DEPARTMENT OF

ELECTRICAL ENGINEERING

Annual Report 2013/2014

KAIST

Koera Advanced Institute of Science and Technology
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KAIST

DEPARTMENT OF

ELECTRICAL ENGINEERING

Annual Report 2013/2014

CONTENTS

KAIST

DEPARTMENT OF ELECTRICAL ENGINEERING

In the beginning of 2009, Information and Communications University (ICU) was merged into KAIST. Given that nearly a half of the studies of ICU focused on electrical engineering, the major contribution of ICU joined our department.

Message from the Department Head

Greetings!

I am pleased to be writing this message on behalf of the Department of Electrical Engineering at KAIST, a department that has supported our country in becoming the world's strongest IT nation. As KAIST's largest department, we consist of approximately 90 professors, 1,500 students (500 undergraduate and 1,000 graduate students), and 19 department employees. Our department has 10,200 graduates (4,000 undergraduate, 2,900 graduate, and 3,300 Ph.D.'s), and these alumni are putting on quite a performance on the advance of electrical engineering.

As we work to become a world top department, we have been pushing forward with our established mission and vision; accordingly, our department is focusing on growth and integrity, and strives to be increasingly competitive. At the graduate level, we are fostering global leaders in electrical engineering who are able to create knowledge and technology for better human life. Furthermore, we are also looking to foster talented experts that have strong fundamentals coupled with application skills, and those that are able to communicate, collaborate, and serve.

The KAIST Electrical Engineering Department is leading the field of electrical engineering with the development of the scientific research satellite KISTAT 1, a touch sensor that imitates the human skin, the world's smallest transistor, intelligent robots, 5G future telecommunications, etc. The constituents of our department are working endlessly to realize our vision, "The creation of knowledge and technology, for the purpose of enhancing the quality of life." New fields of convergence being pioneered by our department include, but are not limited to, medical engineering, network computing and security, energy and environment, and nano and photonics technology. Furthermore, we are constantly developing creative and convergence academic curricula to keep pace with the rapid changes in the environment.

The KAIST Department of Electrical Engineering won't remain satisfied with its ranking at the 24th spot in the 2014 QS Department Evaluation, but will continue putting forth its utmost efforts in becoming the world's best department.

We ask for your continuous support, so that we may continue our growth, and we welcome anyone who wishes to take on the challenge together.

Thank you.

September 2014

Chang Hee Lee
Head of Department of Electrical Engineering

A Brief History

Since1971

1971
Establishment of Korea Advanced Institute of Science (KAIS) at Hongneung, Seoul
Profs. Chung, KunMo and Ra, Jung-Woong joined the Department

1973
Profs. Kim, Jae-Kyoon and Park, Song-Bae joined the Department
First entrance ceremony for the master program

1975
Prof. Kim, Choong-Ki joined the Department
First graduation ceremony for the master program
First entrance ceremony for the Ph.D. program

1977
Profs. Bien, Zeungnam and Un, Chong-Kwan joined the Department

1980s

1980
Establishment of Korea Advanced Institute of Science and Technology (KAIST), merged with KIST

1981
First graduation ceremony for the Ph.D. program

1984
Establishment of Korea Institute of Technology (KIT) starting the undergraduate program

1986
First entrance ceremony for KIT

1989
KIST separated from KAIST
KAIST merged with KIT and moved to Daejeon
Former faculty members of KIT joined the Department as of September 1, 1989.

1990s

1990
First graduation ceremony for the undergraduate program

1995
Prof. Kim, Choong-Ki was elected a Fellow of IEEE

1997
Establishment of Information and Communications University (ICU)

1998
First entrance ceremony for the graduate program of ICU

1999
First graduation ceremony for the graduate program of ICU

2000s

2002
First entrance ceremony for the undergraduate program of ICU

2004
Foundation of the National Nano fab Center

2005
1000th Ph.D. graduated from the Department
Prof. Moon, Jaekyun was elected a Fellow of IEEE

2006
Prof. Chung, Yun Chur was elected a Fellow of IEEE

2007
Prof. Bien, Zeungnam was elected a Fellow of IEEE

2008
Profs. Lee, Ju-Jang and Yoo, Hoi-Jun were elected Fellows of IEEE

2009
Merger of KAIST and ICU
Former faculty members of the ICU joined the Department as of March 1, 2009.
Profs. Kim, Jong-Hwan, Kyung, Chong-Min and Song, lickho were elected Fellows of IEEE

2010
Prof. Lee, Chang Hee was elected a Fellow of IEEE

2013
Foundation of Kim, Beang-Ho, Kim, Sam-Youl ITC Building

2014
Prof. Lee, Kwyro was elected a Fellow of IEEE

Vision Statements

Vision

Create Knowledge and Technology for Human
Global Leader in EE

World-class faculty and outstanding students

Home of global leaders, innovators, and entrepreneurs

Home of new knowledge and break-through technologies

Mission

Foster Global Leaders in Electrical Engineering
Educate EE students for diverse career paths

Organization

Lee, Chang Hee
Head, Dept. of Electrical Engineering

Executive Committee

Group Directors

- **Choi, Yang-kyu**
  NDIS
  (Nano Devices & Integrated Systems)
- **Park, Seong-Ook**
  EP
  (Electromagnetics & Photonics)
- **Kang, Joonhyuk**
  COM
  (Communications)
- **Ro, Yong Man**
  SS
  (Signals & Systems)
- **Kim, Yongdae**
  CNS
  (Computing, Networking & Security)
- **Lee, Sang-Gug**
  CS
  (Circuits & Systems)

Associate Heads

- **Chung, Sae-Young**
  Education
- **Park, Chul Soon**
  Industry Relations
- **Moon, Gun-Woo**
  Student Affairs

Professors Emeritus

Bien, Zeungnam
Professor Emeritus

· Ph.D., University of Iowa (1975)
· Automation System, Intelligent Fuzzy Control, Service Robotics
· zbien@kaist.ac.kr

Choi, Soon Dal
Professor Emeritus

· Ph.D., Stanford University (1969)
· Satellite Communication, Remote Sensing
· sdchoi@kaist.ac.kr

Kang, Min ho
Professor Emeritus

· Ph.D., University of Texas at Austin (1997)
· Intergrated Network Engineering
· minhokang@kaist.ac.kr

Kim, Choong-Ki
Professor Emeritus
and Distinguished Professor

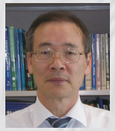
· Ph.D., Columbia University (1970)
· Semiconductor Engineering, Infrared Detecting Device Development
· ckkim58@kaist.ac.kr

Kim, Jae-Kyoon
Professor Emeritus

· Ph.D., University of Southern California (1971)
· Video Coding, Visual Communication Systems
· kimjk@kaist.ac.kr

Kwon, Young-Se
Professor Emeritus

· Ph.D., University of California, Berkeley (1977)
· Opto Electronic Integrated Circuit(OEIC) Monolithic Microwave Integrated Circuit(MMIC)
· kwon@kaist.ac.kr



Lee, Hyuckjae
Professor Emeritus

· Ph.D., Oregon State University (1983)
· Radio and Communications
· hjleekim@kaist.ac.kr

Lee, Ju-Jang
Professor Emeritus

· Ph.D., University of Wisconsin (1984)
· Emotional Robot, Artificial Life, Intelligent Transportation System
· leejj@kaist.ac.kr

Lim, Jong-Tae
Professor Emeritus

· Ph.D., University of Michigan (1986)
· Nonlinear Control, Congestion Control, Supervisory Control
· jtlim@kaist.ac.kr

Lim, Koeng Su
Professor Emeritus

· Ph.D., Tokyo Institute of Technology (1984)
· Solid State Devices, a-Si Solar Cells, TFLED, Poly Silicon Solar Cells, CIS Solar Cells, Digital Sun Sensor
· kslim@kaist.ac.kr

Park, Sin-Chong
Professor Emeritus

· Ph.D., University of Minnesota (1979)
· Wireless Communications SoC
· park1499@kaist.ac.kr

Park, Song-Bae
Professor Emeritus

· Ph.D., University of Minnesota (1968)
· Ultrasonic Systems
· sbpark@ee.kaist.ac.kr

Ra, Jung-Woong
Professor Emeritus

· Ph.D., Polytechnic Institute of Brooklyn (1971)
· Scattering of EM Waves by Dielectric Wedge, Inverse Scattering, Underground Tomogram
· jungwoong@kaist.ac.kr

Shin, Sang-yung
Professor Emeritus

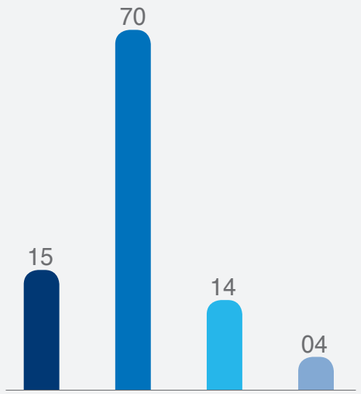
· Ph.D., Polychnique Institute of New York (1976)
· Electro-Optics, Optoelectronic Devices for Optical Communications, Sensing, and Signal Processing
· syshin@kaist.ac.kr

Youn, Myung Joong
Professor Emeritus

· Ph.D., University of Missouri, Columbia (1978)
· Power Electronics, Servo Motor Control
· mmyoun@kaist.ac.kr

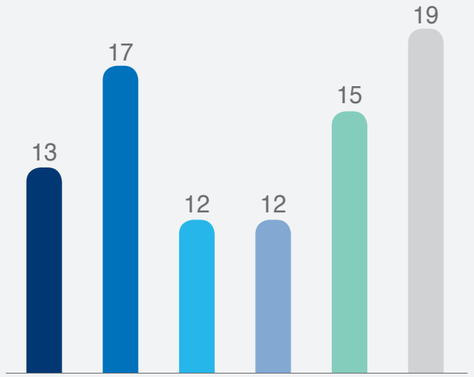
Overview & Statistics

Faculty



Professor Emeritus
Professor
Associate Professor
Assistant Professor

Faculty by Research Fields

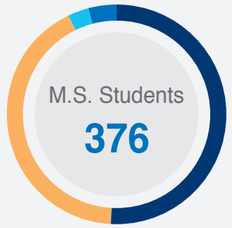


CNS(Computing, Networking, and Security)
COM(Communications)
CS(Circuits and Systems)
EP(Electromagnetics and Photonics)
NDIS(Nano Devices and Integrated Systems)
SS(Signals and Systems)

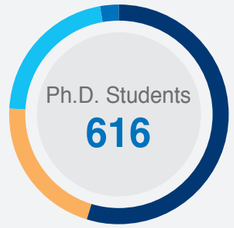
Student Enrollment

(July 2014)

Government Scholarship **535**
International **27**

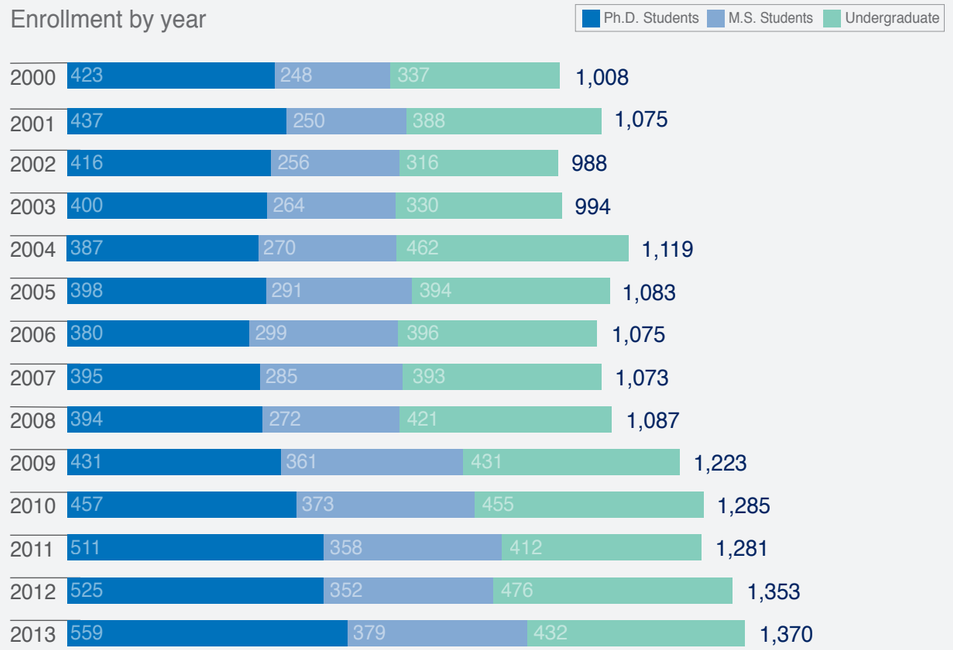


Government Scholarship **242**
KAIST Scholarship **100**
General / Industry Scholarship **15**
International **19**



Government Scholarship **338**
KAIST Scholarship **130**
General / Industry Scholarship **131**
International **17**

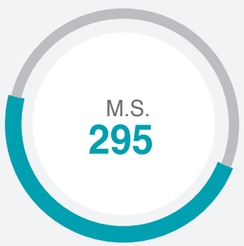
Enrollment by year



Graduates

Degrees Awarded

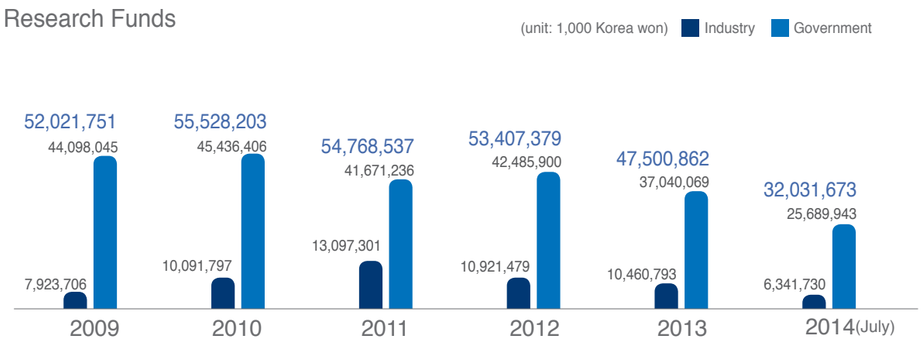
(Feb. 2013 - Feb. 2014)



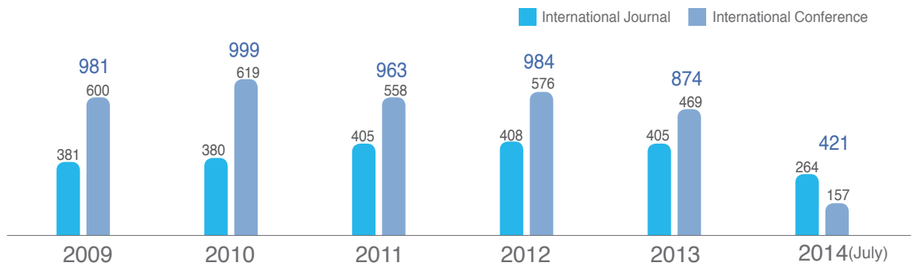
Overview & Statistics

Research & Activities

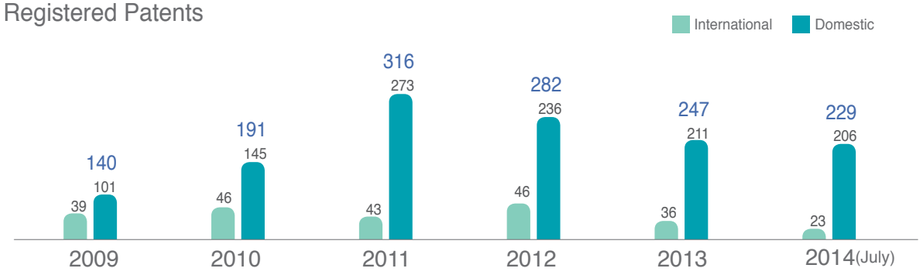
Research Funds



Publications



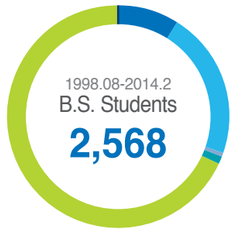
Registered Patents



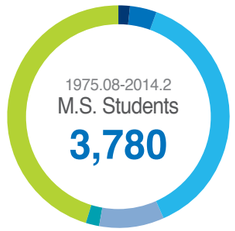
Department Scholarship

- 01. Creative Activity Prize - donated by the families of EE graduate students
- 02. Distinguished Thesis Prize - established by the trust fund of Prof. Park, Song-Bae
- 03. Augustinus Han Chul Hee Scholarship - donated by Prof. Han, Chul Hee & his students
- 04. Hwang Yoon-Ho Scholarship - donated by Mr. Hwang, Yoon-Ho
- 05. Il-Soo Scholarship - donated by the father of Prof. Kwon, Young-Se
- 06. Kim Choong-Ki Scholarship - donated by Dr. Lim, Hyung-Kyu
- 07. Lee Min-Hwa Scholarship - donated by Dr. Lee, Min-Hwa
- 08. No Yop Scholarship - donated by No Yop Culture Foundation
- 09. Sang-Ae Scholarship - donated by Sang-Ae Foundation
- 10. So-Chun Scholarship - donated by the father of Prof. Youn, Myung Joong
- 11. Suk Rim Scholarship - donated by Suk Rim Academic Foundation
- 12. Un Chong-Kwan Scholarship - donated by Prof. Un, Chong-Kwan

Career Status of Alumni



Educational Institutes	04
Others	230
Industries	547
Research Institutes	13
Government Agerncies	27
Advanced to higher-degree programs	1747



Educational Institutes	73
Others	143
Industries	1432
Research Institutes	353
Government Agerncies	68
Advanced to higher-degree programs	1711

Educational Institutes	179
Others	66
Industries	1021
Research Institutes	380
Government Agerncies	19
Advanced to higher-degree programs	01

CNS Group

On the Levy-walk Nature of Human Mobility
- Professor Chong, Song

COM Group

Achieving Unlimited Degrees of Freedom in Wireless Communications
- Professor Chung, Sae-Young

Optimal Pilot Beam Pattern Design for Massive MIMO Systems
- Associate Professor Sung,Youngchul

CS Group

Low-power Next Generation 100Gbps Ethernet Transceiver IC
- Associate Professor Bae, Hyeon-Min

A 5.6mV Inter-channel DVO 10b Column Driver IC with Mismatch-Free Switched-Capacitor Interpolation for Mobile Active-Matrix LCDs
- Professor Cho, Gyu-Hyeong

EP Group

Polarization and Beam Switching Technique for Sensor Network
- Professor Yu, Jong-Won

NDIS Group

EMI (Electro Magnetic Interference) Shielding Effectiveness of Mono-layer Graphene sheet
- Professor Cho, Byung Jin

Various Material, High-Throughput Nanowire Production Based on a Large-Area Nanotemplate
- Professor Yoon, Jun-Bo

SS Group

Zero-Blur Camera: Complementary Set of Fluttering Patterns for Image Blur Removal
- Professor Kweon, In So

Research On the World Best Efficiency Wireless Power Transfer Systems with Multi-Coil Resonator for Electric Vehicle Battery Charger
- Professor Moon, Gun-Woo

Ten Achievements of EE Department 2013

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CNS Group

Professor

Chong, Song

On the Levy-walk Nature of Human Mobility

This pioneering work by Professor Song Chong discovered atypical supper-diffusive nature of human movement patterns and analyzed its impact on mobile networking performance. It has been cited over 520 times in last three years and received the IEEE ComSoC William R. Bennett Prize Paper Award in 2013, given to the best original paper published in IEEE / ACM Transactions on Networking in 2011-2013.

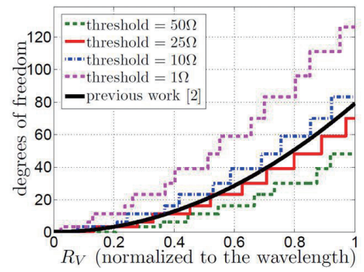
COM Group

Professor

Chung, Sae-Young

Achieving Unlimited Degrees of Freedom in Wireless Communications

We characterize the Shannon limit of wireless communication channels by combining Maxwell's equations and Shannon theory. We show that unlimited degrees of freedom can be obtained in principle regardless of the physical sizes of transceivers. Our result can be used to design antenna arrays that can provide a huge gain over conventional ones.



COM Group

Associate Professor

Sung, Youngchul

Optimal Pilot Beam Pattern Design for Massive MIMO Systems

The massive MIMO technology is considered to be one of the key enabling technologies for 5G mobile communication. One of the hurdles to realizing the massive MIMO technology is channel estimation from a very large transmit antenna array to each receiver. In collaboration with a Purdue team, exploiting both channel's spatial and time correlation, Prof. Youngchul Sung developed an optimal pilot beam pattern design method for efficient channel estimation for massive MIMO systems. This work is expected to provide basic guidance on how to design pilot signals in FDD massive MIMO systems.

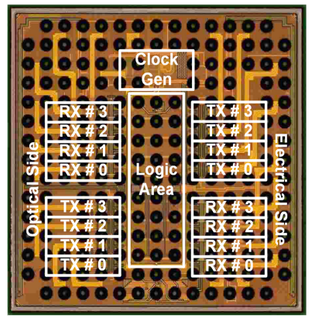
CS Group

Associate Professor

Bae, Hyeon-Min

Low-power Next Generation 100Gbps Ethernet Transceiver IC

The proposed 100Gbps Ethernet transceiver IC is used in linecards or optical modules for data centers. It based on a total of six patented technologies geared toward ultra-low power consumption, has achieved 1/3 level of power consumption of today's state of the art ICs.



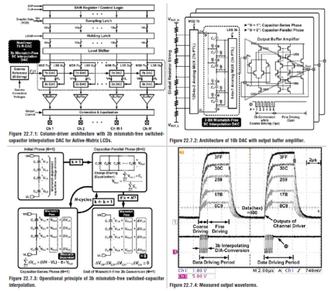
CS Group

Professor

Cho, Gyu-Hyeong

A 5.6mV Inter-channel DVO 10b Column Driver IC with Mismatch-Free Switched-Capacitor Interpolation for Mobile Active-Matrix LCDs

We present a 10b column-driver IC with a mismatch-free switched-capacitor (SC) interpolation scheme for mobile AMLCDs. The proposed mismatch-free interpolation scheme provides further reduction of the driver size, good linearity, highly uniform channel performance, and more effective bit resolution.



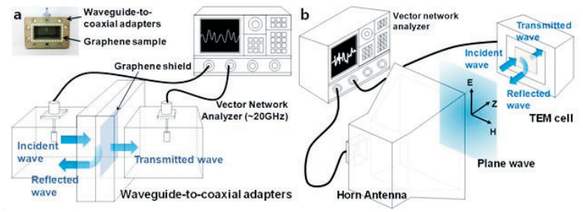
NDIS Group

Professor

Cho, Byung Jin

EMI (Electro Magnetic Interference) Shielding Effectiveness of Mono-layer Graphene sheet

Prof. BJ Cho's team has demonstrated that graphene is the most effective material for EMI shielding. CVD-synthesized graphene shows more than seven times greater EMI shielding effectiveness than gold film of the same thickness. Since graphene has negligible mass and is ultrathin, transparent, and flexible, it will be an excellent choice of EMI shielding material for portable electronic devices, automobiles, and EMI isolation of 3D integrated circuits, etc.



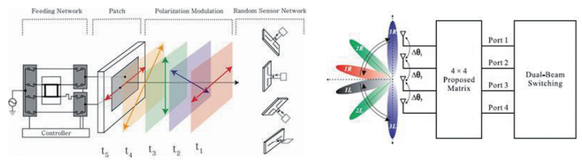
EP Group

Professor

Yu, Jong-Won

Polarization and Beam Switching Technique for Sensor Network

We propose two major researches in RF energy transport for maximizing operation range and increasing energy transport efficiency which are demanded for sensor network applications. One research is about wide-coverage array antenna with 4×4 proposed matrix which generates three dual-beams for UHF RFID applications. Another research is about polarization modulation antenna which can select the best polarization mode for efficient energy transport to the sensor node.



Polarization and Beam Switching Technique for Sensor Network

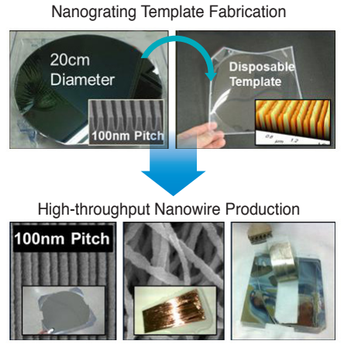
NDIS Group

Professor

Yoon, Jun-Bo

Various Material, High-Throughput Nanowire Production Based on a Large-Area Nanotemplate

We proposed and realized a new top-down nanowire fabrication method using large area Si nanograting template. According to this method, perfectly aligned nanowire array with nanowire aspect ratio of 4,000,000:1 can be fabricated based on various materials.



SS Group

Professor

Kweon, In So

Zero-Blur Camera: Complementary Set of Fluttering Patterns for Image Blur Removal

We present a novel computational camera system to handle image blur. This system has following features: (1) closed form solution for camera shutter patterns, (2) much smaller computational complexity, (3) generalization to video. The system can be applied to various areas such as cameras, surveillance systems, and blackbox cameras etc.

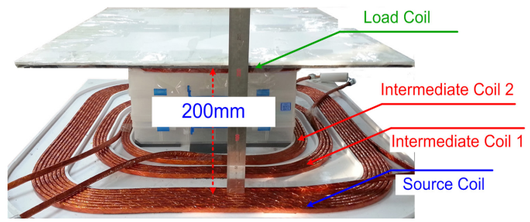
SS Group

Professor

Moon, Gun-Woo

Research On the World Best Efficiency Wireless Power Transfer Systems with Multi-Coil Resonator for Electric Vehicle Battery Charger

In the proposed asymmetric 4-coil system, two intermediate coils boost the apparent coupling coefficient at around the operating frequency. Because of this double boosting effect, the WPT system with the proposed method has higher efficiency 96.56% than the conventional symmetric 4-coil WPT system.



DEPARTMENT OF

ELECTRICAL ENGINEERING

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Computing, Networking and Security
CNS GROUP

01 I Media Network Laboratory — Professor **Choi, Jun Kyun**
02 I Wireless Communication Systems Laboratory — Professor **Chong, Song**
03 I Intelligent Network Architecture and Distributed Systems Laboratory — Assistant Professor **Han, Dongsu**
04 I Systems Modeling and Simulation Laboratory — Professor **Kim, Tag Gon**
05 I System Security Laboratory — Professor **Kim, Yongdae**
06 I Multimedia Traffic Engineering Laboratory — Professor **Park, Hong-Shik**
07 I Networked and Distributed Computing Systems Laboratory — Associate Professor **Park, KyoungSoo**
08 I COmputer engineering REsearch (CORE) Laboratory — Professor **Park, Kyu Ho**
09 I Communications and Networking Engineering Laboratory — Professor **Rhee, June-Koo Kevin**
10 I Network Intelligence and Analytics Laboratory — Assistant Professor **Shin, Jinwoo**
11 I Communication Networks Research Laboratory — Professor **Sung, Dan Keun**
12 I Laboratory of Network Architecture, Design, and Analysis — Associate Professor **Yi, Yung**
13 I Network and Computing Laboratory — Professor **Youn, Chan-Hyun**

CNS GROUP

Computing, Networking and Security (CNS) Group explores a wide range of projects in operating systems, networking, mobile and distributed systems, theory and systems for big data, and their security. In addition to fundamental contribution to the above areas, our group also pursues immediate impact on industry, government, open-source community as well as the society we live.

Cloud, Mobile & Big Data

- Mobile Cloud Technology and Mobile Computing
- Big Data Analytics and Platforms
- Cloud Computing

Networked System

- 4G / 5G Cellular Networks
- Software Defined Networking
- Future Internet(CCN, DTN), IoT
- Cyber-Physical Systems
- Network Science & Economics

CNS Group has 13 faculty members, 77 Ph.D. students, and 28 M.S. students. CNS group is the fast growing group in EE at KAIST: Six new faculty members have joined CNS group in the last five years. While young, CNS group members have shown excellent academic leadership: three professors serve as editors for IEEE / ACM Trans. on Networking, IEEE Trans. on Mobile Computing, IEEE Trans. on Wireless Communications and ACM Transactions on Information and System Security. Four faculty members serve on program committee for top conferences such as Mobicom, Mobihoc, Sigcomm, NSDI, CCS, S&P, NDSS, and WWW.

This young research group, leading academia and industry, has awarded several international awards and published numerous papers in top conferences in networking, systems, theory and security in a short period.

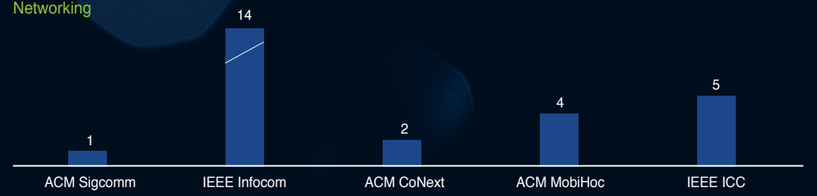
Recent notable research results (2013~2014)

On the Levy-Walk Nature of Human Mobility,
· IEEE William R. Benett Prize Paper Award _ Chong, Song(2013)

Randomized Scheduling Algorithm for Queueing Networks
· The APS of INFORMS Best Publication Award_Shin, Jinwoo(2013)

mTCP: A Highly Scalable User-level TCP Stack for Multicore Systems
· USENIX Symposium on NSDI 2014 Community award_Park, KyoungSoo and Han, Dongsu(2013)

Networking



Professor
Choi, Jun Kyun
Senior Member, IEEE

Media Network Laboratory

RESEARCH INTERESTS
- Internet of Thing / Web of Object / Smart Learning
- Network Caching
- Energy-Efficient Network

RECENT RESEARCH ACTIVITIES
Our research topics in 2013-2014 include

• Web of Object: Regarding both physically and virtually existing things into usable objects and develop ways to formulate a Web for such objects, so that they can communicate and collaborate with existing services, Web, and human-beings and by themselves as well. The Web of Object project's goal is to simplify object and application deployment, maintenance and operation on in-building Internet of Things infrastructures.

• Smart Learning: We have studied novel methods and functions for next-generation of smart learning; remote collaboration & education platform named "KAISquare", web-based content sharing framework, and social feedback features.

• Network Caching: To increase cache efficiency in wired and wireless network, bio-inspired algorithm as caching solution has recently been studied. Bio-inspired algorithm has the characteristic to adopt to various environment with flexibility. In this research, we focus on the method to save the data stored in cache efficiently for reducing end-to-end delay.

• Energy-Efficient Network: To increase energy efficiency of network, many research items have been studied including standard activities such as ITU-T SG 13 and GreenTouch. Since 2011, we have provided some solutions for energy measurement framework of networks, power-efficient load distribution for multi-homing in wireless network, and efficient sleep mode controlling for TDM-PON, as well as energy efficient relay selection for mmWave communications.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Lee, J. ; Dinh, N.T. ; Hwang, G. and Choi, J.K., "Power-efficient load distribution for multihomed services with sleep mode over heterogeneous wireless access networks," *IEEE Tr. Veh. Tech.,* vol. 63, no. 4, pp. 1843-1854, May. 2014.

[2] Newaz, S.H.S. ; Cuevas, A. ; Gyu Myoung Lee ; Crespi, N. and Jun Kyun Choi, "Evaluating energy efficiency of ONUs having multiple power levels in TDM-PONs," *IEEE Comm. Lett.,* vol. 17, no. 6, pp. 1248-1251, June. 2013.

[3] Lee, J. ; Yeo, B. ; Kim, J. ; Jang, M. and Jun Kyun Choi, "Energy efficient scalable video coding based cooperative multicast scheme with selective layer forwarding," *IEEE Comm. Lett.,* vol. 17, no. 6, pp. 1116-1119, June. 2013.

Professor
Chong, Song
Member, IEEE

Wireless Communication Systems Laboratory

RESEARCH INTERESTS
- Wireless networks
- Mobile networks and systems
- Network data analytics

RECENT RESEARCH ACTIVITIES
The Network Systems Laboratory (NSL) focuses on developing fundamental design concepts and methodologies for wireless networks and high speed networks. The research topics include control and optimization of communication networks and radio resource management, cross-layer resource allocation, testbed and measurement for wireless mesh networks, delay tolerant networks and mobility model.

Our research topics in 2013-2014 include

• Mobility aware networks: Delay / Disruption Tolerant Networking (DTN) is an approach to computer network architecture that seeks to address the technical issues in heterogeneous networks that may lack continuous network connectivity. NSL investigates link opportunity due to mobility pattern of nodes. Also, we focus on developing resource allocation for DTNs.

• Cellular networks with two directions: one direction is towards to maximize network capacity by mitigating inter-cell interference or reducing cell coverage or using smart antenna techniques. The other movement is reducing network energy such as base station and mobile station power consumption with satisfying reasonable network throughput. These problems are jointly related to resource control problem such as user scheduling, power allocation, power management policies and base station association. NSL has interested in analyzing existing well known resource control technique on mathematical background, and ultimately developing fully distributed or utility-optimal resource control algorithms on existing or future cellular network environments.

• Implementation: To bridge the gap from simulation and practice, NSL focuses on experimentation-based evaluation for developing new protocols such as MAC scheduling and routing algorithms. As a good example, through our code-reuse platform called CommonCode, NSL evaluates some nice optimal cross-layer protocol, optimal CSMA, which is based on CSMA used in 802.11 technology.

MAJOR ACHIEVEMENTS in 2013/2014
[1] K. Lee, Y. Yi, J. Jeong, H. Won, I. Rhee and S. Chong,

"Max Contribution: An On-line Approximation of Optimal Resource Allocation in Delay Tolerant Networks," *IEEE Tr. Mob. Com.,* vol. PP, no. 99, pp. 1-1, June 2014.

[2] K. Lee, J. Lee, Y. Yi, I. Rhee and S. Chong, "Mobile Data Offloading: How Much Can WiFi Deliver?," *IEEE / ACM Tr. Networking,* vol. 21, no.2, pp. 536-550, Apr. 2013.

[3] IEEE William R. Bennett Prize Paper Award, IEEE Communication Society, May 2013.

Assistant Professor
Han, Dongsu
Member, ACM / Member, USENIX

Intelligent Network Architecture and Distributed Systems Laboratory

RESEARCH INTERESTS
- Cloud and Big Data systems
- Networked systems
- Internet security

RECENT RESEARCH ACTIVITIES
The INA lab covers broad range of topics related to Cloud computing, including the networking stack, operating system, and application-level algorithms. We focus on developing practical ideas to create new services and dramatically improve existing services that run on the Cloud and the Internet.

Cloud and Big Data
- Providing QoS in multi-tenant cloud environments through virtual network embedding
- Enabling Distributed Optimization (Algorithm design and system implementation)
- Scalable, high-performance networking stack, services, and applications

Internet Content Delivery (as Cloud application)
- VDN: Enabling Software-defined, Near-Real Time Control for Content Delivery Networks
- Understanding the Internet video Quality of Experience (QoE) and QoE engineering
- Enhancing DASH / HAS (HTTP adaptive streaming) with Network-level Predictions

Internet Security
- Intrusion detection using many-core systems
- Automatic application classification and behavior analysis of Android Applications through binary analysis

MAJOR ACHIEVEMENTS in 2013/2014
[1] H. Lim, D. Han, D. G. Andersen, and M. Kaminsky, "MICA: A Holistic Approach to Fast In-Memory Key-Value Storage", USENIX NSDI, Seattle, Apr. 2014.

