Conference: 4; Domestic Conference: 8; Patent Registration: 35

Prof. Junil Choi Intelligent Communication Systems Lab.	Professor	Email: junil@kaist.ac.kr	Tel:
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■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 1 PhD Students: 12 Master's Student: 5

■ Research Areas

[MmWave Maasive MIMO] Millimeter-wave (mmWave) massive multiple-input multiple-output (MIMO) refers to wireless communication systems that exploit carrier frequencies around 30~300 GHz spectra with a large number of antennas at transceivers. The widespread use of millimeter wave (mmWave) communications makes it possible to deploy a large number of antennas in a small form factor, which has popularized the use of massive MIMO in 5G and future wireless communications.

[Distributed Reception] In the IoT environment, devices could be used as distributed transmit and/or receive entities allowing massive distributed multiple-input multiple-output (MIMO) systems to be implemented. Potentially, a large number of built-in sensors in a home, used to monitor the environment or actuate devices such as bulbs or locks, could be exploited as transmit/receive entities to support data transmission by smartphones or laptops. By employing low-cost and low-power-consumption but a massive amount of distributed sensors, distributed reception enables reliable data communications as centralized systems do.

[Vehicular Communication] As driving becomes more automated, vehicles are being equipped with more sensors generating even higher data rates. Radars (RAdio Detection and Ranging) are used for object detection, visual cameras as virtual mirrors, and LIDARs (LIght Detection and Ranging) for generating high resolution depth associated range maps, all to enhance the safety and efficiency of driving. Connected vehicles can use wireless communication to exchange sensor data, allowing them to enlarge their sensing range and improve automated driving functions.

[Intelligent Reflecting Surface] Intelligent reflecting surface (IRS) is a large 2D surface of metamaterial, which is composed of passive scattering elements. Each element can be controlled to change the electromagnetic properties such as phase shift of the reflection of incident signals to make better communication channels. As millimeter wave (mmWave) communication systems are becoming the standard in 5G and future wireless communications, the role of IRS is expected to grow even more as mmWave communications suffers from high propagation path loss and blockage.

[ML-based Communication] Machine learning (ML)-based communication systems are a promising technology for 5G and beyond wireless communication systems. ML-based approaches can discover inherent linear or nonlinear characteristics from sufficient amount of data, which can be applied to wireless communication systems. As the structure of wireless communication systems is becoming more complex, designing optimal channel estimators and symbol detectors is extremely challenging, often impossible. Surprisingly, it has been shown that a deep neural network (DNN), e.g., deep convolutional neural network (CNN) or multi-layer perceptron (MLP), can achieve nearly optimal channel estimation and symbol detection performance. Also, wireless communications-based ML framework introduces various interesting systems that differ from the conventional systems, such as over-the-air federated learning systems. To make ML-based communication systems practical, however, the large training overhead and overfitting must be resolved, which require extensive research efforts.

■ 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 aims to design state-of-art communication techniques related to 5G/6G communication systems. 5G/6G communication services require enhanced mobile broadband (eMBB), ultra-reliable and low-latency communications (URLLC), and massive machine-type communications (mMTC), and our research supports them to be commercialized. Specifically, our research interest is in the physical layer design, which needs mathematical analysis and simulation experiments. Including the research areas written above, our current interest expands to the satellite communications and THz communications. Our professor Junil Choi is always willing to support the student's research, and our members are happy to involve with other studies in the Lab. If you have any interest with our Lab., please contact us.

■ Recent research achievements (2020-2022)

18 journal papers and 13 conference papers are accepted or published.

Professor Junil Choi received two IEEE journal paper awards. (IEEE VTS, 2021/2022)

Students received multiple awards in various societies.

⟨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 2022 Fall Semester)**

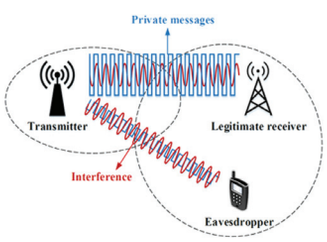
Postdoctoral Fellows : 1 PhD Students: 8 Master's Student: 3

■ **Research Areas**

- **Error-Correction-Codes with Machine Learning for 6G Communication Systems and Data Storage**

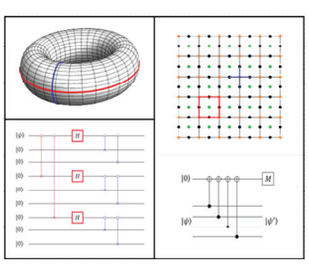
Error-correction-codes (ECCs) protect information from noisy environments. ECCs are essential part of the digital communications and used in countless real world applications. CoCoA Lab studies theoretical aspect of advanced ECCs like low-density-parity-check and polar codes. Recently, we are developing smart ECC solutions for data-centric computing devices and 6G wireless, optical, and space communication systems under the support of LG electronics, ETRI, IITP, and the National Research Foundation (NRF) of Korea.

