Biennial Report 2024

Mechanical Engineering

Mechanical Engineering Without Machines

Biennial Report 2024

KAIST MECHANICAL ENGINEERING

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KAIST MECHANICAL ENGINEERING

Mechanical Engineering

BIENNIAL REPORT 2024

Mechanical Engineering Without Machines

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Greetings from Department Head

Welcome to the KAIST Department of Mechanical Engineering!

Since 1971, our department has cultivated industry and academic leaders and will further foster individuals who can solve the global problems of humanity. Our goal is to establish our department as an international hub department where innovative and young leaders from the world will want to study and a department that provides new stimuli and challenges to the students. In today's rapidly changing environment, facing mega-trend issues including the digital transformation, carbon neutrality, and aging societies, we aim to provide students with a vision for the future and the foundation to achieve such a vision. Up to now, mechanical engineering has played a key role in creating new value for human civilization. Future innovations will be in the areas of Energy, Healthcare, and Robotics/Mobility. Research in our department takes on challenges to solve problems ranging from the nanoscale to large scale structures in a diverse range of areas, including functional materials, intelligent vehicles, ultra-precision measurement machinery, robots, digital fabrication engineering, eco-friendly energy, AI based-design, and biomedical engineering. Based on such research, we are collaborating with researchers worldwide to develop technologies that can produce wealth and improve the quality of life for everyone. We provide a balanced curriculum covering the fundamentals of mechanical engineering and state-of-the-art research, with additional emphasis on experiments, hands-on learning, and collaborative system design. The exchange of students is actively pursued through international joint degree programs with top mechanical engineering departments over the world. We respect diversity and openness and will provide an education to help students meet the most important challenges in their lives. This biennial report helps you understand our department and reach us in many ways in education and research.



July, 2024
Head of Department of Mechanical Engineering
Professor **Jung Kim**, Ph.D.

Vision

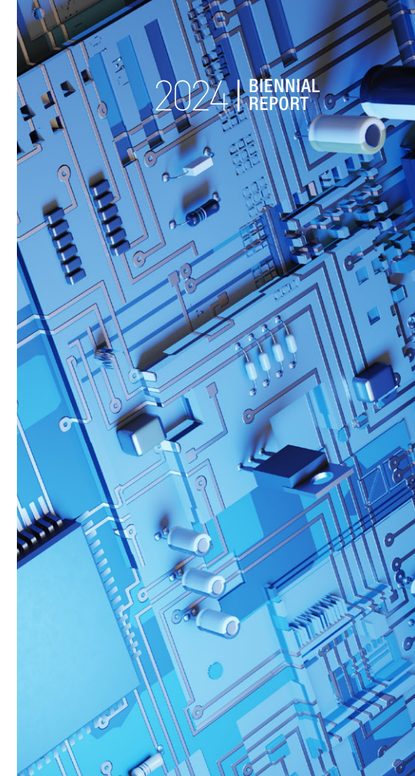
Vision — Mechanical engineering creating human-centered engineering value

Core values — Creativity and challenge

Mission
- Education to enhance creative thinking based on fundamentals of mechanical engineering disciplines
- Original world-leading research that exceeds knowledge limits
- Social contributions based on education and research

Mechanical Engineering (ME) covers a wide spectrum of technologies, including the design, manufacturing, and control of mechanical systems. More recently, it has rapidly expanded into interdisciplinary areas, such as bio-medical engineering, technologies for human welfare, and nanotechnologies. Mechanical engineering plays fundamental and essential roles across all fields of industries in Korea, and it continues to evolve for the new frontiers of industries and academics as well.

The vision of KAIST ME is to create human-centric engineering values through the unique missions of education and research with societal contributions. KAIST ME focuses on educating graduate and undergraduate students to enhance their creative and critical thinking on the basis of the strong fundamentals of mechanical engineering disciplines. We also pursue innovative and revolutionary research that exceeds current knowledge limits. In the end, the KAIST ME will contribute to the enrichment and improvement of our nation's industry and social communities as well as academia.



A brief History

Since 1971, our department has cultivated industry and academic leaders and will further foster individuals who can solve the global problems of humanity.



1970's

1971 Establishment of Department as part of Korea Advanced Institute of Science (KAIS) in Seoul campus

1973 First admissions to the Master's program (17 students)
Prof. Bae, Soon-hoon, Prof. Lee, Choong Hong and Prof. Lee, Chung Oh joined the department

1975 First graduation from the Master's program (14 M.S.)
First admission to the Ph.D. program (3 students)

1978 First graduation from the Ph.D. program (1st Ph.D. : Dr. Yang, Dong-Yol)
Inauguration of the master of engineering of Production engineering program in the department

1980's

1981 Merger with Korea Institute of Science and Technology (KIST)
Establishment of Korea Advanced Institute of Science and Technology (KAIST)

1982 Separation of the Production engineering program from the department as Department of production engineering

1984 Establishment of Korea Institute of Technology (KIT)
Beginning of undergraduate programs

1986 First admission to the undergraduate program of KIT

1989 Separation of KIST from KAIST
Merger of KAIST with KIT
First graduation from Bachelor's program (31 B.S.)

1990's

1990 Move to Daejeon campus

1992 Change of the name of Department of production engineering to Department of precision engineering

1995 Merger with Department of precision engineering
The 25th Anniversary of the Department

1996 Joining of Department of automation and Design engineering (from Seoul campus) to the department

2000's

2008 1000th Ph.D. graduate from the Department

2010's

2013 Ranked the 19th in 2013 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2014 Ranked the 21st in 2014 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2015 Merger with Division of Ocean systems engineering

2016 Ranked the 21st in 2016 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2017 Mechanical Engineering Building Remodeling
(Certification of Conversion of Green building-the first in Korea)
Ranked the 15th in 2017 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2018 Ranked the 16th in 2018 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2019 Ranked the 23th in 2019 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2020's

2020 Ranked the 22th in 2020 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2021 Ranked the 22th in 2021 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2022 Ranked the 22th in 2022 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering

2023 Ranked the 24th in 2023 QS World university ranking by subject of Mechanical, Aeronautical & Manufacturing Engineering







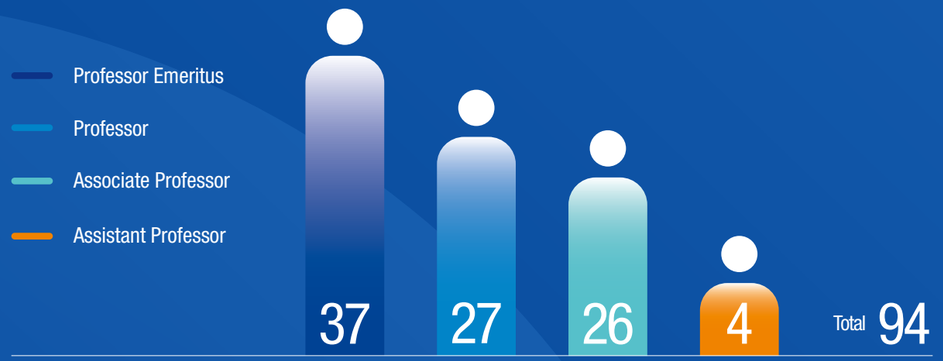


Overview and Status

QS Ranking

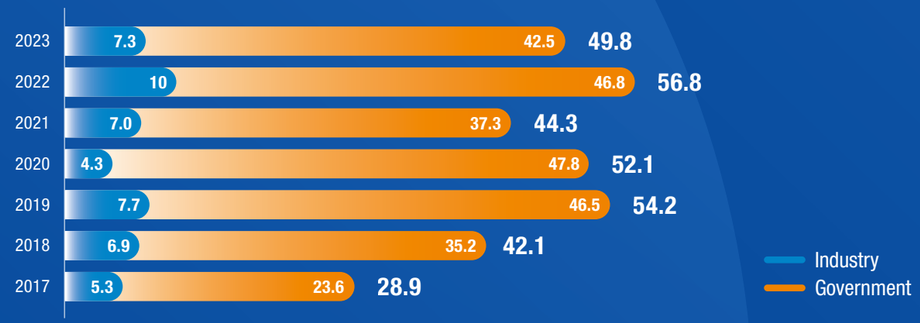


Faculty(Aug. 2024)

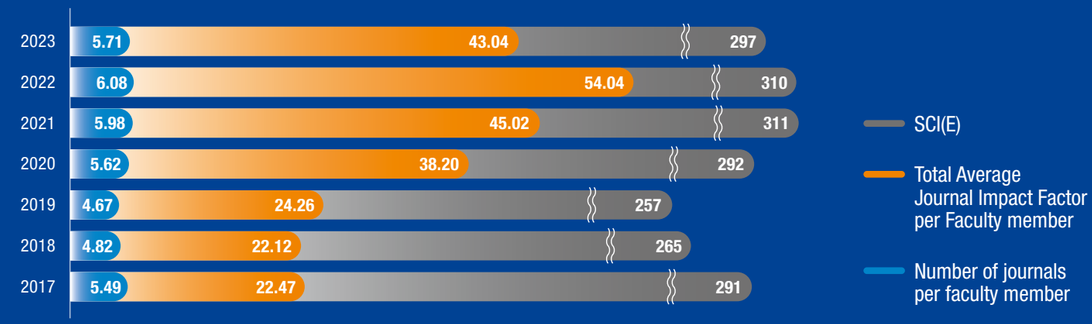


Research Activities

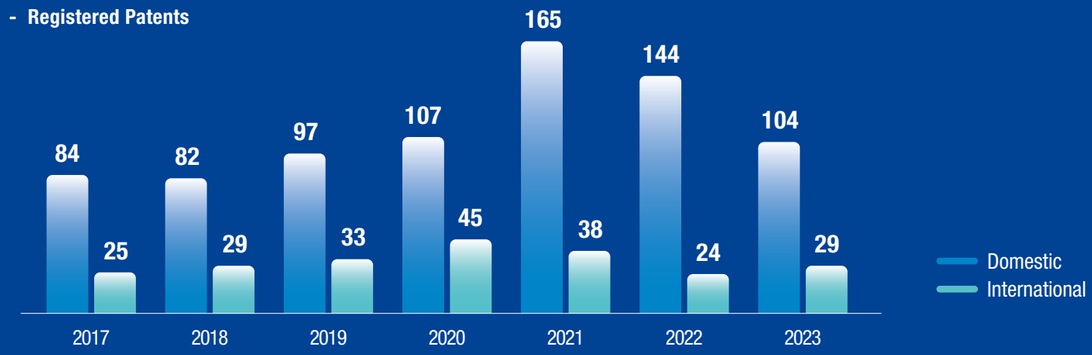
- **Research Contracts** (unit: 1 billion Korea won)



- **Academic Performances**



- **Registered Patents**



Student Enrollment(April. 2024)

B.S. students 209	Government Scholarship	197
	KAIST Scholarship	-
	General/Industry Scholarship	-
	International	12
M.S. students 201	Government Scholarship	153
	KAIST Scholarship	28
	General/Industry Scholarship	5
	International	15
Ph.D. students 433	Government Scholarship	209
	KAIST Scholarship	141
	General/Industry Scholarship	65
	International	18

Alumni Career Statistics

Aug. 1989 ~ Feb. 2023 B.S.: 2,299	High Degree	68.2	Industry	28.5
	Research Institute	0.6	University	0.0
	Government office	0.1	etc	2.6
Aug. 1975 ~ Feb. 2023 M.S.: 3,669	High Degree	40.2	Industry	41.9
	Research Institute	11.3	University	3.3
	Government office	1.8	etc	1.5
Aug. 1978 ~ Feb. 2023 Ph.D.: 1,846	High Degree	0.0	Industry	48.8
	Research Institute	32.5	University	13.3
	Government office	2.9	etc	2.5

Research Centers



Center for Noise and Vibration Control (NOVIC+)

Director : **Prof. PARK, Yong-Hwa**
Year established : **1993**

NOVIC+ is the first research center at ME, KAIST established in 1993, aiming to promote teaching word-wide leading specialties and researches in the field of vibration, sound, control and AI-based perceptions. Recently 5 professors are involved in the center focusing on the fundamental researches on sound and vibrations; and variety of industry-led projects in acoustics, condition monitoring, industrial AI, 3D printing and soft actuators.

Human-Robot Interaction Research Center

Director : **Prof. KYUNG, Ki-Uk**
Sponsor : **Ministry of Trade, Industry and Economy**
Year established : **2004**

The HRI Research Center, sponsored by the 21C Frontier Program, aims to develop core technology for human-robot interactions for the coexistence of service robots and humans in everyday life.

Humanoid Robot Research Center

Director : **Prof. PARK, Hae-Won**
Sponsor : **Ministry of Commerce Industry and Energy, Agency for Defense Development, National Research Foundation, Samsung Electronics, NAVER LABS**
Year established : **2005**

The ultimate goal of the research center is to enhance human welfare by providing and advancing robotics technologies that are essential for robot development and human-robot interaction.

Ultrafast Optics for Ultraprecision Technology Research Group

Director : **Prof. KIM, Young-Jin**
Year established : **2008**

- Establishing the new foundation for ultra-precision technologies enabling next-generation nano-fabrication and nano-metrology
- Development of noble coherent light sources covering the whole optical spectrum spanning from THz waves to X-ray
- Connecting ultrafast photonics to ultra-precision for IT, NT, BT and aerospace technology
- Strengthening the national capabilities for ultra-precision in distance metrology, precision manufacturing, optical communications and 6G THz technologies

High Speed Mechanical Properties Data Center

Director : Prof. **YOON, Jeong Whan**
Sponsor : **Ministry of Trade, Industry and Economy**
Year established : **2010**

The goal of the center is to develop national standard reference data pertaining to high-speed material properties. Measurement and evaluation procedures are developed for accurate and reliable high-speed material properties of steels and metallic and polymeric materials. Improving the technological capabilities of industries and research institutes is promoted by managing the national standard reference database of high-speed material properties.

Kaist Ocean Technology Center

Director : **Prof. LEE, Phill-Seung**
Year established : **2011**

Objectives
- Close links with shipbuilding, marine and related industries.
- Research and development of innovative ocean systems.
- Discovering large research projects related to ocean systems engineering.
- Laying the foundation for securing next-generation marine technologies.

Center for Functionally Antagonistic Nano-Engineering: Creative Research Initiatives (CRI)

Director : **Prof. Il-Kwon Oh**
Sponsor : **Ministry of Science, ICT and Future Planning**
Year established : **2015**

The present objective of the research center is to develop a new multiscale and multidisciplinary process that creates a strong engineering synergy between two antagonistic functions (viz., defect vs crystal, hydrophilic vs hydrophobic, conductive vs insulative, and energy dissipation and energy storage) based on multifunctional hetero nanostructures and materials.