[2] E. Jeong, S. Woo, M. Jamshed, H. Jeong, S. Ihm, D. Han, K. Park, "mTCP: a Highly Scalable User-level TCP Stack for Multicore Systems", USENIX NSDI, Seattle, Apr. 2014. (NSDI Community Award)

[3] D. Han, R. Grandl, A. Akella, and S. Seshan, "FCP: A Flexible Transport Framework for Accommodating Diversity", ACM SIGCOMM, Hong Kong, Aug. 2013.

Professor
Kim, Tag Gon
Fellow, SCS / Life Member, IEEK
/ Life Member, KSS

Systems Modeling and Simulation Laboratory

RESEARCH INTERESTS
- Theory of Discrete Events
- M&S Theory / Methodology / Environment Development
- HLA / RTI based Interoperation / Distributed Simulation

RECENT RESEARCH ACTIVITIES
SMS Lab is devoted to researching on theory and applications of modeling, simulation and analysis of discrete event systems. The modeling framework in our research is DEVS (Discrete Event Systems Specification) formalism which supports specification of discrete event models in a hierarchical modular manner. Research emphasis is given to two areas: methodology and tools for (1) systems analysis at a high level and for (2) simulators development and their interoperation. The first area is to develop a new framework for the efficient analysis of complex systems, such as application-specific digital systems, using discrete event system M&S. The second area is mainly aimed at the development of HLAcompliant military wargame simulators. Such simulators should be interoperable with other simulators through HLA (High Level Architecture) / RTI (Run Time Infrastructure).

(a) Scenarion Writer (a) Scenarion Viewer

Fig. 1

SMS lab has developed a set of tools for development of simulators which meet the standard: DEVSim++, KHLAAdaptor, and KComLib. The tools set has been used to develop 3 major military wargame simulators in Korea such as Navy's Chunghae Simulator, Air Force's Changkong Simulator and Marine's Chunjabong Simulator (Fig.1).

MAJOR ACHIEVEMENTS in 2013/2014
[1] Changbeom Choi, Kyung-Min Seo, Tag Gon Kim, "DEXSim: an experimental environment for distributed execution of replicated simulators using a concept of single simulation multiple scenarios," SIMULATION: Transaction of The Society for Modeling and Simulation International, Vol. 90, No. 4, Apr., 2014 pp. 355 - 376.

[2] Kyung-Min Seo, Changbeom Choi, Tag Gon Kim, and Jung Hoon Kim, "DEVS-based combat modeling for engagement-level defense simulation," SIMULATION: Transaction of The Society for Modeling and Simulation International, Vol. 90, No. 7, Jun., 2014 pp. 759 - 781.

[3] Daejin Park, and Tag Gon Kim, "A Built-In Binary Code Inversion Technique for On-Chip Flash Memory Sense Amplifier with Reduced Read-Current Consumption," *IEEE Transactions on Very Large Scale Integration (VLSI) Systems,* Vol. 22, No. 5, May, 2014 pp. 1187 - 1191.

Professor
Kim, Yongdae
Publicity Chair, ACM CCS / Area Chair, International World Wide Web Conference

System Security Laboratory

RESEARCH INTERESTS
- Cyber physical system security
- Control plane security
- Penetration testing of Korean cyber infrastructure

RECENT RESEARCH ACTIVITIES
We are interested in security of emerging and current systems. Our research involves design / implementation of novel attacks, and developing countermeasures against such attacks. We currently focus on 1) security issues for Cyber Physical Systems (CPSs) such as medical devices, smart grid, and automobiles, 2) control plane security of mobile / ad hoc / sensor / cellular networks, Internet, P2P systems, 3) Penetration testing of Korean cyber infrastructure, and 4) other security issues such as cloud / storage security, anonymous communication systems and censorship-resistant systems.

1. CPS security
CPS is a system featuring a tight combination of, and coordination between, computational elements and physical elements such as smart grid and autonomous automotive systems. In CPS security research, we focus on traditional security problems (such as operating systems, malware, binary analysis, patching...) as well as novel physical security problems (such as sensor spoofing, radar spoofing...). Current target applications include medical devices, automobiles, and drones.

2. Control plane security
In this research, we focus on control plane security of current and emerging telecommunication infrastructure such as 3G, 4G LTE cellular communication, Internet, and future Internet. Among others, we are currently focusing on security, robustness, and accounting issues on these networks.

3. Penetration testing of Korean cyber infrastructure
We are helping 1) companies to find security problems of their products, 2) government to evaluate security of cyber infrastructure. For example, we are currently evaluating security problems of significant number of Korean smart phone apps and report them to related companies and government organizations. We are also looking at security of Wibro eggs, 3G Femtocells, and popular navigation systems.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Y. Go, E. Y. Jeong, J. Won, Y. Kim, D. F. Kune, K. S. Park, "Gaining Control of Cellular Traffic Accounting by Spurious TCP Retransmission", *NDSS*, San Diego, CA, USA, Feb. 2014.

[2] D. F. Kune, J. Backes, S. S. Clark, D. Kramer, M. Reynolds, K. Fu, Y. Kim, and W. Xu, "Ghost Talk: Mitigating EMI Signal Injection Attacks against Analog Sensors", *IEEE S&P*, San Francisco, CA, USA, May 2013.

[3] A. Mohaisen, H. Tran, A. Chandra, Y. Kim, "SocialCloud: Using Social Networks for Building Distributed Computing Services", *AsiaCCS*, Hangzhou, China, May 2013.

Professor
Park, Hong-Shik
Member, IEEE / Member, IEICE

Multimedia Traffic Engineering Laboratory

RESEARCH INTERESTS
- Energy saving network
- SNS analysis
- Wireless mesh network based on Bio-inspired algorithm

RECENT RESEARCH ACTIVITIES
Multimedia Traffic Engineering Laboratory (MTEL) is interested in the technologies for Future Network and Next Generation Network, such as Quality-of-Service provisioning, traffic and congestion control, traffic engineering technology for resource management and construction of reliable communication network, next generation router technology, high-speed switching and routing technology, IP forwarding technology, and protocol engineering technology for open network which are necessitated for the next generation router and broad-band switching system.

Our research topics in 2013-2014 include
• Bio-inspired network engineering is a strategy for efficient and scalable networking under uncertain conditions, e.g. for autonomic organization in largely distributed systems. In nature, it is clearly observed that the dynamics of many biological systems and laws governing them are based on a surprisingly small number of simple generic rules which yield collaborative yet effective patterns for resource management and task allocation. We are interested in ant colony optimization based self-organizing QoS framework, energy saving routing, and bio-inspired synchronization for wireless network.

• Social network services are rapidly growing in order to share information between people through the Internet and create a social networking. We are interested in developing a bio-inspired self-organizing distributed virtual cloud technology for efficiently accommodating social network service.

• Intelligent-wireless mesh network is essential in order to manage effectively increasing wireless traffic. We are interested in next generation intelligent-wireless mesh network based on bio-inspired algorithm which is able to provide enhanced throughput.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Y. Kim, H. Kim, B. Jung, H. Park and H. Park, "Bio-inspired Load Balancing Routing for Delay-Guaranteed Services in Ever-Changing Networks," *ETRI Journal*, vol. 35, no. 3, pp. 414-424, June 2013.

[2] Y. Kim, E. Lee, B. Jung, H. Kim, H. Park, and H. Park, "Swarm Intelligence Based Self-organizing QoS Framework for Ever-changing Future Networks," *IEEE J. Sel. Area. Comm.*, vol. 31, no. 12, pp. 735-749, Dec. 2013.

[3] N. Kim, H. Park and H. Lim, "Adaptive Packet Transmission Scheduling Using Multicast Service Efficiency in TDM-PON," *IEEE J. Lightwave Technology,* vol. 32, no. 9, pp. 1759-1769, May 2014.

Associate Professor
Park, KyoungSoo

Networked and Distributed Computing Systems Laboratory

RESEARCH INTERESTS
- High performance network system
- Network traffic optimization and security
- Multimedia delivery system

RECENT RESEARCH ACTIVITIES
Networked and Distributed Computing Systems Research Lab (NDSL) focuses on the performance, reliability, scalability and security issues in the design and implementation of modern networked computing systems. Main research topics include scalable content distribution networks (CDNs), high-performance network server design, delay-tolerant network infrastructure, scalable network redundancy elimination, multimedia system, and networked systems security. The goal of our research is to find the fundamental design principles in building innovative computer systems that would improve the quality of our daily computing life.

Our research topics in 2013-2014 include
• Accounting: The goal of the accounting project is to build an accurate cellular data traffic accounting system by monitoring the flows from the middle of the two communicating hosts. In this research, we propose to build a high-speed cellular traffic monitoring system that can both detect any attacks that try to bypass charging as well as accounting for the correct volume in real-time.

• Media-aware caching: Recent study shows that network redundancy elimination (NRE) on the content level could produce high bandwidth savings in ISPs. However, blindly employing existing NRE techniques to video contents could lead to suboptimal redundancy suppression rates. In this research, we present two novel schemes that help similar or aliased videos to be cached more effectively in the NRE system.

• mTCP: Scaling the performance of short TCP connections is fundamentally challenging due to inefficiencies in the kernel. mTCP addresses these inefficiencies from the ground up - from packet I / O and TCP connection management all the way to the application interface.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S. Woo, E. Jeong, S. Park, J. Lee, S. Ihm, and K. Park, "Comparison of caching strategies in modern cellular backhaul networks," *11th Int. conf. on Mobile Systems, Applications and Services (MobiSys)*, Taipei, Taiwan, June 2013.

[2] Y. Go, J. Won, D. F. Kune, E. Jeong, Y. Kim, and K. Park, "Gaining control of cellular traffic accounting by spurious TCP retransmission", *21th Netwok and Distributed System Security Sympo. (NDSS)*, San Diego, CA, Feb. 2014.

[3] E. Jeong, S. Woo, M. Jamshed, H. Jeong, S. Ihm, D. Han, and K. Park, "mTCP: a highly scalable user-level TCP stack for multicore systems," *9th USENIX Sympo. Networked Systems Design, Implem. (NSDI)*, Seattle, WA, Apr. 2014.

Professor
Park, Kyu Ho
Member, KISS / Member, KIT / Member, ACM / Member, IEEE / Member, IEICE

COmputer engineering REsearch (CORE) Laboratory

RESEARCH INTERESTS
- Flash Memory Architecture for Storage
- Memory Architecture using PCRAM
- Cloud Computing and Many-core Environment

RECENT RESEARCH ACTIVITIES
Our laboratory is interested in the hot research topics of computer engineering such as PCRAM, SSD, Cloud Computing, and Manycore system. Mainly, we contribute to those areas by suggesting a novel memory / storage architecture or enhancing existing system softwares to obtain gain in performance, power, durability, consistency, and so on.

Our research topics in 2013-2014 include
• Mancore Architecture: On the given manycore architectures such as NUMA system, GPGPU, and so on, we have studied CPU and memory resource management methods embedded in the system software layer.

• SSD / PCRAM(PRAM) Architecture: Based on simulation, we have suggested novel architectures for SSD and hybrid memory composed of DRAM and PCRAM(PRAM).

• System Software utilizing SSD: As SSD has changes I / O performance dramatically, the techniques embedded in the system software layer should consider what SSD can do. We have found and studied several points which can be optimized by considering SSD intensively.

MAJOR ACHIEVEMENTS in 2013/2014
[1] C. Kim and K. Park, "Credit-based Runtime Placement of Virtual Machines on a single NUMA system for QoS of Data Access Performance," IEEE Tr. Computers (accepted), May. 2014.

[2] W. Hwang and K. Park, and K. Park, "Reference Pattern-Aware Instant Memory Balancing for Consolidated Virtual Machines on Manycores," IEEE Tr. Parallel and Distributed Systems (accepted), June 2014.

Professor
Rhee, June-Koo Kevin
Member, IEEE

Communications and Networking Engineering Laboratory

RESEARCH INTERESTS
- Quantum Information Systems
- Wireless and Mobile Network Solutions
- Flexible and Reliable Networking

RECENT RESEARCH ACTIVITIES
• Researches at Communications And Networking Engineering Lab (CANE Lab) focuses in the three areas: Secure networking with quantum information system, the 5G mobile network solutions with content-aware mobile / wireless networking, and 5G front and backhaul networking with flexible and reliable SDN cloud networking solutions.

• Quantum information researches focus on the development of novel but commercially applicable technology for the quantum cryptography to share critical information with a remote node unconditionally securely. As a long-term research goal, the research and development of the quantum information system has been initiated.
(Sponsor: MSIP, SKT; Collaborator: KRISS, HRF.)

• Wireless and mobile networking brings tremendous new opportunities to human beings, such as with 5G and IoT - Unmanaged manageability of wireless mesh and capacity optimality of D2D networking with multimedia and contents services will open up the unforeseen new opportunities, being pursued at us.
(Sponsor: LG Electronics; Collaborators: SKT, KUSTAR.)

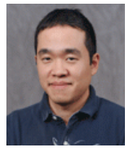
• Networking solutions are advancing with more and more flexible resource management and reliable services for application networks - We study and develop truly optimal network designs and services in Tbps optical core networks and SDN networks, even under disaster.
(Sponsor: NRF, MSIP, HFR; Collaborator: PioLink, AttoResearch, NICT.)

Our research topics in 2013-2014 include
• Quantum cryptography (QKD) for PON applications,
• Tera-bit-scale buffer and cache based optical flow switching,
• NFV-based network switch and an middle-box operating system, and
• Scale-free autonomous wireless mesh networks, including PAC and HEW networking technologies and networked speaker systems.

MAJOR ACHIEVEMENTS in 2013/2014
Award: Korea MSIP Minister's Certificate of Commendation, Dec. 2013.
Selected publications:

[1] C. Lee, and J.-K. K. Rhee, "Traffic grooming for IP-over-WDM network: Energy and delay perspectives," *IEEE / OSA JOCN,* vol. 6, Issue 2, pp. 96-103, Feb. 2014.

[2] K. Lim, Y. Bang, J. Sung, and J.-K. K. Rhee, "Joint optimization of cache server deployment and request routing With cooperative content replication," *ICC 2014,* Sydney, Australia, June, 2014.



Assistant Professor
Shin, Jinwoo

Network Intelligence and Analytics Laboratory

RESEARCH INTERESTS
- Machine Learning and Data Mining
- Communication and Networks
- Theoretical Computer Science

RECENT RESEARCH ACTIVITIES
Network Intelligence and Analytics Laboratory (NIA) carries out advanced research on the area of network and data sciences via interdisciplinary approaches through "mixing" mathematical tools in algebra, combinatorics, analysis, probability, optimization and information theory. Recently, we have been particularly focused on developing algorithms processing information on various types of large-scale data including biometric data (e.g., ECG, EEG, EMG), time-series data (e.g., HVAC), spatial / geographic data (e.g., images), ranking data (e.g., NETFLIX), social data (e.g., FACEBOOK, NAVER) and network sensing / traffic data (e.g., IDS).

Our research topics in 2013-2014 include
• Information processing on biometric data: Due to the emergence of wearable devices such as Google Glass and Galaxy Gear, biometric data mining techniques have gained much attention recently. We have developed authentication algorithms using ECG (electrocardiogram) and motion-detection algorithms using EMG (electromyography). This is a joint work with Samsung Electronics.

• Information processing on social data: We have established theoretical foundations on how to analyze social data. In particular, we have studied how various information is propagated over social networks and how to infer important meanings behind social data.

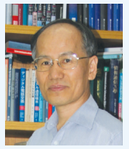
• Information processing on time-series data: We have been developed algorithms for prediction, anomaly detection and anomaly consolidation on time-series data. This is a joint work with IBM T. J. Watson Research Laboratory.

• Theoretical machine learning: We have studied theoretical aspects of machine learning algorithms, where its particular topics include graphical model, matrix completion, bandit optimization and rank aggregation. This is, in part, a joint work with Los Alamos National Laboratory.

MAJOR ACHIEVEMENTS in 2013/2014
[1] R. Restrepo, J. Shin, P. Tetali, E. Vigoda and L. Yang, "Improved Mixing Condition on the Grid for Counting and Sampling Independent Sets", Probability Theory and Related Fields, vol. 156, no. 1, pp. 75-99, 2013

[2] Best Paper Award, ACM MOBIHOC, Jul. 2013.

[3] Best Publication Award, INFORMS Applied Probability Society, Oct. 2013.



Professor
Sung, Dan Keun
Senior Member, IEEE / Member, KISS / Member, KICS

Communication Networks Research Laboratory

RESEARCH INTERESTS
- Cellular M2M communications
- Smart grid communications
- Energy-aware communications, etc

RECENT RESEARCH ACTIVITIES
Communication Networks Research Laboratory was founded in 1990 and our research interests include cellular M2M (machine to machine) communications, smart grid communications, energy-aware communications, and etc. We perform integrated research on wireless communication with energy in cellular system and in smart grid system. Our conceptual research topics are described in Fig. 1. and Fig. 2.

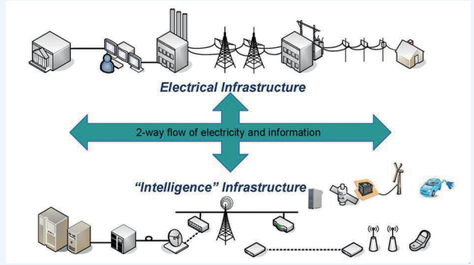


Figure 1. Concept of Grid System

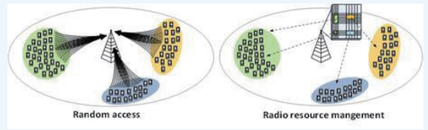


Figure 2. Research Topics in M2M Communications

MAJOR ACHIEVEMENTS in 2013/2014
[1] H.S. Jang, S.M. Kim, K.S. Ko, J.Y. Cha, and D.K. Sung, "Spatial Group based Random Access for M2M Communications," *IEEE Comm. Lett.,* vol.18, no.6, pp.961-964, June 2014.

[2] B.H. Jung, N. Song, and D.K. Sung, "A Network-assisted User-Centric WiFi-Offloading Model for Maximizing Per-User Throughput in an Overlay Network," *IEEE Tr. Vehic. Tech.,* vol. 63, no.4, pp.1940, 1945, May 2014.

[3] Haedong Academic Grand Award 2013, the Korean Institute of Communications and Information Sciences, Dec. 2013

Associate Professor
Yi, Yung
Joint Professor of Computer Science and Graduate School of Information Security

Laboratory of Network Architecture, Design, and Analysis

RESEARCH INTERESTS
- Design and analysis of computer networking and wireless communication systems
- Congestion control, scheduling and interference management
- Wireless ad hoc network, broadband access networks and network economics and network greening

RECENT RESEARCH ACTIVITIES
• The Laboratory of Network Architecture, Design, and Analysis (LANADA in short) was established in August of 2008 by Prof. Yung Yi. LANADA has performed research on futuristic communication networking systems. Nowadays the communication networking systems have been changed vertically and horizontally at an alarming scale and speed. Horizontally, various network infrastructures such as broadband access networks, wireless cellular / ad-hoc networks, wired core networks, and overlay networks have been evolved and combined together, and also vertically, the division of each layer has become more ambiguous and cross-layer network designs are becoming more and more preferable.

• LANADA has focused on developing algorithmic and practical solutions of networking problems, their performance evaluation and analysis over various communication networking systems. We look at many problems fundamentally and transfer them to practice by developing theory-driven algorithms and protocols. Recently, we also increase our interest in economic aspects in communication networking systems and network greening, and are challenging due to its necessity to view problems from various angles and tools such as stochastic theory, control theory, economic theory, optimization theory, and even biological theory.

• LANADA has established strong collaboration with other research groups inside and outside Korea, such as SK Telecom, Korea Telecom, North Carolina University, Princeton University, University of Texas at Austin, Microsoft Research lab, and Chinese University of Hong Kong. Our recent research publications appear at various top conferences and journals, such as IEEE Infocom, ACM Mobihoc, ACM Sigmetrics, and IEEE / ACM Transactions on Networking.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Hyeryung Jang, Se-Young Yun, Jinwoo Shin and Yung Yi, "Distributed Learning for Utility Maximization over CSMA-based Wireless Multihop Networks," *Proceedings of IEEE INFOCOM, 2014.*

[2] Dongmyung Lee, Donggyu Yun, Jinwoo Shin, Se-Young Yun and Yung Yi, "Provable Per-Link Delay-Optimal CSMA for General Wireless Network Topology," *Proceedings of IEEE INFOCOM, 2014.*

[3] Jungseul Ok, Youngmi Jin, Jinwoo Shin and Yung Yi, "On Maximizing the Diffusion Speed in Social Networks: Impact of Random Seeding and Clustering," *Proceedings of ACM Sigmetrics, 2014.*

Professor
Youn, Chan-Hyun
Member, IEEE / KICS / KIPS

Network and Computing Laboratory

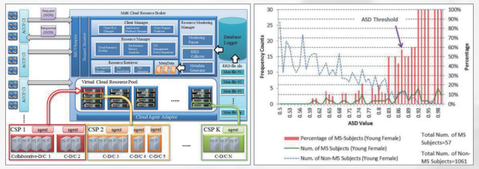
RESEARCH INTERESTS
- High Performance Computing Platform
- Workflow Computing Management in Cloud
- Advanced Healthcare Service System

RECENT RESEARCH ACTIVITIES
Network and Computing Lab (NCL), a founder of Grid Middleware Research Center, has been focusing on key technologies underlying the design and engineering of distributed computing systems and computing middleware. (For more information at http://ncl.kaist.ac.kr)

Our research works in 2013-2014 include

• Policy-based Cloud Collaboration: To deploy advanced computing application services (e.g. scientific application service) to the mobile cloud environment, we implemented a broker system with the integration of mobile cloud broker and cost effective adaptive resource collaboration framework. Especially, we designed the broker interface and its functionalities including policy and profiling based resource management schemes and workflow based system control methodologies.

• Healthcare system in cloud: Chronic diseases care require periodic monitoring, multidimensional quantitative analysis, and the classification of patients' diagnostic information. With the studies of chronological clustering method to analyze the temporal progress of the disease, new services, such as a knowledge-based decision support tool, can be applicable. Also, with the cloud-based personalized healthcare system which supports dynamic provision and configuration of at-home healthcare system in cloud environments, we can provide cost effective and personalized chronic disease care.



MAJOR ACHIEVEMENTS in 2013/2014
[1] S.-J. Jeong, Y.-M Jo, S.-O. Shim, Y.-J. Choi, and C.-H. Youn, "A novel model for metabolic syndrome risk quantification based on areal similarity degree", *IEEE Tr. on Biomedical Eng.,* vol. 61, iss. 3, pp. 665-679, Mar 2014.

[2] L. Peng, C.-H. Youn, and C. Qiao, "Theoretical analyses of lightpath blocking performance in CO-OFDM optical networks with / without spectrum conversion", *IEEE Comm. Lett.,* vol. 17, iss. 4, pp. 789-792, Apr. 2013.

[3] Y.-H. Moon, J.-N. Kim, and C.-H. Youn, "Churn-aware optimal layer scheduling scheme for scalable video distribution in super-peer overlay networks", *J. Supercomput.,* vol. 66, iss. 2, pp. 700-720, Nov 2013.

DEPARTMENT OF
ELECTRICAL ENGINEERING
Annual Report 2013/2014

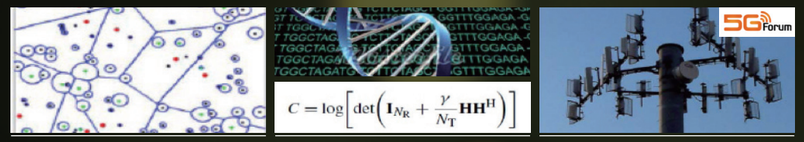
Communications
COM Group

01 l Ubiquitous Mobile Life Systems Laboratory — Professor **Cho, Dong-Ho**
02 l Wireless Communication Systems Laboratory — Associate Professor **Choi, Wan**
03 l Scientific Computing Laboratory — Professor **Chun, Joo Hwan**
04 l Information Theory Laboratory — Professor **Chung, Sae-Young**
05 l Coding and Communication Laboratory — Associate Professor **Ha, Jeongseok**
06 l Wireless Innovative Technologies Laboratory — Professor **Han, Youngnam**
07 l Wireless Communication Systems Laboratory — Associate Professor **Kang, Joonhyuk**
08 l Communications Signal Processing Laboratory — Professor **Kim, Hyung-Myung**
09 l Mobile Communications Laboratory — Professor **Lee, Hwang Soo**
10 l Digital Communications Laboratory — Professor **Lee, Yong Hoon**
11 l Mobile Multimedia Laboratory — Professor **Ma, Joong Soo**
12 l Communications and Storage Laboratory — Professor **Moon, Jaekyun**
13 l Information Processing Systems Laboratory — Professor **Park, Dong-Jo**
14 l Laboratory for Information Transmission — Professor **Park, Hyuncheol**
15 l Statistical Signal Processing Laboratory — Professor **Song, Iickho**
16 l Information Systems Laboratory — Assistant Professor **Suh, Changho**
17 l Wireless Information Systems Research Laboratory — Associate Professor **Sung, Youngchul**

COM Group

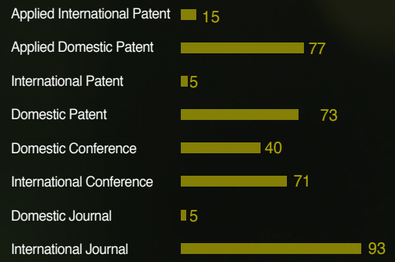
Communications Group conducts fundamental and pioneering study on signals, information, networking, and data storage to provide Giga bps wireless experience for everyone and everywhere. Our research themes include network information theory, error control coding, communication theory, statistical signal processing, network architecture, and radio resource management.

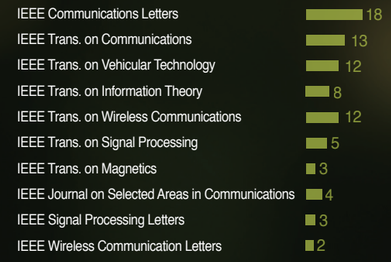
Network architecture and radio resource managements	Information theory and error control coding	Communications theory and statistical signal processing
· Radio resources allocations	· Network information theory	· Massive MIMO
· Wireless protocols	· Interference alignments	· Multiuser MIMO
· Heterogeneous Wireless Networks	· Unlimited wireless comm.	· MM wave beamforming
· Node-centric network	· Network coding	· Cooperative comm.
· Wireless power / info transfer	· Capacity achieving codes	· Wireless localizations
	· Big data mining	· Storage signal processing
	· Physical layer security	· Cognitive radio



Communications Group has 17 Professors, 93 Ph.D. students, and 51 M.S. students. The members of Communications Group have shown outstanding academic leadership as IEEE Fellows, General / Technical Chairs of top conferences, and Editors for top Journals; As of June 2014, 2 professors in our group are IEEE Fellows, 4 professors serve as Editors for *IEEE Tr. Inf. Theory, IEEE J. Sel. Areas in Comm., IEEE Tr. Wireless Comm., IEEE Tr. Veh. Technol. IEEE Signal Process. Lett., and IEEE Wireless Comm. Lett.*, and 2 professors serve as TPC / General Chairs for IEEE ISIT 2014 and IEEE VTC 2014.

From Jan. 2013 to June 2014, leading academia and industry, we have published over 61 journal papers and 32 issued patents.





Professor

Cho, Dong-Ho

Senior Member, IEEE / President, KICS

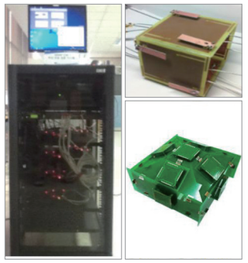
Ubiquitous Mobile Life Systems Laboratory

RESEARCH INTERESTS

- 5th generation wireless communication network
- Magnetic communication & wireless power transfer
- Precise disease diagnostic system based on repetitive element arrangement

RECENT RESEARCH ACTIVITIES

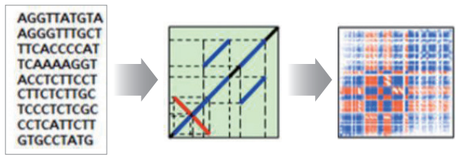
We have researched a novel 5th generation wireless communication system based on the pattern, MIMO technology in beam space domain.



< Prototype of P2BDMA system and antennas>

In the research area of magnetic communication and wireless power transfer system, we have developed a wireless power transfer system which transfers energy efficiently between mid-range coils via the wireless magnetic resonance technology.

Finally, we have verified the hypothesis through the systematic analysis of the DNA sequence including RE array by using various information analysis and modelling technologies.



< DNA sequence > < Alignment and dot matrix > < Repetitive element array >

MAJOR ACHIEVEMENTS in 2013/2014

[1] W.S. Lee, D.H. Cho, “New Cooperation-Based Channel State Acquisition Scheme for Ad Hoc Cognitive Radio Systems,” *IEEE Tr. Veh. Tech.,* vol. 62, no. 7, pp. 3325-3338, Sep. 2013.

[2] D.H. Cho, R.N You, W.C.Kim, et. al., “REViewer: A tool for linear visualization of repetitive elements within a sequence query,” *Genomics,* vol. 102, issue. 4, pp. 209-214, Oct. 2013.

[3] J.G. Shin, S.Y. Shin, D.H. Cho, et. al., “Design and Implementation of Shaped Magnetic-Resonance-Based Wireless Power Transfer System for Roadway-Powered Moving Electric Vehicles,” *IEEE Tr. Industrial Electronics,* vol. 61, no. 3, pp. 1179-1192, Mar. 2014.

Associate Professor

Choi, Wan

Senior Member, IEEE / Member, KICS / Member, IEEK

Wireless Communication Systems Laboratory

RESEARCH INTERESTS

- Wireless communications / communication theory
- Statistical signal processing for communications

RECENT RESEARCH ACTIVITIES

Wireless Communication Systems Lab (WCSL) carries out advanced research on academic and technological fronts in wireless communications. We identify theoretical capacity and performance limits and thereof rooms to improve, and investigate advanced techniques for the improvements. Our research methodologies exploit many advanced analytical tools in matrix theory, analysis, statistics and probability theory, optimization theory, stochastic geometry, and information theory. We find our applications to cooperative communications, interference management, heterogeneous networks, beamforming for the advance of wireless communications.

Our research topics in 2013-2014 include

• Interference Management: Recognizing that interference management is essential for achieving high spectral efficiency, we have studied interference channel models connected with practical environments. We have developed novel key technologies for interference mitigation and theoretically analyzed their gains.

• Limited feedback: The capacity of feedback is typically limited and shared by multiple users in communication systems. Using vector quantization theory, we have studied and identified optimal transmission / reception strategies in various communication systems with limited feedback.

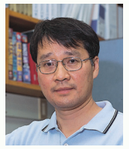
• Compressive sensing: Based on the revelation that a small number of collection of linear projections of a sparse signal contains enough information for stable, sub-Nyquist signal acquisition, compressive sensing finds various applications in communications. We have proposed new communication systems based on compressive sensing, and investigated its gain.

MAJOR ACHIEVEMENTS in 2013/2014

[1] J. H. Lee and W. Choi, “Multiuser diversity for secrecy communications using opportunistic jammer seelction: Secure degrees of freedom and jammer scaling law,” *IEEE Tr. Signal Process.,* vol. 62, no. 4, pp. 828-839, Feb. 2014.

[2] J, H. Lee and W. Choi, “Optimal feedback rate sharing strategy in zero-forcing MIMO broadcast channels,” *IEEE Tr. Wireless Comm.,* vol. 12, no. 6, pp. 2568-2579, June 2013.

[3] S. Cho and W. Choi, “Energy-efficient repulsive cell activation for heterogeneous cellular networs,” *IEEE J. Sel. Areas in Comm.,* vol. 31, no. 5, pp. 870-882, May 2013.



Professor

Chun, Joo Hwan

Senior Member, IEEE

Scientific Computing Laboratory

RESEARCH INTERESTS

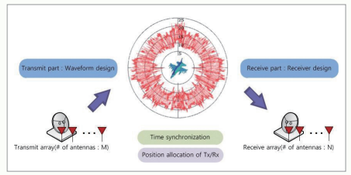
- Radar subgroup
- Development of 5G wireless communication technology and simulator

RECENT RESEARCH ACTIVITIES

Scientific Computing Laboratory has been working on development of algorithms and fundamental techniques in wireless communication and radar systems.

Our research topics in 2013-2014 include

• Radar subgroup: Our research topic ranges from the classical beam synthesis problem to the recent topic such as a distributed and multi-static radar system. We have been developing an active radar system with a cylindrical multi-array.



• Development of 5G wireless communication technology and simulator: In order to increase the capacity of wireless network and reduce the expense of backhole by connecting it to microcell, we develop an integrated technology of VCN and BDMA. VCN offers wireless data communication service through dynamic topology control and monitoring with cooperation amongst multiple antennas, whereas BDMA utilizes spatial multiple access of sharp adaptive beam for multiple antenna array. Based on our research experience with beamforming technology our goal is applying beamforming technology to accurately estimated location of the device and developing an optimal beam management technology. The location of the device is estimated by GPS in the case of outdoor and TDOA / FDOA PN code for the indoor. In addition, we consider optimal adaptive beamforming technique for the time varying channel.

MAJOR ACHIEVEMENTS in 2013/2014

[1] D. Park, E. Yang, S. Ahn and J. Chun, "Adaptive beamforming for low-angle target tracking under multipath interference," *IEEE Tr. Aero Elec and Syst.,* accepted 2014.

[2] N. Lee and J. Chun, "Degrees of freedom for a MIMO Gaussian K-way relay channel: Successive network code encoding and decoding," *IEEE Tr. Inf Theory.,* vol. 60, no. 3, pp. 1814-1821, Mar. 2014.

[3] J. Park, B. Clerckx, J. Chun and B. Jeong, "Lattice reduction-aided successive interference cancellation for MIMO interference channels," *IEEE Tr. Veh. Tech.,* vol. PP, no. 99, Jan. 2014.

Professor

Chung, Sae-Young

Senior Member, IEEE / Member, KICS / Member, IEEK

Information Theory Laboratory

RESEARCH INTERESTS

- Information Theory
- Coding Theory
- Communication Theory & Wireless Communications

RECENT RESEARCH ACTIVITIES

Our main research focus is on information theory and its applications to wireless communications, storage, and signal processing. Specifically, we characterize the fundamental limits of various wireless and wireline communication channels and storage channels. Based on this, we develop schemes that can approach such limits closely. For example, we develop some key technologies for the next generation wireless systems including dirty paper coding, network coding, rateless coding, and new cooperation strategies for relay networks.

Research activities in 2013-2014

• Wireless communication achieving unlimited degrees of freedom: We characterize information-theoretic fundamental limits of wireless communication by combining Maxwell’s equations and Shannon’s information theory [1]. We show that, unlike previous belief, unlimited degrees of freedom can be achieved theoretically for any transceiver of finite physical size. This enables new antenna designs that can potentially provide a huge gain over conventional antenna arrays.

• Capacity characterization for relay networks: We characterize information-theoretic capacity region of a class of linear binary field multisource relay networks [2]. We observe that fading can play an important role in mitigating inter-user interference effectively for both single-hop and multi-hop networks. We propose new coding schemes with randomized ergodic channel pairing.