- **Secure Communications with Machine Learning for 6G Communication Systems**



CoCoA Lab is studying innovative solutions for the 6-th generation wireless communication systems. In particular, we have been investigating secure wireless communication for 6-th generation communication systems such as covert communication system and secure cell-free massive MIMO system under the support of Institute for Information & Communications Technology Promotion (IITP).

- **Quantum Computing for Artificial Intelligence**



Artificial Intelligence (AI) is advancing rapidly, which however is expected to reach its limit due to relatively slow-growth computing power. To solve this problem, quantum computers have been extensively studied. CoCoA Lab conducts researches on the quantum communication, information theory, as well as quantum-error-correction codes that are essential techniques for realizing quantum computers. We are currently working with Quantum Computing for AI Center supported by the ITRC.

■ **Recommended courses & Career after graduation**

Recommended courses include introduction to information theory and coding, and basic probabilities. Graduates of CoCoA Lab have excelled in leading information technology companies 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, leaded by Prof. Jeongseok Ha, seeks to develop theories and applications of state-art error-correcting codes and wireless communications. Our research interests include machine learning based smart error correcting codes, physical layer security and quantum communication. Researches are supported by various institutes and companies such as LG electronics, ETRI, NRF, ITRC, IITP. CoCoa has a very friendly lab atmosphere and we welcome everyone interested in our research topics.

■ **Recent research achievements (2020-2022)**

International Journals: 8, International Conferences: 5, International Patents: 7, Domestic Patents: 26

[1] S. Han, J. Oh, K. Oh and J. Ha, "Deep-Learning for Breaking the Trapping Sets in Low-Density Parity-Check Codes," IEEE Transactions on Communications, vol. 70, no. 5, pp. 2909-2923, May 2022.

[2] J. Lee, S. Yun, I. Kim and J. Ha, "Deep Neural Network-based Precoder for Fairness Aware Secure NOMA Scheme," IEEE Transactions on Vehicular Technology, vol. 71, no. 5, pp. 5615-5620, May 2022.

[3] S. Jeong, H. Jung and J. Ha, "Rate-Compatible MET-LDPC Code Ensembles for CV-QKD Systems," npj Quantum Information 8, 6 (2022)

⟨Professor Dongsu Han⟩

Intelligent Network Architecture and Distributed Systems Lab.	■ Contact information		
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	Lab.	Email: inalab@kaist.ac.kr	Tel: 7631
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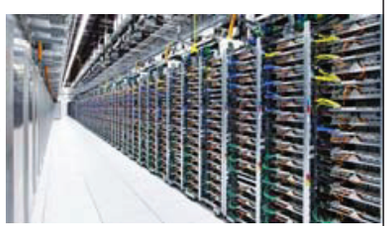
■ **Current state of the Lab. (in 2022 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 7 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 (2022)**

We publish top conference papers on csrankings.org annually.

Top research group at ACM SIGCOMM and USENIX NSDI in Korea (published 13 papers in the past 10 years)

- Co-optimizing for Flow Completion Time in Radio Access Network [CoNEXT 2022]
- NeuroScaler: Neural Video Enhancement at Scale [SIGCOMM 2022]
- TSPipe: Learn from Teacher Faster with Pipelines [ICML 2022]
- BWA-MEME: BWA-MEM emulated with a machine learning approach [BioInformatics 2022]

<Professor Hamza Kurt's Lab.>

Metaphotonics Research Laboratory	■ Contact information		
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	Lab.	**Email:** wnsgud@kaist.ac.kr Junhyeong Kim (김준형)	**Tel:** 042-350-7465
	Website	https://kurtresearch.com, http://mpl.kaist.ac.kr/	

■ **Current state of the Lab. (in 2020 Fall Semester)**

Postdoctoral Fellows: 0 PhD Students: 8 Master's Student: 2

■ **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 engineered nanostructured antennas arrays allow the realization of the manipulation of light on a flat surface.
4. **Light harvesting in solar cells for renewable energy:** The objective of the study is to demonstrate that the inclusion of nanophotonic structures in conventional, single-junction silicon solar cells will increase the efficiency of the cell by minimizing reflection, thermalization and transmission losses within the cell. We strongly expect that the proposed work will
provide techniques for the widespread and low-cost use of highly efficient, thin-film silicon solar cells.

■ **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. Besides, one can find researcher positions in optics and photonic R&D centers supported by governments in different countries around the world. 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, IEEE Photonics), 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).