Rehabilitation Engineering for Neurological disorders Worldwide Center (RENEW Center)

Director : **Prof. PARK, Hyung-Soon**
Year established : **2019**

Objectives
The present objective of the research center is to develop the patient-specific optimized rehabilitation method based on the profound understanding of the human motor function recovery. In this center, the human movement modeling from the neuron, neural network to the musculoskeletal system is studied, and the novel engineering approaches for effective neuro-rehabilitation are developed.

KAIST-CERAGEM Next Generation Healthcare Research Center

Director : **Prof. PARK, Hyung-Soon**
Year established : **2021**

In KAIST-CERAGEM research center, KAIST research laboratories expertised in various healthcare science/engineering and the CERAGEM research center work together for developing future healthcare technology to prepare for the aging society worldwide.

Daedong-KAIST Research Center for Mobility

Director : **Prof. KIM, Kyung-Soo**
Year established : **2022**

Objectives
- Providing the research cooperation platform between KAIST and the Daedong, a Korean leading machinery company for agriculture.
- Developing the core technologies for autonomous agricultural machines and new mobility vehicles.
- Studies on the e-mobility systems using e-powertrains, sensors and batteries.

Korea Innovative Technology Startup Center (기술창업혁신단)

Director : **BAE, Joongmyeon**
Sponsor : **Ministry of Science and ICT**
Year established : **2016**

Objectives
Public Technology-Based Market Link Customer Discovery Support Project To promote the commercialization of public research achievements under research by universities, the government supports Customer Discovery for start-ups in the market linkage.

KAIST-HHI Research Cooperation Center

Director : **LEE, Phill-Seung**
Year established : **2019**

Objectives
The research center focuses on strengthening industry-academic cooperation with Hyundai Heavy Industries Group and developing key technologies for next-generation manufacturing solutions.

Research center for next-generation metal-supported protonic ceramic fuel cells

Director : **Prof. BAE, Joongmyeon**
Sponsor : **Ministry of Science and ICT**
Year established : **2021**

Objectives
This research center aims to develop core technologies for a world's first, novel, and next-generation hydrogen fuel cell; metal-supported protonic ceramic fuel cell. The ultimate goal of the center, based on the technologies, is vitalization and commercialization of the hydrogen industry infra-structure.

Human Augmentation Research Center

Director : **Prof. Kyoungchul Kong**
Sponsor : **National Research Foundation of Korea (NRF)**
Year established : **2022**

Objectives
The Human Augmentation Research Center is conducting various research to recreate human capabilities based on robotics technology. In particular, it specializes in the fundamental technology of design and control for wearable robots.

Faculty Startups





나노스코프시스템즈
Nanoscope Systems

NANOSCOPE SYSTEMS

Founder | GWEON, Dae-Gab

Year of establishment | 2006

Web page | http://www.nanoscope.co.kr

Nanoscope Systems, Inc. is a developer and manufacturer of a confocal laser scanning microscope.
Established in 2006 by the engineering researchers specialized in confocal microscopy, we have successfully built up the world class confocal microscope for three-dimensional measurement and inspection in industrial applications and academic researches for the first time in Korea.
As a leading developer and provider of confocal microscopic technology, we are dedicated to the realization of newer technology for three-dimensional measurement at higher speed with superior resolution.
We believe that our continuous investment in research and development is the best way to increase our technical capabilities, and it is also the best way to enhance our customers' competitive position. We will strive to build customers' trust and royalty by providing reliable products and services.



HnPower

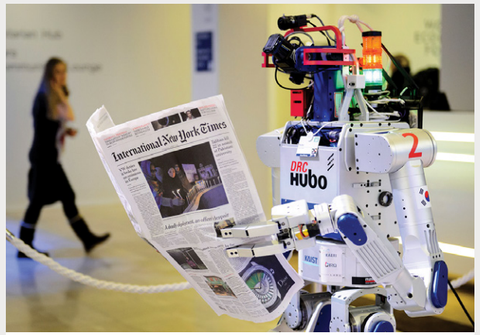
HnPower

Founder | BAE, Joongmyeon

Year of establishment | 2009

Web page | http://www.hnpower.co.kr

HnPower is constantly striving to move towards a true hydrogen society.
Our goals are to save Earth by creating a hydrogen society, prevent environmental pollution by reducing carbon emissions, provide animals and plants with a better life, and encourage hydrogen-related industries, which are in a rapid decline.
We want to share the dream of an eco-friendly future through our products.
HnPower is a leader in solving environmental issues with technology that covers the extraction and utilization of hydrogen.
HnPower is the only company in the world that can extract hydrogen by reforming liquid raw materials.
We can process not only light natural gas but also diesel and heavy marine oil. We can also obtain energy and produce clean oil using waste materials.
We aim to solve environmental problems with technologies that extract and utilize hydrogen in various ways.



RAINBOW ROBOTICS

RAINBOW ROBOTICS

Founder | OH, Jun-Ho

Year of establishment | 2011

Web page | www.rainbow-robotics.com

Rainbow Robotics, founded by experienced researchers from the prestigious KAIST Humanoid Robot Research Center (HUBO Lab), leads the robot platforms industry. Our mission is to commercialize cutting-edge robots through relentless research and development. We achieve this by securing our own technology and offering high-quality products at competitive prices.

With expertise in humanoid robotics technology, we proudly showcase our in-house developed cobots and world-renowned disaster response robots. However, our commitment to innovation and making a significant impact goes beyond these achievements. Our diverse portfolio includes bimanual mobile manipulator, autonomous mobile robots, quadruped robots, and astronomical mounts. We continuously explore new business opportunities, aiming to revolutionize the robotics industry and shape the future of automation.



LATTICE TECHNOLOGY

LATTICE TECHNOLOGY

Founder | CHANG, Daejun

Year of establishment | 2012

Web page | https://lattice-technology.com

LATTICE Technology provides the LPV-based solutions of liquefied gases, especially for the energy and transport sectors. Lattice Pressure Vessel (LPV) is the world's first and unique free-shape free-size pressure vessels adaptable to any space. In this regard, it is a revolution in the area of pressure vessel technology and awarded "the ASME emerging technology award in pressure vessel in 2019". The LPV provides less CAPEX, less OPEX, more safety, more compact and better space utilization. This technology was approved by ASME, all major classification societies, and US Coastal Guard. It has been already commercialized in LNG, LPG, NH3, CO2, and liquid hydrogen (LH2).

LATTICE Technology is also developing an innovative vacuum insulation technology, called the V-CCS (Vacuum Cargo Containment System). The conventional vacuum insulation is based on the tank-in-tank configuration, which cannot be applicable to large-scale LH2 storage such as cargo tanks for ships and terminals handling LH2. Since the V-CCS is modular and limitless scalable, it is a breakthrough insulation solution for large-scale LH2 storage.



J-micro

J-micro Inc.

Founder | LEE, Seung Seob

Year of establishment | 2017

Web page | https://www.jmicro.co.kr

j-micro is a manufacturer of 'transparent conductive films' with high performance (90% transparency and 0.3 Ω /sq).
Currently, we are manufacturing and developing various application products such as 'transparent antenna film' and 'transparent heating film' using 'transparent conductive film'.

We have developed 'transparent antenna film' with a company specializing in antennas and are promoting it in the U.S. and Europe. And we are developing 'smart glass for mobility' with Korean auto parts manufacturers.



angel robotics

ANGEL ROBOTICS

Founder | KONG, Kyoungchul

Year of establishment | 2017

Web page | www.angel-robotics.com

Angel Robotics, recognized as "The Abilitics Company," is driven by a mission to "recreate human ability with technology."

We are committed to harnessing advanced technology to enhance human potential in the realms of mobility, activity, and labor.

Angel Robotics leverages internationally acclaimed and award-winning wearable robotics technology to develop a diverse array of wearable robots. These range from robots designed for daily rehabilitation to those providing everyday assistance and industrial support.

Furthermore, we have successfully developed and localized key components of wearable robots.
Our goal is to establish the global standard in the wearable robotics industry, supported by our cutting-edge technological expertise.



ROEN Surgical

Founder | KWON, Dong-Soo

Year of establishment | 2018

Web page | www.roensurgical.com

ROEN Surgical is a company created by a group of young researchers to develop excellent surgical robot systems to contribute to patients, doctors, and society.

We strive to bring flexible robotics to the surgery room, to introduce the next generation of robotic surgery.

Flexible robots enable surgeries that previously required incision, to be scarless.



A2US

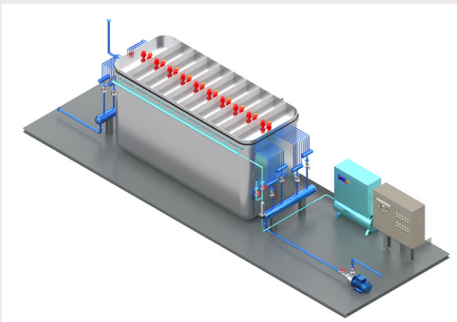
Founder | LEE, Seung Seob

Year of establishment | 2021

Web page | http://a2us.co.kr

A2US is a company founded based on 'Water Micro Electrospray' technology.
'Water Micro Electrospray' of A2US is a new concept of technology that can simultaneously perform functions
such as "antibacterial/antivirus," "humidification," "fine dust removal," and "deodorization."

Currently, products that can be applied to various fields such as homes, public facilities, and agriculture are being developed in cooperation with various companies and research institutes.



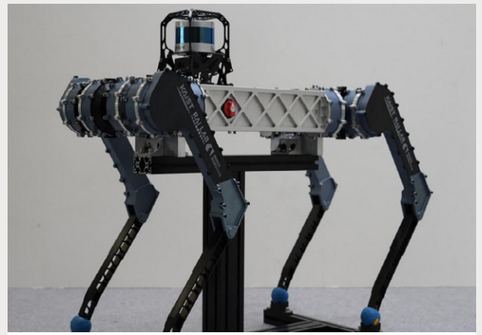
GIGAette

Founder | CHANG, Daejun

Year of establishment | 2023

Web page | www.gigaette.com

GIGAette provides a thermal energy storage solution, called ITP Battery (Iso Thermal Piston Battery) and related engineering services. ITP Battery stores renewable electricity or waste heat and supplies decarbonized heat to thermal energy consumers. Its unique value is to supply high-pressure heat at constant temperature for a prolonged period. It also provides outstanding performances in robustness to intermittency, heat transfer rate, energy storage efficiency, space utilization, sustainability, and safety.



RAION ROBOTICS

Founder | HWANGBO, JE MIN

Year of establishment | 2023

Web page | raionrobotics.com

Based in Daejeon, Korea, our robotics company specializes in the development of advanced quadrupedal robots. With expertise spanning the entire creation process, we engineer each robot from scratch, designing every aspect of both hardware and software. Our robots excel in autonomously navigating complex environments, from rugged mountains to industrial factories, demonstrating unparalleled adaptability and efficiency.

Industry Cooperations

Industrial Advisory Board

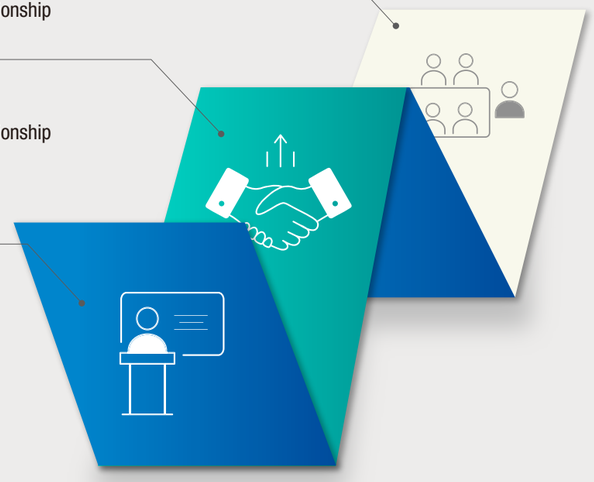
- Consultation and Evaluation of Department education and research activities
- IAB Annual Boards Meeting consisting of industry representatives
- Systematization of Industry cooperation and Providing specialized human resources
- Direct bridge between KAIST-Industry for promoting cooperation and mutual relationship

Industry Academia Consortium

- Direct bridge between KAIST-Industry for promoting cooperation and mutual relationship
- Consulting technology problems in Industry
- Dispatch of cooperation human resources

Industry-cooperated open lecture

- 204 open lectures held since 1982
- Providing research expertise from traditional and new areas of ME



• **IAB** (Industrial Advisory Board)

In order to reflect opinions from industries on education and research, we have established the IAB (Industrial Advisory Board) and held meetings of the board of directors of IAB. We systematize industry-academia cooperation and provide on-demand high-quality human resources. IAB advises and evaluates education and research activities and helps industries to understand the research achievements produced by KAIST ME. IAB serves as a direct bridge to enhance mutual understanding and cooperation between industries and KAIST ME.

• Industry-Academia Consortium

An industry-academia consortium is run by the department to improve industry-academic cooperation. The consortia include Samsung Heavy Industries, LG Electronics, HD Korea Shipbuilding & offshore Engineering, HD Hyundai Electric. The consortium carries out industry-KAIST ME research and development, consultations on industry-related technologies, and exchanges of manpower and academic information together with on-demand education using the KAIST scholarship program. A steering committee for each consortium meets twice a year on a regular basis.

• Short Courses for Engineers in Industry

In order to transfer professional knowledge and new technologies to industry, more than 202 short courses have been provided since 1982. For engineers in the automotive, electronics, ocean, aeronautical, and heavy industries, where many ME alumni hold positions, we provide not only fundamental subjects but also high-quality specialized knowledge in emerging fields of mechanical engineering. Students from other universities also attend these short courses to gain an understanding of recent technologies and trends.