• Multicast tree networks: We characterize the capacity of a new class of discrete memoryless multicast networks having a tree topology [3]. For achievability, a novel coding scheme is constructed where some relays employ a combination of decode-and-forward and compress-and-forward and the other relays perform a random binning.

MAJOR ACHIEVEMENTS in 2013/2014

[1] W. Jeon and S.-Y. Chung, “The capacity of wireless channels: A physical approach,” in Proc. *IEEE International Symp. on Information Theory,* Istanbul, Turkey, Jul. 2013.

[2] S.-W. Jeon and S.-Y. Chung, "Capacity of a class of linear binary field multisource relay networks," *IEEE Tr. Inf. Theory,* vol. 59, no. 10, pp. 6405-6420, Oct. 2013.

[3] S.-H. Lee and S.-Y. Chung, "Capacity of a class of multicast tree networks," *IEEE Tr. Inf. Theory,* vol. 59, no. 6, pp. 3848-3857, June 2013.

Associate Professor

Ha, Jeongseok

Member, IEEE / Member, KICS / Member, IEEK

Coding and Communication Laboratory

RESEARCH INTERESTS

- Error-control codes (ECCs) for storage devices
- Information theoretic and physical layer security
- Wireless communications and communication theory

RECENT RESEARCH ACTIVITIES

Coding and Communications lAb (CoCoA) was established in 2004 by Professor Jeongseok Ha. The research interests of the CoCoA include the general area of communication systems, coding theory, and physical layer security. CoCoA has on-going projects in signal processing and error-control system design for storage devices, information theoretic security and theories / practice of advanced error-control codes such as LDPC codes, Turbo codes and Polar codes.

Our research topics in 2013-2014 include

• Error-control systems for NAND flash memories: SSDs (Solid-state Drives) using NAND flash memories have many advantages over traditional hard disks (HDDs), e.g. higher throughput and low power consumption. As technology scaling progresses for increasing storage capacity, error rate of stored data in SSDs sharply grows. To resolve such technical challenges, CoCoA has been conducting intensive researches on developing efficient error-control systems for NAND flash memory based SSDs.

• Physical layer security: Due to the broadcast nature of wireless channels, wireless communication is especially vulnerable to security threats. The physical layer security provides unique solutions to such security threats. CoCoa have been studying physical layer security techniques and cross-layer optimization between the application and physical layers to provides innovative solutions to security issues in the future distributed communication networks such as Internet of Things.

• Wireless Communications: In recent years, there have been unprecedented demands on data throughputs of wireless networks. CoCoA is currently developing coding techniques for next general cellular systems, and modulation techniques for chip-to-chip communication systems based on advanced communication, signal processing and coding theories.

MAJOR ACHIEVEMENTS in 2013/2014

[1] J. Oh, J. Ha, J. Moon, and G. Ungerboeck, "RS-Enhanced TCM for Multilevel Flash Memories," *IEEE Tr. Comm.,* vol. 61, no. 5, pp. 1674-1683, May 2013

[2] H. Jeon, S. McLaughlin, I. Kim, and J. Ha "Secure Communications with Untrusted Secondary Nodes in Cognitive Radio Networks," *IEEE Tr. Wireless Comm.,* vol. 13, no. 4, pp. 1790-1805, Apr. 2014

[3] S. Cho, D. Kim, J. Choi, and J. Ha "Block-wise Concatenated BCH Codes for NAND Flash Memories," *IEEE Tr. Comm.,* vol. 62, issue 4, pp. 1164-1177, Apr. 2014

Professor

Han, Youngnam

Senior Member, IEEE

Wireless Innovative Technologies Laboratory

RESEARCH INTERESTS

- Wireless communications / communication theory
- Radio resource management

RECENT RESEARCH ACTIVITIES

Researches in wireless innovative technologies laboratory (witLab) focus on wireless communication systems engineering and networking. The witLab is conducting research to improve the wireless network performance and design innovative and efficient algorithms for current and next-generation wireless communication systems. The research contribution of witLab is mainly to the methodologies for the efficient use of radio resource management (RRM) that may be the main issue of the future wireless network due to the scarcity of wireless resources such as frequency, power, and space.

Our research topics in 2013-2014 include

• Radio resource management: Networks where a user equipment can transmit its data over multiple radio access technologies simultaneously are named multi-radio access (MRA) system. Studies are rare on the optimal solution of joint resource (i.e., RAT, BW, and power) allocation for a parallel MRA scheme from a viewpoint of a scheduler, partly due to the fact that these are multi-dimensional optimization problems with complexity. We have studied the optimal resource allocation issues to support parallel MRA for much higher system capacity.

• Vertical handover: In heterogeneous wireless networks with a mixture of macro and small BSs, efficient vertical handover is necessary for a mobile terminal to support seamless service among different access networks. We have studied vertical handover schemes to accomplish green wireless networks

• Location based service: We have focused on designing smartphone-based indoor positioning algorithm using embedded inertial sensors without global positioning system (GPS) or Wi-Fi positioning system (WPS).

MAJOR ACHIEVEMENTS in 2013/2014

[1] J. Kim, W. Choi, S. Nam, and Y. Han, "An Efficient Pre-whitening Scheme for MIMO Cognitive Radio Systems," *IEEE Tr. Veh. Tech.,* vol.63, no.4, pp. 1934-1939, May 2014.

[2] Y. Song, P-Y. Kong, and Y. Han, "Power-optimized Vertical Handover Scheme for Heterogeneous Wireless Networks," *IEEE Commun. Lett.,* vol.18, no.2, pp. 277-280, Feb. 2014.

[3] S. Nam, J. Kim, and Y. Han, "A User Selection Algorighm Using Angle between Subspaces for Downlink MU-MIMO Systems," *IEEE Tr. Comm.,* vol. 62, no. 2, pp. 616-624, Feb. 2014.

Associate Professor

Kang, Joonhyuk

Member, IEEE / Member, KICS

Wireless Communication Systems Laboratory

RESEARCH INTERESTS

- Wireless communications / communication theory
- Signal processing for digital communication

RECENT RESEARCH ACTIVITIES

The research of Advanced Radio Technology(ART) laboratory focuses on signal processing for digital communication systems. The various related topics are being studied such as Massive Multiple-Input Multiple-Output (Massive MIMO) for green communication, cognitive radio(CR) for spectral efficiency, collaborative signal processing for physical-layer security. We also do researches on localization without using Global Positioning Systems for indoor applications.

Our research topics in 2013-2014 include

• Massive MIMO: While the research on multiple-input multiple-output (MIMO) techniques has focused on increasing link reliability and spectral efficiency, the new direction is being established for the energy efficient communications. By installing hundreds of antennas on transmitting part, the significant amount of energy can be saved. Our focus is on the optimal design of the beamformer for the energy saving problem.

• Cooperative Communication: Cooperative communication systems, such as multi-cell coordinated system and relay based system, provide reliable data transmission that satisfies user's QoS. We study the optimal relay's beamformer design for various objectives.

• Localization: For location-aware services, the less complex but accurate ranging technology is essential. We develop low-complexity algorithms for super-resolution time-of-arrival or angle-of-arrival estimation, which can be used for sensor networks or for WiFi and cellular networks.

MAJOR ACHIEVEMENTS in 2013/2014

[1] J. Kang, O. Simeone, J. Kang, and S. Shamai (Shitz), "Joint Signal and Channel State Information Compression for the Backhaul of Uplink Network MIMO Systems", *IEEE Tr. Wireless Comm.,* Vol. 13, No. 3, pp. 1555-1567, Mar. 2014

[2] HumanTech Award 2014 (Two Bronze Awarded to supervising students, J. Kang and S. Jeong)

[3] K. Lee, C Chae, and J Kang, "Spectrum Leasing via Cooperation for Enhanced Physical-Layer Secrecy," *IEEE Tr. Veh. Tech.,* Vol. 62, No. 9, pp. 4672-4678, Nov. 2013

Professor

Kim, Hyung-Myung

Senior Member, IEEE

Communications Signal Processing Laboratory

RESEARCH INTERESTS

- Resource allocation in wireless communication systems
- Statistical signal processing for wireless communications

RECENT RESEARCH ACTIVITIES

Communications Signal Processing Lab (CSP LAB) carries out advanced research on signal processing in wireless communication systems. We have investigated advanced techniques to improve the system performance with various research topics and communication systems. Recently, we research on channel estimation, precoder design and resource allocation in multiple-input multiple-output (MIMO) two-way relay systems. We also consider the physical layer security and various systems with co-channel interference (CCI) for the next generation communication systems.

Our research topics in 2013-2014 include

• Channel estimation: For practical system designs, an accurate channel state information (CSI) is needed to improve the system performance. A popular approach is to estimate CSI by the aid of a priori known training signals. We study the channel estimation schemes for many systems such as MIMO and two-way relay systems.

• Precoder design: In wireless communication, the use of antenna arrays at the transmitter can greatly improve the spectral efficiency and system performance such as data rate and bit error rate (BER). One of the principal methods to use the antenna arrays is precoder design. In order to maximize data rate or to minimize BER, we research on the precoder design in MIMO two-way relay systems.

• Resource allocation with limited feedback: In OFDM-based communication networks, such as LTE systems, resource (subcarriers, power) allocation is essential for achieving high data rate. For practical system, we investigate the resource allocation strategies with limited feedback based on statistical channel state information.

MAJOR ACHIEVEMENTS in 2013/2014

[1] S. W. Keum, D. H. Kim, and H. M. Kim, "An improved frequency offset estimation based on companion matrix in multi-user uplink interleaved OFDMA systems," *IEEE Signal Process. Lett.,* vol. 21, no. 4, pp. 409-413, Apr. 2014.

[2] D. H. Kim, M. Ju, and H. M. Kim, "Optimal training signal design for estimation of correlated MIMO channels in two-way amplify-and-forward relay systems," *IEEE Comm. Lett.,* vol. 17, no. 3, pp.491-494,Mar. 2013.

[3] D. W. Lim, C. J. Chun, J. H. Lee, and H. M. Kim, "Power allocation for time division broadcast protocol over Rayleigh fading channels," *IEEE ICNC,* San Diego, USA, Jan. 2013.

Professor
Lee, Hwang Soo
Member, IEEE / Member, KICS / Member, IEIE

Mobile Communications Laboratory

RESEARCH INTERESTS
- Wireless communication theory
- Statistical signal processing for communications
- Safety communication in vehicular networks

RECENT RESEARCH ACTIVITIES
Mobile Communications Lab (MCL) carries out advanced researches on various issues in wireless communications. We analyze theoretical performance bounds on communication systems by using analytical tools such as statistics and probability theory, optimization theory, and information theory. We also develop advanced communication schemes with the consideration on the real implementation. Our research interests include cooperative communication schemes, interference management, and congestion control.

Our research topics in 2013-2014 include

• Interference Management: Interference management has been a crucial issue in wireless communication systems. We consider the interference channel models, which can reflect the realistic network, and develop novel schemes for the interference mitigation while satisfying the given required quality of service (QoS). Also, we analyze the achievable degrees-of-freedom (DoF) according to the network environment, which denotes the number of data streams independent of the interference. For the interference management, we consider various types of interference management schemes such as interference alignment, fractional frequency reuse, and directional antennas, etc.

• Beacon Broadcast for Safety Application in Vehicular Networks: In the vehicular networks, the beacon broadcast for the safety application is considered as a solution to reduce the real vehicle accident. In the vehicular network, the safety message should be received at each vehicular terminal while satisfying the two following requirements: small delay and high reception rate. We analyze the reception rate of the safety message in the vehicular network and develop the scheme which enhances the performance in terms of delay and packet deliver rate.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. Yoon, W.-Y. Shin, and H. S. Lee, "Energy-efficient opportunistic interference alignment," *IEEE Commun. Lett.,* vol. 18, no. 1, pp. 30-33, Jan. 2014.

[2] Y. H. Cho, S. Seo, J.-S. Song, S.-H. Lee, and H. S. Lee, "Adaptive fractional time reuse for multi-cell OFDMA networks," *IEEE Comm. Lett.,* vol. 17, no. 9, pp. 1798-1801, Sep. 2013.

[3] H. Song and H. S. Lee, "A Survey on Vehicle Density Estimation in Vehicular Safety Communications and its Challenging Issues," *Int. IEEE Conf. Intel. Transp. Syst.,* Hague, Netherlands, Oct. 2013.

Professor
Lee, Yong Hoon
Member, The National Academy of Engineering of Korea (NAEK)

Digital Communications Laboratory

RESEARCH INTERESTS
- Physical layer design
- Communication signal processing

RECENT RESEARCH ACTIVITIES
Digital Communications LAB (DCLAB) actively conducts research on physical layer design and signal processing for next generation mobile communication systems. Current research activities include the following:

• Massive MIMO systems and mm-wave communication: Recently massive MIMO (Multi Input Multi Output) and mm-wave systems have received considerable attention as useful tools for achieving the target capacity of 5G mobile communications (e.g. 1,000 times the 4G system capacity). Both massive MIMO and mm-wave systems employ a large number of antennas and require novel signal processing techniques that can increase the capacity with minimal overhead. Compressed sensing is a promising technique for these systems. We are developing channel estimation and beamforming techniques for massive MIMO and mm-wave systems based on compressed sensing.

• Energy efficient communication: The energy efficiency, which is the ratio of the spectral efficiency (capacity) over the total power consumption, has been recognized as an important metric for energy efficient 5G communications. We are investigating the design of energy efficient cooperative 5G communication systems.

• Signal processing for antennas and RF devices: To reduce either the size or the overhead of conventional MIMO systems, new antenna structures such as ESPAR (Electrically Steerable Parasitic Array Radiator) and OAM (Orbital Angular Momentum) have been proposed recently. We are investigating signal processing techniques for the ESPAR and OAM. In addition, we study signal processing for recent power amplifiers (PAs) such as envelop tracking PAs.

MAJOR ACHIEVEMENTS in 2013/2014
[1] B. Chun, C. Kim, and Y. H. Lee, "Reduced complexity beamforming with optimal power allocation in two-way multi-antenna relay systems," *IEEE Comm. Lett.,* vol. 17, no. 5, pp. 848-851, May 2013.

[2] W. Shin, S-Y. Chung, and Y. H. Lee, "Parallel opportunistic routing in wireless networks," *IEEE Tr. Inf. Theory,* vol. 59, no. 10, pp. 6290-6300, Oct. 2013.

[3] K. Lee, J. Yang, H. Kwon, H. Park, and Y. H. Lee, "Closed form of optimum cooperative distributed relay amplifying matrix," *IEEE Tr. Wireless Comm.,* vol. 13, no. 5, pp. 2741-2755, May 2014.

Professor
Ma, Joong Soo
Member, IEEE / Member, KICS / Member, IEICE

Mobile Multimedia Laboratory

RESEARCH INTERESTS
- Analysis and Design of Communication Network Protocols
- Multi-Channel Multi-Radio Wireless Mesh Networks
- Localization of Multi-hop Neighbors

RECENT RESEARCH ACTIVITIES
Mobile Multimedia Lab conducts research on performance evaluation of next generation wireless networks and develops advanced network protocols and algorithms for improving network performances or for enabling new applications. A WMN (Wireless Mesh Network) is an advanced technology of forming communication networks directly between user nodes in an ad hoc manner without requiring any infrastructure support. A WMN can be an effective networking solution in environments where physical cabling is not feasible or too time-consuming as in battle fields or in disaster areas. Also WMNs can save high cabling costs in many commercial applications.

Our research topics in 2013-2014 include

• Multi-channel multi-radio medium access control and routing protocol in an ad hoc WMN: Nodes constantly monitor channel usage and received signal strength. They exchange these information with their neighbors. Nodes adopt noble algorithms for estimating distances to their multi-hop nodes to identify conflicting nodes. Nodes can conflict as contention nodes or as hidden, collision nodes. Nodes allocate channels and routes to maximize the network-wide total throughput in a distributed manner. Our research results show that a significant performance improvement is possible with our noble algorithm of identifying contention nodes in comparison to traditional hop-count-based methods.

• Estimation of External Interference: Many independent networks can co-exist in license-free frequency bands. Channel usages must add up for correct estimation of interference. In this research, we explore different methods of handling external interference measurements from neighbors and compare their relative accuracies.

• VoIP Service in Wireless Mesh Network

• Wireless Mesh Network Testbed and Simulator.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S. C. Choi and J. S. Ma, "Novel distance estimation algorithm of two-hop neighbors in wireless sensor networks," International Conference on Advanced Communications Technology, Pyeongchang, Korea, Feb. 2014.

[2] S. C. Choi and J. S. Ma, "Comparison of distance estimation accuracy in wireless sensor networks," Joint Conference on Communications and Information, Yusu, Korea, Apr. 2014.

[3] K. H. Lee, J. Y. Choi, and J. S. Ma, "Performance evaluation for delay time estimation in IEEE 802.16m sleep mode," Peer-to-peer Networking and Applications, Springer, Apr. 2014.

Professor
Moon, Jaekyun
Fellow, IEEE

Communications and Storage Laboratory

RESEARCH INTERESTS
- Channel characterization, signal processing and coding for data storage and digital communication
- Coding and equalization for interference-dominant channels

RECENT RESEARCH ACTIVITIES
The ComSto Lab's current research emphasis is on how to design coding and equalization schemes geared to known or partially known interference structures. Interference-dominant channels are an important current trend in any crucial communication systems including high-speed computer buses, wireless Femto cells, high-density Flash memory, high-density hard disk drives, multi-giga networks and underwater communications. ComSto's interests cover a broad spectrum of disciplines ranging from mathematical theory to low-complexity FPGA / VLSI architecture solutions, all with applications to communication and storage in mind.

Wireless / Wireline Communication

• Wireless / wireline systems suffer from increasingly severe interference. One way to cope with the highly structured interference channel is to try to understand or estimate the structure of the interference and then design the signals. Our own current efforts are on channel estimation and equalization for interference-limited communication channels. In particular, we are developing joint channel estimation and detection / decoding strategy based on optimal estimation theory expanded to handle iterative processing of soft decisions.

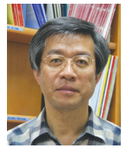
Storage Channels

• The demand for data storage space will continue to grow with the explosion of digital data and multimedia contents. Advanced coding and signal processing are a key technology that can make next generation ultra-high-density and ultra-high-speed storage possible. As packing density increases in storage, nearby data cells interact with one another creating mutual interference. In this case, efficient 2-dimensional equalization becomes critical in recovering data error-free. Error-correction coding geared to specific error patterns that are known to dominate the sector failure rate is also a fruitful research area that we are currently pursuing.

MAJOR ACHIEVEMENTS in 2013/2014
[1] G. Yu and J. Moon, "Concatenated Raptor Codes in NAND Flash Memory," *IEEE J. Sel. Areas in Comm.,* vol. 32, no. 5, pp. 857-869, May 2014.

[2] S. Jeong and J. Moon, "Self-Iterating Soft Equalizer," *IEEE Tr. Comm.,* vol. 61, no. 9, pp. 3697-3709, Sep. 2013.

[3] J. Moon, J. No, S. Lee, S. Kim, S. Choi and Y. Song, "Statistical Characterization of Noise and Interference in NAND Flash Memory," *IEEE Tr. Circuits Syst. I, Reg. Papers,* vol. 60, no. 8, pp. 2153-2164, Aug. 2013.



Professor

Park, Dong-Jo

Member, IEEE / Member, KICS / Member, IEEK / Member, ICROS

Information Processing Systems Laboratory

RESEARCH INTERESTS

- Wireless Communication Systems
- mmWave Channel Modeling
- Imaging Processing

RECENT RESEARCH ACTIVITIES

Information processing and systems laboratory (IPSL) is focusing on two major parts: wireless communication systems and multimedia information processing including image processing, hyperspectral remote sensing, and Lidar systems. Students are enthusiastically involved in researches and projects.

Our research topics in 2013-2014 include

• Communication Signal Processing:
-Research objective: future 5G communication technology
-Details: relay communication, spectrum sensing, compressed sensing, cell clustering
-Application area: cooperative communication, cognitive radio, massive MIMO system, spatial modulation, virtual cellular network

• mm-Wave Channel Measurement / Modeling:
-Research objective: Spatial Channel Modeling (SCM) for 28 GHz
-Details: SCM parameters, statistical analysis (using horn antennas)
-Application area: MIMO channel realization for system level simulation, analysis on indoor / outdoor channel characteristics at 28 GHz

• Hyperspectral Imaging Systems / FTIR:
-Research objective: design of hyperspectral imaging system / FTIR system design
-Details: hyperspectral imaging processing, FTIR signal processing
-Application area: detection and identification of materials and gases

MAJOR ACHIEVEMENTS in 2013/2014

[1] Y. J. Cho and D. J. Park, "Closed Form Expressions for Detection Threshold and Sample Size for Spectrum Sensing Considering Instantaneously Non-Identically Distributed Samples," *IEEE Comm. Lett.,* vol. 18, no. 2, pp. 233-236, Feb. 2014.

[2] Y. H. Cho and D. J. Park, "Timing Estimation Based on Statistical Change of Symmetric Correlator for OFDM Systems," *IEEE Comm. Lett.,* vol. 17, no. 2, pp. 397-400, Feb. 2013.

[3] J. Kwun, Y. Cho, D. Park, S. Park and W. Choi, *Inter-cell interference coordination method and apparatus for use in mobile communication system,* US 2014 / 0128117 A1, United States, May 8, 2014.

Professor

Park, Hyuncheol

Senior Member, IEEE / Member, KICS / Member, IEEK

Laboratory for Information Transmission

RESEARCH INTERESTS

- Transmission technologies in communication systems
- Advanced signal processing for communications
- Cross layer optimization

RECENT RESEARCH ACTIVITIES

The Laboratory for Information Transmission (LIT) has conducted researches in theoretical analysis and practical design of transmission technologies in communication systems. LIT aims to study and develop key technologies in the field of wireless communications such as millimeter-wave beamforming for 5G mobile, user scheduling and multiuser MIMO detection, and link-adaptation using machine learning.

Our research topics in 2013-2014 include

• Millimeter-wave beamforming: Researches on millimeter wave beam-forming technologies have been conducted for 5G mobile communications systems. In millimeter wave channel, the conventional MIMO technologies cannot be used because of the high path-loss which results in the limited scattering. For this reason, the millimeter-wave MIMO technologies such as digital and hybrid beamforming structure, adaptive beamforming algorithm, and multi-user MIMO technologies in millimeter wave channel are being focused.

• User selection and Multiuser MIMO detection: Demands for high-speed wireless communication have driven the continuing effort of the multiuser MIMO system. Major challenges in the multiuser MIMO system are user selection, and inter-user interferences. Since total number of users is normally larger than that of users which can be supported at the base station, there are various approaches to improve the system performance. The configuration of the multiuser MIMO system with low complexity and high effectiveness such as user scheduling and precoding schemes are focused.

• Link adaptation using machine learning: Adjusting transmission parameters is an important task for having efficient transmissions in wireless channel. Optimal link adaptation algorithms are developed using machine learning approach, especially focused on supervised learning and reinforcement learning. Improved transmission performance is obtained by effectively reflecting wireless channels and finding optimal solutions.

MAJOR ACHIEVEMENTS in 2013/2014

[1] C. Shin, H. Park, and H. M. Kwon, "PHY-Supported Frame Aggregation for Wireless Local Area Networks," *to appear, IEEE Tr. Mobile Computing.*

[2] J. Kim and H. Park, "A Coding Scheme for Visible Light Communication with Wide Dimming Range," *IEEE Photon. Tech. Lett.,* vol. 26, no. 5, pp. 465-468, Mar. 2014.

[3] K. Kim, H. Park, and H. M. Kwon, "New Subcarrier Allocation for Uplink-OFDMA under Time-Varying Channels," *IEEE Tr. Comm.,* vol. 61, no. 1, pp. 7-12, Jan. 2013.

Professor

Song, Iickho

Member, ASK / Member, IEEK / Member, KICS / Fellow, IEEE / Fellow, IET / Fellow, KAST

Statistical Signal Processing Laboratory

RESEARCH INTERESTS

- Communication theory: Spectrum sensing for cognitive radio
- Feature extraction for massive data processing
- Statistical signal processing

RECENT RESEARCH ACTIVITIES

Research activities in the Statistical Signal Processing Laboratory have mainly been on the fundamental theory and applications of various communication / signal processing techniques. Particularly, we have focused on the studies related to weak signal detection, code acquisition, frequency synchronization, and multiple-input multiple-output (MIMO) system, and have obtained various interesting results.

Recently, we have addressed the following quintessential problems:

• Decoding schemes for MIMO systems: We have proposed a near maximum likelihood (ML) scheme for the decoding of MIMO systems. By employing the technique of hypothesis testing in the searching procedure based on the metric-first search, the proposed decoding scheme provides higher efficiency than those of other conventional near ML decoding schemes.

• Wideband spectrum sensing scheme for cognitive radio: We have proposed novel detection schemes of spectrum sensing for cognitive radio with multiple receive antennas operating over a wideband channel composed of a multitude of subbands. By taking the observations in all subbands into consideration in the likelihood functions for sensing a subband, the proposed schemes provide better performance than other conventional schemes.

• Complexity-reduced scheme for discriminant analysis: By reformulating the constraint of the discriminant analysis, we have transformed the problem of obtaining the feature extractor of the discriminant analysis into a linear equation problem, which can be solved by Cholesky decomposition, allowing a complexity reduction. The proposed scheme offers a significantly lower complexity than conventional schemes at a competent pattern recognition performance.

MAJOR ACHIEVEMENTS in 2013/2014

[1] S. R. Park, I. Song, S. Yoon, T. An, and H.-K. Min, "On the sums of probability functions of order statistics," *J. Korean Stat. Soc.,* vol. 42, no. 2, pp. 257-265, June 2013.

[2] I. Song, S. Lee, S. R. Park, and S. Yoon, "Asymptotic value of the probability that the first order statistic is from null hypothesis," *Applied Math.,* vol. 4, no. 12, pp. 1702-1705, Dec. 2013.

[3] I. Song, C. H. Park, K. S. Kim, and S. R. Park, *Random Variables and Random Processes,* Freedom Academy, 2014.

Assistant Professor

Suh, Changho

Information Systems Laboratory

RESEARCH INTERESTS

- Information Theory & Coding Theory

RECENT RESEARCH ACTIVITIES

• Interactive communication: Feedback is one of the important topics in a wide variety of research areas such as control and communications. It is well known that feedback has a significant role to play in stabilizing control systems or improving the reliability of communication links. However, the earlier results on feedback capacity in communications were somewhat discouraging. This is mainly due to Shannon's result in the 50s, where he showed that feedback cannot increase the capacity in point-to-point communication links. Hence, the use of feedback has been so far limited to improving the reliability of communication, usually in the form of ARQ. We have found a promising role of feedback in networks. What we have shown is that when there are two interfering point-to-point links, not only feedback can increase the capacity of each link, it can in fact provide an unbounded increase in capacity. This work has contributed to changing traditional viewpoint on the role of feedback, winning the Best Student Paper Award of the IEEE International Symposium on Information Theory 2009.

• Interference alignment: Inspired by a recent breakthrough, the concept of interference alignment, we developed an interference alignment technique for cellular networks. This work has contributed to providing a new practical insight into the design of cellular networks, winning the 2013 IEEE Communications Society Stephen O. Rice Prize.

• Distributed storage networks: Drawing parallels between wireless and storage networks through the interference alignment principle, we have addressed one of the significant problems in distributed storage networks: the storage repair problem. Specifically, with a deep understanding of this connection, we leverage the interference alignment principle to develop a new class of Maximum Distance Separable codes that achieve information-theoretic optimal bound on the repair cost of all admissible code parameters. The conference version of the paper won a finalist of the Best Student Paper Award of the IEEE International Symposium on Information Theory 2010.

MAJOR ACHIEVEMENTS in 2013/2014

[1] S. Lashgari, S. Avestimehr and C. Suh, "Linear degrees of freedom of the X-Channel with delayed CSIT," *IEEE Tr. Inf. Theory,* vol. 60, no. 4, pp. 2180-2189, Apr. 2014.

[2] V. Cadambe, S. Jafar, H. Maleki, K. Ramchandran and C. Suh, "Asymptotic interference alignment for optimal repair of MDS codes in distributed storage," *IEEE Tr. Inf. Theory,* vol. 59, no. 5, pp. 2974-2987, May 2013.

[3] S. H. Chae, C. Suh and S.-Y. Chung, "Degrees of freedom of the rank-deficient interference channel with feedback," *submitted to the IEEE Tr. Inf. Theory,* (arXiv:1307.1461), July 2013.

Associate Professor
Sung, Youngchul
Senior Member, IEEE / Member, IEEK / Member, KICS

Wireless Information Systems Research Laboratory (WISRL)

RESEARCH INTERESTS

- Statistical signal processing: Inference, large deviations, information geometry
- Wireless communication systems and theory

RECENT RESEARCH ACTIVITIES

WISRL focuses on communication, networks and statistical inference. The research topics include signal processing, statistical inference and information geometry with applications to next generation wireless communications and related fields. The research direction of WISRL is two-fold. First, WISRL is conducting research to improve the performance and devise innovative methods for current and next wireless communication systems. Second, WISRL is trying to advance the fundamental understanding of information embedding and related statistical inference associated with large data set that will be the main issue of the system area in the future. The current research topics are briefly introduced below.

• Next generation wireless communications: We are inventing effective interference control methods, new multi-user MIMO scheduling algorithms and system architectures with significant performance improvement over existing methods for wireless communication networks. Currently, we are investigating major physical-layer issues for 5G wireless networks such as massive MIMO (pilot design, transmit signal design, user scheduling), optimal interference control (the rate-region Pareto-optimal transmit beamforming).

• Statistical signal processing, inference, information geometry, and learning: Statistical signal processing, statistical inference and learning are basic tools for making prediction and decision based on incomplete data. This field has been an important branch in the signal processing area and has gained a recent interest in the era of big data. In this field, WISRL is investigating new possibilities and invention of more efficient inference algorithms based on sparsity, Riemannian manifold structures, information geometry, and other optimization tools.

MAJOR ACHIEVEMENTS in 2013/2014

[1] Song Noh, Michael Zoltowski, Youngchul Sung*, and David Love, "Pilot beam pattern design for channel estimation in massive MIMO systems," *IEEE Journal of Selected Topics in Signal Processing,* vol. 8, no. 5, pp. 787 – 801, Oct. 2014.

[2] J. Park and Y. Sung, "On the Pareto-optimal beam structure and design for multi-user MIMO interference channels," *IEEE Tr. Signal Process.* vol. 61, no. 23, pp. 5932-5946, Dec. 2013.

[3] M. Yukawa, Y. Sung, and G. Lee, "Dual-domain adaptive beamformer under linearly and quadratically constrained minimum variance," *IEEE Tr. Signal Process.* vol. 61, no. 11, pp. 2874-2886, Jun. 2013.

DEPARTMENT OF
ELECTRICAL ENGINEERING
Annual Report 2013/2014

Circuits and Systems

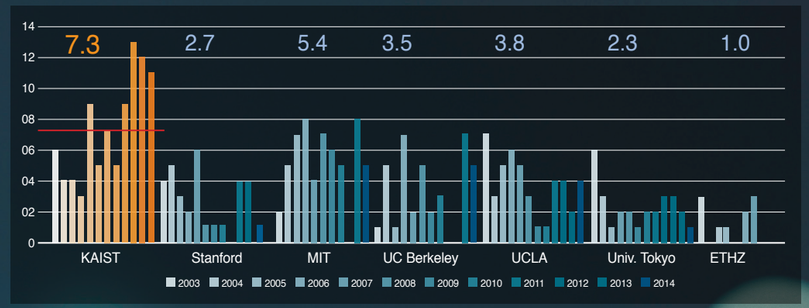
CS Group

01 I Nanoscale Advanced Integrated System Laboratory
02 I Computer-Aided Design for “X” (CAD4X) Laboratory
03 I Circuit Design And System Application Laboratory
04 I Communication Circuits and Systems Laboratory
05 I System VLSI Laboratory
06 I Multimedia VLSI Laboratory
07 I Smart Sensor Architecture Laboratory
08 I Nano Integrated Circuits Expertise Laboratory
09 I Integrated Computer Systems Laboratory
10 I Mixed-Signal Integrated Circuits Laboratory
11 I Micro Computing Laboratory
12 I Semiconductor Systems Laboratory

Associate Professor **Bae, Hyeon-Min**
Professor **Chang, Naehyuck**
Professor **Cho, Gyu-Hyeong**
Professor **Cho, SeongHwan**
Professor **Choi, Hae-Wook**
Professor **Kim, Lee-Sup**
Professor **Kyung, Chong-Min**
Professor **Lee, Sang Gug**
Professor **Park, In-cheol**
Associate Professor **Ryu, Seung-Tak**
Professor **Shin, Youngsoo**
Professor **Yoo, Hoi-jun**

CS Group

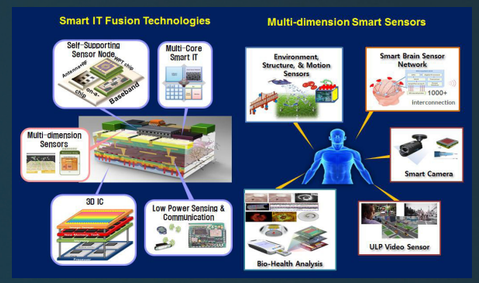
ISSCC Papers 2003-2014 KAIST Ranks #1 (12 years Avg.) among universities



Circuits and systems (CS) group is recognized as a world top group in circuits and systems area specializing digital, analog, mixed-mode, circuits and systems design. Currently, 12 professors, 103 Ph.D. students, and 80 master students constitutes CS group with worldly renowned research reputation and expertise. Thanks to the efforts of CS group, KAIST has been able to keep the position of number one academic institute in the number of ISSCC (International Solid-State Circuits Conference) paper publication on the average in the past 12 years. ISSCC is a top conference that is recognized as a circuits and systems technology olympic. In 2013, two professors in CS group has been recognized as top 10 paper contributors of ISSCC in the past 10 years.

The research subjects that have been focused by the members of CS group includes optical transceivers, time-to-digital converters, sensors and biomedical circuits, integrated smart sensors, bio-diagnostic sensor ICs, brain imaging system, energy harvesting ICs, wireless power transfer ICs, display driver ICs, touch screen readout ICs, microprocessor, VLSI for communication and multimedia, multimedia processor, THz system ICs, wireless transceivers, etc.

As a future research direction, CS group focuses on smart IT fusion technologies and multi-dimension smart sensors with constituting core technologies shown in the figure on the right side.



Associate Professor

Bae, Hyeon-Min

TPC Member, IEEE

Nanoscale Advanced Integrated System Laboratory

RESEARCH INTERESTS

- Clock Data Recovery (100Gbps Ethernet)
- Next Generation Interconnect (E-TUBE)
- Functional Neural Interface (NIRS)

RECENT RESEARCH ACTIVITIES

The relentless scaling of feature sizes exemplified by Moore's Law has enabled the application of sophisticated signal processing techniques to high speed broadband communication links employing mixed analog and digital architectures and circuits. The Nanoscale Advanced Integrated Systems (NAIS) Laboratory focuses on developing innovative solutions by jointly optimizing algorithm, architecture, and circuits for broadband systems.