■ **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 (2018-2022):** The scientific outcome between 2018-2022 is the publication of total 50 journal articles. Selected articles are given below:

- Experimental demonstration of inverse-designed silicon integrated photonic power splitters, Nanophotonics, (2022)
- A Broad-Band Achromatic Polarization-Insensitive In-Plane Lens with High Focusing Efficiency, ACS Photonics, 8, 2481–2488 (2021)
- Nanostructured Multilayer Coatings for Spatial Filtering, Advanced Optical Materials, 9, 2001730 (1-7), (2021)
- Ultra-compact, high-numerical-aperture achromatic multilevel diffractive lens via metaheuristic approach, Photonics Research 9(10), 2095-2103 (2021)
- Nanosphere Concentrated Photovoltaics with Shape Control, Advanced Optical Materials 9 (3), 2000943 (1-11) (2021)
- Demonstration of carpet cloaking by an anisotropic zero refractive index medium, Optics Letters 45(8), 2423-2426 (2020)

⟨Professor Songcheol Hong's Lab⟩

W E I S
Wave Embedded Integrated Systems

■ Contact information

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Lab.	NanoFab Center S-216	**Tel: 042-350-9940~9945**
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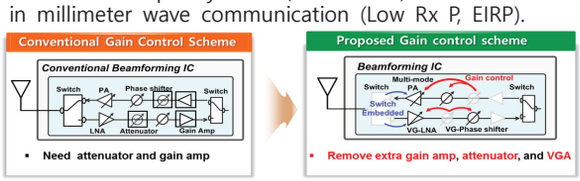
■ Current state of the Lab. (in 2022 Fall Semester)

Postdoctoral Fellows : 2 PhD Students: 8 Master's Student: 6

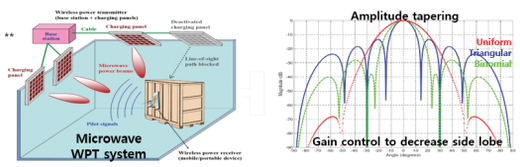
■ Research Areas

● Beamforming IC WIreless Power transfer for 5G communication

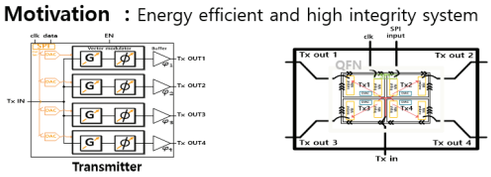
We are studying about 5G communication system. 5G communication system is targeting to increase bandwidth using millimeter wave frequency band(<110 GHz). There are some issues in millimeter wave communication (Low Rx P, EIRP).



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

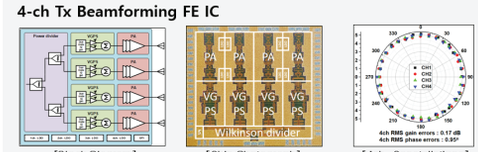
● Radar Transceivers

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.

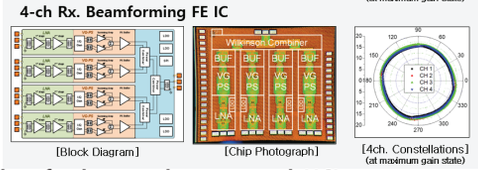
1) 60 GHz Radar

A. Applications : Sensing & 6G communications for future mobility, Indoor sensing for smart home & smart building

4-ch Tx Beamforming FE IC

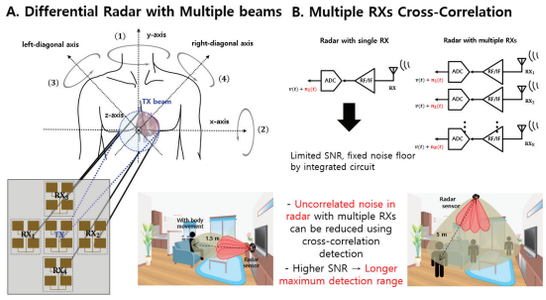


4-ch Rx. Beamforming FE IC



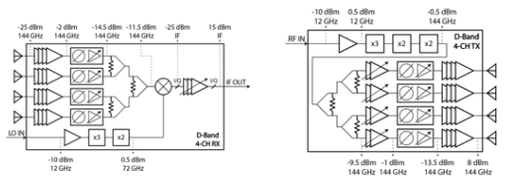
2) Radars for human detectors and HCI

A. Differential Radar with Multiple beams B. Multiple RXs Cross-Correlation



3) 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 (2020-2022)

[1] K. Han and S. Hong, "High-Resolution Phased-Subarray MIMO Radar With Grating Lobe Cancellation Technique," in IEEE Transactions on Microwave Theory and Techniques, vol. 70, no. 5, pp. 2775-2785, Mar. 2022.
[2] J. Lee and S. Hong, "Millimeter-Wave Frequency Reconfigurable Dual-Band CMOS Power Amplifier for 5G Communication Radios," in IEEE Transactions on Microwave Theory and Techniques, vol. 70, no. 1, pp. 801-812, Nov. 2021.
[3] S. Park and S. Hong, "Millimeter-Wave Wideband Differential Four-Way Wilkinson Power Divider With 90° Rotational Symmetric Layout," in / IEEE Microwave and Wireless Components Letters, Early Access, May, 2022.