Industry Collaboration Programs

- 1999 — SHI-KAIST Samsung Heavy Industries | POSCO-BK21 POSCO
- 2005 — HANON-KAIST Hanon Systems | DHI-KAIST Doosan Heavy Industries
- 2006 — DI-KAIST Doosan Infracore | DSME-KAIST Daewoo Shipbuilding and Marine Eng.
- 2008 — STX-KAIST STX Offshore and Shipbuilding
- 2010 — SCP-KAIST Samsung Corning Precision Materials | MI-KAIST Microinspection | LG-KAIST LG Electronics
- 2013 — KATECH-KAIST Korea Automotive Technology Institute
- 2015 — HHI-KAIST Hyundai Heavy Industries
- 2016 — HYUNDAI-KAIST Hyundai Motor co.
- 2018 — NAVER LABS-KAIST Naver Labs. | KIMM-KAIST Korea Institute of Machinery & Materials
- 2021 — CERAGEM-KAIST CERAGEM
- 2022 — DAEDONG-KAIST Daedong
- 2024 — HDE-KAIST HD Hyundai Electric

ME Co-op Programs

An educational program designed for third- and fourth-year undergraduate students of the Department of Mechanical Engineering at KAIST to gain real-world research experience and gain credits by participating in a joint project between KAIST and a matched company through two months of prior learning at KAIST and six months of full-time dispatch at the participating company (1+9 credits to be completed)

Program Organization

Prior Learning (2 months)

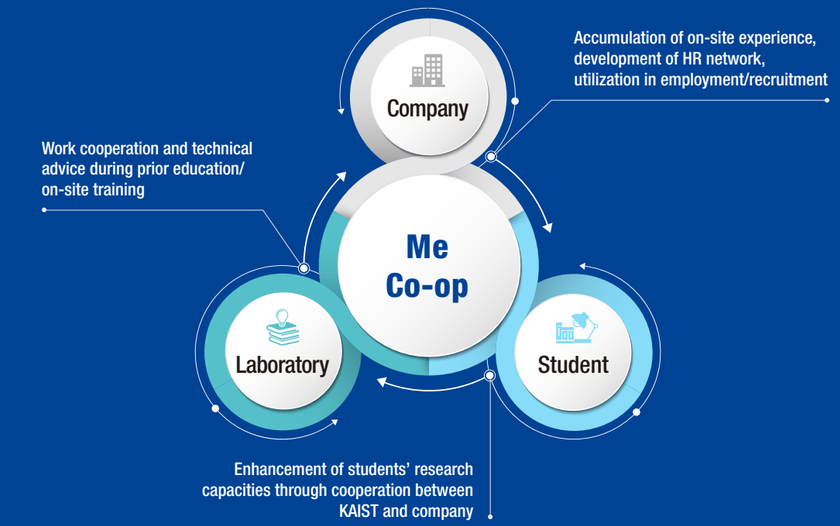
Students conduct individual research during the school break in a laboratory related to duties proposed by the company to make up for their absence from classes during on-site training and gain knowledge in their major (1 credit)

On-site Training Semester (6 months)

Students gain real-world experience by participating in a six-month customized project during the regular semester and school break (Spring semester: March–August / Fall semester: September–February, 9 credits)



Program Characteristics and Expected Outcomes



1. Students matched to companies based on company-provided work plans
2. Two-month prior education conducted to minimize companies' burden of providing job training for students
3. Students can make practical contributions by participating in actual projects during the long-term dispatch (six months)
4. KAIST ME Co-op Center conducts one mid-term assessment during the six-month program, and organizes company visits or student guidance where necessary
5. Efficient on-site training supported by continuous cooperation via the KAIST ME laboratory-business-student network
6. Support for participation in prestigious exhibitions at home and abroad (CES, etc.) based on outcomes
7. Follow-up research and startup support using outcomes

List of Participating Companies in ME Co-op Program

Period	Participating Companies
1st batch (Fall/winter 2019)	Naver Labs, Samsung Heavy Industries, InBody, Hanon Systems
2nd batch (Spring/summer 2020)	Koh Young Technology, InBody, Hanon Systems
3rd batch (Fall/winter 2020)	Koh Young Technology, Naver Labs, InBody, Samsung Heavy Industries, Comotomo, Korea Institute of Science and Technology
4th batch (Spring/summer 2021)	InBody
5th batch (Fall/winter 2021)	Naver Labs, Samsung Electronics, Samsung Heavy Industries, Angel Robotics, InBody, Korea Institute of Science and Technology, Hanon Systems
6th batch (Spring/summer 2022)	Samsung Heavy Industries, Angel Robotics, InBody, Korea Institute of Science and Technology
7th batch (Fall/winter 2022)	42dot, Samsung Electronics, Samsung Heavy Industries, Angel Robotics, InBody
8th batch (Spring/summer 2023)	THK
9th batch (Fall/winter 2023)	Hyundai Motor, Samsung Electronics, POSCO

International Collaboration(Dual Degrees/MOUs)

The goal of international collaboration is to achieve practical globalization such that students can be nurtured as global leaders. To strengthen the capability of graduate students as global leaders, we run a dual-degree program, long-term and short-term exchange programs, and international student symposiums organized by graduate students. In addition, our international collaborative research activities with overseas industries and universities are extensive. With such efforts, the numbers of graduate students and alumni going abroad and faculty visiting overseas universities are increasing continuously. In addition, the world-leading international conferences in Korea organized by ME faculty members increase the opportunities for student participation and enhance the visibility of our department.

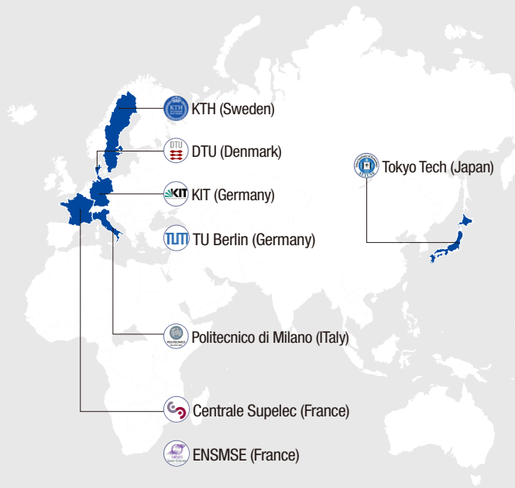
MOU (Memorandum of Understanding)

We have MOU agreements to promote exchanges of faculty and students, for the publication of educational information, to realize international joint lectures, and to undertake joint workshops with overseas institutes. Currently, we have MOUs with 34 institutes (Asia 16, Europe 11, North America 6, Oceania 1), including the University of Michigan, UCLA, ITB, Tokyo Tech. We are in the process of reaching agreements with other renowned institutes, to be completed in the near future.



Dual-Degree Program

We have implemented a dual-degree program and produced 41 M.S. graduates from the dual-degree program thus far. The dual-degree program is an educational program that pursues the globalization of graduate students. Students are exchanged under mutually agreed-upon principles with overseas universities, where the students obtain an overseas dual degree as well as diverse international experience and a broadened viewpoint. The dual-degree program plays an important role in educating international human resources and in enhancing the department's global competitiveness. We have exchanged graduate students through the dual-degree program with KTH Royal Institute of Technology(KTH), Tokyo Institute of Technology, Karlsruhe Institute of Technology (KIT), Politechnico di Milano (PoliMi) and the Technical University of Denmark(DTU).



Inbound & Outbound Student Exchange

	University	Number of Students	
		Completed	Enrolled
Inbound	TU Berlin	6	2
	KIT	13	3
	ENSMSE	1	0
	DTU	17	3
	KTH	8	0
	Politecnico di Milano	6	1
Outbound	KIT	4	0
	ENSMSE	1	0
	Tokyo Institute of Tech	1	0
	DTU	8	0
	Centrale suplec	1	0
	Politecnico di Milano	1	0

International Collaborative Research Activities

Continuous and practical collaborative research activities play a significant role in world-class research and provide opportunities for students to participate in research activities. We are involved in international collaborative research activities with overseas universities, research institutes, and industries, such as Drexel University, the University of Arizona, HP Company, Aramco Overseas Company, the Institute for Infocomm Research, Equinor Korea, the Office of Naval Research Global, and the US National Science Foundation.

Long-term and Short-term Exchange Programs for Graduate Students

We offer long-term exchange programs to provide opportunities for students to study and conduct research at overseas universities and overseas companies. The period of the long-term exchange program is a minimum of two months and a maximum of 12 months. Funding for living expenses and round-trip airfare are provided through the BK21 program. More than ten students have visited and carried out research at overseas universities and research institutes.

A short-term exchange program lasting less than two months is offered to enhance the capabilities of graduate students in their efforts to conduct research by attending and presenting papers at international conferences and workshops. In particular, graduate students are encouraged to organize and participate in student symposiums, such as the KAIST-Kyushu university student symposium and the China-Japan-Korea student symposium.

Faculty

Professor

Professor	Laboratory	E-mail
AHN, Song Ih	Biohybrid Systems Engineering Laboratory	-
BAE, Choongsik	Future Transport Power Laboratory	csbae@kaist.ac.kr
BAE, Joongmyeon	New Energy Conversion System Laboratory	jmbae@kaist.ac.kr
CHANG, Daejun	Innovative Energy Systems Engineering Laboratory	djchang@kaist.ac.kr
CHO, Yeunwoo	Waves & Fluid Mechanics Laboratory	ywoocho@kaist.ac.kr
CHOI, Seibum	Automotive Control Laboratory	sbchoi@kaist.ac.kr
HWANG, Joonsik	Multiphase Reactive Flow Laboratory	-
HWANGBO, JE MIN	Robotics and Artificial Intelligence Laboratory	jhwangbo@kaist.ac.kr
JEON, Jessie Sungyun	Biomicrofluidics Laboratory	jsjeon@kaist.ac.kr
JEON, Wonju	Wave Energy Control Laboratory (Wave Lab.)	wonju.jeon@kaist.ac.kr
JEONG, Sangkwon	Cryogenic Engineering Laboratory	skjeong@kaist.ac.kr
KANG, Joon Sang	Advanced thermal and energy transport Laboratory	jskang1@kaist.ac.kr
KIM, Daegyoum	Applied Fluid Mechanics Laboratory	daegyoum@kaist.ac.kr
KIM, Hyoungsoo	Fluid & Interface Laboratory	hshk@kaist.ac.kr
KIM, Hyun Jin	Computational Cardiovascular Biomechanics Laboratory	kim.hyunjin@kaist.ac.kr
KIM, Ji Tae	Nanoscale Manufacturing Laboratory	jitae.kim@kaist.ac.kr
KIM, Jinwhan	Mobile Robotics and Intelligence Laboratory	jinwhan@kaist.ac.kr
KIM, Jung	Biorobotics Laboratory	jungkim@kaist.ac.kr
KIM, Jungwon	Ultra-Scale Photonic Control and Measurement Group	jungwon.kim@kaist.ac.kr
KIM, Kyung-Soo	Mechatronics, System and Control System Laboratory	kyungsookim@kaist.ac.kr
KIM, Nam Il	Combustion Laboratory	nikim@kaist.ac.kr
KIM, Sanha	Advanced Manufacturing and Surface Engineering Laboratory	sanhkim@kaist.ac.kr
KIM, Seong Su	Mechanical Design Lab. with Advanced Materials	seongsukim@kaist.ac.kr
KIM, Sung Jin	Applied Heat Transfer Laboratory	sungjinkim@kaist.ac.kr
KIM, Sung Yong	Environmental Fluid Mechanics Laboratory	syongkim@kaist.ac.kr
KIM, Teak-Soo	Advanced Packaging and Thin Film Laboratory	tskim1@kaist.ac.kr
KIM, Young-Jin	Ultra-Precision Metrology and Manufacturing Laboratory	yj.kim@kaist.ac.kr
KONG, Kyoungchul	Exoskeleton Laboratory	kckong@kaist.ac.kr
KOO, Seungbum	Musculoskeletal BioDynamics Laboratory	skoo@kaist.ac.kr
KYUNG, Ki-Uk	Human-Robot Interaction Laboratory	kyungku@kaist.ac.kr
LEE, Bong Jae	Thermal Radiation Laboratory	bongjae.lee@kaist.ac.kr
LEE, Doo Yong	Robotics and Simulation Laboratory	leedy@kaist.ac.kr
LEE, Ikjin	Innovative Design Optimization Laboratory	ikjin.lee@kaist.ac.kr
LEE, Jungchul	Manufacturing and Instrumentation Laboratory	jungchullee@kaist.ac.kr
LEE, Kang Taek	Advanced Energy Conversion and Storage Laboratory	leekt@kaist.ac.kr
LEE, Phill-Seung	Computational Mechanics and Structural Systems	phillseung@kaist.edu
LEE, Seung S.	Micro Mechanical System Technology Laboratory	sslee97@kaist.ac.kr
Lee, Seungchul	Industrial Artificial Intelligence Laboratory	seunglee@kaist.ac.kr
NAM, Donguk	NEMS-Based Semiconductor Quantum Photonics (NEST) Lab	dwnam@kaist.ac.kr
NAM, Youngsuk	Multiscale Energy Laboratory	ysnam1@kaist.ac.kr
NOH, Minkyun	Precision Mechatronics Laboratory	minkyun.noh@kaist.ac.kr
OH, Il-Kwon	Soft Robotics and Intelligent Materials Laboratory	ikoh@kaist.ac.kr
OH, Wang-Yuhl	Photonic Imaging Laboratory	woh1@kaist.ac.kr
PARK, Hae-Won	Dynamic Robot Control and Design Laboratory	haewonpark@kaist.ac.kr
PARK, Hyung-Soon	Neuro-Rehabilitation Engineering Laboratory	hyungspark@kaist.ac.kr
PARK, Inkyu	Machine Intelligence and Novel-sensor Technology (MINT) Laboratory	inkyu@kaist.ac.kr
PARK, Sukyung	Biomechanics Laboratory	sukyungp@kaist.ac.kr
PARK, Yong-Hwa	Human-Machine Interaction Laboratory	yhpark@kaist.ac.kr
RYU, Seunghwa	Multiscale Mechanics and Materials Modeling Laboratory	ryush@kaist.ac.kr
SHIN, Jennifer Hyunjong	Soft Biomechanics and Biomaterials Laboratory	j_shin@kaist.ac.kr
SIM, Gi-Dong	in-situ Characterization and Reliability Evaluation Laboratory	gdsim@kaist.ac.kr
YOO, Hongki	Biomedical Optics and Optical Metrology Laboratory	h.yoo@kaist.ac.kr
YOON, Jeong Whan	Computer-Aided Net Shape Manufacturing	j.yoon@kaist.ac.kr
YOON, Kuk-Jin	Visual Intelligence Laboratory	kjyoon@kaist.ac.kr
YOON, Yong-Jin	Just Do it Laboratory	yongjiny@kaist.ac.kr
Yun, Huitaek	Smart Manufacturing Systems Laboratory	htyun@kaist.ac.kr



Affiliated Professor



Professor
JANG, Young Jae
Department
Dept. of Industrial & Systems Engineering, KAIST



Professor
KANG, Nam Woo
Department
Dept. of The Cho Chun Shik Graduate School of Green Transportation, KAIST



Professor
KOO, Je Min
Department
School of Business and Technology Management, KAIST



Professor
KUM, Dong Suk
Department
Cho Chun Shik Graduate School of Mobility, KAIST



Professor
MIN, Bum Ki
Department
Dept. of Physics, KAIST

Adjunct Professor



Professor
LEE, Jin Oh
Department
DLR German Aerospace Center



Professor
PARK, Jin Soo
Department
HYUNDAI ELECTRIC



Professor
RHA, Koon Ho
Department
NAVER HEALTHCARE LAB



Professor
SEOK, Sang Ok
Department
NAVER LABS



Professor
YUK, Hyun Woo
Department
Sanaheal, Inc.