Our research topics in 2013-2014 include

• 100Gbps Ethernet: 100Gb/s parallel CDR with 25.0~28.3Gb/s per lane in 8mm X 8mm standard BGA package for CFP4 / QSFP28 modules, supporting CEI-28G-VSR specifications. It consumes only 0.75W power with 0.25~1.3V TX output swing and 40mV RX sensitivity at 10-15 BER. It features reference-less / master-less mode and jitter filtering operation with no external filter capacitor required.

• E-TUBE: Copper based interconnect has been widely adopted for various high-speed wireline communications owing to its cost / power efficiencies. However, the skin effect exerts a fundamental limitation on the utilization of metallic interconnects for high-speed communications. Given that, we are proposing a completely new ultra high speed / cost-effective / low power / short reach (1~2m) interconnect solution.

• NIRS: Portable functional brain imaging systems would enable us to sense the brain regions associated with daily activities. We propose an efficient data extraction method that produces increased spatial resolution in NIRS (Near Infrared Spectroscopy for Portable Brai Imaging System) without sacrificing the temporal resolution.

MAJOR ACHIEVEMENTS in 2013/2014

[1] H. S. Won, J. H. Han, T. H. Yoon and H. M. Bae, the Presidential Award, Korean Intellectual Property Office (KIPO), Oct. 2013

[2] K. H. Kwon, J. H. Yoon, S. W. Kwon, J. Y. Yang, J. Y. Lee, H. S. Won, H. M. Bae,"A 6Gb/s transceiver with a nonlinear electronic dispersion compensator for directly modulated distributed-feedback lasers," *IEEE International Solid-State Circuits Conference 2014*, San Francisco, Feb. 2014.

[3] J. K. Choi, M. G. Choi, J. M. Kim, H. M. Bae, "Efficient Data Extraction Method for Near Infrared Spectroscopy (NIRS) Systems with High Spatial and Temporal Resolution," *IEEE Transactions on Biomedical Circuits and Systems*, vol. 7, no. 2, pp. 1-9, April 2013

Professor

Chang, Naehyuck

Fellow, IEEE / Distinguished Scientist, ACM / Member, KIISE

Computer-Aided Design for "X" (CAD4X) Laboratory

RESEARCH INTERESTS

- Low-Power Systems
- Embedded System and Energy-Efficient System Design
- Electromobility

RECENT RESEARCH ACTIVITIES

CAD4X (Computer-aided design for 'X') stands for systematic design and optimization using computer-aided design of beyond semiconductor circuits and systems including energy systems. The CAD4X laboratory is one of the leading groups in power and energy optimization from embedded systems applications to large scale energy systems. The CAD4X Laboratory has introduced numerous world-first innovative techniques for device- and system-level power / energy measurement / estimation, LCD power reduction, low-power SDRAM and flash memory systems, FPGA power minimization, practical issues on dynamic voltage scaling, fuel cell and battery hybrid power source for portable systems, hybrid electrical energy storage systems, dynamically reconfigurable photovoltaic cell arrays, storage-less and converter-less maximum power point tracking, and so forth. Introducing a full-custom electric vehicle, the CAD4X laboratory recently initiated systematic optimization of electric vehicles and electromobility.

The CAD4X laboratory publishes above-mentioned research contribution at premier venues including journals, magazines, conferences, symposia and workshops. The CAD4X laboratory pursuits practically applicable design and optimization techniques, and most of the developed techniques have been demonstrated with working prototypes at ISLPED design contest and Design Automation Conference University Booth.

MAJOR ACHIEVEMENTS in 2013/2014

[1] Q. Xie, Y. Wang, Y. Kim, M. Pedram, and N. Chang, "Charge allocation in hybrid electrical energy storage systems," *IEEE Tr. Computer-Aided Design of Integrated Circuits and Syst.*, vol. 32, no. 7, pp. 1003–1016, Jul. 2013.

[2] Outstanding Dissertation Award 2013, European Design and Automation Association, Jan. 2014. (Winner: Younghyun Kim, Advisor: Nahyuck Chang)

[3] Y. Kim, B. Koh, Q. Xie, Y. Wang, N. Chang, and M. Pedram, "A scalable and flexible hybrid energy storage system design and implementation," *Elsevier J. Power Sources*, vol. 255, pp. 410–422, Jun. 2014.

Professor

Cho, Gyu-Hyeong

Senior Member, IEEE / Associate Editor, JSSC

Circuit Design And System Application Laboratory

RESEARCH INTERESTS

- Power Management IC (DC-DC Converter)
- Energy Harvesting
- Data Drivers for LCD and AMOLED Displays

RECENT RESEARCH ACTIVITIES

Circuit Design and System Application Laboratory is established in KAIST in 1984. 10 master course students and 18 doctoral course students in our laboratory are currently enrolled in the list of the graduate course of KAIST. Researchers and administrative members in our laboratory are led by professor Gyu-Hyeong Cho. Main areas are

• Power Management IC: IC is important in portable electronic devices which get their operation powers from batteries. Power management technology can generate various controlled voltages from a battery which is required for the sub-circuits in the device. SIMO can generate multiple controlled voltages from a single battery with single inductor, which can reduce the size and cost of the DC to DC converters.

• Energy Harvesting: Nowadays, A technology for obtaining energy from the surrounding environment by using energy harvesting device has been focused recently. A interface circuit which supplies a constant energy to drive the electronic device is essential because the energy changes according to the surrounding environment. And energy harvesting supplied by several harvesting source interface circuit is used to charge a battery of wireless sensor network or a mobile device

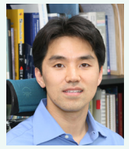
• Data Drivers for LCD and AMOLED Displays: Our researches in data driver ICs for displays are mainly focused on high resolution and low power-consumption in driving schemes. Another special interest in our research is aiming at AMOLED displays. Innovative driving schemes and dedicated circuits for AMOLED drivers have been developed for fast and accurate AMOLED data driver ICs.

MAJOR ACHIEVEMENTS in 2013/2014

[1] J. H. Choi, S. K. Yeo, S. H. Park, J. S. Lee and G. H. Cho, "Resonant Regulating Rectifiers (3R) Operating for 6.78 MHz Resonant Wireless Power Transfer (RWPT)" *IEEE J. Solid-State Circuits*, vol. 48, no. 12, pp. 2989-3001, Dec. 2013.

[2] Y. S. Yuk, S. C. Jung, H. D. Gwon, S. H. Choi, S. D. Sung, T. H. Kong, S. W. Hong, J. H. Choi, M. Y. Jeong, J. P. Im, S. T. Ryu and G. H. Cho "An energy pile-up resonance circuit extracting maximum 422% energy from piezoelectric material in a dual-source energy-harvesting interface" *IEEE International Solid-State Circuits Conference*, San Francisco, CA, Feb. 2014.

[3] W. Y. Qu, J. P. Im, H. S. Kim and G. H. Cho, " A 0.9V 6.3μW Multistage Amplifier Driving 500pF Capacitive Load with 1.34MHz GBW" *IEEE International Solid-State Circuits Conference,* San Francisco, CA, Feb. 2014.



Professor

Cho, SeongHwan

Senior Member, IEEE

Communication Circuits and Systems Laboratory

RESEARCH INTERESTS

- Low-noise, low-power Phase-Locked-Loops(PLL)
- High speed, high resolution, low power Data Converters
- Biomedical circuits & low-power CMOS sensors

RECENT RESEARCH ACTIVITIES

Communication Circuits and Systems Lab (CCS) explores emerging technologies for various high-performance, low-power wired and wireless communication and biomedical systems. Our main area of focus is in the design and implementation of analog and mixed-signal integral circuits with multiple layers of system abstraction in mind, from algorithms, protocols, and system architectures to circuit techniques.

Our research topics in 2013-2014 include

• Phase-locked-loops: Phase-locked loops provide precise generation and alignment of timing signals for a wide variety of applications including frequency synthesizers, clock and data recovery circuits for micro-processors, DSP, and ADCs. We have focused on the issue of achieving low-jitter and low-power phase-locked loops, and developed high performance fractional-N-PLL, ADPLL, MDLL etc.

• Data Converters: Time-to-Digital converter (TDC) has become increasingly more important with the advent of digital-friendly analog circuits such as ADPLL / DLLs. We have studied and identified high-order ΔΣ TDCs which have low integrated noise and complexity, and proposed pipelined TDCs for achieving finer time resolutions and the highest conversion rates.

• Biomedical circuits & CMOS sensors: Pulse Wave Velocity (PWV) is a measure of arterial stiffness and one of the important indicators to diagnose cardiovascular diseases such as hypertension, stroke and arrhythmia. We adapted ECG and bio-impedance method to get the body signals and utilized a noise-shaped body-channel communication method that does not require any cumbersome wires over the body.

MAJOR ACHIEVEMENTS in 2013/2014

[1] K.S. Kim, Yu. W and S.H. Cho, "A 9b, 1.12ps resolution 2.5 b/Stage Pipelined Time-to-Digital Converter in 65nm CMOS Using Time-Register," *IEEE J. Solid-State Circuits*, vol. 49, no.4, pp. 1007–1016, 2014.

[2] K.S. Kim, Y.H. Kim, W. Yu and S.H. Cho, "A 7b, 3.75ps resolution two-step time-to-digital converter in 65nm CMOS using pulse-train time amplifier," *IEEE J. Solid-State Circuits*, vol. 48, no. 4, pp. 1009-1017, 2013.

[3] W. Lee, and S.H. Cho, "An Integrated Pulse Wave Velocity Sensor using Bio-impedance and Noise-shaped Body Channel Communication," *IEEE Symposium on VLSI Circuits*, 2013.

Professor
Choi, Hae-Wook

System VLSI Laboratory

RESEARCH INTERESTS
- System VLSI of reconfigurable core IP design

RECENT RESEARCH ACTIVITIES
Main research topics of the System VLSI Lab (SVL) include reconfigurable core IP design for important system algorithms, MPSoC based Intelligent NoC design, and energy harvesting sensor / actuator network design for IT convergence systems.

Reconfigurable Core IP Design for Important System Algorithms: One of the big issues in advanced system design is how to effectively implement its complex algorithms with realtime and low-power requirements. The System VLSI Lab's approach is to thoroughly analyze the system algorithms and devise some optimal architectures that meet conflicting system requirements. These architectures are system algorithm core IPs (Intellectual Properties). System algorithms of interest in the lab are those of cryptography, 3D-multimedia and Mobile communication. Currently, we are focusing on core IP design for elliptic curve cryptography (ECC) algorithm. MPSoC based Intelligent NoC Design: 'Small, Green and Smart' is today's keyword. To achieve this, the lab, SVL, is conducting research on MPSoC based intelligent NoC (networkon-chip). An NoC is composed of MPSoC, i.e., many microprocessors and / or DSPs, memories, and on-chip network (OCN). It is very small, consumes low energy and analyzes very complex phenomena. MPSoC based Intelligent NoC design includes parallel processing, energy calculation methodology, network parameter evaluation and modeling, and SoC design methodology. Main application areas of interest are noisy video and audio signal processing.

Energy Harvesting Sensor / Actuator Network Design for IT Convergence Systems: A world wide issue is 'IT Convergence'. That is to apply well advanced IT technologies to science and engineering. In this regard, the System VLSI Lab is focusing on Energy Harvesting Convergence Sensor / Actuator Network Design in the ocean and fishery science / engineering and plant science. The electric energy is obtained by conversion from the sun, wind, wave, & movement. The science and engineering requirement adapted sensors and actuators are properly applied to the system in question and optimally networked.

MAJOR ACHIEVEMENTS in 2013/2014
[1] H. Y. Rha, C. J. Youn, E. S. Nam, and H.-W. Choi, "Simple full-range carrier frequency offset estimation for high speed CO-OFDM," *Optics express,* vol. 21, pp. 23896-23906, 2013.

[2] H. Y. Rha, B. G. Jeon, and H.-W. Choi, "Efficient guard interval reduction for coherent optical OFDM," in *Optical Fiber Communication Conference,* p. Th2A. 26, 2014.

[3] Thu Phuong Nguyen, Le Quy Don et al., "Spatial Modulation for High-Rate Transmission Systems" *IEEE Vehicular Technology Conference,* VTC-2014, pp. 18-21, May 2014.

Professor
Kim, Lee-Sup
Senior Member, IEEE

Multimedia VLSI Laboratory

RESEARCH INTERESTS
- Energy-efficient multimedia processor design
- High-speed interface circuits
- DRAM architecture & Memory controllers

RECENT RESEARCH ACTIVITIES
Multimedia VLSI Lab (MVLSI) pursues highly novel technologies that cover a wide range of VLSI designs from analog and digital circuits to computer architecture. Our research has steadily made a valuable contribution to VLSI design technologies. We respect all kinds of academic novel ideas which are challenging and innovative to VLSI design world, targeting at the top-notch conferences and journal papers in the world. Our research methodologies include a variety of design and verification skills such as chip implementation, simulator design, and so on. We are always ready to start a new research area if it is critical to VLSI technology developments.

Our research topics in 2013-2014 include
• Image Recognition Accelerator: Vision application is one of the challenging topics that have real-time issues. We have came up with a novel algorithm that is most appropriate for hardware and implemented the algorithm as a chip. It achieved a highly energy-efficient real-time vision system that supports full HD resolution.

• High-speed Receiver With Jitter Filtering: One of the issues that should be solved is many kinds of jitters existing in chip-to-chip communications. We developed a novel high-speed forwarded clock receiver while achieving low-power implementation simultaneously. For low-power circuits, we exploited Injection-Locked Oscillator (ILO).

• Low-latency Memory Systems: The bottleneck of modern computer systems is long latency of data access in memory systems. To solve this problem, we proposed a novel memory controller that exploits DRAM's circuit phenomena. That's why we made a low-latency memory system without any modification of existing DRAM. Given the cost-sensitive DRAM market, it is a big advantage for implementation.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Y.-J. Kim and L.-S. Kim, " A 12Gb/s 0.92mW/Gb/s Forwarded Clock Receiver based on ILO with 60MHz Jitter Tracking Bandwidth Variation Using Duty Cycle Adjuster in 65nm CMOS," *IEEE International symposium on VLSI Circuits,* Kyoto, Japan, June 2013.

[2] H.-E. Kim, J.-S. Park, J.-S. Yoon, S.-H. Kim, and L.-S. Kim, "A 1mJ frame Unified Media Application Processor with Dynamic Analog-Digital Mode Reconfiguration for Embedded 3D-Media Contents Processing," *IEEE J. Solid-State Circuits,* vol. 48, no. 13, pp.1970-1985, Aug. 2013.

[3] W. Shin, J. Yang, J. Choi, and L.-S. Kim, "NUAT: A Non-Uniform Access Time Memory Controller," *IEEE International Symposium on High-Performance Computer Architecture,* Orlando, Florida, USA, Feb. 2014. (Best Paper Runner-up Award)

Professor
Kyung, Chong-Min
Fellow, IEEE

Smart Sensor Architecture Laboratory

RESEARCH INTERESTS
- Smart camera system
- Low power and low cost depth estimation

RECENT RESEARCH ACTIVITIES
Smart Sensor Architecture Laboratory (SSAL) pursues advanced research on smart sensor systems, where smart means intelligent, compact and energy-aware. Applications include surveillance / vehicular camera system and health-monitoring apparatus such as capsule endoscope. Research focus is on the design of system architecture, event detection algorithm, image signal processor and CMOS image sensor for the smart camera system. It also includes development of depth estimation algorithm considering accuracy and space / time complexity. SSAL operates in team worked efforts based on universal sensor system development platform with proper technology road map and working scenarios for each research item, which is essential to accomplish this goal.

Our research topics in 2013-2014 include
• Smart camera system design: Most surveillance cameras today consume too much energy, or most low-power cameras today are not smart enough. We implement low-power, low cost and reliable camera system which can be used and applied in practical situation. It includes development of system architecture, design of system architecture, event detection algorithm, image signal processor and CMOS image sensor.

• Development of depth estimation algorithm: Obtaining depth information from camera consumes heavy resource, because its algorithm requires long computing time, high memory usage and high hardware complexity. We develop fast and accurate depth estimation algorithms which can extract depth information from blur based image using single camera. It requires low-power, low hardware complexity and it should be performed in real-time with high accuracy.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S. Lee, K. Kang, J. Jung and C.-M. Kyung, "Runtime 3-D stacked cache data management for energy minimization of 3-D chip-multiprocessors", *IEEE Int'l Symp. on Qual. Elec. Design,* Santa Clara, USA, Mar. 2014.

[2] Best Paper Award, International Symposium on Quality Electronic Design, Mar. 2014.

[3] S. Lee, K. Kang and C.-M. Kyung, "Runtime thermal management for three-dimensional chip-multiprocessors with hybrid SRAM / MRAM L2 cache", *IEEE Tr. VLSI Systems* Mar. 2014.(Accepted)

Professor
Lee, Sang Gug
Member, IEEE

Nano Integrated Circuits Expertise Laboratory

RESEARCH INTERESTS
- RF Integrated Circuit(IC) and transceiver system
- CMOS Tera-Hertz(THz) communication and imaging system
- Automotive IC / Power management IC

RECENT RESEARCH ACTIVITIES
Nano Integrated Circuits Expertise Laboratory (NICE LAB) has been working on the research for CMOS Integrated Circuit design since 1998. NICE Lab's research area covers a wide range of frequency including analog integrated circuit, RF integrated circuit, and Tera-Hertz. The Lab's recent research topics include wake-up transceiver, RFID system, automotive narrow band impulse radar, automotive switch driver, power management circuit and THz RF integration technology, etc.

Our research topics in 2013-2014 include
• Sub-THz communication and THz imaging system: Research on THz amplifier, Shottky barrier diode, plasma wave detector, passive sub-harmonic mixer, transmission line, and others devices to realize THz source and detectors using CMOS technology.

• RF circuit and transceiver design: As the main research area of NICE lab, subjects include low noise amplifier, mixer, voltage controlled oscillator, phase locked loop, and other components and systems used for wireless communication systems such as wake-up and automotive radar. Recent research is focused on low power transceivers due to the uprising demand for low-power RF transceivers crucial for future ubiquitous lifestyle.

• Automotive ICs: Researches on low-cost hardware and signal-processing, automotive stop lamp switch driver IC, accelerator pedal angle sensing IC.

• Power management IC: Research and development on energy harvesting circuits and power management ICs such as DC-DC converter and battery charger.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S. S. Lee, J. H. Lee, I. Y. Lee, S. G. Lee, and J. H. Ko "A New TX Leakage-Suppression Technique for an RFID Receiver Using a Dead-Zone Amplifier" *IEEE International Solid-State Circuits Conf.(ISSCC),* San Francisco, CA, USA, Feb. 2013.

[2] J. Y. Bae, S. N. Kim, H. S. Cho, I. Y. Lee, D. S. Ha, and S. G. Lee, "A CMOS Wideband Highly Linear Low-Noise Amplifier for Digital TV Applications," *IEEE Tr. on Microwave Theory and Tech.* vol. 61, no. 10, pp. 3700-3711, Oct. 2013.

[3] I. Y. Lee, S. S. Lee, D. G. Im, S. J. Kim, J. K. Choi, S. G. Lee and J. H. Ko, "3.7 A fully integrated TV tuner front-end with 3.1dB NF, >+31dBm OIP3, >83dB HRR3 / 5 and >68dB HRR7," *IEEE International Solid-State Circuits Conf.(ISSCC),* San Francisco, CA, USA, Feb. 2014.

Professor
Park, In-cheol
Senior Member, IEEE

Integrated Computer Systems Laboratory

RESEARCH INTERESTS
- The design of microprocessors
- VLSI design for error correcting codes
- VLSI design for communication systems

RECENT RESEARCH ACTIVITIES
The research focus of Integrated Computer Systems Laboratory (ICSL) is on computer architecture, embedded processors, and VLSI architectures for computationally intensive function blocks, such as error correcting code blocks and communication systems

Our research topics in 2013-2014 include

• The design of microprocessors: Many kinds of processors have been 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 has been developed together with its corresponding development environment such as compiler, assembler and debugger.

• 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. Energy-efficient high-throughput architectures are proposed for decoding concatenated-BCH (CBCH) codes to improve the reliability of MLC NAND flash memory. In addition, a low-power LDPC decoder optimized for NAND flash is devised. Also, a multi-rate turbo decoder for mobile communication standards such as 3GPP LTE and LTE-Advanced is developed to achieve near-optimal error-correcting performance.

• VLSI design for communication systems: A low-complexity MIMO symbol detector for wireless communications systems is proposed to reduce the number of operators significantly, especially multipliers, without degrading the bit error rate.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Y. Lee, H. Yoo, J. Jung, J. Jo and I.-C. Park, "A 2.74pJ/bit, 17.7Gb/s Iterative Concatenated-BCH Decoder in 65nm CMOS for MLC NAND Flash Memory," *IEEE J. Solid-State Circuits,* vol. 48, no. 10, pp. 2531-2540, Oct. 2013.

[2] B. Kim, I. Yoo and I.-C. Park, "Low-Complexity Parallel QPP Interleaver Based on Permutation Patterns," *IEEE Tr. Circuits and Syst. II: Express Briefs,* vol. 60, no. 3, pp. 162-166, March 2013.

[3] B. Kong and I.-C. Park, "Hardware-efficient tree expansion for MIMO symbol detection," *Electronics Letters,* vol. 49, no. 3, pp. 226-228, Jan. 2013.

Associate Professor
Ryu, Seung-Tak
Senior Member, IEEE / Member, IEEK

Mixed-Signal Integrated Circuits Laboratory

RESEARCH INTERESTS
- Circuits and architectures for A / D and D / A conversion
- Analog readout circuits for various sensor applications
- Design methodology for scalable mixed-signal circuits

RECENT RESEARCH ACTIVITIES
Mixed-Signal Integrated Circuits Lab (MSICL) carries out researches on analog and mixed-signal circuits design with emphasis on data conversion techniques. With strong fundamentals of analog circuits and intuitions on circuit behaviors obtained from numerous experiences of design and measurement, we have developed various state-of-the-art class prototype ICs including low-power high-speed ADCs and compact DACs. Based on specialty in analog-digital interfaces, recent research topics have been extended to various sensor applications such as CMOS image sensors, bio-signal acquisition and battery monitoring systems, and digital-intensive design methodology for automated design generation.

Our research topics in 2013-2014 include

• Data converters: In order to satisfy demands for lower power and higher speed in data converters, we have developed various circuit techniques and architectures including time-domain latch interpolation technique for flash ADCs, 2b/cycle architectures, and flash-assisted time-interleaving scheme for high speed SAR ADCs.

• Readout circuits for various sensors: Power-efficient and FPN-reducing readout scheme for CMOS image sensors is newly proposed and actively studied. A high resolution battery monitoring circuit is being developed through coworking with industry.

• Design methodology (automation) for mixed-signal circuits: Recognizing most parts of mixed-signal IPs are occupied by digital circuits, researches on design automation have been conducted and a prototype generated recently has proved the proposed design methodology can reduce the time required for data converter development significantly.

MAJOR ACHIEVEMENTS in 2013/20144
[1] G. Oh, C. Lee, and S. Ryu, "A 10 b 40 MS/s Pipelined ADC with Wide Range Operating Temperature for WAVE Applications," *IEEE Tr. Circuits and Systems II,* vol. 61, no. 1, pp. 6-10, Jan. 2014.

[2] J. Kim, B. Sung, W. Kim, and S. Ryu, "A 6 bit 4.1 GS/s Flash ADC with Time-domain Latch Interpolation in 90nm CMOS," *IEEE J. Solid-State Circuits,* vol.48, no.6, pp.1429-1441, June 2013.

[3] H. Hong, H. Kang, B. Sung, C. Lee, M. Choi, H. Park, and S. Ryu, "An 8.6 ENOB 900 MS/s Time-Interleaved 2b/cycle SAR ADC with a 1b/cycle Reconfiguration for Resolution Enhancement," *IEEE ISSCC. pp.* 470-471. Feb. 2013.

Professor
Shin, Youngsoo
Senior Member, IEEE

Micro Computing Laboratory

RESEARCH INTERESTS
- Low-power design
- Lithography-aware design
- Mesh clock network

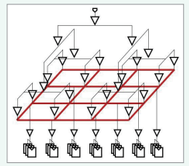
RECENT RESEARCH ACTIVITIES
We do research on how we compute in micro scale. In traditional silicon computing, the topics we are interested in include mesh clock network, lithography-aware design, low-power design, logic synthesis, structured ASIC, timing analysis, and thermal analysis. We are also interested in non-traditional or alternative computing such as imprecise circuits, hierarchical temporal memory, and molecular computing.

Our research topics in 2013-2014 include

• Low-power design: we have researched timing error correction in a razor-based pipeline architecture and gate-level clock gating synthesis. In conventional razor architecture, several clock cycles are needed to correct timing error; it is a major obstacle of voltage scaling. We supposed one cycle error-correction technique to reduce the limitation. Gate-level clock gating, which is a promising scheme to help RTL clock gating, requires an efficient implementation of clock gating logic. We suggested a technique to simplify gating logic by using the existing logic as far as possible.

• Lithography-aware design: technology node continuously shrinks down, but the lithography process can not support that fine feature. So, a lithography defect originated from the lithography process has been become more important. We attempt to optimize design with considering lithography limitations and yield.

• Mesh clock network: clock mesh is less susceptible to on-chip process variation, and, thus, has widely been studied recently for a clock network of smaller skew. We are focusing our research effort on the development of a practical mesh clock network for large and complex industrial designs.



MAJOR ACHIEVEMENTS in 2013/2014
[1] I. H. Han and Y. S. Shin, "Simplifying clock gating logic by matching factored forms," *IEEE Tr. Very Large Scale Integration Systems,* vol. 22, no. 6, pp. 1338-1349, June. 2014.

[2] Y. S. Shin, I. S. Shin, D. K. Baek, D. H. Kim and S. H. Paik, "HAPL: heterogeneous array of programmable logic using selective mask patterning," *IEEE Tr. Circuits and Systems I,* vol. 61, no. 1, pp. 146-159, Jan. 2014.

[3] D. K. Baek, I. S. Shin and Y. S. Shin, "Accurate gate delay extraction for timing analysis of body-biased circuits," *IEEE J. Circuits, Systems, and Computers,* vol. 22, no. 8, Sep. 2013.

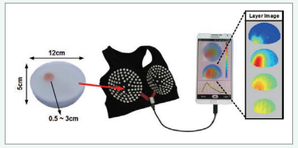
Professor
Yoo, Hoi-jun
TPC Chair, ISSCC / Associate editor, TCAS-II / Fellow, IEEE

Semiconductor Systems Laboratory

RESEARCH INTERESTS
- Humanistic Intelligence Systems(AR, Automotive Vehicle, AI)
- Wearable Healthcare(EIT, P-FCB, BCC, Neuro-feedback)

RECENT RESEARCH ACTIVITIES


< Augmented Reality (AR) >



< EIT >

Our research topics in 2013-2014 include

• Electrical Impedance Tomography IC: Electrical Impedance Tomography (EIT) has been studied to measure the impedance distribution around the breast as an alternative cancer detection method. We proposed compact and convenient breast cancer detection system using EIT.

• Augmented Processor for HMD Applications: Augmented reality (AR) is being investigated in advanced displays for the augmentation of images in a real-world environment. We proposed a high-throughput low-energy AR processor mainly targeted for advanced 3D AR HMD applications.

• Neuro-feedback Processor: Recently, mental diseases have been successfully treated by neuro-feedback therapy based on Quantitative EEG (QEEG) and Event Related Potential (ERP) online data measurements. We proposed a wearable mental healthcare system for real-time regulation, which has not only mental health status monitoring function but also mental health therapeutic purposes such as neuro-feedback and non-invasive stimulations.

MAJOR ACHIEVEMENTS in 2013/2014
[1] K. H. Kim, J. O. OH, S. L. Lee and H. J. Yoo, "An 86 mW 98GOPS ANN-Searching Processor for Full-HD 30 fps Video Object Recognition With Zeroless Locality-Sensitive Hashing," *IEEE J. Solid-State Circuits,* vol. 48, no. 7, pp. 1615-1624, July. 2013.

[2] J. O. OH, K. H. Kim, B. G. Nam and H. J. Yoo, "A 57 mW 12.5 μJ/Epoch Embedded Mixed-Mode Neuro-Fuzzy Processor for Mobile Real-Time Object Recognition," *IEEE J. Solid-State Circuits,* vol. 48, no. 11, pp. 2894-2907, Nov. 2013.

[3] K. S. Song, U. S. Haa, J. H. Lee, K. Y. Bong and H. J. Yoo, "An 87- mA·min Iontophoresis Controller IC With Dual-Mode Impedance Sensor for Patch-Type Transdermal Drug Delivery System," *IEEE J. Solid-State Circuits,* vol. 49, no. 1, pp. 167-168, Jan. 2014.

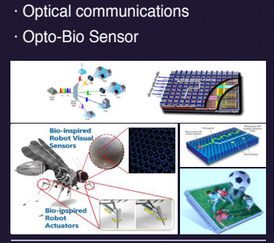
Electromagnetics and Photonics
EP Group

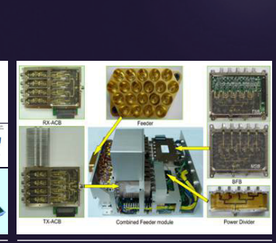
01 I Lightwave Systems Research Laboratory — Professor **Chung, Yun Chur**
02 I Electromagnetic Wave Laboratory — Professor **Eom, Hyo Joon**
03 I Optical Communications Laboratory — Associate Professor **Kim, Hoon**
04 I Terahertz Interconnection and Package Laboratory — Professor **Kim, Joungho**
05 I Photonics Networks Research Laboratory — Professor **Lee, Chang-Hee**
06 I Photonics Application Laboratory — Professor **Lee, Man Seop**
07 I Electromagnetic Theory and Technology Laboratory — Professor **Myung, Noh-Hoon**
08 I Nano Electronic and Photonic Systems Laboratory — Professor **Park, Hyo-Hoon**
09 I Microwave and Antenna Laboratory — Professor **Park, Seong-Ook**
10 I Convergence Optoelectronic Device Engineering Laboratory — Professor **Won, Yong Hyub**
11 I Radio Frequency Sensor System Laboratory — Professor **Yu, Jong-Won**
12 I Integrated Nanophotonics Laboratory — Associate Professor **Yu, Kyoungsik**

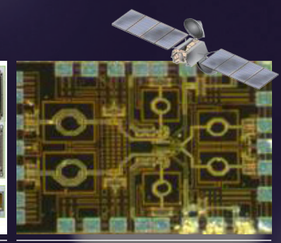
EP Group

Electromagnetics and photonics group research activities cover the two areas; the one research area focus on the electromagnetics scattering, diffraction, wave propagation, including RF / Microwave and Millimeter-Wave Circuits, Antennas, packaging, system, the other area conduct research in the photonic areas of photonics, quantum optoelectronics, optical communication, nanostructure optical device, nanophotonics, optical sources, optical MEMS, biophotonics.

Photonics / Optics	Antenna & Systems	Electromagnetics & RF / MW
· Photonic devices	· Antenna and Active Antenna System	· Microwave Circuit and System
· Photonic interconnections	· Microwave to Sub-millimeter Defense	· RF / MW / mm Device & system
· 3D Display	· Nonlinear Electromagnetics in nano	· Electromagnetic Theory
· Nano Photonics		
· Optical communications		
· Opto-Bio Sensor		







Application areas of our group include the physics, devices, and systems using electromagnetics and photonics, for applications including communications, display, energy, green sphere, imaging, health care, sensing, security, and nanostructure.

From Jan. 2013 to June 2014, leading academia and industry, we have published over 86 journal papers and 40 issued patents.

International Patent	4
Domestic Patent	38
Applied International Patent	10
Applied Domestic Patent	30
Domestic Conference	30
International Conference	50
Domestic Journal	4
International Journal	86

Optics Express	8
Electronics Letters	7
IEEE Transactions on Components Packaging and Manufacturing Technology	6
Journal of Lightwave Technology	6
Microwave and Optical Technology Letters	6
IEEE Transactions on Antennas and Propagation	5
IEEE Photonics Technology Letters	4
Progress in Electromagnetics Research-PIER	4
IEEE Photonics Journal	3
Optics Communications and Letters	3

Professor
Chung, Yun Chur
Fellow, IEEE / Fellow, OSA /
President-Elect, OSK

Lightwave Systems Research Laboratory

RESEARCH INTERESTS
- Lightwave communication systems & networks

RECENT RESEARCH ACTIVITIES
Lightwave Systems Research Laboratory (LSRL) works on various aspects of lightwave communication systems, networks, and related technologies. In particular, we endeavor to identify the fundamental limitations imposed on the lightwave systems / networks, and discover new practical solutions to overcome such limitations. Our research activities include both experimental and theoretical works. We have a well-equipped laboratory to support these activities with state-of-the-art test gears and various types of advanced components and simulation tools. Recently, we have been working on ultrahigh-speed (>100 Gbps) fiber-optic transmission systems, space-division-multiplexing (SDM) techniques, digital coherent detection techniques, advanced modulation formats, optical performance monitoring techniques, WDM passive optical networks, and wireless backhaul / fronthaul networks.

Our research topics in 2013-2014 include

• High-speed coherent WDM PON: We have developed the high-speed WDM PON operating at the per-wavelength speed of >10 Gbps by using RSOAs and digital coherent detection technique. We have also evaluated the maximum operable speed of the RSOA-based WDM PON by using the Shannon theorem.

• Space-division-multiplexing technique: The transmission capacity of the optical fiber is rapidly approaching its fundamental limit. Recently, it has been proposed to overcome this limitation by using the space-division-multiplexing (SDM) technique over the multi-core / multi-mode fibers. We have evaluated the impacts of using multi-level modulation formats on the ultimate transmission capacity of the multi-core fiber and developed a practical solution to utilize SDM in the conventional multi-mode fibers for data-center applications.

MAJOR ACHIEVEMENTS in 2013/2014
[1] H. K. Shim, K. Y. Cho, U. H. Hong and Y. C. Chung, “Transmission of 40-Gb/s QPSK upstream signal in RSOA-based coherent WDM PON using offset PDM technique,” *Optics Express,* vol. 21, no. 3, pp. 3721, Feb. 2013.

[2] J. H. Chang, H. G. Choi, and Y. C. Chung, “Achievable capacity improvement by using multi-level modulation format in trench-assisted multi-core fiber systems,” *Optics Express,* vol. 21, no. 12, pp. 14262, June. 2013.

[3] K. Y. Cho, U. H. Hong, H. G. Choi, and Y. C. Chung, “Maximum operable speed of WDM PON employing bandwidth-limited RSOAs,” *Optics Comm.,* vol. 312, pp. 159, Feb. 2014.

Professor
Eom, Hyo Joon
Senior Member, IEEE

Electromagnetic Wave Laboratory

RESEARCH INTERESTS
- Mode-matching for electromagnetic boundary-value problems
- Electromagnetic scattering and propagation
- Antenna modeling

RECENT RESEARCH ACTIVITIES
The Electromagnetic Wave Laboratory develops new analytic solutions of mode-matching method for electromagnetic problems. The research covers a wide range of electromagnetics and microwave engineering including electromagnetic wave scattering, radiation, diffraction, antennas, and waveguides. We intend to solve the boundary-value problems by using the Fourier transform and the mode-matching method. We use various transform techniques to solve scattering problems for canonical aperture geometries. Our theoretical approach has direct relevance to electromagnetic interference / compatibility, electrostatic / magnetostatic problems, acoustic problems, and microwave antenna applications.