<Professor Steven Euijong Whang's Lab>

Data Intelligence Lab

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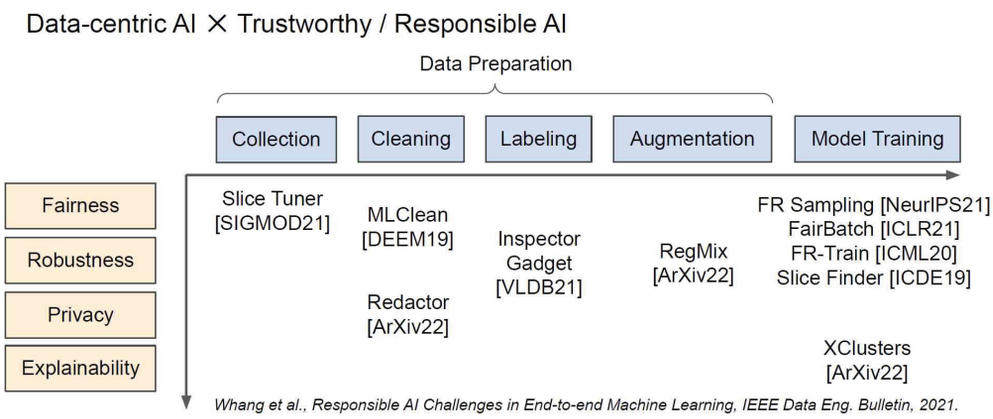
■ **Current state of the Lab (in 2022 Fall Semester)**

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

■ **Research Areas**

The goal of the Data Intelligence Lab is to pioneer the areas of Data-centric AI and Trustworthy/Responsible AI. As AI becomes more prevalent in our everyday lives, we not only have to make machine learning more accurate, but also need it to be fair, robust, private, and explainable. We need to address all these issues starting from the data. In particular, we are interested in all data management challenges that occur in end-to-end machine learning.



■ **Recommended courses & Career after graduation**

Recommended courses: Discrete mathematics, data structures, algorithms, databases, data mining, probability theory, linear algebra, and machine learning.

Career after graduation: Students will be trained to be world-class researchers and have career opportunities both in academia and industry.

■ **Introduction to other activities besides research**

All members are encouraged to participate in extracurricular activities. For example, Prof. Whang likes swimming and is an alum of KAIST swimming team KAORI. Our lab also has regular social events.

■ **Introduction to the Lab**

The goal of the Data Intelligence Lab is to pioneer the inevitable trend of Data-centric and Trustworthy/Responsible AI and train the next leaders from KAIST. Our students publish papers in top Machine Learning (NeurIPS, ICML, ICLR), Data Mining (ACM SIGKDD), and Database (ACM SIGMOD, VLDB) conferences. We work closely with the industry: Google AI, Samsung Electronics, SK Hynix, and SK Telecom. Steven Euijong Whang is a Kwon Oh-Hyun Associate Professor at the School of Electrical Engineering (Computer division) and Graduate School of AI at KAIST. Previously he was a Research Scientist at Google Research from Dec. 2012 to Jan. 2018 and co-developed the data infrastructure of the TensorFlow Extended (TFX) machine learning platform. Prof. Whang received his Ph.D. in computer science in 2012 from Stanford University and his B.S. in computer science from KAIST in 2003 (graduated first in class). He received the Google AI Focused Research Award (2018; the first in Asia).

■ **Recent research achievements (2020-2022)**

[1] Y. Roh, K. Lee, S. E. Whang, and C. Suh, "Sample Selection for Fair and Robust Training" In NeurIPS (Top Machine Learning conference), Dec. 2021.

[2] H. K. Tae and S. E. Whang, "Slice Tuner: A Selective Data Acquisition Framework for Accurate and Fair Machine Learning Models" In SIGMOD (Top Database conference), June 2021.

[3] G. Heo, Y. Roh, S. Hwang, D. Lee, and S. E. Whang, "Inspector Gadget: A Data Programming-based Labeling System for Industrial Images" In VLDB (Top Database conference), Aug 2021.