Research Professor



Professor
CHOI, Keun Ha



Professor
KIM, Min Su



Professor
LEE, Deok Won

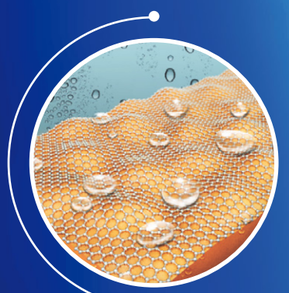


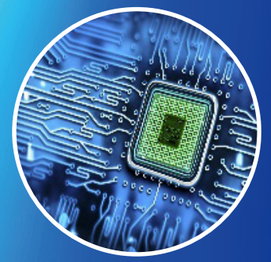
Professor
MANMATHA MAHATO



Professor
NAM, Hyeong Soo

RESEARCH AREAS









Mechanical Engineering Without Machines

MATERIALS, MECHANICS AND MANUFACTURING

ENERGY, ENVIRONMENT AND OCEAN

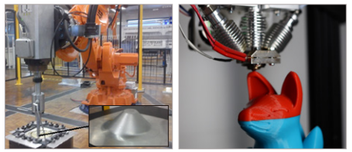
ROBOTICS, CONTROL AND MOBILITY

HEALTHCARE, NANO AND OPTICS

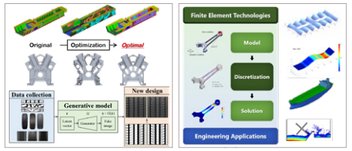
MATERIALS, MECHANICS and MANUFACTURING

Schematic diagram of research fields

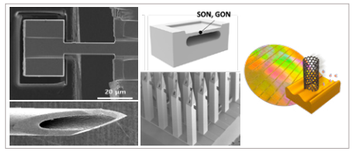
Customized & Personalized Manufacturing with High Process Flexibility



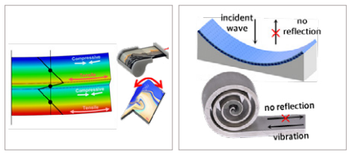
Optimized Design, Computer Modeling & Simulation, Digital Twin



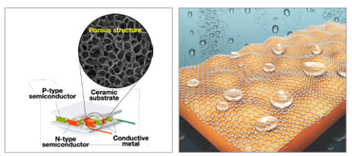
Micro/Nano Ultra-Precision Machining & Measurement



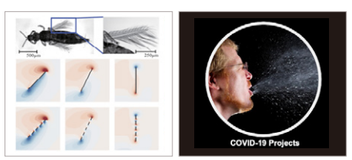
Rollable/Foldable Multi-Layered Devices & Noise/Vibration Cancelling Composite Structures



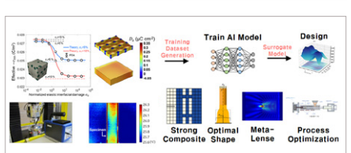
Mechanical Design using Advanced Nano Materials



Fluid-Structure-Environmental Interaction



AI/Big-Data Infused Design & Manufacturing



Introduction

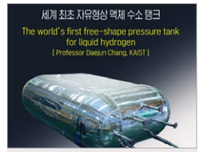
We keep strengthening our global leadership in the field of Materials, Mechanics, and Manufacturing by establishing fundamentals in mechanics, by analyzing and applying new materials and structures, and by developing design and production strategies based on innovative theories and AI algorithms to realize high-reliability, high-precision, and intelligent system, which is essential in the key national industries, including automotive, semiconductor, aerospace, shipbuilding, electronics, and energy.

Research keywords

- Establish fundamentals in mechanics to quantitatively understand and effectively utilize physical phenomena that exist in a variety of ways from everyday life to industries.
- Analyze thermal & mechanical characteristics of various materials, such as metals, polymers, ceramics, composites, and advanced materials, and their structures and systems.
- Understand mechanics and develop analysis techniques for macroscopic systems such as automobiles, aerospace, and shipbuilding, and for microscopic systems such as semiconductors, electronic components, and secondary batteries.
- Develop optimal design techniques and advanced production processes, which is essential for high value-added manufacturing industries.
- Realize intelligent and autonomous material characterization and manufacturing processes for future customized flexible production system.
- Utilize AI and big data in the entire manufacturing cycle, ‘material development - shape design - process optimization‘.

ENERGY, ENVIRONMENT and OCEAN

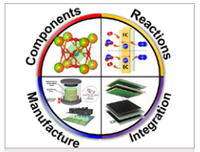
Schematic diagram of research fields



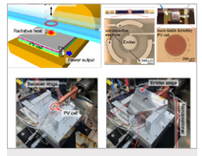
Liquid Hydrogen Storage



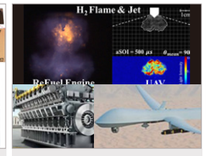
Cryogenics Cryocooler Design Applied Superconductivity



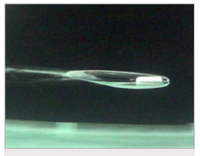
Fuel Cells / Electrolysis Cells



Energy Conversion Devices



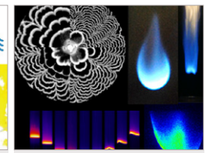
Carbon-neutral Energy Technology



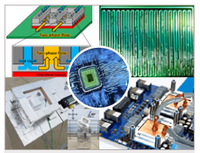
Fluid Mechanics / Supercavitation



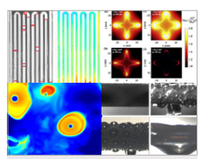
Environmental Fluid Dynamics / Environmental Sensing



Clean Combustion Technology



Cooling Technology for Semiconductor



Heat Transfer Enhancement



Hydrogen Energy System



Autonomous Surface Ship Technology

Introduction

Research on state-of-the-art technologies for response to climate change and sustainability: Carbon-neutral & Eco-friendly & Higly Efficient Energy Conversion/Storage/Transfer System, Carbon-neutral Power Generation, Ocean Renewable Energy (Wind Power/Photovoltaics/Tidal Power), Large-scale Energy Storage.

Research keywords

- New energy conversion and storage technology for green hydrogen production and eco-friendly power generation
- Multi-scale energy system design for CO_2 capture and emission reduction technology & hybrid/hydrogen engine toward carbon-neutrality
- Free-shape liquid hydrogen storage & Cryogenic applications research & Superconducting quantum computers
- Heat transfer & fluid mechanics-based technologies including combustion system control, AI-based heat exchange design, nanoscale thermal energy transfer, and supercavitation
- Global infrastructure technology for marine data-based statistical analysis, renewable energy exploration technology and intercontinental energy transport system
- Thermal management technology for wearable & portable devices and data management center for artificial intelligence / big data / cloud computing

ROBOTICS, CONTROL and MOBILITY

Schematic diagram of research fields



Humanoid and multi-legged robots



Medical, rehabilitation and wearable robots



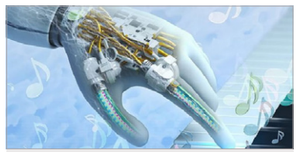
Future mobility, transportation and mobile robots



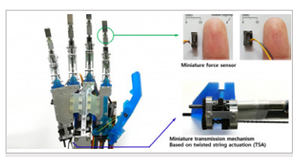
Machine learning and computer vision



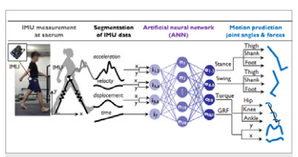
Vibration, sound, vision and emotional engineering



Soft robotics, sensors and actuators



Design and control of mechatronic systems



Biomechanics and machine-learning based healthcare

Introduction

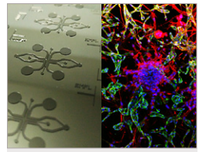
Our research group aims to enhance the visibility of mechanical engineering technologies required by the 4th Industrial Revolution and to support related domestic industries for global technological competitiveness. Our research areas include intelligent robots and future mobility that represent cutting-edge research in mechanical engineering and, in addition, medical and rehabilitation robotic research that can improve the quality of human life.

Research keywords

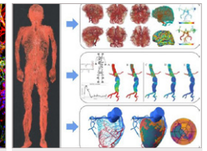
- Design and control of mechatronic systems representing intelligent advanced machines as the combination of mechanical and electronic systems
- Future mobility and mobile robot technologies that will change the paradigm of transportation and logistics
- Humanoid and multi-legged robots as new mobility platforms to overcome the limitations of existing mobile robots
- Medical, rehabilitation and wearable robots that will play a key role in improving the quality of human life in a rapidly aging society
- Development of soft robot, sensor and artificial muscle driver technology to overcome the limitations and disadvantages of existing sensors and actuators
- Emotional engineering technology that analyzes the characteristics of hearing and visual functions and actively reflects them in product design
- Maximize the usefulness of technology in real-world physical environments by incorporating software technology, machine learning and computer vision technology into machine/hardware systems

HEALTHCARE, NANO and OPTICS

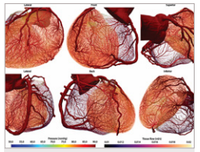
Schematic diagram of research fields



Lab-on-a-chip & organ-on-a-chip



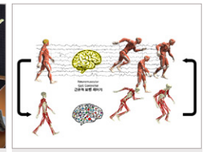
Diagnosis of Cardiovascular Disease



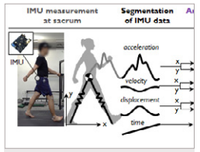
Computational Biomechanics



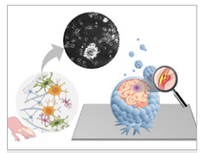
Micro/nano-structure based environment & healthcare sensors



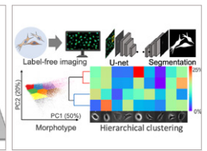
Human musculoskeletal digital twin



AI-based human dynamics estimation



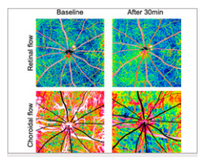
Cell-Based Disease Model



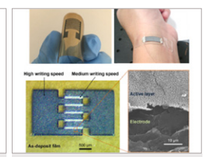
AI-Based Cellular Morphotyping



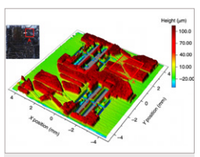
Optical biomedical imaging technology



Photonic blood flow imaging for early disease diagnosis



Ultra-fast laser based ultra-precision patterning



Ultrahigh-speed & precision 3D photonic imaging

Introduction

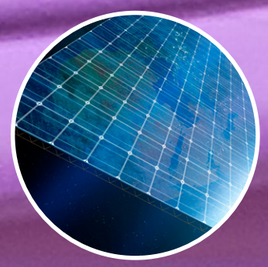
We investigate the mechanical properties of biological systems ranging from cells to tissues to the human body, and develop sensors, microfluidic chips, disease models, biomaterials, and algorithms for diagnosis and treatments. We also perform researches on the high-tech sensors, actuators, and displays based on the design and manufacturing of micro/nanoscale materials and structures. In addition, we develop novel photonic measurement, machining, patterning, and imaging technologies, and explore their application to healthcare and various industrial manufacturing processes.

Research keywords

- Development of organ and disease models, AI-based cell classification algorithms, and patient-specific drug screening technologies
- Understanding the dynamics and control mechanisms of the musculoskeletal and nervous systems for human movement and apply them to customized healthcare and sports training
- Development and application of computerized methods for accurate understanding of biological and industrial systems
- Development of cutting edge photonic imaging technologies and application to healthcare and industrial manufacturing processes
- Development of ultrafast laser-based ultra-precision measurement/control/manufacturing/patterning technologies
- Development of nanosensor devices and systems and application to healthcare and environment IoT

Mechanical Engineering Without Machines

RESEARCH





Biohybrid Systems Engineering Laboratory



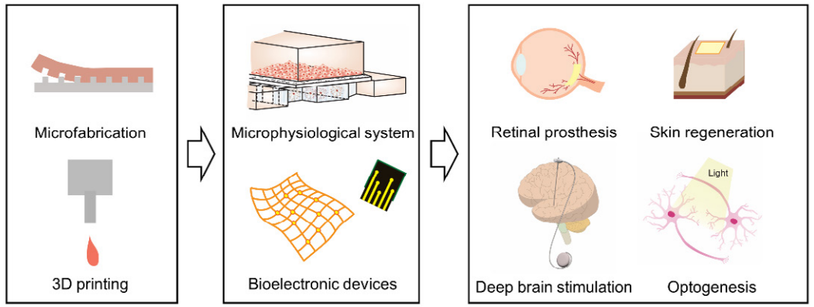
Assistant Professor
AHN, Song Ih

Ph.D., Georgia Institute of Technology [2019]

Research Interest
- Tissue engineering
- Organs-on-chips
- 3D printing of bioelectronics
- Implantable device

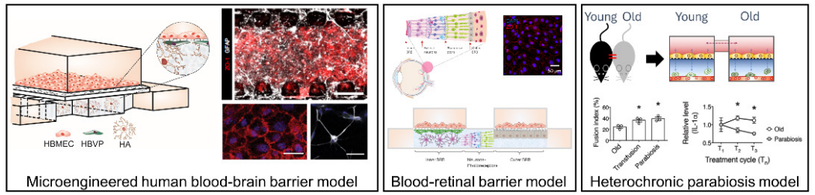
RESEARCH OVERVIEW

We engineer preclinical human tissue models by interweaving biological and electronic materials, using a combination of microfabrication and 3D printing technologies. Our research mainly focuses on two areas: (1) the development of human tissue models on microfluidic devices for studying the interface between tissues; and (2) 3D printing of electronic devices for biomedical applications. Our research goal is to develop in vitro models that provide reliable preclinical tools for bioelectronic device implantation.

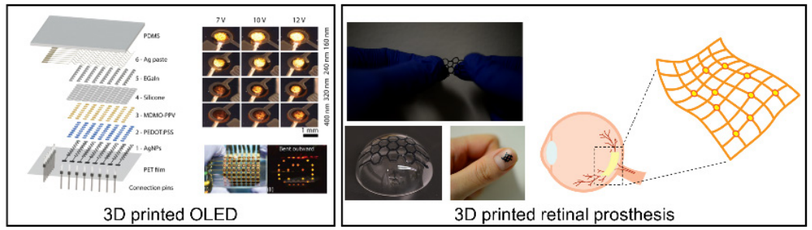


RESEARCH HIGHLIGHTS

***In vitro* modeling of human tissues:** We develop various types of microengineered physiological systems (organs-on-chips) of blood-tissue interfaces. Our models can be used for drug screening our device testing.