Our research topics in 2013-2014 include

• Various transform applications: Different transforms are utilized and applied to circular cylindrical structures often encountered in electromagnetic and microwave circuits / systems. The applications of various transforms, which are interesting approaches in electromagnetic scattering, yield very compact analytic solutions to electromagnetic scattering problems.

• Cell-modeling: Wave propagation along the TEM cell and its derivatives are investigated by using the eigenfunction expansions. The cell-modeling based on the eigenfunction expansion and the mode-matching method yields simple and computationally efficient solutions, which estimate TEM, TM, and TE waves in various cell structures.

• Slot antenna model: Using the Green's function approach, we formulate radiation from current sources placed in slotted structures. This study provides fundamental analytic solutions to the slotted antenna problems.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. Choo, H. J. Eom, and D. Kim, “Characteristic impedance of pyramidal transmission line,” *IEEE Antennas Wireless Propag. Lett.,* vol. 12, pp. 445-447, 2013.

[2] D. Kim, H. J. Eom, and Y. S. Lee, “Electrostatic solution for 3-port pyramidal cell,” *IEICE Electron. Express,* vol. 11, no. 10, pp. 1-6, 2014.

Associate Professor
Kim, Hoon
Senior Member, IEEE

Optical Communications Laboratory

RESEARCH INTERESTS
- Lightwave communication systems, subsystems, and networks
- Fiber-optic communication systems

RECENT RESEARCH ACTIVITIES
Optical communications have shaped up the modern communication infrastructure for a couple of decades. Not only optical communications connect the continents through trans-oceanic transport systems, they are also being used at every corner of the globe in the forms of terrestrial backbone networks, fiber-to-the-home systems, mobile backhaul / fronthaul systems, in-building access networks, data center networks, and home appliances. It is also expected that fiber-optic cables will replace most of high-speed electrical communication wires in the near future.

Optical Communications Lab has engaged in research activities on various aspects of lightwave communication systems and related technologies, including high-capacity fiber-optic communication systems, broadband optical access systems, and lightwave subsystems.

Our research topics in 2013-2014 include

• Optical access networks using vertical-cavity surface-emitting laser diodes (VCSELs): We utilize 1.5-μm low-cost VCSELs for cost-sensitive optical access networks. We identify the technical challenges of using this cost-effective opto-electronic devices for the applications, and propose and demonstrate practical solutions.

• Ultra-narrow spectrum-sliced incoherent light source for wavelength-division-multiplexed passive optical networks: This new type of light source can generate multiple wavelength light simultaneously with dramatic improvement in spectral efficiency, compared to the conventional incoherent light source.

• Carrier phase estimation for coherent optical receivers: We devise a novel method for estimating the carrier phase of the transmitter laser even in the presence of frequency offset between the transmitter laser and local oscillator.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Z. Al-Qazwini, M. Thollabandi, and H. Kim, “Colorless optical transmitter for upstream WDM PON based on wavelength conversion,” *J. Lightwave Technol.,* vol. 31, no. 6, pp. 896-902, Mar. 2013.

[2] Z. Al-Qazwini, J. Zhou, and H. Kim, “1.5-μm, 10-G/s VCSEL link for optical access applications,” *IEEE Photon. Technol. Lett.,* vol. 25, no. 22, pp. 2160-2163, Nov. 2013.

[3] Q. Hu and H. Kim, “Performance improvement of ultranarrow spectrum sliced incoherent light using offset filtering,” *IEEE Photon. Technol. Lett.*, vol. 26, no. 9, pp. 870-873, May 2014.

Professor
Kim, Joungho
Senior Member, IEEE

Terahertz Interconnection and Package Laboratory

RESEARCH INTERESTS
- Signal & Power Integrity / EMI / EMC in 2.5D / 3D-ICs
- Wireless Power Transfer Technologies
- EMI / EMC in the Automotive Vehicles

RECENT RESEARCH ACTIVITIES
The research of Terahertz Interconnection and Package Laboratory (TERA Lab.) focuses on the signal & power integrity / electromagnetic Interference (EMI) / electromagnetic compatibility(EMC) in through silicon via (TSV) and interposer-based three dimensional integrated circuit (3D IC). TERA Lab. also focuses on the EMC issues from the electromagnetic field (EMF) coupling required for the wireless power transfer (WPT) technology and EMC in the automotive vehicles.

TSV and Interposer-based 3D IC Technology: Recently, the realization of high-speed IC systems with wider bandwidths, smaller form factors and better electrical performance has been a continuous challenge. TSV and interposer-based 3D ICs have attracted a lot of attention as a solution for the challenges. However, due to the material properties of silicon and the vertically stacked structure, noise coupling and simultaneous switching noise become severe and the SI, PI, EMC issues should be considered. Hence, the modeling, optimal design, and testing technologies of 3D ICs are very crucial and must be considered. TERA Lab. is also working on SI / PI / EMC in glass interposer and through glass via (TGV)-based 3D ICs with international research partners.

Wireless Power Transfer Technology: WPT utilizes time-varying magnetic field to transfer the required power to a specific load across a relatively large air gap without any physical contact. TERA Lab. is trying to advance the fundamental understanding of the EMF coupling mechanism and apply WPT system to automotive vehicles, mobile electronics, and system in package (SiP) without EMC problems and EMF exposure to the users. Thus, we are focusing on developing efficient WPT system and applying it to the devices that we use in daily life, at the same time solving EMC / EMF to make WPT system more safe.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. Kim, J. Kim, S. Kong, H. Kim, I. S. Suh, N. P. Suh, D. H. Cho, J. Kim and S. Ahn, “Coil Design and Shielding Methods for a Magnetic Resonant Wireless Power Transfer System,” *Proceedings of IEEE.*, vol. 101, no. 6, pp. 1332-1342, June. 2013.

[2] K. Kim, J. M. Yook, J. Kim, H. Kim, J. Lee, K. Park, and J. Kim, “Interposer Power Distribution Network (PDN) Modeling Using a Segmentation Method for 3D ICs With TSVs,” *IEEE Tr. Components, Packaging. and Manufacturing Tech.,* vol. 3, no. 11, pp. 1891-1906, July. 2013.

[3] M. Lee, J. S. Pak, J. Kim, *Electrical Design of Through Silicon Via,* Springer, 2014.

Professor
Lee, Chang-Hee
Fellow, IEEE

Photonics Networks Research Laboratory

RESEARCH INTERESTS
- Quantum Information (e.g. Quantum key distribution)
- Port agnostic WDM transceiver up to 100 Gb/s
- Standardization of WDM technology in access network

RECENT RESEARCH ACTIVITIES
Photonic Networks Research Laboratory (PNRL) is the leading group in the field of optical communication system in access network. For 17 years, we have been investigating wavelength division multiplexing(WDM) in access network by using experimental demonstration and theoretical analysis. Especially, out injection seeded WDM system was standardized by ITU-T. Currently, we are expanding our research area to metro network and quantum information.

Our research topics in 2013-2014 include

• Quantum Information: Quantum cryptography has been increasingly investigated since it guarantees unconditionally-secure communication thanks to quantum nature. We are investigating single-photon sources, single photon detection, entangled photon generation for quantum communication. Our research include new protocols for a point-to-multipoint quantum network, which will pave the path of perfectly secure access-networks.

• Development of port-agnostic WDM system in metro network: We are investigating optical transceiver for 100 Gb/s based on DP-QPSK. Especially, wavelength independent operation, format independent operation, and variable baud rate are the major target of our research. We are expecting this investigation will be lead to optical software-defined network(SDN) in the near future.

• Standardization of port-agnostic WDM system in access network: Already, we standardized 1.25 Gb/s × 32 channels WDM-PON system. Based on this result, we are struggling to standardize the 2.5 Gb/s and 10 Gb/ WDM-PON. To achieve this goal, intensity noise suppression is the key issue and we propose feed-forward method and fiber-based Mach-Zehnder Interferometer.

MAJOR ACHIEVEMENTS in 2013/2014
[1]J. Kim, S.-R. Moon, S.-H Yoo, and C.-H Lee,"800 Gb/s (80×10 Gb/s) capacity WDM-PON based on ASE injection seeding", *Optics Express*, vol. 22, no. 9, pp. 10359-10365, April. 2014.

[2]S.-H. Yoo, S.-R. Moon, M. Kye, and C.-H. Lee,"Pulsed-ASE seeded DWDM optical system with interferometric noise suppression", *Optics Express*, Vol. 22, No. 7, pp. 8790-8797, April. 2014.

[3]S.-M. Moon, S.-H. Yoo, and C.-H. Lee."Effect of noise distribution in a WDM system seeded by a spectrum-sliced ASE" *IEEE Journal of Lightwave Technology*, vol. 32, no. 12, pp 2271-2276, June. 2014.

Professor
Lee, Man Seop
Member, IEEE / Member, KICS /
Member, IEEK

Photonics Application Laboratory

RESEARCH INTERESTS
- Ultra short pulsed laser micromachining and microfabrications
- Optical system and network technology

RECENT RESEARCH ACTIVITIES
The Photonics Application Laboratory (PALAB) has primarily focused on research and developing technologies in the field of laser applications, especially ultra-short pulsed laser applications, and optical communications. An ultra-short pulsed laser with its high power can be applied to study material surface treatments, micromachining, microfabrication of bio-devices and optical devices such as biosensors, optical gratings, optical waveguide devices, and so on.

Our research topics in 2013-2014 include

• Formation of periodic micro/nano-holes on the surface of as well as inside boro-aluminosilicate glass by controlling the irradiation conditions of a single-beam femtosecond laser has been studied. The lowest diameter of the nanovoids reaches down to 650 nm. We also pattern periodic microholes' array on the surface of the sample glass by focusing the laser beam on the front surface of the glass substrate. The fabricated micro/nano-metric holes and voids are very uniform in size and shape throughout large sample area.

• Formation of periodic micro/nano scale holes/voids on the surface of and inside Al_2O_3-coated boro-aluminosilicate glass by means of single pulse femtosecond laser irradiation has been reported. The lowest diameter of the nanoholes printed on the Al_2O_3 coating reaches down to 700nm where the lowest diameter of the nano voids inside the glass was 1.1 μm. The fabricated micro/nano metric holes and voids show uniformity in size and shape throughout the sample area. We don't observe any structure on the sample surface, when the voids have been evolved inside the glass sample. In addition, we investigate the formation mechanism of the micro/nano-holes or voids in the double-layer samples. It is strongly believed that the periodic micro/nano-voilds array will be useful in fabricating various photonic/optical devices, especially, in spreading light.

MAJOR ACHIEVEMENTS in 2013/2014
[1] M.S. Ahsan, Y.Y Kwon, I.B. Sohn, Y.C Noh, and M.S. Lee, "Formation of Periodic Micro/nano-holes Array in Boro-aluminosilicate Glass by Single-pulse Femtosecond Laser Machining," Journal of Laser Micro/Nanoengineering, vol. 9, no. 1, pp. 819-24, Feb. 2014.

Professor
Myung, Noh-Hoon

Electromagnetic Theory and Technology Laboratory

RESEARCH INTERESTS
- EM scattering analysis
- Radar target recognition
- RF system design

RECENT RESEARCH ACTIVITIES
Electromagnetic Theory and Technology laboratory`s main research activities are divided into two groups: electromagnetic wave theory and RF system development. In the electromagnetic wave theory research group, the research topic includes development of the wave propagation prediction model, radar signal processing for target recognition, improvement of antenna diversity considering mutual coupling and MIMO channel analysis. The RF system development group develops a variety of RF system components, such as the dual polarized array antenna, the active phased array antenna without phase shifter, the oscillator with EBG and the new type of RFID tag antennas. The research topic of this group also includes the meta-material issues and high integrity wideband SAR front-end.

Our research topics in 2013-2014 include

• ISAR(inverse synthetic aperture radar) image processing: In case of ISAR imaging via a search radar, several techniques have been studied to obtain a clear ISAR image from receiving data matrix of a single target. In addition, classification of multiple targets is also developed using novel TLS-Prony and Hough-transform techniques.

• JEM(jet engine modulation) analysis: JEM is one of the micro-Doppler phenomena induced by a rotating jet engine compressor. For JEM analysis, various methods have been developed to obtain the information on the jet engine, such as the rotation rate and the number of blades.

• Scattering center extraction: We have obtained information for 2D or 3D ISAR image using the SBR technique and the one-shot ISAR image formula. Then, using Sullivan's scheme and CLEAN algorithm, we can extract 2D or 3D scattering centers of CAD model.

• Antenna diversity improvement considering mutual coupling: The analysis of antenna mutual coupling is a significant issue related to the antenna diversity analysis. The skewed dipoles with the estimated mutual coupling were examined to improve the performance of MIMO communications systems.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. H. Park and N. H. Myung, "Effective reconstruction of the rotation-induced micro-Doppler from a noise-corrupted signature," *Progress In Electromag. Research,* vol.138, pp. 499-518, Apr. 2013.

[2] J. H. Han and N. H. Myung, "Novel Feed Network for Circular Polarization Antenna Diversity," *IEEE Antennas and Wireless Propagation Letters,* vol. 13, pp. 979-982, May 2014.

Professor
Park, Hyo-Hoon
Senior Member, IEEE / Senior Member, SPIE

Nano Electronic and Photonic Systems Laboratory

RESEARCH INTERESTS
- Silicon nanophotonic devices and integration
- Photonic interconnection for high speed data link
- Nano electronic and photonic circuits for 2D and 3D chips

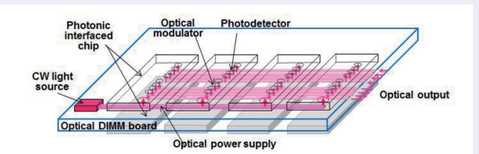
RECENT RESEARCH ACTIVITIES
Nano Electronic and Photonic Systems (NEPS) Lab is challenging to create next generation chips and computer systems in which MPU / memory chips and peripheral equipments are optically linked. Major research subjects are CMOS-compatible Si-nanophotonic devices and photonic circuits for 3 dimensional chips and high performance computer systems. We have established key concepts on the high-speed and low-energy Si-photonic amplitude modulators, 3D photonic data networking for optically interfaced chips, and 20Gbps/ch transceiver ICs for multi-channel optical interconnects.

Our research topics in 2013-2014 include

• Silicon nanophotonics for microprocessor-memory interfaces
- CMOS-compatible Si-nanophotonic high speed optical modulators
- Photonic data link in DIMM (dual in-line memory module)
- 3D chip nanophotonic interconnection

• Optical link for high-performance computer systems
- Silicon photonic based logic gates and arithmetic circuits
- Optical PCB-based data link between microprocessor and memory

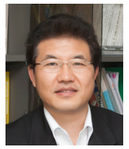
• High-speed optical interconnect modules
- 25Gbps optical interconnect module for multimedia interfaces
- 10 ~ 25 Gbps optical transceiver ICs



MAJOR ACHIEVEMENTS in 2013/2014
[1] N. T. H. Nguyen, I. A. Ukaegbu, J. Sangirov, M.-H. Cho, T.-W. Lee, and H.-H. Park, "Bi-wavelength transceiver module for parallel- simultaneous bidirectional optical interconnects," *Optical Eng. Lett.,* vol. 52, no.12, p.120502, Dec. 2013.

[2] J. Sangirov, G.-C. Joo, J.-S. Choi, D.-H. Kim, B.-S. Yoo, I. A. Ukaegbu, N. T. H. Nga, J.-H. Kim, T.-W. Lee, M.-H. Cho, and H.-H. Park, "40Gb/s optical subassembly module for a multi-channel bidirectional optical link," *Optics Express,* vol. 22, p. 1768, Jan. 2014.

[3] N. T. H. Nguyen, G.-C. Joo, B.-S. Yoo, I. A. Ukaegbu, J. Sangirov, M.-H. Cho, T.-W. Lee, and H.-H. Park, "10 Gbps/ch full-duplex optical link using a single-fiber channel for signal transmission," *IEEE Photon. Tech. Lett.,* vol. 26, no. 6, p. 609, March 2014.



Professor
Park, Seong-Ook
Senior Member, IEEE / Member, IEEE MTT-S / Member, KIEES

Microwave and Antenna Laboratory

RESEARCH INTERESTS
- Antenna Theory / precision measurement and techniques
- Radar system application development
- Electromagnetic characterization in nano material

RECENT RESEARCH ACTIVITIES
Microwave and Antenna Laboratory research activities cover theory and techniques for antenna theory / measurement of next-generation mobile communication device, development of radar system application, and electromagnetic analysis and characterization in nano material.

Our research topics in 2013-2014 include

• Antenna design / measurement: The creative antenna design and techniques using new materials and electromagnetic phenomena analysis are investigated for future antenna design. The design and development of sophisticated and reliable solutions for multi-beam generation are pursued by new structure of antenna itself, and enhanced measurement techniques.

• Radar system application: MA Lab researches the channel and vital signal measurement radar systems such as FMCW and Chirp-Pulse. We are studying the design of radar system and antennas for radar. All this researches are integrated to application of the non-invasive vital signal detection and measurement of real-time rainfall data for local area.

• Electromagnetic characterization in nano material: In electromagnetic analysis and its application, the analysis of electromagnetic characteristic of nano material is new area and essential. Permeability and permittivity of a nano material are analytically analyzed and measured precisely. These methods are studied to utilize the material for antenna and various microwave devices.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Yun-Taek Im, Ali M., and Seong-Ook Park, "Slow Modulation Behavior of the FMCW Radar for Wireless Channel Sounding Technology," *IEEE Tr. on Electromagnetic Com.,* 2014.

[2] M.T Dao, D. H Shin, Y.T Im, S.O Park, "A Two Sweeping VCO Source for Heterodyne FMCW Radar," M.T Dao, D.H Shin, Y.T Im, S.OPark," *IEEE Tr. Instru. and Meas.* vol. 62, no. 1, pp. 230-239, Jan. 2013.

[3] Jong-Guk Kim, Ki-Beom Kim, Dong-Hun Shin, SO Park, "Design of Null-Filling Antenna for Automotive Radar Using the Genetic Algorithm," *IEEE Ant. and Wireless Propagat. Lett.* vol. 13, pp. 738-741, Apr. 2014.

Professor
Won, Yong Hyub
Member / IEEE, OSA, KICS, IEEK, Fellow / OSK

Convergence Optoelectronic Device Engineering Laboratory

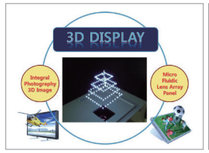
RESEARCH INTERESTS
- 3D display using varifocal liquid lens array panel
- Optically driven bio-sensors for remote medical treatment
- Smart wearable camera for augmented reality

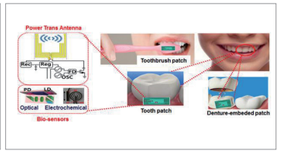
RECENT RESEARCH ACTIVITIES
The Convergence Optoelectronic Device Engineering [CODE] Laboratory has primarily focused on developing key optical modules for 3D display, high security ID card, optical logic gates, optical bio-sensors and networks applications.

Our research topics in 2013-2014 include

• 3D display: The development of a 3D display front-panel which is capable of offering clear 3D images without glasses is one of main subjects in our lab. This 3D technology is based on integral photography (or integral imaging) which shows natural 3D images closed to holography 3D images. The micro fluidic lens array panel, a functional key element, is made by electrowetting lens formation technology. This method has critical advantages compared with conventional Barrier and Lenticular methods. For this evolutionary technology, we have developed novel technologies for fab processing and system implementation.

• Bio-sensor: The bio-sensors for detecting glucose in saliva and mucous membrane in mouth is developing using optical and electrochemical methods including surface plasmon resonance and near infrared detecting technologies. The small patch-type bio-sensors are attached or embedded in tooth which is operated by wireless power supporting system.





MAJOR ACHIEVEMENTS in 2013/2014
[1] H. H. Choi and Y. H. Won, "Fluidic lens of floating oil using round-pot chamber based on electrowetting," *Optics Lett, vol.* 38, no. 13, pp. 2197-2199, 2013.

[2] H. H. Choi and Y. H. Won, "Fluidic lens of floating water using Intermediate hydrophilic layer based on electrowetting," *IEEE Photon. Tech. Lett,* vol. 25, no. 18, pp. 1829-1831, Sept., 2013.

[3] B. Nakarmi, T. Q. Hoai, Y. H. Won, X. Zhang, "Analysis of Hysteresis Width on Optical Bistability for the Realization of Optical SR Flip-Flop Using SMFP-LDs With Simultaneous Inverted and Non-Inverted Outputs," *IEEE Photon. J.* vol. 6, no. 3, June 2014.

Professor
Yu, Jong-Won
Member, IEEE

Radio Frequency Sensor System Laboratory

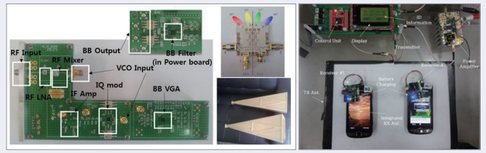
RESEARCH INTERESTS
- RF Sensor System: RFID, NFC, RF-Bio, Radar
- RF Power Charging & Energy Harvesting: WPT
- Integrated Antenna Technology: Minimized Antenna / Intenna / Rectenna

RECENT RESEARCH ACTIVITIES
Radio Frequency Sensor System (RFSS) Laboratory focuses on improving the performance of various RF systems for the future wireless environment in a system point of view. Solutions for more appropriate, more reliable and more efficient system are mainly studied. Our research covers RF energy harvesting, smart antenna, massive MIMO antenna, beamforming, wireless power transfer, RFID, NFC, and radar for emerging RF systems.

Our research topics in 2013-2014 include

• Next Generation Communication System: Interference among antennas can be one of threats which can degrade radiation efficiency and increase correlation, degrade performance. To avoid this, Pattern diversity multi-input multi-output (MIMO) antenna manipulates polarization diversity to attain MIMO gain. Using beam division multiple access (BDMA) and beamforming with smart array antenna are also useful for increasing channel capacity and faster data rate at millimeter wave frequency.

• Wireless Power Transfer: We develop wireless power transfer system according to A4WP, Qi, NFC, and other agreements. Apart from high power transfer, wireless power transfer with mobile devices has an issue of free positioning and multi-charging. Not just transferring power, we implement wireless interface such as bluetooth to monitor charging state and control receiver.



MAJOR ACHIEVEMENTS in 2013/2014
[1] W.S. Lee, K.S. Oh, and J.W. Yu, "Distance-Insensitive Wireless Power Transfer and Near-Field Communication Using a Current-Controlled Loop With a Loaded Capacitance," *IEEE Trans. Antennas and Propagation*, vol.62, no.2, pp.936-940, Feb. 2014.

[2] H.L. Lee, D.H. Park, M.Q. Lee, and J.W. Yu, "Reconfigurable 2x2 Multi-Port Amplifier Using Switching Mode Hybrid Matrices," *IEEE Microwave and Wireless Components Letters,* vol.24, no.2, pp.129-131, Feb. 2014.

[3] Best paper award, 7th Annual IEEE International Conference on RFID, May 2013.

Associate Professor
Yu, Kyoungsik
Member, IEEE / Member, IEEK

Integrated Nanophotonics Laboratory

RESEARCH INTERESTS
- Optoelectronics / Nanophotonics
- Optical MEMS (MicroElectroMechanical Systems)
- Micro- / nano-scale fabrication

RECENT RESEARCH ACTIVITIES
Integrated Nanophotonics Laboratory focuses on nano- and micro-scale optoelectronic devices and their integration techniques for photonic interconnects, information processing, bio / chemical sensing and imaging applications. The emerging field of nanophotonics can provide unique solutions to important problems in modern information / communication technologies by processing optical signals in multiple physical domains. Integrated nanophotonic devices offer exciting opportunities in the generation, control, and detection of photons and their interaction with semiconductor and / or biochemical materials. The range of optical wavelengths useful for most communication and sensing applications is on the order of micrometers, and therefore micro- / nano-fabrication technologies allow us to precisely fabricate features in subwavelength dimensions that can best interact with photons.

Our research topics in 2013-2014 include

• Subwavelength-scale metal optic resonators and their applications for optical interconnects: Conventional semiconductor light sources are usually in the micrometer range due to the diffraction limit, whereas the length scale of electronic transistors is currently approaching tens of nanometers with the advance of fabrication technologies. Subwavelength-scale optoelectronic devices and their integration techniques will play important roles for future integration of electronic and photonic devices on a chip-scale platform.

• Control of optical directionality and chirality: Subwavelength-scale perturbations around the circular resonator boundary can induce asymmetric back scattering of counter propagating optical modes for accurate control of electromagnetic chiralities. The generation of such optical vortices enables additional degree of freedom for optical signal processing and quantum manipulation.

MAJOR ACHIEVEMENTS in 2013/2014
[1] M. Kim, K. Kwon, J. Shim, Y. Jung, and K. Yu, "Partially-directional microdisk laser with two Rayleigh scatterers," *Opt. Lett.,* vol. 39, no. 8, pp. 2423-2426, Apr. 2014.

[2] J.-B. You, W.-J. Lee, D. Won, and K. Yu, "Multiband perfect absorbers using metal-dielectric films with optically dense medium for angle and polarization insensitive operation," *Opt. Express*, vol. 22, no. 7, pp. 8399-8348, Apr. 2014.

[3] Best Poster Award (Gold medal), Nano Korea, July 2014.

Nano Device and Integrated System
NDIS Group

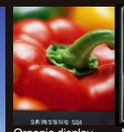
01 I Nano IC Technology Laboratory — Professor **Cho, Byung Jin**
02 I Advanced Display & Nano Convergence Laboratory — Professor **Choi, Kyung Cheol**
03 I Molecular and Nano Device Laboratory — Associate Professor **Choi, Sung-Yool**
04 I Nano-Oriented Bio-Electronics Laboratory — Professor **Choi, Yang-Kyu**
05 I Wave Embedded Integrated Systems Laboratory — Professor **Hong, Songcheol**
06 I Infrared Image Sensor Laboratory — Professor **Lee, Hee Chul**
07 I Wireless PHYCOM Laboratory — Professor **Lee, Kwyro**
08 I Nano Deivces Laboratory — Associate Professor **Lee, Seok-Hee**
09 I Microwave Microsystems Laboratory — Professor **Park, Chul Soon**
10 I Computational Nanotechnology Laboratory — Professor **Shin, Mincheol**
11 I High Speed Nonoelectronics Laboratory — Professor **Yang, Kyounghoon**
12 I Communication Devices and Systems Laboratory — Professor **Yoo, Hyung-Joun**
13 I Integrated Organic Electronics Laboratory — Associate Professor **Yoo, Seunghyup**
14 I Terahertz Nano System Laboratory — Professor **Yoon, Gi Wan**
15 I 3D Micro-Nano Structures Laboratory — Professor **Yoon, Jun-Bo**

NDIS Group

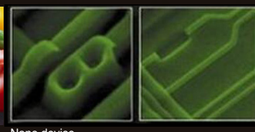
Nano Device and Integrated System(NDIS) Group has world top level clean rooms and many good facilities and world leading 15 faculties, which conducts fundamental and pioneering researches in the areas of large area electronics, novel nano devices, and high speed electronics. We direct efforts to build multidisciplinary research programs on Energy, Bio & healthcare, Human-machine interface, and Advanced signal processing and link devices.

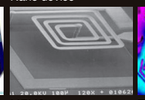
Large area Electronics Display/Flexible E.	Novel Nano Devices	High Speed Electronics
Solar cell Display · LED · LCD · OLED · TFT · Organic transistor	Carbon devices Energy devices Memory Logic Sensor systems · MEMS · Bio Sensors · Integrated sensor Nano CMOS	mm-wave / THz Devices and integrated system Compound semiconductor · MMIC / OEIC · Novel devices · Packages

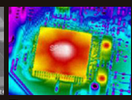

Solar energy

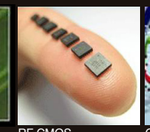

Organic display


Flexible display

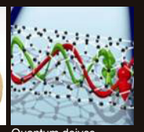

Nano device


MEMS


Thermal image sensor


RF CMOS


OEIC


Quantum deivce


Wireless technology

NDIS Group has 15 Professors, 114 Ph.D. students, and 77 M.S. students. The members have shown outstanding academic leadership as IEEE Fellows, General / Technical Chairs of top conferences, and Editors for top Journals. NDIS group is expected to play a key role in EE department to provide new horizons to well developed IT technologies by promoting multidisciplinary researches. Therefore, we educate students to have strong backgrounds of various basic sciences as well as electrical engineering.

Energy	Signal Process and Link	Human Machine Interface	Bio and Health care
- Energy harvest / cell - Conversion - Transfer - Storage	- Storage - High speed devices - Wireless & Optical Link	- Sensors & Actuators - Wearable sensors - Display & Image - Robot and Automobile	- Integrated Sensors - Medical Image & Devices - Bio-Physics and Photonics

Professor
Cho, Byung Jin
Senior Member, IEEE /
Chair, Korea Graphene Research Society

Nano IC Technology Laboratory

RESEARCH INTERESTS
- Silicon-based CMOS technology
- Beyond silicon (Graphene and soft electronics)
- Nano energy (Flexible thermo-electronics)

RECENT RESEARCH ACTIVITIES
Nano IC Technology Lab (NIT) carries out advanced research on academic and technological fronts in semiconductor device and soft electronics. We identify the theoretical analysis and performance limitation, and investigate advanced techniques for the improvements. We are closely working with NNFC and other semiconductor companies, and this is one of the ideal research environment for semiconductor technology development. The research goal is to develop the core technology for next-generation electronics based on advanced fabrication process, novel structure and soft materials.

Our research topics in 2013-2014 include

• Silicon-based CMOS technology: From the point of view of high mobility, Ge transistors are promising candidates for near the end of the ITRS CMOS solutions. So we have researched on Ge transistors with multi-gate structures for sub-hundreds nm nodes technology. We also have studied silicon nano-membrane which is extremely thin silicon to suppress short channel effect for next generation sub-10nm device and soft-wearable electronics.

• Graphene electronics: The graphene has specific characteristics such as high carrier mobility and zero bandgap which can induce the large current density and fast switching in transistor. The essential elements (cut-off frequency and current gain)of RF transistor are effected by current density and carrier mobility. So RF transistor with graphene channel has the possibility in RF electronic applications.

• Thermo-electronics: Screen printing and related nanotechnology are being studied to fabricate a thermoelectric power generator, which made up of thin or thick thermoelectric films. The device generates much more enhanced power density compared to the conventional bulk device. And flexible property of the thin or thick film make it possible to be embedded in a car, TV, mobile phone, PC and so on, as well as improve their energy efficiency.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. H. Mun and B. J. Cho, "Synthesis of Monolayer Graphene having Negligible Amount of Wrinkles by Stress Relaxation", *Nano Lett.,* vol. 13, no. 6, pp 2496-2499, May 2013.

[2] S. J. Kim, J, H. We and B. J. Cho, "A Wearable Thermoelectric Generator Fabricated on a Glass Fabric", *Energy Environ. Sci,* vol. 7, pp. 1959, June 2014.

[3] J. K. Park, S-Y. Kim, K-H. Lee, S. H. Pyi, S-H. Lee, and B. J. Cho, "Surface-controlled Ultrathin (2 nm) Poly-Si Channel Junctionless FET towards 3D NAND Flash Memory Applications", *2014 Symposium on VLSI Technology,* Hawaii, USA, June 9-13, 2014.

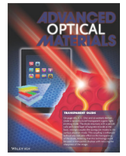
Professor
Choi, Kyung Cheol
Editor, IEEE Transaction on Electron Devices
/ Member of IEEE, SID & KIDS

Advanced Display & Nano Convergence Laboratory

RESEARCH INTERESTS
- Advanced displays such as flexible displays, transparent displays, wearable displays, and novel displays
- Nano convergence technologies for displays, solar cells, and semiconductor
- Study on efficiency / reliability improvement of displays and thin film transistors

RECENT RESEARCH ACTIVITIES
Research topics of ADNC Lab

Advanced display
- Flexible display
- Transparent display
- Wearable display
- Inkjet printing technology
- Oxide Thin-Film Transistor



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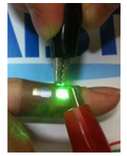
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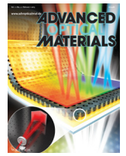
Nano convergence
- Surface Plasmon for Display
- Plasmonic Color Filter
- SPP for Solar cell
- SPP for Nano Lithography



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<Plasmonic OTFT>

MAJOR ACHIEVEMENTS in 2013/2014
[1]Y. S. Do and K. C. Choi, "Plasmonic color filter and its fabrication for large area applications", Advanced Optical Materials, Vol.1, No.2, pp.133-138, Feb. 2013. [Cover paper]

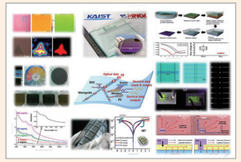
[2] C. S. Choi and K. C. Choi, "Blur-free outcoupling enhancement in transparent organic light emitting diodes: a nanostructure extracting surface plasmon modes", Advanced Optical Materials, Vol.1, No.10, pp.687-691, Oct. 2013. [Frontispiece]

[3] Y. S. Do and K. C. Choi, "Photo-Insensitive Amorphous Oxide Thin-Film Transistor Integrated with Plasmonic Filter for Transparent Electronics", Advanced Functional Materials, Vol.24, No.23 pp.3482-3487, June 2014. [Frontispiece]

Associate Professor
Choi, Sung-Yool
Director, Graphene Research Center (KAIST)

Molecular and Nano Device Laboratory

RESEARCH INTERESTS
- Electronics and photonics applications of graphene
- Two dimensional soft materials synthesis and application
- Physics and applications of memristive devices

RECENT RESEARCH ACTIVITIES


The research of Molecular and Nano Device Laboratory (MNDL) primarily focuses on molecular-scale materials and devices for next-generation IT-ET-BT convergence technology. The research topics include electronics and photonics applications of graphene, two dimensional soft materials synthesis and devices, and physics andapplications of mem ristive devices.The research objective of MNDL is understanding the underlying principle in the conduction and switching behavior of the single molecule or molecular scale materials for the development of noble molecular scale devices.

Our research topics in 2013-2014 include

• Electronics and photonics applications of graphene: We focus on several technological issues in real applications of graphene in electronics and optoelectronics. We have studied improvement of the optical power and thermal stability of GaN LEDs using a chemically doped graphene, and direct delamination and transfer method of single layer graphene.

• Two dimensional soft materials synthesis and application: We have developed a facile liquid-phase exfoliation method to improve the exfoliation efficiency for single-layer MoS_2 sheets. We also have demonstrated the synthesis of large area $MoSe_2$ via chemical vapor deposition on arbitrary substrates such as SiO_2 and sapphire.

• Physics and applications of memristive devices: There has been strong demand for a novel nonvolatile memory technology in low-cost, large-area, low-power, and flexible electronic applications. We are investigating the fundamental physics of resistive switching in nanoscale polymer and graphene oxide thin films for the nonvolatile memory applications in future electronic systems.

MAJOR ACHIEVEMENTS in 2013/2014
[1] D.H. Youn, Y.J. Yu, H.K. Choi, S.H. Kim, S.Y. Choi and C.G. Choi, “Graphene transparent electrode for enhanced optical power and thermal stability in GaN light-emitting diodes,” *Nanotechnology,* vol. 24, no. 7, pp. 075202, Jan. 2013.