3D printing of organic electronics: We 3D print organic electronic devices for biomedical applications. Using our direct-ink writing based 3D printing system, we can interweave electronic and biological materials on free-form surfaces.



SELECTED PUBLICATIONS

[1] Ahn SI, Sei YJ, Park HJ, Kim J, Ryu Y, Choi JJ, Sung HJ, MacDonald TJ, Levey AI, and Kim Y, Microengineered human blood-brain barrier platform for understanding nanoparticle transport mechanisms, Nature Communications (2020) 11(1): 175

[2] Lee Y*, Choi JJ*, Ahn SI*, Lee N, Han WM, Mohiuddin M, Shin EJ, Wood LB, Park KD, Kim Y†, and Jang YC†, Engineered heterochronic parabiosis in 3D microphysiological system for identification of muscle rejuvenating factors, Advanced Functional Materials (2020) 30(46): 2002924.

[3] Su R*, Park SH*, Ouyang X, Ahn SI, and McAlpine MC, 3D Printed Flexible Organic Light-Emitting Diode Displays, Science Advances (2022) 8, eabl8798.

Future Transport Power Laboratory



Professor
BAE, Choongsik

Ph.D., Imperial College London [1994]

Research Interest
- Carbon-neutral Technology for Transport Power on Air, Sea and Land
- Advanced Engines; Hybrid, Hydrogen Engines
- Combustion Process in Engines
- Laser Diagnostics and Instrumentation
- Fuel Spray and Atomization
- Energy Technology Perspective

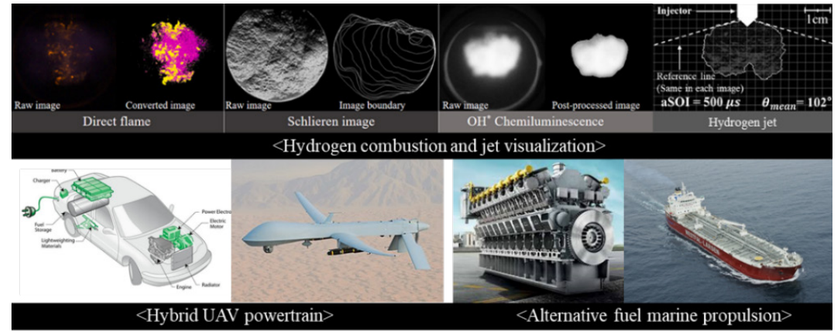
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RESEARCH OVERVIEW

Hydrogen Engine
Hydrogen direct injection engine. Fundamental hydrogen jet and combustion diagnostics in a constant volume chamber. Hydrogen stratified energy conversion research with high-pressure hydrogen injection.

Unmanned Aerial Vehicle (UAV) powertrain
Application of intermittent engine in a UAV system. Analysis of IC engine operation under the high-altitude condition. Powertrain optimization research with simulation data for hybrid UAV powertrain.

Carbon-neutral and Alternative Fuels
The application of carbon neutral fuels, and alternative fuels such as hydrogen-based synthetic fuel, Bio-diesel, LPG, CNG, DME, Methanol, Ethanol in both compression ignition and spark ignition engines are on-going.

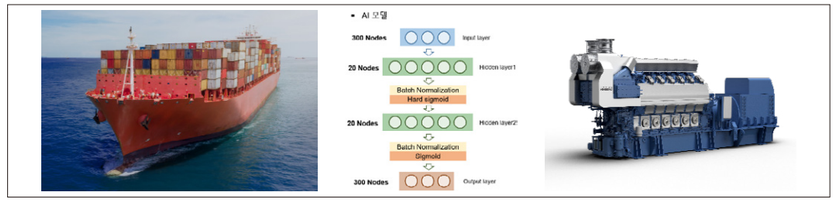


Advanced Combustion
New combustion strategies such as duel-fuel combustion, gasoline direct injection compression ignition and low temperature combustion which are regarded as clean and efficient future engine technologies.

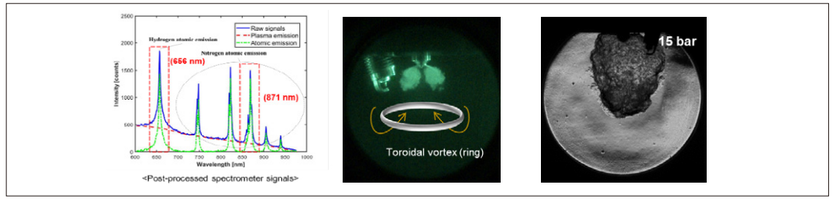
Environmentally Friendly Powerplant
Particulate number (PN) and NOx emission in gasoline direct injection engines. The effect of flow characteristics on the PN and NOx generation mechanism in an optically accessible acryl engine. Optimization of fuel injector nozzle design for better fuel economy and emission characteristics.

RESEARCH HIGHLIGHTS

AI (Artificial Intelligence)-based Diagnostics
Cylinder pressure reconstruction with machine learning. Vibrational signal from CNG-Diesel dual-fuel marine engine is used to detach malfunction and achieve low-burst operation of the engine.

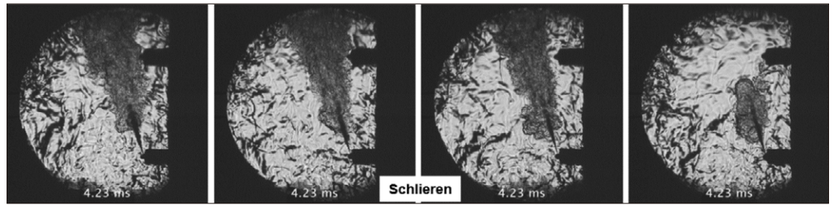


Received KAIDA Academic Award, 2023, KSAE. Stratified Hydrogen Lean combustion
Hydrogen spray and combustion with laser diagnostic technologies, such as Laser-Induced Breakdown Spectroscopy and Planar Laser-induced Fluorescence.



<Post-processed spectrometer signals>

Spray Characterization of the Various Fuels
Spray characteristics of various fuels for marine engine Dual Fuel application to reduce exhaust emissions and improve combustion behavior of the low-flash point fuel.



Received Yeonsong Academic Award, 2022, ILASS-Korea

SELECTED PUBLICATIONS

[1] Bae, C., & Kim, J. (2017). Alternative fuels for internal combustion engines. Proceedings of the Combustion Institute, 36(3), 3389-3413.

[2] Kook, S., Bae, C., Miles, P. C., Choi, D., & Pickett, L. M. (2005). The influence of charge dilution and injection timing on low-temperature diesel combustion and emissions. SAE transactions, 1575-1595.

[3] Lee, S., Hwang, J., & Bae, C. (2023). Understanding of Hydrogen Jet Dynamics for Direct Injection Hydrogen Engines. International Journal of Engine Research, 24, 4333-4444.

[4] Lee, S., Kim, G., & Bae, C. (2022). Effect of mixture formation mode on the combustion and emission characteristics in a hydrogen direct-injection engine under different load conditions. Applied Thermal Engineering, 209, 118276.

[5] Shin, J. Y., Lee, S., Bae, C., Jung, J., Son, Y., Heo, H., & Lee, J. (2022). Effect of late intake valve closing on the particle number emissions of a turbocharged gasoline direct injection engine. Fuel Processing Technology, 230, 107209.

[6] Kim, G., Park, C., Kim, W., Jeon, J., Jeon, M., & Bae, C. (2021). The Effect of Natural Gas Substitution Ratio and Diesel Injection Timing on Accuracy of In-cylinder Pressure Prediction DNN Model from Vibration Signal in a CNG-Diesel Dual-Fuel Engine. Transactions of the Korean Society of Automotive Engineers, 29(10), 909-919.

New Energy Conversion System Laboratory



Professor
BAE, Joongmyeon

Ph.D., Imperial College London [1996]

Research Interest
- Solid oxide fuel cell (SOFC)
- Fuel processing
- Hydrogen carrier
- Numerical analysis

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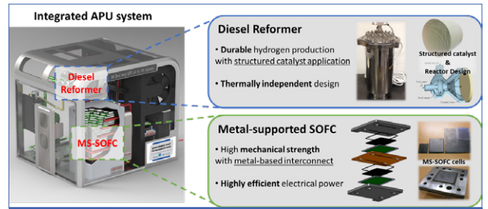
RESEARCH OVERVIEW

Prof. Bae's group (New Energy Conversion System Laboratory, NECS) focuses on solid oxide fuel cells, hydrogen generation and hydrogen storage systems. Research is being conducted on the development of metal-supported SOFC cells and SOFC stacks, hydrogen generation using fuel processor, and hydrogen storage systems using metal hydride and LOHC.

RESEARCH HIGHLIGHTS

Metal-supported SOFC
A metal-supported solid oxide fuel cell (MS-SOFC) platform based on interconnect material was developed as a solution for the low thermo-mechanical strength of a conventional SOFC. By introducing a thin-film electrolyte, the MS-SOFC unit cell, which operates at a relatively low temperature and has excellent chemical and mechanical stability under thermal impacts, is being developed.

Fuel processor
A fuel processor converts hydrocarbon fuels into gases for fuel cells. In order to supply hydrogen to FCEVs, we have been developing a novel "Membrane fuel processor" to produce pure hydrogen (>99.9%) by reforming liquid HCs and selectively permeating hydrogen. Especially, diesel is difficult to handle because it is composed of heavy hydrocarbons. We conduct diesel reforming using our proprietary technology. We have also developed a PROX catalyst to remove carbon monoxide under 10ppm level and investigated the reaction mechanism and kinetics.



Solid Oxide Fuel Cell (SOFC) Auxiliary Power Unit (APU) modeling operated diesel

Hydrogen carrier (Metal hydride and liquid organic hydrogen carrier, LOHC)
A hydrogen energy storage system, so called water battery, was developed for portable/mobile applications. An application-oriented design and system integration strategy were newly suggested to maximize energy density while incorporating technologies for the electrolyzer, the metal hydride, and the fuel cell. We found that developed system can produce 1,200Wh of electricity, which is twice the capacity of conventional energy storage systems.
LOHC is safe hydrogen storage technology in which hydrogen is stored in form of liquid organics. It is not flammable and can be used for long-term hydrogen storage on a large scale. Recently we have developed core technologies of LOHC catalysts, the nation's largest LOHC demonstration system designs, and integrated operation with PEMFC.

SELECTED PUBLICATIONS

Journals

[1] J. Lee, M. Bae, J. Bae*, "Effects of preparation method on exsolution and alloy formation in a PtRu bimetallic catalyst for hydrogen production via diesel reforming: Impregnation versus combustion synthesis", International Journal of Hydrogen Energy 47, pp. 29327-29336 (2022).

[2] J. Lee, C. Yeon, J. Oh, G. Han, J. Yoo, H. Yun, C. Lee, K. Lee*, J. Bae*, "Highly active and stable catalyst with exsolved PtRu alloy nanoparticles for hydrogen production via commercial diesel reforming", Applied Catalysis B: Environmental 316, pp. 121645 (2022).

[3] S. Lee, K. Lee, J. Lee, J. Lee, T. Kim, J. Bae*, "Evaluation of Electrolyte Materials of Gd- and Ce-Doped Scandia-Stabilized Zirconia and Yb- and Bi-Doped Gadolinium-Doped Ceria for Highly Durable Solid Oxide Fuel Cells", International Journal of Precision Engineering and Manufacturing-Green Technology 10 (2023).

[4] J. Yoo, J. Lee, H. Lee, J. Kang, M. Bae, J. Bae*, "A parametric computational-fluid-dynamics study on improving the performance of a flat membrane reactor for on-site hydrogen production", Chemical Engineering Research and Design 197, pp. 821-837 (2023).

Patents

[1] Solid oxide fuel cells, 2023, Korea

[2] Solid oxide electrolyte including thin film electrolyte layer of multiple repetitive structures, method for manufacturing the same, solid oxide fuel cell and solid oxide electrolysis cell comprising the same, 2021, Korea

[3] Module typed system for liquid organic hydrogen carrier and operation method for the same, 2021, Korea

Innovative Energy Systems Engineering Laboratory



Professor
CHANG, Daejun

Ph.D., Korea Advanced Institute of Science & Technology [1997]

Research Interest
- Liquid hydrogen solutions
- Thermal energy storage
- Climate-critical gases

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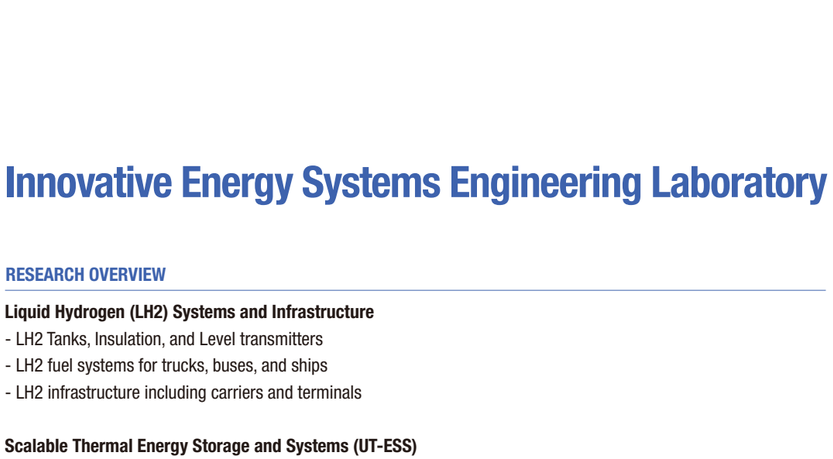
RESEARCH OVERVIEW

Liquid Hydrogen (LH2) Systems and Infrastructure
- LH2 Tanks, Insulation, and Level transmitters
- LH2 fuel systems for trucks, buses, and ships
- LH2 infrastructure including carriers and terminals

Scalable Thermal Energy Storage and Systems (UT-ESS)
- Scalable solutions (0.1 MWhr ~ 10 GWhr) for both hot and cold energy storage
- High-quality decarbonized thermal energy supply
- Utilizing intermittent renewable energy and waste heat

Climate-Critical Gases
· H2, CO2, NH3 & MeOH
· Storage, Shipping & Systems
· Life Cycle & Supply Chain Assessment

RESEARCH HIGHLIGHT – World's first innovations by IESEL



MAJOR PUBLICATIONS

[1] J.W. Kim, et al., "Technical feasibility of large-scale transportable liquid hydrogen export terminal", Int'l J. Hydrogen Energy, 66, pp. 499 (2024).

[2] S.H. Kim, et al., "Techno–economic analysis of fuel cell powered urban air mobility system", Int'l J. Hydrogen Energy, 50, pp 988 (2024).

[3] S.H. Che, et al., "Thermodynamic analysis of molten salt-based single-tank thermal energy storage system with heat transfer enhanced by gas injection", J. Energy Storage, 77, pp. 109959 (2024).

[4] W.G. Jung, "Heat Integration of Liquid Hydrogen-Fueled Hybrid Electric Ship Propulsion System", J. Marine Sci. & Eng., 11, pp. 2157 (2023).

Waves & Fluid Mechanics Laboratory



Associate Professor
CHO, Yeunwoo

Ph.D., Mechanical Engineering, Massachusetts Institute of Technology [2010]

Research Interest
- Fluid Mechanics on Supercavitation, Wave-vortex interaction, Waves

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RESEARCH OVERVIEW

Supercavitation
- 2-D/3-D supercavitation

Wave-vortex interaction
- Flow around a cylinder near free surface

Waves in Fluids and on Soft Matter
- Linear/nonlinear surface/internal waves

RESEARCH HIGHLIGHTS

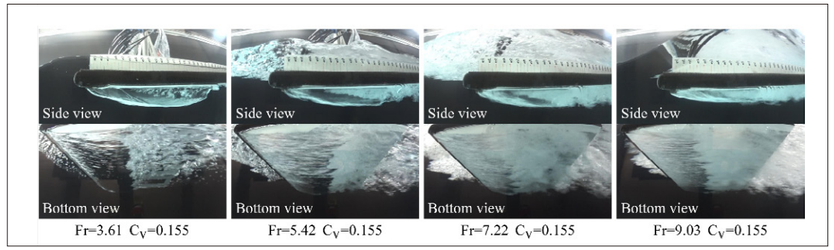


Fig.1. 2-D supercavity shapes according to Froude number (Fr) and air-entrainment coefficient (C_v), where Fr=U/ $\sqrt{gh}$, U: moving speed, g: gravitational acceleration, h: cavitator height, C_v=Q/Uhb, Q: air flow rate, b: water tank width.

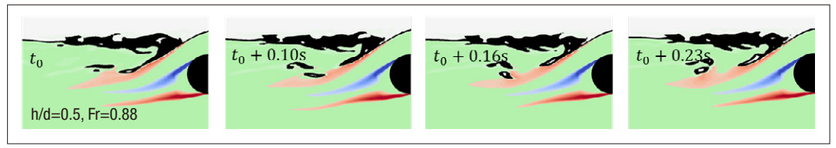


Fig.2. Flow around a cylinder near free surface according to gap ratio (h/d) and Froude number (Fr), where d: diameter of the cylinder, h: distance between the still free surface and the top of the cylinder, Fr=U/ $\sqrt{gd}$, U: free stream velocity, g: gravitational acceleration.

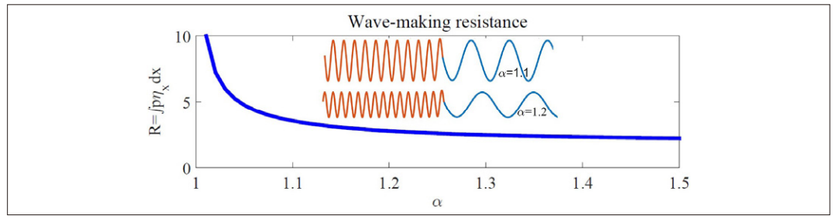


Fig.3. Gravity-capillary wave-making resistance: Forced inviscid linear wave profiles (η) for the left-moving forcing speeds for α=1.1 and 1.2, where α=V/c_{min}, V: forcing speed (at x=0), c_{min}=23cm/s

SELECTED PUBLICATIONS

[1] Y. Cho, 2024, "Gravity-capillary wave-making resistance on deep water", Physics of Fluids, 36, 017125

[2] Y. Cho, 2023, "Analytic calculation of two-dimensional linear viscous gravity-capillary waves on deep water generated by a moving forcing at non-critical conditions: wave patterns and spatial decay rate", Journal of Engineering Mathematics, 139:4

Automotive Control Laboratory



Professor
CHOI, Seibum

Ph.D., University of California, Berkeley [1993]

Research Interest
- Vehicle Dynamics and Control
- Advanced Powertrain Systems
- Transportation Systems
- Vehicle State Observer
- Sensor Applications
- Intelligent Tires
- Fault Diagnosis

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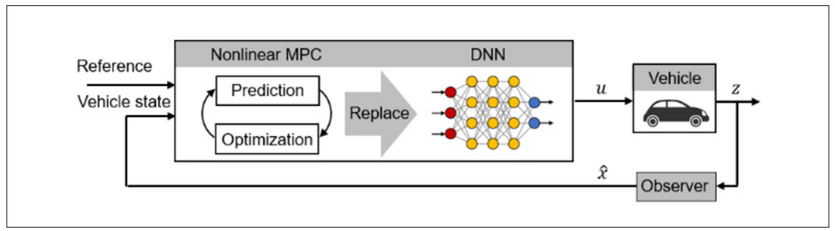
RESEARCH OVERVIEW

Vehicle Dynamics and Control

The main goal of this research is enhancing the driving performance using vehicle dynamics and applying controls. The vehicle states required for vehicle motion control but unmeasurable are obtained through vehicle dynamics-based state observers. By controlling driving or braking torque appropriately, vehicle dynamic performance is maximized.

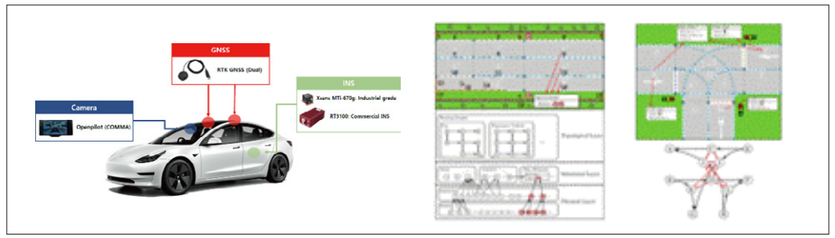


Various Methods of Path Planning and Tracking Control



The main goal of this research is performing optimal path planning and tracking control for in various methods and vehicle plants. Since path planning and tracking control target / strategy are different for conventional cars, articulated trucks and pickup truck-trailer systems, in-depth research is essential. Moreover, nearly every vehicle system is nonlinear, which leads to difficulties when performing real-time control. In order to mitigate this problem, replacing conventional nonlinear MPC(Model Predictive Control) with DNN(Deep Neural Network) is also studied. Other related topics are: fault tolerance control, full range ACC(Adaptive Cruise Control), intention prediction of surrounding vehicles. Vehicle maneuver performance can be maximized through this research.

Sensor Fusion and Lane Map Generation



The main goal of this research is to reconstruct vehicle trajectory using various sensor information and automatically generate lane maps. Automation of map generation process will greatly enhance the quality of lane level maps, which are used in several ADAS(Advanced Driver Assistance System) applications and Autonomous Vehicles

RESEARCH HIGHLIGHTS

[1] JH Lee, YJ Hwang, Seibum B. Choi, “Robust Tube-MPC based Steering and Braking Control for Path Tracking at High-Speed Driving“, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY vol.72, no.12, pp.15301~15316, 2023.06

[2] JY Do, KS Han, SB Choi, “Lane Change–Intention Inference and Trajectory Prediction of Surrounding Vehicles on Highways”, IEEE TRANSACTIONS ON INTELLIGENT VEHICLES vol.8, no. 7, pp.3813~3825, 2023.7

[3] TH Lee, SB Choi, “Real-time Optimization of Gear Shift Trajectories using Quadratic Programming for Electric Vehicles with Dual Clutch Transmission”, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY vol. 72, no. 7, pp.8647~8660 , 2023.6

[4] JH Lee, SB Choi, “Integrated Control of Steering and Braking for Path Tracking using Multi-Point Linearized MPC”, IEEE TRANSACTIONS ON INTELLIGENT VEHICLES vol. 8, no. 5, pp. 3324~3335, 2023.5

[5] DS Jeong, SB Choi, “Tracking Control Based on Model Predictive Control Using Laguerre Functions with Pole Optimization”, IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, vol. 23, no. 11, 2022.1

[6] HJ Lee, SB Choi, “Development of Collision Avoidance System in Slippery Road Conditions”, IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, Vol. 23, 2022.10

[7] YJ Hwang, YS Jeong, IS Kweon, SB Choi, “Identification of Vehicle Dynamics Model and Lever-arm for Arbitrarily Mounted Motion Sensor”, IEEE SENSORS JOURNAL, vol.22, no.10, pp.9843~9856, 2022.05

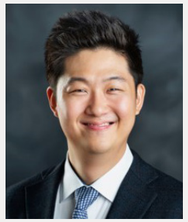
[8] TH Lee, DH Kim, SB Choi, “Driveline Modeling with Transmission Loss and Robust Torque Observer Design for Dual Clutch Transmission”, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, vol.71, no.2, pp.1267~1279, 2022.02

* 23 More journal papers and 2 conference proceedings published/accepted in 2022~2023

HONORS/AWARDS

[1] 2023 국가연구개발 우수성과 100선 선정 “세계 최초 자율주행기반 대용량 굴절버스 운행제어 기술 개발”
[영문] National Best Research Top 100 in 2023, “Development of Autonomous Articulated-Mass-Transit-Bus Control System”

Multiphase Reactive Flow Laboratory



Associate Professor
HWANG, Joonsik

Ph.D., KAIST [2017]

Research Interest
- High-speed optical diagnostics
- Turbulent flow
- Spray atomization
- Propulsion systems

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RESEARCH OVERVIEW

Vehicle Dynamics and Control

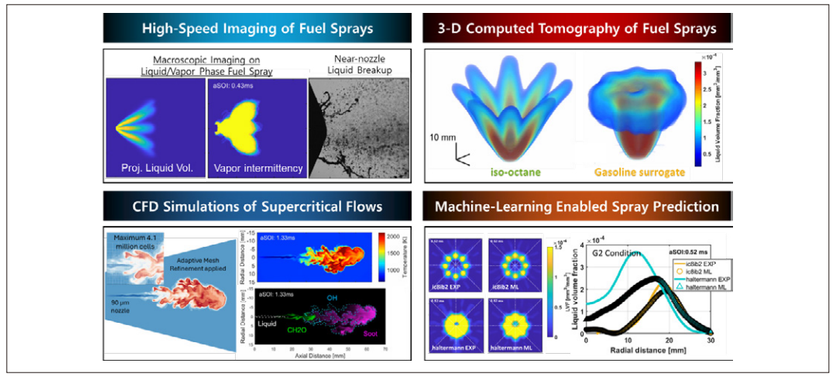
The primary mission of MRF Lab is to drive innovation in propulsion and power generation systems through a scientific understanding of multi-phase reactive flow characteristics and the application of advanced analytical techniques such as Computational Fluid Dynamics (CFD) and Machine Learning algorithms. We foster multidisciplinary teamwork and collaboration, engaging with diverse partners including global open networks, national laboratories, universities, and OEMs.

RESEARCH HIGHLIGHTS

HIGH-SPEED OPTICAL DIAGNOSTICS: Characterization of reactive flows remains as an important component of research and development for advanced energy conversion systems. We apply cutting-edge high-speed imaging techniques for spatio-temporal assessment of plume dynamics and chemical reactions.

COMPUTATIONAL FUID DYNAMICS: CFD delivers detailed physical understanding and thermodynamic data such as temperature, pressure, velocity, etc. Combination of experimental work and CFD result provide comprehensive physical understanding. We use CONVERGE software for Lagrangian and Eulerian flow simulations.

AI-GUIDED PREDICTION: Applications of artificial intelligence (AI) using massive experimental data enabled cost-effective prediction of reactive flow characteristics. We are developing innovative computational models for multi-physics flow predictions.



SELECTED PUBLICATIONS

[1] Hwang, J., Karathanassis, I. K., Koukouvinis, P., Nguyen, T., Tagliante, F., Pickett, L. M., ... & Powell, C. F. (2024). Spray process of multi-component gasoline surrogate fuel under ECN Spray G conditions. International Journal of Multiphase Flow, 104753.

[2] Lee, S., Hwang, J., & Bae, C. (2023). Understanding hydrogen jet dynamics for direct injection hydrogen engines. International Journal of Engine Research, 24(10), 4433-4444.

[3] Koukouvinis, P., Rodriguez, C., Hwang, J., Karathanassis, I., Gavaises, M., & Pickett, L. (2022). Machine Learning and transcritical sprays: A demonstration study of their potential in ECN Spray-A. International Journal of Engine Research, 23(9), 1556-1572.

[4] Hwang, J., Weiss, L., Karathanassis, I. K., Koukouvinis, P., Pickett, L. M., & Skeen, S. A. (2020). Spatio-temporal identification of plume dynamics by 3D computed tomography using engine combustion network spray G injector and various fuels. Fuel, 280, 118359.

Robotics and Artificial Intelligence Laboratory



Associate Professor
HWANGBO, JE MIN

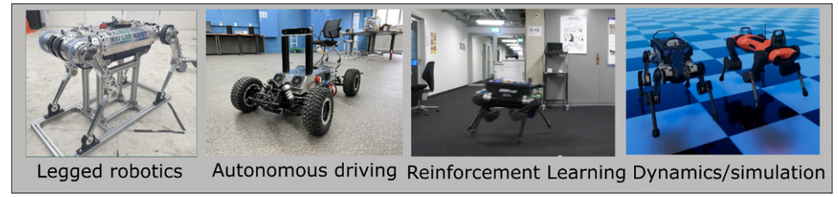
Ph.D., ETH ZURICH [2019]

Research Interest
- Reinforcement learning
- Legged robots

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RESEARCH OVERVIEW

The goal of our research is to develop dynamic and intelligent legged robots for many industrial applications. Even though legged robotics has been advancing remarkably in the past four decades, the existing legged robots are not yet robust and reliable enough to perform many real-world tasks. Furthermore, their limited speed and efficiency make them an uneconomical option for long-range applications. We address these issues from two different angles: intelligence and design. To make legged robots more intelligent, we devise deep learning algorithms and network architectures tailored for legged robots. Our artificial neural networks not only control the robots but also estimate the state; perceive the environment; plan the trajectory for a short horizon. They replace the heuristic rules that have been used to control the robots and thereby make the systems more agile and reliable. In addition, we design high-performance and energy-efficient legged robots to embody the intelligence that we develop. Transparent transmission and low-delay actuators allow us to accurately model the hardware and consequently lead to efficient simulation-to-real transfers. They reduce energy expenditure and thus lead to longer battery life. By concurrently developing the hardware, software, and algorithms, we make highly performant legged systems for the most challenging environments.