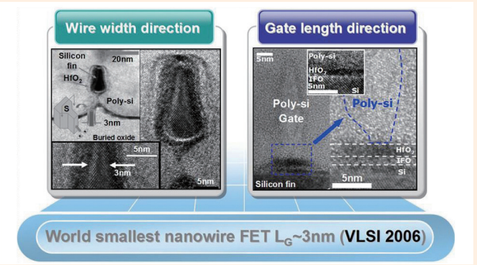
[2] G.S. Bang, K.W. Nam, J.Y. Kim, J.W. Shin, J.W. Choi and S.Y. Choi, “Effective liquid-phase exfoliation and sodium ion battery application of MoS_2 nanosheets,” *ACS Appl. Mater. Interfaces,* vol. 6, no. 10, pp. 7084-7089, Apr. 2014.

[3] S.Y. Choi, *Resistive memory device and method for fabricating the same,* 1014054210000, Korea, June 02, 2014.

Professor
Choi, Yang-Kyu

Nano-Oriented Bio-Electronics Laboratory

RESEARCH INTERESTS
- Nano CMOS and electronic device
- Bio sensor device
- Energy harvesting

RECENT RESEARCH ACTIVITIES


Nano-Oriented Bio-Electronics Laboratory (NOBEL) is the research group led by professor Yang-Kyu Choi. NOBEL was established in the Department of Electrical Engineering at KAIST (Korea Advanced Institute of Science and Technology), 2004.

NOBEL persues commercial development of nano-bio electrical devices based on reliable silicon manufacturing techniques with new structure, new material, new technology. NOBEL developed Double-gate FinFET, silicon MOSFET, first in the world and keep a world record of smallest semiconductor device with 15nm gate length Double-gate FinFET in 2001. The FinFET technology which is developed first in university transferred to top semiconductor companies (Samsung, Intel, IBM, AMD, TI, Motorola, TSMC). This is successful industry-university co-work model. Many nanofabrication techniques have developed in the process of making sub-10nm structure and every techniques have infinite possibilities. NOBEL is developing many devices using these techniques.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Chang-Hoon Kim, Jae-Hyuk Ahn, Jee-Yeon Kim, Ji-Min Choi, Kyung-Choon Lim, Tae Jung Park, Nam Su Heo, Hee Gu Lee, Jong-Wan Kim, Yang-Kyu Choi "CRP detection from serum for chip-based point-of-care testing system", Biosensors and Bioelectronics, Vol. 41, pp. 322-327, Mar. 2013.

[2] Myeong-Lok Seol, Hwon Im, Dong-Il Moon, Jong-Ho Woo, Daewon Kim, Sung-Jin Choi, Yang-Kyu Choi "Design Strategy for a Piezoelectric Nanogenerator with a Well-Ordered Nanoshell Array", ACS Nano, Vol. 7, No. 12, Nov. 2013.

[3] Dong-Il Moon, Jee-Yeon Kim, Joon-Bae Moon, Dong-Oh Kim, and Yang-Kyu Choi "Evolution of Unified-RAM: 1T-DRAM and BE-SONOS Built on a Highly Scaled Vertical Channel", IEEE Transactions on Electron Devices, Vol. 61, No. 1, Jan. 2014.

Professor
Hong, Songcheol
Member, IEEE

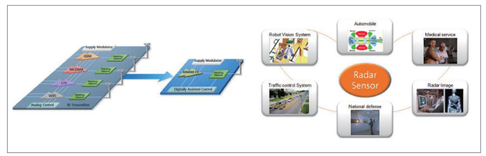
Wave Embedded Integrated Systems Laboratory

RESEARCH INTERESTS
- Wireless future transceiver
- Miniaturized RADAR systems

RECENT RESEARCH ACTIVITIES
Research area of WEIS(Wave Embedded Integrated Systems) Laboratory covers RF transceiver for wireless communication and RADAR systems. There are two groups that dedicate to each research topic: FT(Future Transceiver) and SOAC(System-On-A-Chip).

The main topics of FT group are a CMOS power amplifier and digital RF transmitter, which are the most important issue that determines the performance of various mobile handset applications. Recently, many efforts have been made to improve the efficiency of a power amplifier which consequently affects the life-time of a cell-phone battery. Digital RF transmitter is the new research area which will lead to the increased flexibility, programmability and better tolerance against PVT variation.

And SOAC research group focuses on sensor system using miniaturized RADAR. This group has pursued studies of RADAR systems, which can be applied to various industries, based on the Si semiconductor design technology and is mainly interested in RF front-end of miniaturized RADAR. RADAR sensor system detects the position(range, angle) and the velocity of an target by echo signal returning from the target. This group has been studied remote bio-sensor which extracts heart-beat and respiration signals and image sensor which can get the information of distance and shape of an object for the application of the robot vision.



MAJOR ACHIEVEMENTS in 2013/2014
[1] T. Joo, B. Koo and S. Hong, "A WLAN RF CMOS PA With Large-Signal MGTR Method," *IEEE Trans. on Microw. Theory and Tech.,* vol. 61, no. 3, pp. 1272-1279, Mar. 2013.

[2] S. Kong, S. Lee, C.Y. Kim and S. Hong, "Wireless Cooperative Synchronization of Coherent UWB MIMO Radar," *IEEE Trans. Microw. Theory and Tech.,* vol. 62, no. 1, pp. 154-165, Jan. 2014.

[3] H. Choi, Y. Lee and S. Hong, "A Digital Polar CMOS Power Amplifier With a 102-dB Power Dynamic Range Using a Digitally Controlled Bias Generator," *IEEE Trans. Microw. Theory and Tech.,* vol. 62, no. 3, pp. 579-589, Mar. 2014.

Professor
Lee, Hee Chul
Member, IEEE / Member, SPIE /
Member, IEEK

Infrared Image Sensor Laboratory

RESEARCH INTERESTS
- Infrared Detector Sensor
- Readout Integrated Circuit
- Radiation Hardening Device & Circuit

RECENT RESEARCH ACTIVITIES
Infrared Detector is the main research theme of IRIS (InfraRed Image Sensor) LAB. We focused on the cooled type infrared sensor before 2005, and transition to the uncooled type has been made after then. Our research result has led to the beginning of an infrared camera venture company, I3system, whose CEO is the 1st Ph.D. alumni of IRIS LAB. Now, we are focusing on the uncooled infrared detectors which are expected to be used more widely than the cooled one for their low price and reasonable performance.

Our research topics in 2013-2014 include

• Infrared Detector Sensor: we develop the new bolometeric material such as nickel oxide which has high temperature coefficient of resistivity and low 1/f noise. And also we develop the vacuum packaging methods such as wafer to wafer bonding and thin film encapsulation. And we are studying about wafer level vacuum package with high IR transmission and high vacuum level for low cost sensor package.

• Readout integrated circuit: Read-out circuit for the bolometer which has TEC-less characteristic has being developed. Thermoelectric cooler (TEC) is used for maintaining the performance of the bolometer, but the consuming power is too large and the size is obstacle of miniaturization. So the technology of TEC-less circuit with high performance is important for the cost reduction.

• Radiation Hardening Device & Circuit: Radiation damage on integrated circuit due to an incident energetic particle causes functional failure of the electronic device. To minimize the radiation damage, we are researching device simulations for evaluating effectiveness of a proposed the radiation hardness MOSFET structure designed by layout modification technique, and circuit design.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S. M. Park and H. C. Lee, “Analytical model for the electro-thermal feedback effect in a microbolometer infrared focal plane array”, *OPTICAL ENGINEERING,* vol. 53, no. 4, Apr. 2014.

[2] M. S. Lee and H. C. Lee, “Dummy Gate-Assisted n-MOSFET Layout for a Radiation-Tolerant Integrated Circuit” *IEEE TRANSACTIONS ON NUCLEAR SCIENCE,* vol. 60, no. 4, pp. 3084-3091, Aug. 2013.

[3] G. J. Jeon, W. Y. Kim and H. C. Lee, “New selective two-step anodization of porous anodic alumina for thin-film encapsulation”, MICROELECTRONIC ENGINEERING, vol. 103, pp. 99-105, Mar. 2013.

Professor
Lee, Kwyro
Fellow Member, IEEE

Wireless PHYCOM Laboratory

RESEARCH INTERESTS
- RF circuits and systems
- Analog circuits and systems

RECENT RESEARCH ACTIVITIES
The main research area of Wireless PHYCOM Lab. (WPCL) is on wireless physical layer communication system, which includes both the RF and baseband analog / digital circuitry, specifically the low power CMOS circuit design. In addition to R&D, we are highly emphasizing high-tech entrepreneurship.

The recent R&D topic is on the development of multi-band / multi-mode programmable radio receivers and SAW-less RF transceiver for SDR (software defined radio). Modern cellular phone is supposed to have more than 10 radios, composed of several cellular, several mobile TV, and WLAN, Bluetooth, RF-ID, and so forth. The above technology is possible when the challenges of broadband matching, wide band selectivity / sensitivity, a sufficient gain with wide bandwidth, a high linearity, a small noise is settled nicely. It is a great challenge to provide this with acceptable performance with smallest form factors and cost.

Another research includes user interface(UI) technology for a mobile information device in the future. Various sensors, sensing algorithms and modeling, gesture language development, and feedback techniques are the main issues.

MAJOR ACHIEVEMENTS in 2013/2014
[1] B.-K. Kim, D. Im, J. Choi, and K. Lee, “A Highly Linear 1 GHz 1.3 dB NF CMOS Low-Noise Amplifier With Complementary Transconductance Linearization,” *IEEE J. Solid-State Circuits,* vol. 49, no. 6, pp. 1286-1302, June. 2014.

[2] H. Jang, H. Shin, S. Ko, I. Yun, and K. Lee, “12.5 2D Coded-aperture-based ultra-compact capacitive touch-screen controller with 40 reconfigurable channels,” *IEEE International Solid-State Circuits Conf. (ISSCC*), San Francisco, USA, Feb. 2014.

[3] H. Shin, S. Ko, H. Jang, I. Yun, and K. Lee, “A 55dB SNR with 240Hz frame scan rate mutual capacitor 30×24 touch-screen panel read-out IC using code-division multiple sensing technique,” *IEEE International Solid-State Circuits Conf. (ISSCC),* San Francisco, USA, Feb. 2013.

Associate Professor
Lee, Seok-Hee
Member, IEEE

Nano Deivces Laboratory

RESEARCH INTERESTS
- Germanium nanowire / InAs nanowire fabrication processes
- Reliability and low frequency noise of junctionless MOSFETs
- Nanoscale semiconductor device simulation and modeling

RECENT RESEARCH ACTIVITIES
Nano Devices Laboratory (NDL) focuses on nanoscale Si / Ge CMOS device and processing. We pursues high performance transistors that can extend Moore's law to the next decade. We fabricate semiconductor devices such as nanowire MOSFETs and their characterization and performance evaluation are carried out. Simulation and modeling of the devices are utilized in order to have physical insight and understanding of the behavior of the devices.

Our research topics in 2013-2014 include

• Fabrication processes: We have investigated contact engineering of germanium nanowire junctionless MOSFETs for reducing contact resistance. Also, interface engineering of InAs nanowire junctionless MOSFETs was investigated for improving the gate controllability and low frequency noise characteristics.

• Reliability and low frequency noise characteristics: The origin of the low frequency noise and channel-hot carrier degradation were studied in detail. Normalized drain-current noise power spectral density and its degradation by positive substrate bias of p-type junctionless MOSFETs with high-k and metal gate stack were investigated. The ten-year life times under CHC stress of the device with and without positive substrate bias were investigated.

MAJOR ACHIEVEMENTS in 2013/2014
[1] Y. G. Yoon, T. K. Kim, I.-C. Hwang, H.-S. Lee, B.-W. Hwang, J.-M. Moon, Y.-J. Seo, S. W. Lee, M.-H. Jo, and S.-H. Lee, “Enhanced device performance of germanium nanowire junctionless (GeNW-JL) MOSFETs by germanide contact formation with Ar plasma treatment,” *ACS Applied Materials & Interfaces,* vol. 6, no. 5, pp. 3150-3155, Feb. 2014.

[2] T. K. Kim, D. H. Kim, Y. G. Yoon, J. M. Moon, B. W. Hwang, D.-I. Moon, G. S. Lee, D. W. Lee, D. E. Yoo, H. C. Hwang, J. S. Kim, Y.-K. Choi, B. J. Cho, and S.-H. Lee, “First demonstration of junctionless accumulation-mode bulk FinFETs with robust junction-isolation,” *IEEE Electron Device Lett.,* vol. 34, no. 12, pp. 1479-1481, Dec. 2013.

[3] Y. G. Yoon, T. K. Kim, H.-S. Lee, I. Hwang, B.-W. Hwang, J.-M. Moon, Y.-J. seo, S. W. Lee, M.-H. Jo, and S.-H. Lee, “Effective Ar plasma treatment for germanide contact formation of germanium nanowire junctionless(Ge-NW JL) MOSFETs,” *Materials Research Society (MRS),* San Francisco, CA, USA, Apr. 2013.

Professor
Park, Chul Soon
Honorary President, KITS

Microwave Microsystems Laboratory

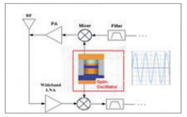
RESEARCH INTERESTS
- Reconfigurable Radio CMOS SoC
- Millimeter Wave / Terahertz Circuits and System
- Spintronics Nano Radio for Next-Generation Mobile Communication

RECENT RESEARCH ACTIVITIES
Microwave Microsystems Laboratory(Microlab) carries out advanced researches on intelligent radio frequency systems to lead next-generation wireless and mobile communication technologies.

Our research topics in 2013-2014 include

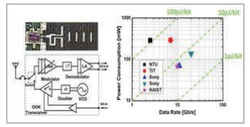
• Spintronics Nano Radio: We have implemented the world-first wireless communication system based on spintronics nano radio technology to realize the ultra low-power and small size next-generation wireless communication, which has been published at the *Nature Scientific Reports*, a journal published by *Nature Publishing Group*.

< Background of Nano Radio >



< Basic Concept of Nano Radio >

• mm-Wave / THz Circuit and System: We have researched on the low power and high speed CMOS mmW and THz wireless transceivers for 25Gbps chip-to-chip wireless interconnection and 10 Gbps 60GHz communication system.



< 60GHz OOK Transceiver on antenna >

• Reconfigurable Radio CMOS SoC: We have developed one-chip multi-band multi-mode CMOS transmitter and receiver for reconfigurable mobile communication system including LTE.

MAJOR ACHIEVEMENTS in 2013/2014
[1] H.S. Choi et al., "Spin Nano–oscillator–based Wireless Communication", *Nature Scientific Reports,* June 2014.

[2] C. W. Byeon, C. H. Yoon, and C. S. Park, "A 67-mW 10.7-Gb/s 60-GHz OOK CMOS Transceiver for Short-Range Wireless Communications," *IEEE Transactions on Microwave Theory and Techniques,* Vol.61, No.9, pp.3391-3401, Aug. 2013

[3] "Low power and High speed wireless communication system 50 times faster than WiFi", broadcasted at KBS NEWSLINE, 13.03.21.

Professor
Shin, Mincheol
Member, IEEE / Member, IEIE / Member, KPS

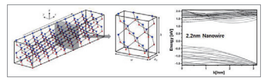
Computational Nanotechnology Laboratory (CNL)

RESEARCH INTERESTS
- Nanoelectronics and TCAD development
- Thermoelectrics
- Spintronics and its application to RF

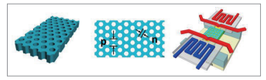
RECENT RESEARCH ACTIVITIES
In CNL, we carry out modeling and simulations of nano-scale electronic devices based on quantum mechanical principles. Closely related areas such as thermoelectricity and spin-RF are also being explored in close collaboration with experimental groups. Our developed tools are aimed to be deployed in Web-based portals for public access.

Research topics in 2013-2014 include

• Nanoelectronics: Development of TCAD tools for multi-scale nanoelectronic devices. We have been keeping expanding the functionalities of our in-house simulators to include various scattering and strain effects and to support various Hamiltonians such as generalized effective mass, k·p, and tight-binding Hamiltonians. In particular, we have investigated the performance of Ge and III-V channel Schottky-barrier MOSFETs. We have also made some meaningful progress in our project to develop a multi-scale simulation framework linking first-principles calculations with device-level simulations. Our current focus lies on the development of atomistically precise yet computationally highly efficient DFT-TB-NEGF tool.



• Thermoelectrics: We have investigated thermal conductivity of ultrathin silicon films with periodic pore patterns. Stillinger-Wever potential and NEGF were used to calculate phonon dispersion and transmission. The effects of device size, pore diameter, porosity, and shape on thermal conductivity were investigated.



• Spin-RF: We have investigated, by solving the LLGS equations, the synchronization condition for electrical coupling in magnetic tunnel junction arrays to generate RF signals. The dynamics of magnetization in a macrospin regime in tri-layer MTJ structures were also studied and a new structure, MTJ on MOSFETs, was proposed to improve output power with low noise.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. Lee and M. Shin, "Performance Assessment of III-V Channel Ultra-thin-body Schottky-Barrier MOSFETs", *IEEE Electron Device Lett.* vol. 35, no. 7, pp. 726-728, July 2014.

[2] W. Choi, J. Lee, and M. Shin, "P-type Nanowire Schottky Barrier MOSFETs: Comparative Study of Ge- and Si-Channel Devices", *IEEE Trans. Electron Devices*, vol. 61, no. 1, pp. 37-43, Jan. 2014.

Professor
Yang, Kyounghoon
Senior Member, IEEE

High Speed Nonoelectronics Laboratory

RESEARCH INTERESTS
- Nano / Quantum Devices & ICs
- III-V & Si-based Image Sensor

RECENT RESEARCH ACTIVITIES
High Speed Nanoelectronics Lab (HSNL) conducts research in next-generation devices and ICs with focus on high speed and high functional applications. The lab is currently involved in four research categories: (i) Quantum-effect based nano devices and multi-functional ICs, (ii) Terahertz devices and ICs, (iii) III-V based optical detectors, (iv) Si-based optoelectronic sensors

Our research topics in 2013-2014 include

• Quantum-effect based nano devices and multi-functional ICs: The RTD(Resonant Tunneling Diode) which has the unique negative differential resistance and very high-speed switching characteristics enables us to develop ultra high-speed and extremely low power analog and digital ICs. The multi-functional ICs achieved by using the RTDs and variable resistance devices are being researched as the primary study of the artificial neural network system.

• Terahertz devices and ICs: The research on terahertz devices and ICs have been performed for THz imaging and high-speed communication systems. The research is focused on the development of the THz-level RTD epitaxial layers, nanoscale RTD devices, THz on-chip antennas and RTD-based THz ICs such as oscillators, amplifiers and detectors.

• III-V based optical detectors: InP-based optoelectronic devices (photo-diodes, avalanche photodiodes, etc.) are important elements for 2D or 3D imaging system in the infrared region. In our lab, for development of high performance optical elements, useful process technology and array production / analysis have been researched.

• Si-based optoelectronic sensors: Si-based optoelectronic sensors are being researched for commercial camera applications such as CMOS Image Sensors (CISs). To improve the performance of the sensors, new photodetector structures are being developed and analyzed. The designed sensors are promising candidates for the cost effective, high performance imaging applications.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. W. Lee, I. K. Baek, D. J. Yang and K. H. Yang, "On-chip FPN calibration for a linear-logarithmic APS using two step charge transfer," *IEEE Tr. Electron Devices*, vol. 60, no. 6, pp. 1989 – 1994, May 2013.

[2] J. W. Lee, J. S. Lee and K. H. Yang, "Reflection-type RTD low-power amplifier with deep sub-mW DC power consumption," *IEEE Microw. Wireless Compon. Lett.*, Apr. 2014.

[3] I. K. Baek, B. S. Yoo and K. H. Yang, "In-pixel calibration of temperature dependent FPN for a wide dynamic range dual-capture CMOS image sensor," *IEEE International Sympo. Consumer Electronics*, Jeju, Korea, Silver Prize, June 2014.

Professor
Yoo, Hyung-Joun
Member, IEEE

Communication Devices and Systems Laboratory

RESEARCH INTERESTS
- RF systems for the next generation wireless communications
- Reconfigurable RFICs and digital RF
- Sensor communications

RECENT RESEARCH ACTIVITIES
The research area of communication devices and systems (CoDeS) laboratory is focused on the RF technology for the next generation wireless communications. In order to implement multi-standard transceiver, RF and digital technologies will be merged in the next generation wireless terminals. To implement an efficient multi-standard transceiver with a high flexibility, we have tried to substitute functions of RF blocks for digital circuitry with minimizing RF / analog parts. Digitalization of RF function results in a highly efficient system with a high integration, a reduced cost, and a low power consumption. Also, CoDeS carries our research on sensor communications. Recently, needs of prevention of a disease and early diagnosis increase for healthy life. Studies have been done on the u-health through convergence of IT and sensor technology. For the u-health environment, we have designed on the communication system between a smartphone and variable sensors.

Our research topics in 2013-2014 include

• Charge sampler-based receiver: Charge sampler is a key block of digital RF technology for the multi-standard receiver. The charge sampler can perform down-conversion and filtering functions that were performed by analog mixer and analog filter. Reconfigurability of charge sampler is very high because the characteristics of charge sampler are controlled by sampling frequency. Especially, we have developed the charge sampler-based receiver for the long term evolution (LTE). To develop the receiver, we have proposed the novel pass-band flattening technique, active-weighting technique, low complexity design technique, and so on.

• Sensor system: We have performed the various researches about convergence between IT and sensor technology in mobile sensor and IT convergence center (MOSAIC). For example, we have developed the system that can control the heater of the mobile gas sensors and acquire the sensor data. Also, we have developed the CO_2 sensor module for automobile, the wireless smart glove system using strain sensors, and so on.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S.-J. Kweon, S.-H. Shin, and H.-J. Yoo, *Analog discrete time filter, receiver system including the same and discrete time filtering method,* 10-1340578, Korea, December 5, 2013.

[2] H.-J. Yoo, J.-H. Park, and C.-O. Park, *Method of detecting ignition and extinguishment condition of gas stove based on carbon dioxide gas concentration change,* 10-2014-0012292, Korea, February 3, 2014.

Associate Professor
Yoo, Seunghyup
Member, IEEE / Member, MRS / Member, OSA

Integrated Organic Electronics Laboratory

RESEARCH INTERESTS
- Organic light emitting diodes for display and lighting
- Organic solar cells for energy generation
- Organic and printed electronics for flexible and low-cost electronics

RECENT RESEARCH ACTIVITIES
Integrated Organic Electronics Lab (IOEL) focuses on developing novel device architectures and integrated systems based on organic materials in three major areas: display, energy, and flexible low-cost electronics. IOEL is currently a key member of Center for Advanced Flexible Display Convergence (CAFDC) and KAIST Institute (KI) Graphene Research Center. Prof. Yoo is currently leading KAIST Samsung Display Research Center which hosts an interdisciplinary consortium across several departments.

Our research topics in 2013-2014 include

• Outcoupling enhancing structures for OLEDs based on various approaches such as index-matched substrates and graphene transparent electrodes. Optical simulation and analysis are also carried out for a rational design of efficient OLEDs that can fulfill various needs of emerging applications.

• Organic solar cells, which are rapidly gaining perception as potential low-cost alternatives to conventional PV technologies. IOEL's mission is finding innovative ways to enhance the efficiency while demonstrating the form factor advantages of organic solar cells and to realize scalable and reliable module technologies.

• Integrated organic / oxide electronics based on organic and oxide field-effect transistors (FET), which are expected to play an important role in advancing low cost electronic devices that can benefit from thin, flexible form factors. IOEL recently realized a colorless, fully transparent TFT using wide-bandgap organic semiconductors.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S. Lee et al."Overcoming the "retention vs. voltage" trade-off in nonvolatile organic memory: Ag nanoparticles covered with dipolar self-assembled monolayers as robust charge storage nodes", *Org. Electron.* vol. 14, no. 12, pp. 3260-3266, Dec. 2013.

[2] H. Moon et al. "Towards Colorless Transparent Organic Transistors: Potential of Benzothieno[3,2-b]benzothiophene based Wide-gap Semiconductors", *Adv. Mater.* Vol. 26, pp. 3105-3110, Feb. 2014.

[3] D. Han and S. Yoo, "The stability of normal vs. inverted organic solar cells under highly damp conditions: Comparison with the same interfacial layers", *Sol. Energy Mater. Sol. Cells,* Vol.128, pp 41–47, May, 2014.

Professor
Yoon, Gi Wan
Member, IEEE

Terahertz Nano System Laboratory

RESEARCH INTERESTS
- Nano Devices & Systems for THz Applications
- Micro Energy Generation & Harvesting Systems
- Novel Nano Electronic Materials & Structures

RECENT RESEARCH ACTIVITIES
Terahertz Nano System Laboratory explores a vision of multi-functional devices, systems and more intelligent algorithms for more efficient and seamless information communications.
Our research areas of interest include the solid-state micro and nano scale devices for nano battery and bio system applications, and also intelligent algorithms for the future RF and wireless applications.
Recently, our research efforts have focused mainly on the development of communication related technologies, involving RF devices and MIMO algorithms. More efforts will be made to develop nano structures and devices based on the design and fabrication of novel materials and structures.
More recently, we have started an intriguing research on the piezoelectricity-based devices for energy generation / harvesting as well as their bio & healthcare applications. Furthermore, in partnership, we are performing a new study on the intelligent algorithms for the future real-time mobile systems.

Our research topics in 2013-2014 include

• Nano Devices & Systems for THz Applications:
- Micro devices including FBAR devices based on piezoelectric materials and structures
- Innovative nano devices & systems for THz applications

• Micro Energy Generation & Harvesting Systems:
- Nano-generators based on piezoelectric materials & structures
- Research on micro-energy generation and transport mechanism

• Novel Nano Electronic Materials & Structures:
- Research on fundamentals & applications of nano materials & structures

MAJOR ACHIEVEMENTS in 2013/2014
[1] S. B. Jeong, E. J. Lee, M. H. Yim, and G. W. Yoon, “Excellent epitaxial graphene layers grown simply on SiC substrates and their characterisation,” *Electron. Lett.*,vol. 50, no. 2, pp. 98-99, Jan. 2014.

[2] E, J. Lee, J. D. Park, M. H. Yim, S. B. Jeong, and G. W. Yoon, “High-efficiency micro-energy generation based on free-carrier-modulated ZnO:N piezoelectric thin films,” *Appl. Phys. Lett.*, vol. 104, pp. 213908_1-213908_5, May 2014.

Professor
Yoon, Jun-Bo
Member, IEEE / Leader, Korean Young MEMS SIG / Associate Editor, MNSL

3D Micro-Nano Structures Laboratory

RESEARCH INTERESTS
- MEMS(micro electro mechanical system) for memory and imaging
- Gas sensor based on nanowire structure

RECENT RESEARCH ACTIVITIES
The main research area of 3DMNSL Lab is the development and research of MEMS(Micro Electro Mechanical Systems). We exploit the 3D structure for IT devices and have reliable skills for that. Moreover, cross-link of MEMS and Nano Technology, which has an enormous potential, is our concern and one of the main research areas.

Our research topics in 2013-2014 include

• Memory MEMS: The main objective of the research is to solve the issues of conventional MOSFET based switches by developing nanometer scale mechanical switches. We have fabricated the world smallest nano-gap mechanical switch in cooperation with national nanofab center(NNFC), and are trying to apply the developed switch technology to other areas. We are now focusing on overcoming the limits of existing MEM switches and proposing a new concept of memory device.

• Imaging MEMS: In this area, we propose novel solutions to recent breakthroughs of imaging devices such as 3-dimensional(3D) displays, and 3D cameras. Our major achievements in this field are micro-structures like micro-lens array, micro-mirror, micro-shutter, and so on.

• Gas sensor: We have successfully developed a fast and easy fabrication technique of nanowires, and are now seeking applications of it. Especially, we have combined our nanowire technique and gas sensing, which receives much attention recently.

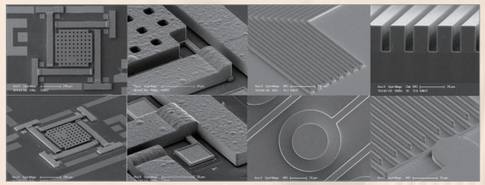


Figure. Various 3D micro / nano-structures

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. O. Lee, Y.-H. Song, M.-W. Kim, M.-H. Kang, J.-S. Oh, H.-H. Yang and J.-B. Yoon, "A sub-1-volt nanoelectromechanical switching device", *Nature Nanotechnology,* vol. 8, pp. 36-40.

[2] J.-H. Yeon, Y. J. Lee, D. E. Yoo, K. J. Yoo, J. S. Kim, J. Lee, J. O. Lee, S.-J. Choi, G.-W. Yoon, D. W. Lee, G. S. Lee, H. C. Hwang and J.-B. Yoon, "High throughput ultralong (20cm) nanowire fabrication using a wafer-scale nanograting template", *Nano Letters,* vol. 13, issue 9, pp. 3978-3984.

[3] Y.-H. Song, M.-W. Kim, M.-H. Seo and J.-B. Yoon, "A Complementary dual-contact MEMS switch using a “zipping” technique", *Journal of Microelectromechanical Systems,* vol. 23, no. 3, pp. 710-718.

Signal and Systems
SS Group

01 I Robotics Research Laboratory
02 I Speech and Audio Information Laboratory
03 I Real-time Control Laboratory
04 I Computational Imaging Laboratory
05 I Brain Reverse Engineering and Imaging Laboratory
06 I Speech Recognition Technology Laboratory
07 I Robot Intelligence Technology Laboratory
08 I Statistical Inference and Information Theory Laboratory
09 I Video and Image Computing Laboratory
10 I Visual Communications Laboratory
11 I Robotics and Computer Vision Laboratory
12 I Computational NeuroSystems Laboratory
13 I KAIST Power Electronics Laboratory
14 I Image Computing Systems Laboratory
15 I Image Systems Laboratory
16 I Image and Video Systems Laboratory
17 I Computer Vision and Image Processing Laboratory
18 I Cognitive Neurorobotics Laboratory
19 I Statistical Learning for Signal Processing Laboratory

Professor **Chung, Myung Jin**
Professor **Hahn, Minsoo**
Professor **Kim, Byung Kook**
Professor **Kim, Changick**
Professor **Kim, Daeshik**
Professor **Kim, Hoirin**
Professor **Kim, Jong-Hwan**
Assistant Professor **Kim, Junmo**
Professor **Kim, Munchurl**
Professor **Kim, Seong Dae**
Professor **Kweon, In So**
Professor **Lee, Soo-Young**
Professor **Moon, Gun-Woo**
Professor **Park, HyunWook**
Professor **Ra, Jong Beom**
Professor **Ro, Yong Man**
Associate Professor **Tai, Yu-Wing**
Professor **Tani Jun**
Professor **Yoo, Chang Dong**

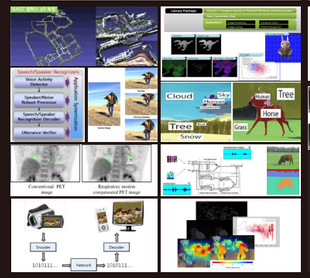
SS Group

Signal and Systems Group researches core theories and technologies needed for the development of signal and information theories / algorithms, as well as the design and implementation of diverse systems.

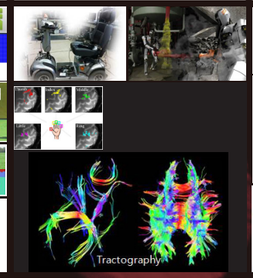
Its areas of research can be divided into three broad categories: image / signal processing / computer vision, control systems / electric power, and brain-IT. In the area of image / signal processing / computer vision, the group carries out research on signal processing, theories and machine learning that involves voice, images, video, multimedia communication. It specifically focuses on voice synthesis and coding, signal processing and prediction, computer vision, pattern recognition, machine learning, multimedia compression, social media processing, multimedia protection, signal detection and prediction, and 3D image processing.

Research related to control systems / electric power is focused mainly on intelligent robots, human-robot interfaces, empathetic robots, electric car power, power electronics, and controls theories used in various intelligent systems. In the area of brain-IT, the group carries out brain simulation, brain signal processing, brain image analysis, fMRI, and PET development.

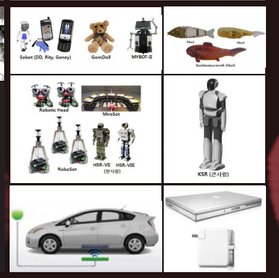
Image and Signal Processing Computer Vision



Brain-IT



Control Systems and Electric Power



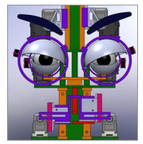
Signal and Systems Group had 19 Professors, 139 Ph.D. students, and 100 M.S. students in 2013. The members of Signal and Systems Group have achieved an outstanding academic performance in 2013 (114 international journal publications (including acceptance) and 95 international conference presentations). In 2013, total project fund of Signal and Systems Group was 9.3 billion KRW.

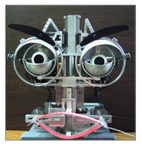
Professor
Chung, Myung Jin
Senior Member, IEEE / Member, KROS / Member, IEEK / Member, RSJ

Robotics Research Laboratory

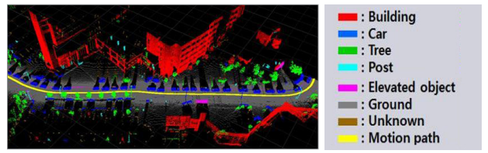
RESEARCH INTERESTS
- 3D reconstruction and perception using multiple sensors
- Robot's emotional behavior for human-robot interaction

RECENT RESEARCH ACTIVITIES
Let us introduce our current on-going projects. Studies for a robot with integrated emotion generation and expression have been carried out to increase the effectiveness of social and emotional interaction between human and a robot. For emotion generation, energy, entropy, and homeostasis are considered. For emotion expression, a new face robot hardware has been developed with auto body gesture.





The environment perception is a fundamental capability for many applications in robotics. Our mobile platform equips with multiple sensors for 3D outdoor world modeling. The laterally installed LRFs(Laser Range Finder) on each side of the vehicle give environmental information. The data from the LRFs are fused with cameras in order to make colored LRF points. With these multiple sensors, we have successfully built spatio-temporal integrated 3D world models of outdoor environments.



Recently a research on extracting semantic knowledge in urban environments is ongoing in order to execute high-level tasks for an autonomous vehicle. This research investigates the design of a system and algorithms for recognizing urban objects based on 3D point clouds collected by our mobile platform.

MAJOR ACHIEVEMENTS in 2013/2014
[1] C. H. Sung and M. J. Chung, "Multi-Scale Descriptor for Robust and Fast Camera Motion Estimation", *IEEE Signal Processing Letters,* Vol. 20, No.7, P.725-728, July 2013.

[2] Y. G. Choe, S. U. Ahn, and M. J. Chung, "Online urban object recognition in point clouds using consecutive point information for urban robotic missions", *Robotics and Autonomous Systems,* Vol. 62, Issue 8, pp. 1130–1152, Aug. 2014.