RESEARCH HIGHLIGHTS

Control of a legged robot with reinforcement learning. We introduced a variety of ways to train control policies for a legged robot in simulation and transfer them to the real robot in various environments. Prof. Hwangbo's publication in Science Robotics in 2019 [1], which was featured as one of the top ten papers in 2019 [3] by Nature, ignited worldwide interest in reinforcement learning in the legged robotics community. His team at KAIST is continuing this line of research to improve the capabilities of legged robots.



SELECTED PUBLICATIONS

[1] Hwangbo, Jemin, Joonho Lee, Alexey Dosovitskiy, Dario Bellicoso, Vassilios Tsounis, Vladlen Koltun, and Marco Hutter. "Learning agile and dynamic motor skills for legged robots." Science Robotics 4, no. 26 (2019): eaau5872.

[2] Hwangbo, Jemin, Inkyu Sa, Roland Siegwart, and Marco Hutter. "Control of a quadrotor with reinforcement learning." IEEE Robotics and Automation Letters 2, no. 4 (2017): 2096-2103.

[3] WRobots, hominins and superconductors: 10 remarkable papers from 2019 by Nature

Biomicrofluidics Laboratory



Associate Professor
JEON, Jessie Sungyun

Ph.D., Massachusetts Institute of Technology [2014]

Research Interest
- Microfluidics
- Lab-on-a-chip
- Organ-on-a-chip
- Drug screening platform
- In vitro disease microenvironment

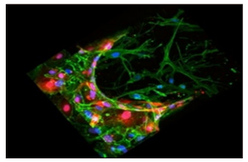
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RESEARCH OVERVIEW

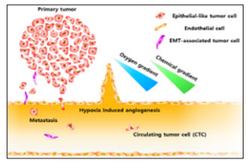
Mimicking 3D Biological System [Fig.1]
- Human biological systems such as bone, muscle, and microvasculature are modeled in microfluidic system.
- Bacterial microenvironment and formation biofilm can be modeled.

Design and Fabrication of Microfluidic System [Fig.2]
- Different microfluidic platforms for each biological systems are designed to best mimic the targeted microenvironments.
- Microfluidic systems are also developed for biosensors or drug screening platforms.

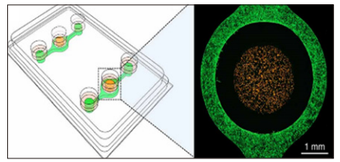
Disease-on-a-chip [Fig3]
- Human diseases such as cancer metastasis and atherosclerosis are modeled in the developed microfluidics systems.
- Effects of biophysical and biochemical external factors for diseases can be tested or identified in the system for therapeutic purposes.



[Fig.1]



[Fig.2]



[Fig.3]

RESEARCH HIGHLIGHTS

[1] S.Kim*, J.Park*, JN.Ho, D.Kim, S.Lee+, J.S.Jeon+, 3D vascularized microphysiological system for investigation of tumor-endothelial crosstalk in anti-cancer drug resistance, Biofabrication, 2023.

[2] H.Nam, J.E.Park, W.Waheed, A.Alazzam, H.J.Sung+, J.S.Jeon+, Acoustofluidic lysis of cancer cells and Raman spectrum profiling, Lab on a Chip, 2023.

[3] U.Nam, S.Lee, J.S.Jeon+, Generation of a 3D Outer Blood–Retinal Barrier with Advanced Choriocapillaris and Its Application in Diabetic Retinopathy in a Microphysiological System, ACS Biomaterials Science & Engineering, 2023.

[4] S.Kim, H.Nam, B.Cha, J.Park, H.J.Sung, J.S.Jeon, Acoustofluidic stimulation of functional immune cells in a microreactor, Advanced Science, 2022, 2105809.

[5] H.Nam, H.J.Sung, J.Park, J.S.Jeon, Manipulation of cancer cells in a sessile droplet via travelling surface acoustic waves, Lab on a Chip, 2022, 22(1), 47-56. travelling surface acoustic waves, Lab on a Chip, 2022, 22(1), 47-56.

[6] J.Park, S.Kim, J.Hong, J.S.Jeon+, Enabling perfusion through multicellular tumor spheroids promoting lumenization in a vascularized cancer model, Lab on a Chip, 2022, 22, 4335-4348

HONORS/AWARDS

[1] KAIST School of Engineering Technological Innovation Award, 2023.

[2] Young Investigator Award, The Korean BloChip Society, 2018.

Wave Energy Control Laboratory (Wave Lab.)



Associate Professor
JEON, Wonju

Ph.D., KAIST [2006]

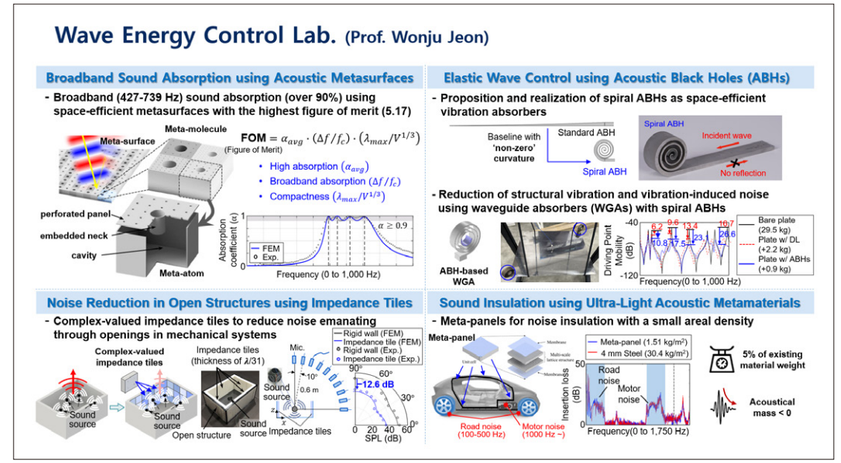
Research Interest
- Sound and Vibration
- Acoustic/Elastic Metamaterial
- Silent Drone and UAM
- Aeroacoustics and Fan Noise

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RESEARCH OVERVIEW

WAVE Lab. led by Professor Jeon aims to develop new and innovative solutions for old and long-standing problems of sound and vibration occurring in various mechanical systems such as home appliances and future mobilities. To overcome the limitation of existing materials or technologies for sound absorption/isolation and vibration damping, we proposed new concepts of meta-structures ('meta' in Greek means 'beyond' in English) such as 'Sound Absorbing Metasurface', 'Spiral Acoustic Black Holes', 'Complex-valued Impedance Tiles', and 'Soundproofing Meta-panels' and 'Sound Absorbing Metasurface' with experimental validation via fabrication. Our main research interests include (but are not limited to) the following topics:

- Broadband Sound Absorption using Acoustic Metasurfaces (Top Left)
- Elastic Wave Control using Acoustic Black Holes (ABHs) (Top Right)
- Noise Reduction in Open Structures using Impedance Tiles (Bottom Left)
- Sound Insulation using Ultra-Light Acoustic Metamaterials (Bottom Right)



RESEARCH HIGHLIGHTS

[1] Development of space-efficient acoustic metasurfaces that achieve high absorption (over 90%) in broadband frequency range

[2] Proposition of a waveguide absorber based on spiral ABHs that suppress vibration and vibration-induced noise in various industries

[3] Development of complex-valued impedance tiles that reduce noise emanating through openings in mechanical systems

[4] Proposition of a lightweight soundproofing meta-panel that can be applied to Electric Vehicles (EVs) and Advanced Air Mobility (AAM) for fuel efficiency and ride comfort

SELECTED PUBLICATIONS

[1] H. Ryoo, K.Y. Lee, and W. Jeon, Broadband sound absorption using hybrid resonators with embedded necks and micro-perforations in parallel, Mech. Syst. Signal Process., Vol. 211, 111205 (Apr. 2024)

[2] E. Yang, J. Kim, and W. Jeon, Complex-valued impedance tiles to reduce noise emanating through openings in mechanical systems, Mech. Syst. Signal Process., Vol. 209, 111054 (Mar. 2024)

[3] J. Kim, E. Choi, and W. Jeon, Lightweight soundproofing meta-panel for separate wide frequency bands, Mech. Syst. Signal Process., Vol. 184, 109647 (Feb. 2023)

[4] S. Park, J.Y. Lee, and W. Jeon, Vibration damping of plates using waveguide absorbers based on spiral acoustic black holes, J. Sound Vib., Vol. 521, 116685 (Mar. 2022)

Cryogenic Engineering Laboratory



Professor
JEONG, Sangkwon

Ph.D., Massachusetts Institute of Technology [1992]

Research Interest

- Cryogenics
- Cryocooler Design
- Applied Superconductivity System
- Cryogenic Heat Transfer
- Refrigeration

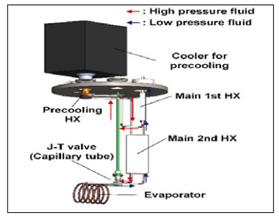
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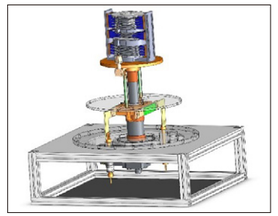
RESEARCH OVERVIEW

Cryogenic refrigerator and superconductivity applications

Cryogenic refrigeration is an enabling technology to create low enough temperature below -150℃ for various low temperature applications including space exploration. The current research in the Cryogenic Engineering Laboratory of KAIST involves cryogenic fluid management such as liquid nitrogen, hydrogen, and oxygen, MR (Mixed Refrigerant) Joule – Thomson (JT) refrigeration, sorption refrigeration, and Magnetic refrigeration.
MR-JT research results can be applied to cryogenic refrigeration system for cryoprobe or large-scale LNG or liquid hydrogen plants. Various cryogenic heat exchanger concepts including PCHE (Printed Circuit Heat Exchanger) is also being examined to enhance the whole system performance efficiency.
Magnetic refrigeration is a new heat pumping method not only for cryogenic temperature
range but also for room temperature environment. The current researches are focused on the technologies related to liquid hydrogen temperature (20 K), High Temperature Superconductor (HTS) cooling schemes, ultra-low temperature cryogenic refrigerators, and cryogenic fluid management







RESEARCH HIGHLIGHTS

[1] D. Kwon, B. Kim, J. Choi, S. Jeong, and S. Kim, "Thermal design of the conduction-cooled high temperature superconducting magnet for pulsating magnetic field," IEEE Transactions on Applied Superconductivity, vol. 33, no. 5, pp. 1-7, 2023.

[2] J. Han, D. Kwon, B. Kim, J. Bae, and S. Jeong, "Investigation of thermal contact conductance of bare copper-copper and aluminum 1070-aluminum 1070 interfaces at low temperatures between 10 and 70 K," Cryogenics, vol. 133, p. 103710, 2023.

[3] J. Bae, K. J. Kim, and S. Jeong, "Leakage analysis of the metal-to-metal contact check valve for a cryogenic sorption compressor," Cryogenics, vol. 131, p. 103650, 2023.

[4] B. Kim, D. Kwon, and S. Jeong, "Investigation on two-stage Stirling cooler driven by two independent displacers," Cryogenics, vol. 131, p. 103653, 2023.

[5] K. J. Kim et al., "Thermal energy storage unit (TESU) design for high round-trip efficiency of liquid air energy storage (LAES)," Cryogenics, vol. 128, p. 103570, 2022.

[6] B. Kim, D. Kwon, and S. Jeong, "Temperature distribution of long-length high temperature superconducting cable cooled by slush-nitrogen," Cryogenics, vol. 124, p. 103369, 2022.

[7] D. Kwon, J. Bae, and S. Jeong, "Development of the integrated sorption cooler for an adiabatic demagnetization refrigerator (ADR)," Cryogenics, vol. 122, p. 103421, 2022.

[8] H. Cho, L. Jin, S. Kim, and S. Jeong, "Experimental validation of heat switch capability of cryogenic loop heat pipe," Cryogenics, vol. 121, p. 103403, 2022.

PUBLICITY(MEDIA+NEWS)

[1] Development of high temperature superconducting motor with on-board cryocooler



Advanced thermal and energy transport Laboratory



Assistant Professor
KANG, Joon Sang

Ph.D., UCLA [2019]

Research Interest

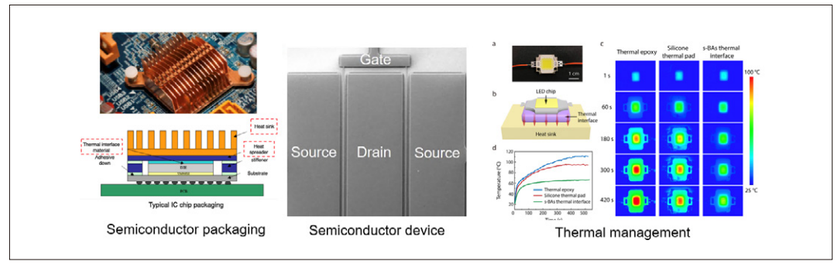
- Semiconductor thermal transport
- Renewable energy generation
- Extreme heat conduction
- Quantum computer cooling technology

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RESEARCH OVERVIEW

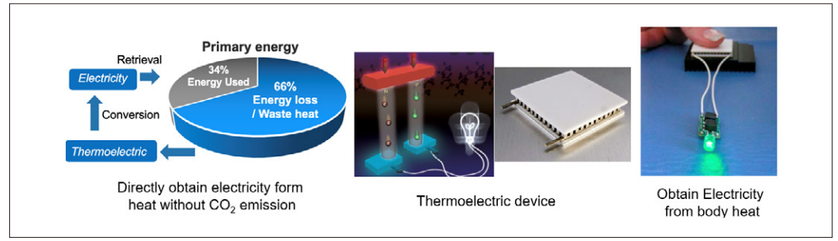
1. Semiconductor thermal transport

- Engineering thermal transport in semiconductor device. Electronics cooling
- Develop new thermal interfacial transport technology



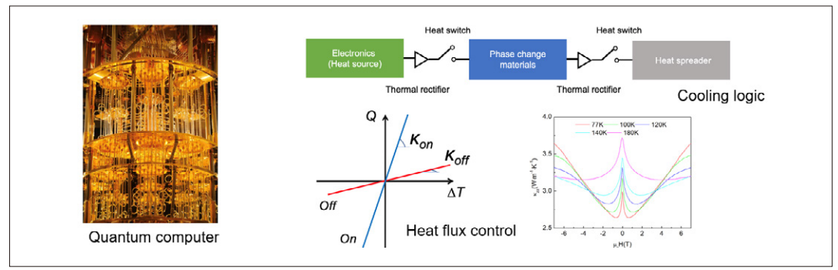
2. Renewable energy generation using thermoelectricity