Professor
Hahn, Minsoo

Speech and Audio Information Laboratory

RESEARCH INTERESTS
- Front-end for speech interface systems
- HMM(Hidden Markov Model)-based speech synthesis
- Super-wideband (SWB) speech / audio coding

RECENT RESEARCH ACTIVITIES
The main research area of our laboratory concerns noise cancelation, speech synthesis, and audio coding techniques (MPEG) to meet the state-of-the-art research trends of the times. Consequently, we have developed beamforming technology which is proven to be highly effective for real-life applications. On top of that, we have conducted a few years of researches on improving the voice quality of the HMM-based speech synthesizer which is the cutting edge technique for the speech synthesis, and with its superiority proven, it is scheduled to be mounted for mobile phone devices sooner or later.

Our research topics in 2013-2014 include

• Front-end for speech interface systems: Speech interface has been emerged as a means of human-machine interaction. However, a significant impediment of applying speech interfaces is the adverse effects of diverse types of noise. To overcome the effects of noises, many efficient speech enhancement algorithms such as Wiener, Kalman filter, and adaptive beamforming have been developed.

• HMM-based speech synthesis: Conventional corpus-based unit concatenating speech synthesis system generates continuous speech by selecting most suitable speech segments. Although it provides good quality output speech, it is unsuitable for mobile device because of its use of large database. To overcome this drawback, HMM-based speech synthesis (HTS) system which needs small speech database has been studied. Our laboratory proposed a two-band excitation model (TBE) for HTS and improved the performance of TBE-based HTS.

• Super-wideband (SWB) speech / audio coding: Embedded super-wideband speech and audio coding techniques are rapidly advancing and the enhancement of coding algorithms has become a popular research issue. This trend in the area of speech-audio convergence coding suggests an increase in the quality and bandwidth of coded speech and music signals. In our laboratory, we research new band-width extension (BWE) algorithm and enhanced SWB coding method for an improvement in the decoded sound quality.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J. Park, K. Kim, and M. Hahn, "Vocal removal from multiobject audio using harmonic information of Karaoke service," *IEEE Tr. Audio, Speech, Language Process.,* vol. 21, no. 4, pp. 798-805, Apr. 2013.

[2] J. Hong, S. Park, S. Jeong, and M. Hahn, "Adaptation mode con- troller using multiple signal classification for GSC-based beamforming," *Electron. Lett.,* vol. 49, no. 17, pp. 1076-1078, Aug. 2013.

[3] K. Cho, S. Jeong, and M. Hahn, "Cepstrum-based bandwidth extension for super-wideband coders," *IEEE Signal Process. Lett.,* vol. 21, no. 4, pp. 503-507, Apr. 2014.

Professor
Kim, Byung Kook
Member, IEEE / Member, KITE / Member, KIEE / Member, KISS

Real-time Control Laboratory

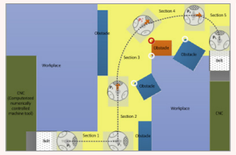
RESEARCH INTERESTS
- Real-Time Control System / Embedded System
- Robot Control System / Mobile robot Localization

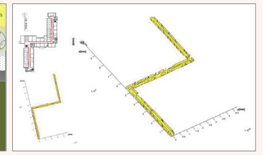
RECENT RESEARCH ACTIVITIES
The Real-Time Control Laboratory is a research laboratory in the Department of Electrical Engineering Computer Science at the Korea Advanced Institute of Science and Technology. Major research areas cover the following: Real-time control systems area including Reliable process control system, Real-time systems, and Automotive control. Robot control system area including Mobile robot sensing and navagation, Manipulator control.

Our research topics in 2013-2014 include

• Optimal control for mobile robot: We are researching various optimal control topics. For example, a research for the optimal control of mobile robot. It is a essential area of battery-powered robot. This topic includes main problems like energy-constraint, time-constraint.

• Localization for mobile robot: Localization is also a fundamental research in multi-task mobile robot to recognize where it is and where to go. Since many sensors have used for this area, this topic includes sensor-fusion, sensor information processing.





MAJOR ACHIEVEMENTS in 2013/2014
[1] S. J. Kim and B. K. Kim, "Dynamic Ultrasonic Hybrid Localization System for Indoor Mobile Robots," *IEEE Tr. Industrial Electro.,* vol. 60, no. 10, pp. 4562-4573, May. 2013.

[2] H. K. Shin and B. K. Kim, "Energy-Efficient Gait Planning and Control for Biped Robots Utilizing the Allowable ZMP Region" *IEEE Tr. Robotics vol.* PP, no. 99, pp. 1-8, Feb. 2014.

[3] H. J. Kim and B. K. Kim, "Online Minimum-Energy Trajectory Planning and Control on a Straight-Line Path for Three-Wheeled Omnidirectional Mobile Robots." *IEEE Tr. Industrial Electro.,* vol. 61, no. 9, pp. 4771-4779, Mar. 2014.

Professor
Kim, Changick
Senior Member, IEEE / Member, IEEK

Computational Imaging Laboratory

RESEARCH INTERESTS
- Intelligent Video, 3D Video, and UHDTV
- Image Analysis, Computer Vision, and Pattern Recognition
- Medical Imaging

RECENT RESEARCH ACTIVITIES
The Computational Imaging Laboratory (CI Lab.) is part of the Signal and Systems Group at the Department of Electrical Engineering. The mission of the CI Lab. is to perform innovative research work in the areas of mobile image communications and intelligent multimedia systems. Members of the lab are investigating advanced technologies on a variety of multimedia systems. Specifically, research has been focused on the followings: Image understanding, immersive and 3D video processing, computational photography, video analysis, nonlinear signal and image processing, and multimedia applications for smart TV / phones.

Our research topics in 2013-2014 include

• Perception based Super Resolution: It is faced with the necessity of the high-resolution and high-definition broadcasting technology of UHDTV, with the increasing demand for extending the human perception through the high quality of immersive media. We develop a perception based super resolution (SR) algorithm which converts the low resolution video signal (SD, HD) to 8K UHD resolution signals using perception based model.

• Smart photo management system: Various digital devices, such as handheld digital cameras, mobile phones, portable laptop computers, and tablets have become a daily life partner of humans. We have developed a method of displaying contents on a portable device for people to browse and search large collections of images effectively.

• Mobile Health: Heart rate is an important factor of our health condition, and is widely used in checking the health of an individual. We develop smart mobile healthcare algorithms which currently measure heart rate using the smart phone camera in real-time without any additional sensors.

MAJOR ACHIEVEMENTS in 2013/2014
[1] C. Jung and C. Kim, "Impact of the Accuracy of Automatic Segmentation of Cell Nuclei Clusters on Classification of Thyroid Follicular Lesions," *Cytometry Part A,* online published [DOI: 10.1002 / cyto.a.22467], Mar. 2014.

[2] W. Kim and C. Kim, "Spatiotemporal Saliency Detection Using Textural Contrast and Its Application," *IEEE Tr. Circuits and Syst. for Video Tech,* vol. 24, no. 4, pp. 646-659, Apr. 2014.

[3] C. Jung, W. Kim, S. Yoo, and C. Kim, "A Novel Monochromatic Cue for Detecting Regions of Visual Interest," *Image and Vision Computing,* vol. 32, no. 6-7, pp. 405-413, Jun.-Jul. 2014.

Professor

Kim, Daeshik

Director, KOLON-KAIST Lifestyle Innovation Center

Brain Reverse Engineering and Imaging Laboratory

RESEARCH INTERESTS

- Deep learning
- Brain decoding via non-invasive methods
- Neuromorphic hardware design

RECENT RESEARCH ACTIVITIES

Brain Reverse Engineering and Imaging Lab (BREIL) tries to understand how human brain works and build artificial intelligence by reverse engineering of the brain. We believe that decoding functionality of brain can be achieved by exploiting complex brain network theory and recent approaches in brain imaging. Our lab also carries out bottom-up research to model intelligence using brain-inspired learning models. Furthermore, interdisciplinary study of brain science and engineering motivates us to develop many interesting applications of neuroscience that can innovate current trends and contribute to industry.

Our research topics in 2013-2014 include

• Deep Learning: Deep learning is one of the most actively studied areas in machine learning community theses days. Our research in deep learning highly focuses on solving vision and motor problem, such as object classification, tracking, and motion data generation. Also, we are trying to apply deep learning on new dataset as well as develop better deep learning algorithms for such high level tasks.

• Brain decoding: Brain is the most complex organ of human and much of its functionality still remains unknown. By examining spatio-temporal patterns captured by fMRI together with novel experimental design, we have been studying lots of functions of the brain.

• Neuromorphic hardware: Based on neuroscience, we have been developing interesting systems, such as next generation haptic interface and wireless neural communication systems. The goal of our research is to develop novel interaction methods using multimodal sensory models of human.

MAJOR ACHIEVEMENTS in 2013/2014

[1] J. Lim, J. Yoo and D. Kim, *Method for Self-recognition in Autonomous System,* 12617972, Korea, April 30, 2013

[2] H. Choi and D. Kim, "Planning as inference in a Hierarchical Predictive Memory", *Proceedings of International Conference on Neural Information Processing,* Daegu, South Korea, Nov. 2013.

[3] J. Lee, J. Lim, H. Choi and D. Kim, "Multiple Kernel Learning with Hierarchical Feature Representations", *Proceedings of International Conference on Neural Information Processing,* Daegu, South Korea, Nov. 2013.

Professor

Kim, Hoirin

Member, IEEE / Member, IEIE / Member, ASK / Member, KSSS

Speech Recognition Technology Laboratory

RESEARCH INTERESTS

- Automatic speech and speaker recognition
- Audio indexing and retrieval
- Machine learning for speech and audio signal processing

RECENT RESEARCH ACTIVITIES

Speech Recognition Technology Lab (SRT-Lab) has focused on developing speech and audio signal processing systems related to speech recognition, speaker identification / verification, keyword spotting, and audio indexing / retrieval. Our research methodologies are mainly based on various machine learning techniques including Bayesian learning, graphical models, linear algebra, statistics and probability theory, optimization theory, and information theory.

Our research topics in 2013-2014 include

• Subspace-based acoustic modeling: The compact representation of acoustic model parameters is important for robust estimation. Using subspace representation, we have studied robust parameter estimation strategies when the amount of training data of interested domain is limited.

• Sparse speaker adaptation: To prevent the redundant model parameter adaptation and to increase the generality, we have proposed new speaker adaptation methods restricting the number of adapted acoustic model parameters using L0 or L1 regularization for speaker verification and speech recognition.

• WFST-based speech recognition: Reducing search space is a key issue for achieving high efficiency, so we have studied efficient search space construction methods based on weighted finite state transducer (WFST) to deal with large vocabulary continuous speech recognition task.

• Dysarthric speech recognition: We have developed a speech recognition system individually customized for disabled persons with dysathria employing the speech modeling and speaker adaptation techniques depending on their severity-levels to make the system more speaker-specific.

MAJOR ACHIEVEMENTS in 2013/2014

[1] Y. J. Suh and H. Kim, "Minimum classification error-based weighted support vector machine kernels for speaker verification," *J. Acoustical Society of America,* vol. 133, no. 4, pp. 307-313, Apr. 2013.

[2] M. J. Kim, J. Yoo, and H. Kim, "Dysarthric speech recognition using dysarthria-severity-dependent and speaker-adaptive models," *Interspeech,* Lyon, France, Aug. 2013.

[3] Y. Kim and H. Kim, "Constrained MLE-based speaker adaptation with L1 regularization," *IEEE Int. Conf. Acoust. Speech, and Signal Process.,* Florence, Italy, May 2014.

Professor

Kim, Jong-Hwan

KT Chair Professor / Fellow, IEEE

Robot Intelligence Technology Laboratory

RESEARCH INTERESTS

- Intelligence technology for intelligence super agent
- Robotics including software robot, embedded robot, mobile robot (omni-direction), humanoid robot, ubiquitous robot, and genetic robot
- Multi-agent system

RECENT RESEARCH ACTIVITIES

• Intelligence Technology (InT) and Intelligence Operating Architecture (iOA): InT is the application of machines and agents to perceive and process data and information for knowledge-based reasoning and to utilize their own reasoning to execute an appropriate action. InT consists of cognitive intelligence, social intelligence, behavioral intelligence, ambient intelligence, collective intelligence, and genetic intelligence. To materialize InT in intelligent agents and machines including robots, a brain-inspired architecture iOA was proposed. iOA consists of perception, internal state, memory, reasoning, and execution parts.

• Bio-inspired Robots: A humanoid robot HSR (HanSaRam) has been developed since 2,000. Recently, a robotic fish Fibo has been developed for entertainment and education purpose. It can swim like a fish based on localization and obstacle avoidance navigation.

• Ubiquitous Robot & Genetic Robot: Rity and Geney are software robots and have their own personality and internal state such as motivation, homeostasis and emotion. Evolutionary Generative Process for an Artificial Creature's Personality (EGPP) has been proposed to create an artificial genome. Bear-type intelligent robot, GomDoll, which endows hardware robot with the genome code, has been developed.

• Multi-agent System (MAS): For FIRA robot soccer, a univector field navigation method using the position and velocity vectors of robot has been proposed. To achieve high mobility in RoboSot soccer game, omni-directional platform with three omniwheels has been developed. HSR has been participating in the HuroCup, FIRA.

MAJOR ACHIEVEMENTS in 2013/2014

[1] J.-H. Kim, S.-H. Choi, I.-W. Park, and S. A. Zaheer, "Intelligence technology for robots that think," *IEEE Comput. Intell. Mag.,* vol. 8, no. 3, pp. 70-84, Aug. 2013.

[2] K.-B. Lee and J.-H. Kim, "Multiobjective particle swarm optimization with preference-based sort and its application to path following footstep optimization for humanoid robots," *IEEE Trans. Evol. Comput.,* vol. 17, no. 6, pp. 755-766, Dec. 2013.

[3] S.-H. Choi, I.-B. Jeong, J.-H. Kim, and J. Lee, "Context generator and behavior translator in a multi-layer architecture for a modular development process of cyber-physical robot systems," *IEEE Trans. Ind. Electron.,* vol. 61, no. 2, pp. 882-892, Feb. 2014.

Assistant Professor

Kim, Junmo

Member, IEEE / Member, IEEK

Statistical Inference and Information Theory Laboratory

RESEARCH INTERESTS

- Statistical signal processing / machine learning
- Image processing / computer vision
- Information theory

RECENT RESEARCH ACTIVITIES

The researches of the Statistical Inference and Information Theory Laboratory focus on development of theoretical methods which can be applied to image processing, computer vision, pattern recognition, and machine learning.

Our research topics in 2013-2014 include

• Salient Region Detection: Salient region detection is important in image understanding and analysis. Its goal is to detect salient regions, in terms of saliency map, from an image where the detected regions would draw the attentions of humans at the first sight of an image. We introduce a novel technique to automatically detect salient regions of an image via high-dimensional color transform.

• Image Segmentation: We proposed an efficient optimization algorithm for mutual information-based unsupervised figure-ground separation, which has been previously solved by level-set method. In this work, we identified a family of tight convex upper bounds for the non-convex energy functional and minimized a sequence of convex upper bounds in a way that guarantees decrease in the energy functional.

• Face Recognition: We proposed a novel classifier fusion method for face image retrieval problem. The proposed classifier fusion is formulated by modeling the relationship among multiple classifiers by Markov network and implemented by belief-propagation algorithm. The novelty of the proposed framework lies in that it takes into account the dependency between classifiers using each classifier's retrieval results.

MAJOR ACHIEVEMENTS in 2013/2014

[1] J. Kim, D. Han, Yu. Tai, and J. Kim, "Salient Region Detection via High Dimensional Color Transform," *IEEE Conf. Computer Vision, Pattern Recognition,* Columbus, USA, June 2014.

[2] Y. Kee, M. Souiai, D. Cremers, and J. Kim, "Sequential Convex Relaxation for Mutual Information Based Unsupervised Figure-Ground Segmentation," *IEEE Conf. Computer Vision, Pattern Recognition,* Columbus, USA, June 2014.

[3] W. Hwang, K. Roh, and J. Kim, "Markov Network-based Unified Classifier for Face Identification," *IEEE Int'l Conf. Computer Vision,* Sydney, Australia, Dec. 2013.

Professor
Kim, Munchurl
Senior Member, IEEE / Member, IEEK

Video and Image Computing Laboratory

RESEARCH INTERESTS
- 2D / 3D Perceptual Video Coding (PVC)
- Video Analysis and Understanding
- Video / Image Processing of High Dynamic Rang (HDR) and Wide Color Gamut (WCG)

RECENT RESEARCH ACTIVITIES
Video and Image Computing (VIC) lab currently conducts research in the areas of 2D / 3D perceptual video coding, DCT-free transform and rate-distortion modeling for low-complexity High Efficiency Video Coding (HEVC) encoders, video / image retargeting from HDR to SDR (standard dynamic range) and vice versa, and context reasoning for video analysis and understanding. The research in VIC includes next-generation video coding, HDR- and WGC-video / image processing, pattern recognition and machine learning.

Our research topics in 2013-2014 include

• 2D / 3D perceptual video coding: We model the characteristics of perceptual visual quality for video / image signals. Based on the perceptual visual quality model, we realized a very effective PVC scheme based on HEVC which greatly enhance coding efficiency by effectively removing the perceptual redundancy.

• Low-complexity HEVC: We factorize DCT into a Hardamard matrix and a sparse matrix. The Hardamard transform is fast performed without multipliers and the sparse matrix is treated in quantization. Based on this, DCT-free HEVC is investigated.

• Video / Image retargeting: High quality video / image is not simply to enlarged image resolutions such 4k / 8k UHD (Untra High Definition). The bit depth range is also increased from 8-bit to 10- / 12-bit or even 16-bit depth. The color gamut is also expanded from BT.709 to BT.2020 color space. Video and image retargeting is investigated for conversion from HDR to SDR or from BT.2020 to BT.709 and vice versa.

MAJOR ACHIEVEMENTS in 2013/2014
[1] S.-H Bae and M. Kim, "A Novel DCT-based JND Model for Luminance Adaptation Effect in DCT Frequency," *IEEE Sig. Process. Lett.,* vol. 20, no. 9, pp. 893-896, Sept. 2013.

[2] T. Na and M. Kim, "A Novel No-Reference PSNR Estimation Method with regard to Deblocking Filtering Effect in H.264 / AVC Bitstreams," *IEEE Tr. on Circuits and Syst. for Video Tech.,* vol. 24, no. 2, pp. 320-330, Feb. 2014.

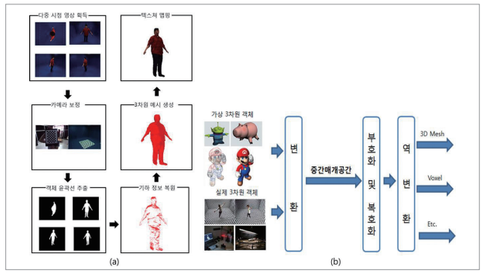
[3] B. Lee, M. Kim and T. Q. Nguyen, "A Frame-level Rate Control Scheme based on Texture and Non-texture Rate Models for High Efficiency Video Coding," *IEEE Tr. Circuits and Syst. for Video Tech.,* vol. 24, no. 3, pp. 465-479, Mar. 2014.

[4] J. Kim and M. Kim, "Best Encoder Optimization for High Efficiency Video Coding" Award with 4,000 USD, "Video Compression Grand Challenges" in Picture Coding Symposium, Dec. 2013, San Jose, USA.

Professor
Kim, Seong Dae
Senior Member, IEEE / Member of IEEK, KICS, ASK, NAEK

Visual Communications Laboratory

RESEARCH INTERESTS
- Image processing
- Pattern recognition, Computer vision
- Image coding, Visual communication system

RECENT RESEARCH ACTIVITIES


• Computer Vision: It is about acquiring and interpreting the rich visual world around us. A theme in the development of this field has been to duplicate the abilities of human vision by electronically perceiving and understanding an image. Problems in this field include reconstructing the 3D shape of an environment, determining how things are moving, and recognizing people and objects and their activities, all through analysis of images and videos.

• Pattern Recognition: Pattern recognition refers to the process of recognizing a set of stimuli arranged in a certain pattern that is characteristic of that set of stimuli. Examples of applications are Optical Character Recognition, Biometrics(face recognition, verification, finger prints recognition), diagnostic systems(X-Ray analysis, waster detection), and military applications(automated target recognition).

• Image Compression: The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. Some of the finer details in the images can be sacrificed for the sake of saving a little more bandwidth or storage space.

MAJOR ACHIEVEMENTS in 2013/2014
[1] J.W.Seo, S.D.Kim, "Novel PCA-BASED COLOR-TO-GRAY IMAGE CONVERSION" *IEEE International Conference on Image Processing,* Melbourne, 2013.

[2] J.S.Yoo, S.S.Hwang, S.D.Kim, M.S.Ki and Jihun Cha, "Scale-Invariant Template Matching using Histogram of Dominant Gradients" *Pattern Recognition*, vol. 47, Issue 9, pp. 3006-3018. Sep. 2014.

Professor
Kweon, In So
Member, IEEE / Member, ICROS / Member, KROS

Robotics and Computer Vision Laboratory

RESEARCH INTERESTS
- Computer vision
- Intelligent robotics
- Unmanned vehicles

RECENT RESEARCH ACTIVITIES
Robotics and Computer Vision(RCV) Laboratory was established in 1993 for the research and development of robotics and computer vision. RCV has a strong history in geometrical 3D reconstruction techniques such as stereo matching, structure-from-motion, bundle adjustment and sensor fusion. Recently, we have utilized photometric ques under known or unknown illumination for pushing the quality of 3D reconstruction to the limit. Moreover, we've tackled various problems in image understanding, image enhancement, robot navigation, unmanned vehicles, and much more.

Our research topics in 2013-2014 include

• Image understanding and enhancement: dealing with fundamental problems in computer vision such as image noise, motion blur, camera response, and cognitive computing.
(noise modeling, coded exposure for deblurring, radiometric calibration, object detection / classification, etc.)

• Sensor fusion and 3D reconstruction: achieving highly accurate 3D reconstruction in terms of quantitative and qualitative fronts.
(camera-laser fusion, photometric methods for depth / geometry refinement, depth from light-field camera, structured light scanning, etc.)

• Robot vision system and system integration: challenging autonomous navigation system for robots and unmanned vehicles in real environment.
(simultaneous localization and mapping, camera-laser fusion based navigation, auto-adjusting camera exposure system, computer vision for unmanned vehicle, etc.)

MAJOR ACHIEVEMENTS in 2013/2014
[1] Y. Bok, D.-G. Choi and I.S. Kweon, "Generalized laser three-point algorithm for motion estimation of camera-laser fusion system," *IEEE International Conference on Robotics and Automation,* Karlsruhe, Germany, May 2013.

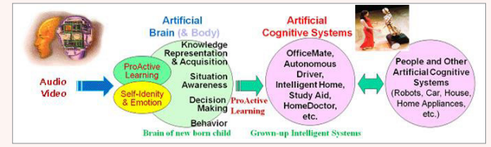
[2] T.-H. Oh, H. Kim, Y.-W. Tai, J. Bazin and I.S. Kweon, "Partial sum minimization of singular values in RPCA for low-level vision," *IEEE International Conference on Computer Vision,* Sydney, Australia, Dec. 2013.

[3] Y. Han, J.-Y. Lee and I.S. Kweon, "High quality shape from a single RGB-D image under uncalibrated natural illumination," *IEEE International Conference on Computer Vision,* Sydney, Australia, Dec. 2013.

Professor
Lee, Soo-Young
Member, IEEE; Governing Board Member, INNS

Computational NeuroSystems Laboratory

RESEARCH INTERESTS
- Machine Learning
- Understanding Human Mind
- Brain Signal Processing

RECENT RESEARCH ACTIVITIES


The main research areas of Computational NeuroSystems Laboratory (CNSL) reside in computational models of brain information processing mechanism and their applications to build human-like intelligent systems, i.e., Artificial Brain and Artificial Cognitive Systems (ACS). These functional models are based on information theory and inspired by findings in cognitive science.
Although human-like perception has been regarded as the main achievements on the laboratory, recently the research topics extend further into the higher brain functions, i.e., mind, including knowledge, emotion, consciousness, and human behavior. We also work on brain-machine interfaces and neurofeedback mind self-controls both based on EEG and possibly eye-movement.

Our research topics in 2013-2014 include

• Human Implicit Intention: We aim to develop user interface technology by recognizing users' implicit intention from speech, facial expression and behavior pattern, and a prototype system based on the technology.

• Deep-Learning Feature Extraction: Both unsupervised and supervised learning algorithms are developed for high discrimination with robustness on distortion and noise.

• Active Learning: Active learning helps a learner choose essential training data or queries from the pool, thereby reducing the cost and the time needed for the machine training. For selective sampling, uncertainty measure is defined using estimated conditional class probabilities.

MAJOR ACHIEVEMENTS in 2013/2014
[1] H. R. Lee, N. Iqbal, W. I. Chang, and S.-Y. Lee, "A calibration method for eye-gaze estimation systems based on 3D geometrical optics", *IEEE Sensors J.,* vol. 13, no. 9, pp. 3219-3225, Sep. 2013.

[2] Y.-S. Choi and S.-Y. Lee, "Nonlinear spectro-temporal features based on a cochlear model for automatic speech recognition in a noisy situation", *Neural Networks,* vol. 45, pp. 62-69, Sep. 2013.

[3] S.-Y. Lee and J.-K. Yoo, *Method and apparatus for blind signal extraction,* 8712073, USA, Apr. 29, 2014.

Professor
Moon, Gun-Woo
Member, IEEE / Member, KIPE / Member, KAST

KAIST Power Electronics Laboratory

RESEARCH INTERESTS
- High efficiency and high power density power supply
- EV charging system (wireless charging type & plug-in type)
- Charge balancing circuit for Li-ion battery

RECENT RESEARCH ACTIVITIES
KAIST Power Electronics Lab. (KPEL) carries out many researches on the server power system, notebook adaptor power system, wireless power charging system for the electric vehicle, and Li-ion battery equalizer for the satellite and hybrid vehicle. Especially, many technologies studied in our laboratory are recognized as the world best in the power electronics field, gaining many achievements in the server power system and wireless power charging system with high power density and high efficiency.

Our research topics in 2013-2014 include

• High efficiency and high power density power supply: we have studied the server power system and laptop adapter with high power density and high efficiency. To design the power supplies with high power density and high efficiency is key technology of our laboratory, and it is currently the highest level in the field of the sever power system and laptop adapter through the project with the samsung electro-mechanics.

• EV charging system (wireless charging type & plug-in type): we have researched the plug-in charging method and wireless power transfer method for the electric vehicles. Through the project with the samsung electronics based on technologies in our laboratory, we have developed the wireless charging system with large capacity. Moreover, the development of personal electric vehicle charging system is also proceeded as a national project.

• Charge balancing circuit for Li-ion battery: We have studied the charge balancing circuits for the satellite and hybrid vehicle with high performance. Through the project with Korea Aerospace Research Institute (KARI), Li-ion battery equalizer was developed for the science and technology satellite no.3 (STSAT-3).

MAJOR ACHIEVEMENTS in 2013/2014
[1] I. O. Lee and G. W. Moon, “Analysis and Design of Phase-Shifted Dual H-Bridge Converter with a Wide ZVS Range and Reduced Output Filter,” *IEEE Trans. Industrial Electronics.,* vol. 60, no. 10, pp. 4415-4426, Oct. 2013.

[2] H. S. Kim and G. W. Moon, “Start-Up Control to Prevent Overcurrent During Hot Swap in Paralleled DC–DC Converters,” *IEEE Trans. Industrial Electronics.,* vol. 60, no. 12, pp. 5558-5574, Dec. 2013.

[3] H. S. Kim and G. W. Moon, “On / Off Control of Boost PFC Converters to Improve Light-Load Efficiency in Paralleled Power Supply Units for Servers,” *IEEE Tr. Industrial Electronics.,* vol. 61, no. 13, pp. 1235-1242, Mar. 2014.

Professor
Park, HyunWook
Senior Member, IEEE / Member, ACM / Member, SPIE

Image Computing Systems Laboratory

RESEARCH INTERESTS
- Digital Image Processing
- NMR (Nuclear Magnetic Resonance) Imaging and fMRI
- Video Transcoding, Super Resolution & Frame Rate Up Conversion (FRUC)

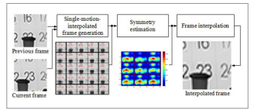
RECENT RESEARCH ACTIVITIES
Members in the KAIST ICSL focus their research on image processing, image and video compression, object recognition, stereo image processing, and medical image processing and imaging systems.

Our research topics in 2013-2014 include

• MR sequence design & reconstruction: MR sequence design: MRI is a medical modality which can offer various contrast images by controlling diverse parameters. MR sequence is a kind of blueprint how to image. Depending on this sequence design, operators can obtain various images such as anatomical, functional images. Reconstruction is a work from measured data to images. Acquisition time is the weakest point of MRI. So we researched how to make images with high quality from small data.

• MR angiography: As concerns about chemical contrast agent increase, non-contrast enhanced MR angiography which does not use any chemicals draws increased attention. Our research focuses on intensifying vessel signal while rejecting background signal using flow characteristics. Furthermore, we investigate how to reduce the scanning time while maintaining image quality of non-contrast enhanced angiogram.

• Frame Rate Up Conversion (FRUC): In order to generate intermediate frames between successive frames, the proposed method utilizes a symmetric motion estimation, which is our own pixel-wise motion estimation method for intermediate frame interpolation.



MAJOR ACHIEVEMENTS in 2013/2014
[1] J.S. Choi, H.S. Seo, Y.W. Lim, Y.J. Han, and H.W. Park, “Sliding TOF: Sliding time of flight MR angiography using a dynamic image reconstruction method,” *MRM* Feb. 2014

[2] S.S. Oh, Y.J. Han, J.H. Lee, S.D. Yun, J.K. Kang, E.M. Lee, J.Y. Chung, H.W. Yoon, and H.W. Park A pulse artifact removal method considering artifact variations in the simultaneous recording of EEG and fMRI *Neuro. Res.* Jan. 2014.

[3] S.Y. Jung, and H.W. Park Offset compensation method for skip mode in hybrid video coding *IEEE Trans. CSVT* Mar. 2014

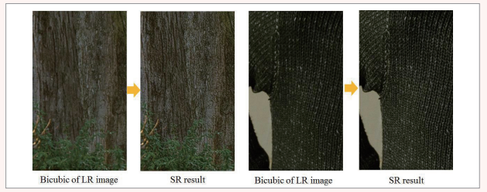
Professor
Ra, Jong Beom
Senior Member, IEEE / Member, SPIE

Image Systems Laboratory

RESEARCH INTERESTS
- Image and video processing
- Medical image processing

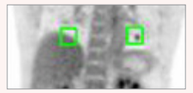
RECENT RESEARCH ACTIVITIES
Image Systems Laboratory (ISL) was founded in 1987. The research field includes image and video processing, and medical image processing. Among various research activities in 2013-2014, we introduce two representative works as follows.

• Super-resolution: Super-resolution (SR) is a process to produce a high resolution (HR) image from one or more low-resolution (LR) images. To increase the resolution of an image, we propose an example-based SR algorithm [1] and a texture synthesis algorithm.



• PET image reconstruction: Since PET image can provide functional information regarding the human body, it often allows the detection of lesions. The respiratory motion during a scan, however, causes motion blurring in thoracic and abdominal PET images. To produce high quality motion compensated PET image, we propose a motion compensated reconstruction framework based on anatomical image registration [2].

< Conventional PET image >



< Respiratory motion compensated PET image >

MAJOR ACHIEVEMENTS in 2013/2014
[1] C. Kim, K. Choi, and J. B. Ra, "Example-based super-resolution via structure analysis of patches," *IEEE Signal Process. Lett.,* vol. 20, no. 4, pp. 407-410, Apr. 2013.

[2] W. H. Nam, I. J. Ahn, K. M. Kim, B. I. Kim, and J. B. Ra, "Motion-compensated PET image reconstruction with respiratory-matched attenuation correction using two low-dose inhale and exhale CT images," *Physics in Medicine and Biology,* vol.58, no.20,pp.7355-7374, Oct. 2013.

[3] W. H. Lee, K. Choi, and J. B. Ra, "Frame rate up conversion based on variational image fusion," *IEEE Tr. Image Process.*, vol. 23, pp. 399-412, Jan. 2014.

Professor
Ro, Yong Man
Senior Member, IEEE / Member, SPIE

Image and Video Systems Laboratory

RESEARCH INTERESTS
- Visual recognition / Image processing
- 3D video processing
- Medical image processing / medical image analysis

RECENT RESEARCH ACTIVITIES
The Image and Video Systems Lab. (IVY Lab.) conducts researches in the area of multimedia processing and communication. The main research topics of IVY Lab. in 2013-2014 are summarized below.

• Visual recognition: Our research includes low-power object detection (e.g., human face, car plate etc.), face analysis (face identification and emotion recognition), and human gesture analysis. For achieving reliable performances in unconstrained environments, we have proposed robust texture features from multiple color-bands, improved classification based on sparsity, and multiple feature fusions for effective and efficient video-based visual analysis.

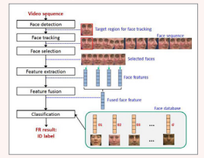


Fig.1_Feature fusion based video FR

• 3D video processing: For a comfortable viewing experience in stereoscopic displays, IVY Lab. has performed research on human 3D perception. From the properties of human visual system, we have developed 3D visual comfort metrics considering disparity, motion, window violation, divergence, etc. Furthermore, the visual comfort improvement methods have been developed based on the visual comfort metrics.

• Medical image processing: To assist doctors for the interpretation of medical images, IVY Lab. is actively developing automatic breast cancer detection in digital breast tomosynthesis (DBT) with a novel approach including a fusion framework on projection views and reconstructed slices, multiple view analysis, and boosting classification techniques.

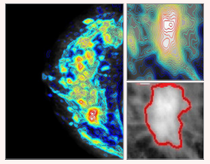


Fig.2_Segmented mass

MAJOR ACHIEVEMENTS in 2013/2014
[1] Y. M. Ro, et. al., “Predicting Visual Discomfort using Object Size and Disparity Information in Stereoscopic Images" *IEEE Tr. on Broadcast.,* vol. 59, no. 1, pp. 28-37, Mar. 2013.

[2] Y. M. Ro, et. al., “Visual comfort amelioration technique for stereoscopic images: disparity remapping to mitigate global and local discomfort causes,” *IEEE Tr. Circuits and Syst. for Video Tech.,* vol. 24, no. 5, pp. 745-758, May 2014.

[3] Y. M. Ro, et. al., “Computer-aided detection of breast masses in mammography: Combined detection and ensemble classification,” *Phys. Med. Biol.,* vol. 59, no. 14, pp. 3697-3719, June 2014.

Associate Professor

Tai, Yu-Wing

Member, IEEE / Member, ACM

Computer Vision and Image Processing Laboratory

RESEARCH INTERESTS

- Computer Vision / Image Processing
- Computational Photography

RECENT RESEARCH ACTIVITIES

Image Processing Lab (CVIP) carries out advanced research on academic and technological fronts in computer vision and image processing which have got many attention and are actively ongoing. We are studying signal processing, artificial intelligence, and mathematic techniques to improve quality of user photo and to extract meaningful information from world scene.

Our research topics in 2013-2014 include

• New-generation camera: Recently, new types of cameras such as light-field, focal stack, and egocentric camera have been developed. These new cameras have different advantages according to the each type. Until now, we already did valuable researches about focal stack and egocentric camera. Currently, we are actively studying light-field imaging system that make post-refocusing and estimating depth map possible on single shot.

• Image Processing Techniques: We are continuously developing Image debluring and super-resolution algorithms to restore high quality images from degradation. The purposes of debluring and super-resolution are to remove blur from shakes of handheld camera and to overcome limited resolution from small CCD sensor respectively. De-noising and other kinds of restoration issues are also our concerns.

• Others: In addition to above topics, we are interested in 3D reconstruction, intrinsic image separation, face tracking, etc.
We always try to submit research results to the international top conference and journal such as CVPR, ICCV, ECCV, TPAMI, TIP, and etc.

MAJOR ACHIEVEMENTS in 2013/2014

[1] D. Cho, S. Kim and Y. Tai, “Consistent Matting for Light Field Images,” *European Conference on Computer Vision,* Zurich, Switzerland, Sep. 2014.

[2] N. Kong, Y. Tai and J. S. Shin, “A Physically-based Approach to Reflection Separation: from Physical Modeling to Constrained Optimization,” *IEEE Tr. Pattern Analysis, Machine Intell,* vol. 36, no. 2, pp. 209-221, Feb. 2014.

[3] Y. Tai, X. Chen, S. Kim, S. Kim, F. Li, J. Yang, J. Yu, Y. Matsushita, and M. S. Brown, “Nonlinear Camera Response Functions and Image Deblurring: Theoretical Analysis and Practice,” *IEEE Tr. Pattern Analysis, Machine Intell,* vol. 35, no. 10, pp. 2498-2512, Oct. 2013.

Professor

Tani Jun

Member: The International Society of Adaptive Behavior

Cognitive Neurorobotics Laboratory

RESEARCH INTERESTS

- Neuro-Robotics toward "General Intelligence"
- Social Cognitive Neuro-Robotics
- Exploring Nontrivial Dynamic Computation by Recurrent Neural Network (RNN)

RECENT RESEARCH ACTIVITIES

We focus on understanding brain-based mechanisms for cognition and action by conducting synthetic brain modeling studies with utilizing robotics experiment platforms. Our essential questions include how compositionality and systematicity in cognition and actions can be developed via consolidative and deep learning of behavioral experiences, how novel actions and thoughts can be generated with "free will", how social cognition with reading others' minds can be developed to support spontaneous generation of cooperative behaviors with others.

Our research topics in 2013-2014 include

• Learning to extract stochastic structures from perceptual sequences: We developed a novel dynamic neural network model which can learn to extract stochastic structures latent in sensory-motor sequences. Our robotics experiments showed that the scheme can be applied successfully to skill learning of robots

• Deep learning for dynamic vision: We proposed a novel dynamic neural network model which can learn to recognize sequential human action combinations by extracting spatio-temporal hierarchy latent in exemplar dynamic visual pixel patterns. This is the first achievement in the world.

MAJOR ACHIEVEMENTS in 2013/2014

[1] S. Murata, J. Namikawa, H. Arie, S. Sugano, and J. Tani: "Learning to reproduce fluctuating time series by inferring their time-dependent stochastic properties: application in robot learning via tutoring", *IEEE Trans. on Autonomous Mental Development,* Vol. 5, No 4, pp. 298-310, 2013.

[2] J. Tani: "Self-Organization and Compositionality in Cognitive Brains: A Neuro-Robotics Study,", *Proceedings of the IEEE,* Vol. 102, no. 4, pp. 586-605, 2014.

[3] M. Komatsu, J. Namikawa, Z. Chao, Y. Nagasaka, N.Fujii, K. Nakamura, and J. Tani: "An artificial network model for estimating the network structure underlying partially observed neuronal Signals, *Neuroscience Research,* Vol. 81-82, pp 69-77, 2014.

Professor

Yoo, Chang Dong

Senior Member, IEEE / Member, IEEK

Statistical Learning for Signal Processing Laboratory

RESEARCH INTERESTS

- Machine Learning for multimedia signal processing (Music, speech, image, video, audio, etc)
- Statistical Learning theory & application
- Deep learning theory & application

RECENT RESEARCH ACTIVITIES

Statistical Learning for Signal Processing (SLSP) Laboratory is interested in the application of statistical machine learning and multimedia signal processing. SLSP Lab. has been trying to apply several state-of-the-art machine learning algorithms to multimedia signal processing. Using various machine learning theories and novel signal processing techniques, signals such as image, text, speech, audio, video, EEG and financial data are processed for long-standing and emerging applications.

Our research topics in 2013-2014 include

• Sound source localization and beamforming: Developing an algorithm for both sound source localization (SSL) and beamforming (BF) based on kernel function representation (KFR).

• Large vocabulary continuous speech recognition (LVCSR): Developing a LVCSR system based on semi-Markov model (SMM). Especially, decision tree (DT)-based tied-triphone SMM and decoding algorithm for SMM based LVCSR is proposed.

• Compex video scene analysis: Developing an algorithm for discovering representative behavior pattern based on kernelized collaborative pattern learning for scene analysis in complex videos such as traffic scene, sports games, etc.

• Dictionary learning-based algorithms & applications: Developing an dictionary learning-based algorithms for various applications such as object recognition, image classification and salient object detection.

• Facial landmark estimation and face verification: Developing an facial landmark estimation algorithm which is robust to pose, illumination and expression, using parallel joint boosting method.

MAJOR ACHIEVEMENTS in 2013/2014

[1] S. Kim, S. Nowozni, P.Kohli and C.D.Yoo, “Task-specific image partitioning,” *IEEE Tr. Image Process.,* vol. 22, no. 2, pp. 488-500, Feb. 2013.

[2] S. Kim, C.D.Yoo, S. Nowozni and P.Kohli, “Image segmentation using higher-order correlation clustering,” accepted for publication in *IEEE Tr. Pattern Analysis, Machine Intell.*

[3] J. Choi and C.D.Yoo, “Underdetermined high-resolution DOA estimation: A 2pth-order source-signal / noise subspace constrained optimization,” accepted for publication in *IEEE Tr. Signal Process.*

Research Centers

Integrated Circuit Design Education Center

Director: Prof. Park, In-Cheol
Sponsor: Ministry of Knowledge Economy

Research Activities
- Provide opportunities to fabricate chips through MPW(Multi-Project Wafer)
- Provide EDA(Electronic Design Automation) tools for free or at low cost
- Develop curriculums and open design-specific lectures

Power Electronics Research Center

Director: Prof. Moon, Gun-Woo
Sponsor: Samsung Electro-Mechanics

Research Activities
- Server power supply with high efficiency and high power density for a data center
- Digital control for the power supply of OLED, LED backlight TV
- Advanced power system and power converter for a next generation

Personal Plug & Play DigiCar Center

Director: Prof. Kweon, In So
Sponsor: Ministry of Education, Science and Technology & National Research Foundation of Korea

Research Activities
- Personal Plug & Play DigiCar Platform
- Distributed Embedded Computing Platform supporting plug and play
- Driver- Assistant Active Safety System

KOLON-KAIST LifeStyle Innovation Center

Director: Kim, Dae-Shik
Sponsor: Kolon, Kolon Industry, Kolon Glotech

Research Activities
- Transparent film, Piezoelectric device, Healthcare, Brain engineering and Neuroscience, Cultural technology related university-industry collaborative research
- Collaborative research for innovative source technology and commercialization

SAMSUNG DISPLAY Research Center

Director: Prof. Yoo, Seunghyup
Sponsor: Samsung Mobile Display

Research Activities
- Fundamental research for future displays through academic-industrial collaboration.
- Research about transparent electrode with multi-layer thin film technology for realizing flexible, tranparent OLED displays
- Development of new organic materials, solution-processable materials for large-area application.

Image Information Research Center

Director: Prof. Ra, Jong Beom
Sponsor: Defense Acquisition Program Administration and Agency for Defense Development

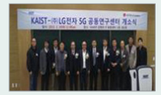
Research Activities
- Research on image acquisition and processing techniques for military applications

Storage Media Solutions Center

Director: Prof. Moon, Jaekyun
Sponsor: SK hynix

Research Activities
- Low power flexible algorithm and architecture for solid state drive (SSD) controller
- Product code algorithm and VLSI design for SSD controller
- Long random code algorithm / architecture

KAIST-LGE 5G Mobile Communication & Networking Research Center



Director: Chong, Song
Sponsor: LG Electronic

Research Activities
- Predicting the evolution of communication technologies beyond 4G
- Survey on candidate technologies for 5G
- Selecting the key research area such as multi-antenna system, polarization antenna and radio resource management

Display Research Center

Director: Prof. Moon, Gun-Woo
Sponsor: Samsung Electronics

Research Activities
- High efficiency & High power density power circuit for the next generation Display
- Power control scheme based on image processing
- Digital control technique for power circuit

Intelligent Robot Vision System(IRVS) Research Center

Director: Prof. Kweon, In So
Sponsor: Samsung Techwin

Research Activities
- Joint research and cooperation for developing intelligent robot technology, such as robot control, vision, artificial intelligence, wireless communication, sensing.
- Development of technologies for multi-sensor fusion based robot localization and scene understanding on static camera.
- Development of technologies for vision sensor based robot localization and scene understanding on moving camera.

System Design Innovation & Application Research Center

Director: Prof. Yoo, Hoi-Jun
Sponsor: Institute for Information Technology Advancement

Research Activities
- The best research center of Robot, Wearable Computer and Bio SoC in the world
- System Design based on human physical, behavioral, psychological feature
- Creation of culture & value changing personal & public life

Center for Advanced Flexible Display Convergence

Director: Prof. Choi, Kyung Cheol
Sponsor: National Research Foundation

Research Activities
Research on flexible and transparent display devices
- Improvement in the optical and electrical characteristics of flexible and transparent OLEDs
- Research on printing technology for flexible and transparent OLEDs
- Improvement in fabrication process and development of low cost technology for flexible and transparent displays

Brain Science Research Center

Director: Prof. Lee, Soo-Young
Sponsor: National Research Foundation, Ministry of Knowledge Economy

Research Activities
- Develop a mathematical model and an intelligent robot for brain information processing mechanism, and conduct a research for brain-machine interface
- National node of South Korea, K-Node (of International Neuroinformatics Coordinating Facility) has been established in Brain Science Research Center in July, 2010
- Build a cooperative system with domestic / international related institutes and hold a joint workshop

Center for Integrated Smart Sensors

Director: Prof. Kyung, Chong-Min
Sponsor: National Research Foundation

Research Activities
- Development of innovative devices, circuits, element technology and system technology to overcome the stagnation in the growth of IT
- Development of common platforms with various devices and sensors
- Creation of epoch-making 'Multi-dimensional Smart IT Convergence Systems' with more than 1,000 times improved Figure of Merits in terms of information processing speed, energy, and physical volume based on the optimization of platform performances through the convergence of hardware and software technologies

Grid Middleware Research Center

Director: Prof. Youn, Chan-Hyun
Sponsor: Ministry of Knowledge Economy and National Research Foundation

Research Activities
- Research and Development of Data and Resource Management Broker in Mobile Cloud Platform
- Research on Data and Resource Management Schemes for Real-time Mobile Cloud Platform and Development of the Corresponding Broker
- Development of adaptive resource collaboration framework technology in multi-cloud environment for origin technology of cloud collaboration

Joint R&D Center for Brain Science and Technology Applications

Director: Lee, Soo-Young

Research Activities
- Develop a next-generation brain science source technology and application technology for commercialization
- Develop a source technology for brain signal measurement and analysis
- Develop a emotion database based on brain science technology and emotion recognition algorithm

LG Display-KAIST Cooperation Center

Director: Prof. Choi, Kyung Cheol
Sponsor: LG Display

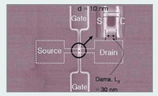
Research Activities
- Conduct joint research with LG Display in the field of Liquid Crystal Display(LCD), Organic Light Emitting Diode(OLED), Inorganic Light Emitting Diode(LED), 3 Dimensional Display, Transparent and Flexible Display, Interactive Display and Solar cell.

Smart Automotive and Electronics Research Center

Director: Prof. Kim, Joungho
Sponsor: Korea Electric Terminal (KET)

Research Activities
- Automotive Electronics EMC Technology
  - Connector and Cable Design for High-voltage EV and High Speed IT Multimedia System
  - Semiconductor Package and PCB Design for ECU in EV Wireless Power Transfer Technology for Automotive System

NANO RADIO Pioneer Fusion Research Center



Director: Prof. Shin, Mincheol
Sponsor: National Research Foundation

Research Activities
- Realization of the Spintronic Nano Radio

Center for Collaborative Internet Ecosystem

Director: Prof. Rhee, June-Koo Kevin

Research Activities
- Construct Content Delivery Network interconnection testbed connected with domestic ISP(Internet Service Porvider)
- IX (Internet eXchange) traffic analysis for CDNi
- Analysis and developement of business model in CDNi

Center for Robot Intelligence Technology

Director: Prof. Kim, Jong-Hwan
Sponsor: Institute for Information Technology Advancement

Research Activities
- Machine Learning, Mobile Robot Localization, Humanoid Robot
- Ubiquitous Robot, Intelligent Robot

Converging Research Center for High Performance medical Imaging

Director: Prof. Ra, Jong Beom
Sponsor: Converging Research Headquarters for Frontier Medical Instruments, Ministry of Science, ICT and Future Planning

Research Activities
- Development of a body-brain convertible PET system and a 3D breast ultrasound imaging system

Intelligent Radio Engineering Center

Director: Prof. Park, Chul Soon
Sponsor: National Research Foundation

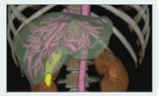
Research Activities
- a multi-standard digital radio
- a reconfigurable mobile radio
- a switchable and reconfigurable radio

Center for Robot Vision & Perception

Director: Prof. Chung, Myung Jin
Sponsor: Ministry of Knowledge Economy

Research Activities
- 3D Reconstruction and Perception using Multiple Sensors for Robot Navigation in Dynamic Environments
- Robot's Multimodal Expression Generation for Human-Robot Interaction

Medical Imaging Research Center



Director: Prof. Ra, Jong Beom

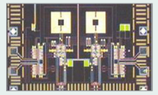
Research Activities
- Research and development of medical imaging systems

Multi-mode Multi-band RF Front-End Center

Director: Hong, Songcheol
Sponsor: Samsung Electro-Mechanics

Research Activities
- Multi-mode Multi-band Power Amplifier
- Envelope Tracking System Architecture
- Envelop Tracking Modulator

CMOS THz Technology Convergence Center



Director: Prof. Lee, Sang-Gug
Sponsor: National Research Foundation

Research Activities
- CMOS THz Technology Convergence center will implement the source, detecter, VCO for THz imaging, spectroscopy and communication by developing the new device of PWT(Plasma Wave Transistor) with extremely high-mobility ballistic transport FET.

Undergraduate

Classification	Subject No.	Subject Name	Lec.:Lab.: Credit(Homework)	Semester	Remark
Mandatory Major Course	EE201	Circuit Theory	3:1:3(6)	Spring. Fall	
	EE202	Signals and Systems	3:1:3(6)	Spring. Fall	
	EE204	Electromagnetics	3:0:3(6)	Spring. Fall	
	EE209	Programming Structure for Electrical Engineering	3:0:3(6)	Spring. Fall	
	EE305	Introduction to Electronics Design Lab.	1:6:3(6)	Fall	
	EE405	Electronics Design Lab.	1:6:3(6)	Spring	
Elective	EE205	Data Structures and Algorithms for Electrical Engineering	3:0:3(6)	Fall	
Major Course	EE210	Probability and Introductory Random Processes	3:0:3(6)	Spring. Fall	
	EE211	Introduction to Physical Electronics	3:0:3(6)	Spring. Fall	
	EE212	Electronics Design and Practice	1:6:3(6)	Fall	
	EE303	Digital System Design	3:1:3(6)	Spring. Fall	*CS211
	EE304	Electronic Circuits	3:1:3(6)	Spring. Fall	
	EE312	Introduction to Computer Architecture	3:1:3(6)	Fall	*CS311
	EE321	Communication Engineering	3:0:3(6)	Spring, Fall	
	EE323	Computer Network	3:0:3(6)	Spring	
	EE324	Network Programming	3:1:3(6)	Fall	
	EE326	Introduction to Information Theory and Coding	3:0:3(6)	Fall	
	EE341	Electromagnetic Waves and Antennas	3:0:3(6)	Spring	
	EE342	Radio Engineering	3:1:3(6)	Fall	
	EE362	Semiconductor Devices	3:0:3(6)	Spring. Fall	
	EE372	Digital Electronic Circuits	3:0:3(6)	Fall	
	EE381	Control System Engineering	3:0:3(6)	Spring	
	EE391	Power Electronics Control	3:0:3(6)	Spring	
	EE402	Future Society and Electrical Engineering	2:0:2(4)	Fall	
	EE403	Analog Electronic Circuits	3:0:3(6)	Spring, Fall	
	EE411	Switching and Automata Theory	3:0:3(6)	Spring	
	EE414	Embedded Systems	3:1:3(6)	Fall	
	EE415	Operating Systems and System Programming for Electrical Engineering	3:0:3(6)	Spring	
	EE421	Wireless Communication Systems	3:0:3(6)	Spring	
	EE425	Wireless Network	3:0:3(6)	Spring	
	EE432	Digital Signal Processing	3:0:3(6)	Spring. Fall	
	EE441	Introduction to Fiber Optic Communication Systems	3:0:3(6)	Spring	
	EE450	Technology Entrepreneurship	3:0:3(6)	Fall	*MSB450
	EE451	IT Venture Start-up	3:0:3(6)	Spring	*MSB451
	EE452	Fundamentals of Photonics	3:0:3(6)	Fall	
	EE463	Semiconductor IC Technology	3:0:3(6)	Spring	
	EE464	Electrical Engineering for Green Energy	3:0:3(6)	Fall	
	EE466	Introduction to Biomedical Electronics	3:0:3(6)	Fall	
	EE474	Introduction to Multimedia	3:0:3(6)	Spring	
	EE476	Audio-Visual Perception Model	3:0:3(6)	Fall	
	EE481	Intelligent Systems	3:0:3(6)	Spring	
	EE485	Special Topics in Electronic Engineering I	1:00:01	Spring. Fall	
	EE486	Special Topics in Electronic Engineering II	2:00:02	Spring. Fall	
	EE488	Special Topics in Electrical Engineering	3:0:3(6)	Spring. Fall	
Research	EE490	B.S. Thesis Research	0:06:03	Spring. Fall	
	EE495	Individual Study	0:06:01		
	EE496	Seminar	1:00:01	Spring	

Notes. i) 400 level course credits except EE405 can be counted as master course credits. ii) "*" mark represents a substitutive subject.

Graduate

Classification	Subject No.	Subject Name	Lec.:Lab.: Credit(Homework)	Semester	Remark
General Course (Select 1 out of 7)	CC010	Special Lecture on Leadership	1:00:00	Spring, Fall	
	CC020	Ethics and Safety I	1AU	Spring.Fall	
	CC500	Scientific Writing	3:0:3(4)	Spring.Fall	
	CC510	Introduction to Computer Application	2:3:3(10)	Spring.Fall	
	CC511	Probability and Statistics	2:3:3(6)	Spring.Fall	*EE528
	CC512	Introduction to Materials Science and Engineering	3:0:3(3)	Spring.Fall	
	CC513	Engineering Economy and Cost Analysis	3:0:3(6)	Spring	
	CC530	Entrepreneurship and Business Strategies	3:0:3(6)	Spring	
	CC531	Patent Analysis and Invention Disclosure	3:0:3(6)	Spring.Fall	
	CC532	Collaborative System Design and Engineering	4:00:04	Spring	
Mandatory Major Course	EE505	Electronics Design Lab.	1:6:3(6)	Spring	
Elective Major Course	EE509	Technical Writing	1:0:1(2)	Spring	
	EE511	Computer Architecture	3:0:3(6)	Spring	
	EE513	Networked Systems and Security	3:0:3(6)	Spring	
	EE515	Theory of Hacking	3:0:3(6)	Fall	
	EE516	Embedded Software	1:6:3(6)	Fall	
	EE520	Telecommunication Networks	3:0:3(6)	Spring	
	EE522	Communicatio n Theory	3:0:3(6)	Spring	
	EE527	Data Communication	3:0:3(6)	Spring	
	EE528	Engineering Random Processes	3:0:3(6))	Spring.Fall	
	EE531	Statistical Learning Theory	3:0:3(6)	Spring	
	EE532	Introduction to Brain IT	3:0:3(6)	Spring	
	EE533	Digital Speech Processing	3:0:3(6)	Spring	
	EE535	Digital Image Processing	3:0:3(6)	Spring	
	EE538	Neural Networks	3:0:3(6)	Fall	
	EE539	Nonlinear Statistical Signal Processing	3:0:3(6)	Fall	
	EE541	Electromagnetic Theory	3:0:3(6)	Spring	
	EE542	Microwave Engineering	3:1:3(6)	Fall	
	EE543	Antenna Engineering	3:1:3(6)	Spring	
	EE546	Fields and Waves	3:0:3(6)	Fall	
	EE548	Matrix Computations for Signal Processing	3:0:3(6)	Fall	
	EE555	Optical Electronics	3:0:3(6)	Spring	
	EE561	Introduction to VLSI Devices	3:0:3(6)	Spring	
	EE563	Display Engineering	3:0:3(6)	Spring	
	EE565	Modern Physics for Engineers	3:0:3(6)	Spring	
	EE566	MEMS in EE Perspective	3:0:3(6)	Fall	
	EE567	Photovoltaic Power Generation	3:0:3(6)	Spring	
	EE568	Introduction to Organic Electronics	3:0:3(6)	Spring	
	EE569	Nanobioelectronics	3:0:3(6)	Spring	
	EE571	Advanced Electronic Circuits	3:0:3(6)	Spring	
	EE573	Introduction to VLSI Systems	3:0:3(6)	Spring	
	EE574	Computer Aided Design of VLSI Circuits and Systems	3:0:3(6)	Fall	
	EE575	Entertainment Platform	3:0:3(6)	Fall	
	EE581	Linear Systems	3:0:3(6)	Spring	
	EE582	Digital Control	3:1:3(6)	Spring	
	EE594	Power Electronics Systems	3:0:3(6)	Fall	

Classification	Subject No.	Subject Name	Lec.:Lab.: Credit(Homework)	Semester	Remark
Elective Major Course	EE612	Discrete Event System Modeling and Simulation	3:0:3(6)	Fall	*CS655
	EE613	Distributed Computing Systems	3:0:3(6)	Spring	
	EE614	Service Oriented Computing Systems	3:0:3(6)	Spring	
	EE621	Coding Theory	3:0:3(6)	Spring	
	EE622	Detection and Estimation	3:0:3(6)	Fall	
	EE623	Information Theory	3:0:3(6)	Fall	
	EE624	Cellular Communication Systems and Protocols	3:0:3(6)	Fall	
	EE626	Advanced Communication Theory	3:0:3(6)	Fall	
	EE627	Performance Analysis of Communication Networks	3:0:3(6)	Spring	
	EE628	Visual Communication Systems	3:0:3(6)	Fall	
	EE629	Mobile Communication Engineering	3:0:3(6)	Fall	
	EE631	Advanced Digital Signal Processing	3:0:3(6)	Spring	
	EE634	Pattern Recognition	3:0:3(6)	Fall	*CS676
	EE635	Functional Brain Imaging	3:0:3(6)	Fall	
	EE636	Digital Video Processing	3:0:3(6)	Fall	
	EE637	Speech & Audio Coding Theory	3:0:3(6)	Spring	
	EE641	Monolithic Microwave Integrated Circuits	3:0:3(6)	Fall	
	EE643	MMIC Design	3:0:3(6)	Spring	
	EE645	Wireless Transceiver Systems	3:0:3(6)	Spring	
	EE647	Nano-Photonics	3:0:3(6)	Spring	
	EE650	Optimization in Communication Network	3:0:3(6)	Spring	
	EE652	Fiber-Optic Communications	3:0:3(6)	Fall	
	EE654	MIMO Wireless Communications	3:0:3(6)	Fall	
	EE655	Economics in Communication Network	3:0:3(6)	Spring	
	EE657	Local Area Network / Metropolitan Area Network (LAN / MAN)	3:0:3(6)	Spring	
	EE658	Queueing theory with applications	3:0:3(6)	Fall	
	EE659	Wireless Communication Protocols and Analysis	3:0:3(6)	Spring	
	EE661	Solid State Physics	3:0:3(6)	Fall	
	EE663	High Frequency Electronic Devices	3:0:3(6)	Spring	
	EE665	CMOS Front-end Process Technology	3:0:3(6)	Fall	
	EE666	Optoelectronic Semiconductor Devices and Their Applications	3:0:3(6)	Fall	
	EE667	Multiple view geometry	3:0:3(6)	Spring	
	EE672	Future and Technology: New Media technology and Business	3:0:3(6)	Fall	
	EE676	Analog Integrated Circuits	3:0:3(6)	Fall	
	EE678	Digital Integrated Circuits	3:0:3(6)	Fall	
	EE679	Analog and Mixed Signal Circuits for Communication	3:0:3(6)	Spring	
	EE681	Nonlinear Control	3:0:3(6)	Fall	
	EE682	Intelligent Control Theory	3:0:3(6)	Fall	
	EE683	Robot Control	3:0:3(6)	Fall	
	EE686	Optimization Theory	3:0:3(6)	Fall	
	EE688	Optimal Control Theory	3:0:3(6)	Fall	
	EE691	Telecom. Network Management	3:0:3(6)	Spring	
	EE692	Parallel and Distributed Computation in Communication Network	3:0:3(6)	Fall	
	EE696	Telecommunication Software Design	3:1:3(6)	Fall	
	EE722	Advanced Signal Detection	3:0:3(6)	Fall	
	EE727	Broadband Network Design and Analysis	3:0:3(6)	Fall	
	EE731	Adaptive Signal Processing	3:0:3(6)	Spring	
	EE733	Multirate Signal Processing	3:0:3(6)	Fall	
	EE734	Image Understanding	3:0:3(6)	Spring	
	EE735	Computer Vision	3:0:3(6)	Fall	
	EE737	Medical Imaging Technology	3:0:3(6)	Spring	
	EE738	Speech Recognition Systems	3:0:3(6)	Fall	
	EE739	Cognitive Information Processing	3:0:3(6)	Fall	
	EE742	Ray Analysis for Electromagnetic Scattering Problems	3:0:3(6)	Fall	
	EE745	EMI / EMC Design and Analysis	3:0:3(6)	Spring	
	EE746	Radar Systems	3:0:3(6)	Fall	
	EE755	Advanced Coding Theory	3:0:3(6)	Fall	
	EE756	Advanced Information Theory	3:0:3(6)	Fall	
	EE757	Nonlinear Fiber Optics	3:0:3(6)	Spring	
	EE758	Optical Networks	3:0:3(6)	Fall	
	EE762	Advanced MOS Device Physics	3:0:3(6)	Fall	
	EE764	Quantum Engineering for Nanoelectronic Devices	3:0:3(6)	Fall	
	EE766	Plasma Electronics	3:0:3(6)	Fall	
	EE772	Electronic Circuits for Green Energy	3:0:3(6)	Fall	
	EE773	Bio-Medical CMOS IC Design	3:0:3(6)	Spring	
	EE783	Adaptive Control Theory	3:0:3(6)	Spring	
	EE785	Robust Control Theory	3:0:3(6)	Spring	
	EE788	Robot Cognition and Planning	3:0:3(6)	Fall	
	EE791	Power Conversion Circuits and Systems	3:0:3(6)	Spring	
	EE807	Special Topics in Electrical Engineering	3:0:3(6)	Spring	
	EE808	Special Topics in Electronic Engineering I	1:00:01	Spring, Fall	
	EE809	Special Topics in Electronic Engineering II	2:00:02	Spring, Fall	
	EE817	Special Topics in Computer Engineering	3:0:3(6)	Spring	
	EE827	Special Topics in Communication	3:0:3(6)	Spring, Fall	
	EE837	Special Topics in Signal Processing	3:0:3(6)	Spring, Fall	
	EE838	Special Topics in Image Engineering	3:0:3(6)	Fall	
	EE847	Special Topics in Electromagnetics	3:0:3(6)	Spring, Fall	
	EE857	Special Topics in Optical Engineering	3:0:3(6)	Spring, Fall	
	EE867	Special Topics in Physical Electronics	3:0:3(6)	Spring, Fall	
	EE868	Special Topics in Solid-State Physics	3:0:3(6)	Fall	
	EE877	Special Topics in Integrated Circuits	3:0:3(6)	Spring, Fall	
	EE878	Special Topics in VLSI	3:0:3(6)	Fall	
	EE887	Special Topics in Robotics	3:0:3(6)	Spring	
	EE888	Special Topics in Control Theory	3:0:3(6)	Spring, Fall	
	EE897	Special Topics in Power Electronics	3:0:3(6)	Spring, Fall	
	EE898	Special Topics in Intelligent Information Processing	3:0:3(6)	Fall	
Research	EE960	M.S. Thesis	–	Spring, Fall	
	EE965	M.S. Individual Study	0:06:01	–	
	EE966	M.S. Seminar	1:00:01	Spring	
	EE980	Ph.D. Thesis	–	Spring, Fall	
	EE986	Ph.D. Seminar	1:00:01	Spring	

Notes. i) 500 level course credits except EE505, EE672 can be counted as bachelor course credits. ii) "*" mark represents a substitutive subject.

Special Programs

Government-Sponsored Program

BK21 PLUS

The BK21 PLUS "Global Leader Education Program for Future Electronics and Communications" of KAIST aims to develop a world-class research oriented graduate program.

The Program is committed to playing a pioneering role in conducting research and educating students who will become leaders in worldwide. The new knowledge and creative technologies produced by this Program will be used to realize creative economy.

Industry-Sponsored Program

LGenius PROGRAM
(LGD Disply Education Program)

LGenius is a cooperative program between academia and industry established to assist specialists in the display field to combine theory and practice through customized selection and training courses provided by KAIST and LG Display (Ltd). LGenius will provide students with opportunities to gain practical work experience through internships. This program's aim is to jointly train exceptional human resources in a variety of interdisciplinary fields, providing the knowledge and skills needed to the supplement the excellent education provided at KAIST.

KEPSI
(KAIST Educational Program for Semiconductor Industry)

KEPSI was established in 1996 to meet the demand of semiconductor industries to foster highly qualified semiconductor engineers who can play a leading role in the area of semiconductors and integrated circuits for information technologies.
This program is supported by SK Hynix.

EPSS
(Educational Program for Samsung Semiconductor)

EPSS was founded in August 2005 to cultivate human resources who will become the forerunners of the semiconductor technologies and the integrated circuit designs with the joint efforts of six departments in KAIST and with the sponsor of Samsung Electronics.

This program directs its efforts to establish successful collaboration model between industry and university.

Applying For Admission to Graduate Program

Scholarships for Graduate Students

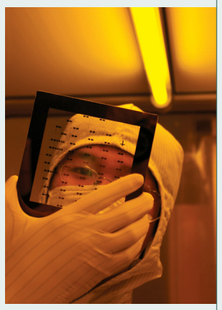
Every graduate student at KAIST is eligible for one of the following scholarships:

A. Government Scholarship (sponsored by the government)

B. KAIST Scholarship (sponsored by the research fund of a faculty member or such industry-funded education programs as LGenius, KEPSI, EPSS, etc.)

C. General Scholarship (sponsored by outside organizations)

Advisor Assignment



A. A student with Government Scholarship shall be assigned a faculty member in the Department by the Department Head.

B. A student with KAIST Scholarship shall be assigned a faculty member who has in advance requested students under the special education programs. The field of the student's research may have been pre-determined if the student is supported by the research fund of a faculty member.

C. A student with General Scholarship shall be assigned a faculty member in the field of research specified by the sponsoring organization.

Admissions Process

Once an applicant submits the academic information together with English score (TOEFL, TOEIC, TEPS, IEPS), the Admissions Committee will review the application material and then interview the qualified applicants as necessary. For more information, please visit. http://admission.kaist.ac.kr

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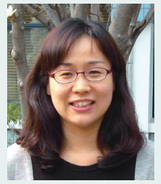

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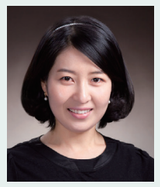

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Location

Information and Electronics

East Campus Map

- E1 Main Gate
- E2 Industrial Engineering and Management
- E3 Information and Electronics
  - 1.Department of Computer Science
  - 2.Department of Electronics Engineering
  - 3.Image Processing
  - 4.Semiconductor
- E4 KAIST Institutes
- E5 Faculty Hall
- E6 Natural Science
- E7 Biomedical Research Center
- E8 Sejong Hall
- E9 KAIST Library
- E10 Storehouse
- E11 Creative Learning
- E12 Energy Plant
- E13 Satellite Technology Research Center
- E14 Main Adminstration
- E15 Auditorium
- E16 ChungMoonSoul
- E17 Stadium
- E18 Bio Model System Park
- E19 National Nano Fab Center
- E20 KyeRyong Hall
- E21 Medical Center West Campus Map

West Campus Map

- W1 Applied Engineering
- W2 Student Center-1 1- International Center
- W3 Galilei Hall
- W4 Heemang Hall, Dasom Hall
- W5 1,2,3- Married Students Housing 4,5- International Village A / B
- W6 Student Dormitory
- W7 Nanum Hall
- W8 Educational Support
- W9 Outdoor Theater
- W10 Wind Tunnel Laboratory
- W11 KAIST Foreign Professor Reidence
- W12 West Energy Plant
- W16 Geotechnical Centrifuge Center North Campus Map

North Campus Map

- N1 Kim Beong-Ho & Kim Sam-Youl ITC Billding
- N2 Branch Administration
- N3 Sports Complex
- N4 School of Humanities and Social Science
- N5 Basic Experiement and Research
- N6 Faculty Club
- N7 Mechanical Engineering
- N7-1 Department of Nuclear & Quantum Engineering
- N7-2 Department of Aerospace Engineering
- N7-3 Department of Mechanical Engineering (East wing)
- N7-4 Department of Mechanical Engineering (West wing)
- N9 Practice
- N10 KAIST Branch Library
- N11 Cafeteria
- N12 Student Center-2
- N13 Tae Wul Gwan
- N14 Sarang Hall
- N15 Bachelors Housing-2
- N16 Somang Hall
- N17 Seongsil Hall
- N18 Jilli Hall
- N19 Areum Hall
- N20 Silloe Hall
- N21 Jihye Hall
- N22 Alumni Venture Hall
- N23 f / MRI Center
- N24 LG Semicon Hall
- N25 Department of Industrial Design
- N26 CHIPS
- N27 Hi-Tech Venture Hall
- N28 Energy and Environment Research Center
- N29 Center for IT Convergence

KAIST

Change the World

Korea Advanced Institute of Science and Technology

KAIST was founded in 1971 to foster highly qualifed scientists and engineers for Korea's industrialization. It was Korea's first research-oriented graduate school in science and engineering.

Now, KAIST has changed dramatically to become one of the world's top-10 universities by responding to our changing world and solving problems that will be of the utmost importance for our future, KAIST will be one of the best science and technology universities in the world.

DEPARTMENT OF

ELECTRICAL ENGINEERING

Annual Report 2013/2014

DEPARTMENT OF ELECTRICAL ENGINEERING
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