- Developing direct renewable energy conversion method of heat to electricity
- Improving energy conversion efficiency of heat to electricity conversion



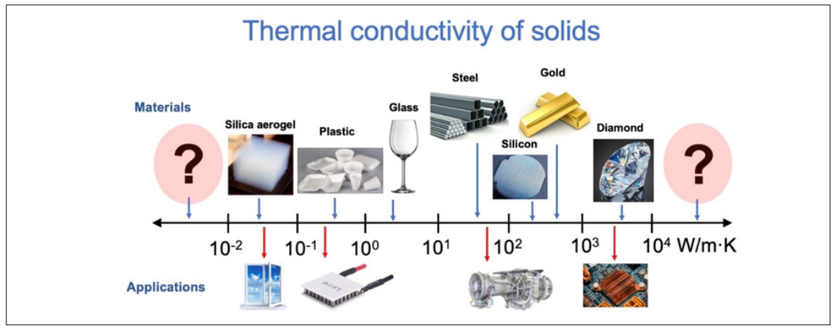
3. Quantum computer cooling technology

- Make new cooling system to cool down quantum computer
- Thermal switch, Thermal diode, Thermal logic circuit.
- Dynamic control of heat flux



4. Extreme heat conduction

- Discover ultrahigh thermal conductivity material for heat dissipation
- Discover ultralow thermal conductivity material for thermal insulation



RESEARCH HIGHLIGHTS

[1] J. S. Kang, D. Vu, Minyue Zhu, and J. P. Heremans, “Large and optimized thermal chiral anomaly in Weyl semimetal BiSb”, Phys. Rev. Appl., 2023, 20, 034014

[2] J. S. Kang, D. Vu, and J. P. Heremans, “Identifying the Dirac point composition in Bi1-xSbx alloys using the temperature dependence of quantum oscillations”, J. Appl. Phys., 2021, 130(22), 225106

[3] J. S. Kang*, M. Li*, H. Wu*, H. Nguyen*, T. Aoki, and Y. Hu, “Integration of boron arsenide cooling substrates into gallium nitride devices”, Nat. Electron., 2021, 4, 416-423.
News and view: Nature Electronics
In the News: Physics World, Nanowerk, Science Daily

[4] J. S. Kang, M. Li, H. Wu, H. Nguyen, Y. Hu, “Basic Physical Properties of Cubic Boron Arsenide”, Appl. Phys. Lett., 2019, 115, 122103

[5] J. S. Kang*, H. Wu*, M. Li, and Y. Hu, “Intrinsic ultralow thermal conductivity and phonon renormalization due to strong anharmonicity of single-crystal tin selenide”, Nano Lett., 2019, 19(8), 4941-4948

[6] J. S. Kang, M. Li, H. Wu, H. Nguyen, and Y. Hu, “Experimental observation of high thermal conductivity in boron arsenide”, Science, 2018, 361(6402), 575-578
In perspective: Science
Highlighted in: Physics Today, Nature Nanotechnology, MRS Bulletin
In the News: Science Daily, Physics World, Physorg, C&EN News, and more than 15 media

Applied Fluid Mechanics Laboratory



Associate Professor
KIM, Daegyoum

Ph.D., California Institute of Technology [2010]

Research Interest

- Fluid-structure interaction
- Biological flow
- Bio-inspired design
- Flow-induced vibration
- Multi-phase flow

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RESEARCH OVERVIEW

Our research group studies multi-scale fluid-structure interactions and flow physics found in nature and technology. Mechanical applications of our researches include developments of novel sustainable energy harvesting systems for winds and water flows, bio-inspired designs of hydrodynamic and aerodynamic propulsion systems, and developments of cutting-edge flow control technology for defense and safety.

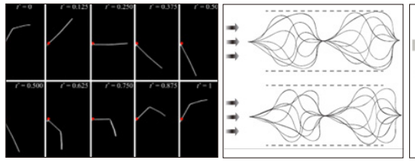
RESEARCH HIGHLIGHTS

Dynamics of multi-segmented structures in unsteady flow [Fig.1]
Multi-segmented structures have an advantage over the conventionally used continuous structures in that its elastic properties can be controlled locally by how individual segments are connected to each other. Utilizing such segmented design, we investigate the deformation and force characteristics of segmented elastic structures with various geometric and flow conditions to understand the relations of the parameters related to such conditions and eventually provide guidelines for optimal design.

Energy harvesting based on flow-induced vibration [Fig.2]
We study the mechanisms of flow-induced vibration of a structure under fluid flow and its applications to energy harvesting. A buckled elastic sheet and an elastically mounted cylinder exhibit novel features of nonlinear dynamics in regards to energy harvesting performance. Furthermore, contacts of an oscillating structure with the sidewalls installed near the structure can be utilized for energy harvesting based on triboelectrification.

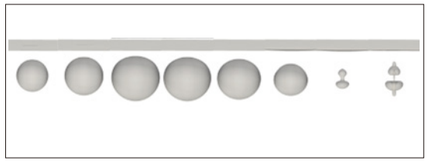
Interaction of cavitating bubbles with interface [Fig.3]
The formation of cavitating bubbles near a solid interface has been major issues in naval architecture and fluid machinery because of strong damage induced by the collapse of bubbles. Furthermore, cavitating bubbles can be used in diverse industrial and medical applications such as jet printing and drug delivery. We investigate the behaviors of bubbles under diverse conditions such as a patterned surface, an viscoelastic solid, a thin liquid film. Depending on such surrounding conditions, a bubble shows novel nonlinear responses throughout its life cycle, compared with under ambient conditions.

[Fig.1 Motion of a segmented structure during power and recovery stroke]
[Fig.2 Periodic snap-through oscillations of elastic sheets in tandem under uniform flow]
[Fig.3 Temporal evolution of cavitation bubble near an elastic wall]



[Fig.1]

[Fig.2]



[Fig.3]

SELECTED PUBLICATIONS

[1] Minho Song, Janggon Yoo, and Daegyoum Kim 2023 “Asymmetric flapping of a multi-segmented elastic structure”, Physics of Fluids, 35, 121911

[2] Minseop Lee, Cheolgyun Jung, Jeongsu Lee, and Daegyoum Kim 2023 “Gravity-coupled flutter and contact of a flag near a wall”, Journal of Fluid Mechanics, 977, A2

[3] Ehsan Mahravan, Mohsen Lahooti, and Daegyoum Kim 2023 “Wall-bounded periodic snap-through and contact of a buckled sheet”, Journal of Fluid Mechanics, 976, A1

[4] Eunseong Moon, Minho Song, and Daegyoum Kim 2023 “Liquid entrainment of the toroidal bubble crossing the interface between two immiscible liquids”, Journal of Fluid Mechanics, 966, A27

Fluid & Interface Laboratory



Associate Professor
KIM, Hyoungsoo

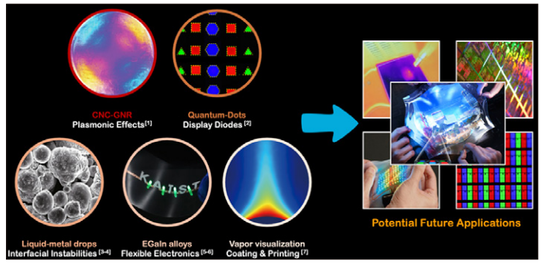
Ph.D., Delft University of Technology [2013]

Research Interest
- Fluid Mechanics
- Soft Matter Hydrodynamics
- Complex Fluids
- Flow visualization

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RESEARCH OVERVIEW

Our recent research endeavors, spanning from 2022 to 2023, continue to center around experimental fluid mechanics with broad implications in physics and engineering, across scales ranging from the nanoscale the macroscale. Collaborating with experts from diverse disciplines and industries remains integral to our approach. Our focus has expanded to include the exploration of novel fluid interface phenomena and the manipulation of complex nanomaterials. Key highlights of our recent work include: [1] Investigating the formation of homogeneous quadrant cellulose nanocrystal matrices through fast evaporative dewetting, elucidating their impact on the plasmonic behavior of co-assembled gold nanorods. [2] Pioneering the use of self-induced solutal Marangoni flows to achieve coffee-ring-less quantum dot microarrays for a potential future display diode, demonstrating extensive geometric tunability and scalability for various applications. [3] Introducing a novel approach for the avalanche coalescence of liquid metal particles, enabling the fabrication of uniform flexible and stretchable electrodes. [4] Exploring the characteristics, fabrication techniques, and diverse applications of liquid metal micro- and nanodroplets. [5-6] Development of self-sinterable liquid metal ink and complex coating materials for flexible electrode applications. Simultaneously, our research efforts continue to advance the development and application of advanced flow field measurement techniques to delve deeper into complex fluid dynamics and flow problems, further enriching our understanding of fluid behavior across scales. In this sense, we also performed direct visualization of evaporated vapors related to coating and printing technologies [7].



RESEARCH HIGHLIGHTS

[1] J. Pyeon, S. Park, J. Kim, J.-H. Kim, Y.-J. Yoon, D.-K. Yoon, H. Kim, "Homogeneous quadrant cellulose nanocrystal matrices by fast evaporative dewetting change plasmonic effect of co-assembled gold nanorods," Nat. Commun. 14:8096 (2023)

[2] J. Pyeon, K. M. Song, Y. Jung, and H. Kim, "Self-induced solutal Marangoni flows realize coffee-ring-less quantum dot microarrays with extensive geometric tunability and scalability," Adv. Sci. 2104519 (2022)

[3] G. Ryu, I. Park, H. Kim, "Liquid metal micro- and nanodroplets: Characteristics, fabrication techniques, and applications," ACS Omega 8(18), 15819-15830 (2023)

[4] G. Ryu, K. Park, and H. Kim, "Interfacial properties of liquid metal immersed in various liquids," J Colloid Interf. Sci. 621, 285-294 (2022)

[5] K. Park, J. Pyeon, S.H. Jeong, Y.-J. Yoon, and H. Kim, "Avalanche coalescence of liquid metal particles for uniform flexible and stretchable electrodes," Adv. Mater. Interfaces 9(35), 2201693 (2022)

[6] D. H. Lee, T. Lim, J. Pyeon, H. Park, S.-W. Lee, S. Lee, W. Kim, M. Kim, J.-C. Lee, D.-W. Kim, S. Han, H. Kim, S. Park, Y.-K. Choi, "Self-mixed biphasic liquid metal composite with ultra-high stretchability and strain insensitivity for neuromorphic circuits," Advanced Materials, 2310956 (2024)

[7] M. Kuk, J. Pyeon, H. Kim, "Vapor distribution changes evaporative flux profiles of a sessile droplet," J Colloid Interf. Sci. 652, 646-652. (2023)

HONORS/AWARDS

[1] 2024, KSME Kasan Research Excellence Award, The Korean Society of Mechanical Engineering, South Korea

[2] 2022, Technology Innovation Award, KAIST

Computational Cardiovascular Biomechanics Lab



Associate Professor
KIM, Hyun Jin

Ph.D., Stanford University [2009]

Research Interest
- Computational Biomechanics
- Computational Fluid Dynamics
- Medical Device Analysis
- Medical Image Processing
- Clinical Applications

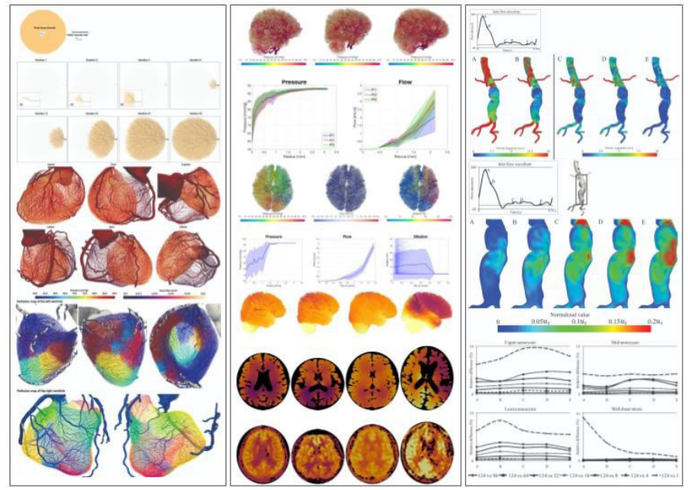
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RESEARCH OVERVIEW

We aim to advance various computational methods to better understand the functions and pathophysiologic process of the cardiovascular system. Our primary focus is on the coronary, cerebrovascular, and the aortic systems as they are the most vulnerable sites for developing cardiovascular diseases.

We recently implemented computational methods of capturing unseen branches below the resolution of medical image data using physiological and mechanical principles. These methods were validated against human tree morphology measurements. Multiscale blood flow and pressure values were additionally evaluated to predict the risk of ischemia and the affected tissue volume due to cardiovascular diseases. We also developed a physiological model of estimating blood flow for each segmented vessel outlet based on supply-demand relationship between blood vessels and tissue in the cerebrovascular system. These methods are being utilized to estimate the severity of the cerebrovascular disease. We further developed multiscale computational methods of heat and mass transfer between blood flow and tissue via constructed extensive vascular networks and simulated blood flow and heat transfer in a biological tissue due to heat therapy.

In addition to research in cardiovascular biomechanics, we also conduct research to analyze transitional flow characteristics of a complex aortic aneurysmal patient model, optimize a molten salt nuclear reactor for safe and efficient operations, and develop a brain mechanics model to holistically monitor the brain functions. Our ongoing research actively explores additional topics that involve the development of new computational methods, validation, and potential clinical applications.



SELECTED PUBLICATIONS

[1] H.C. Rundfeldt et al. Cerebral perfusion simulation using realistically generated synthetic trees for healthy and stroke patients. Computer Methods and Programs in Biomedicine 244:107956, 2024

[2] H.J. Kim et al. Convergence of phase-averaged transitional flow in an abdominal aortic aneurysmal model. Journal of Biomechanical Engineering 45(11):111007, 2023

[3] H.J. Kim et al. Tissue-growth based synthetic tree generation and perfusion simulation. Biomechanics and Modeling in Mechanobiology 22:1095-1112, 2023

Nanoscale Manufacturing Laboratory



Associate Professor
KIM, Ji Tae

Ph.D., POSTECH [2011]

Research Interest
- Additive manufacturing
- 3D-printed electronics and photonics

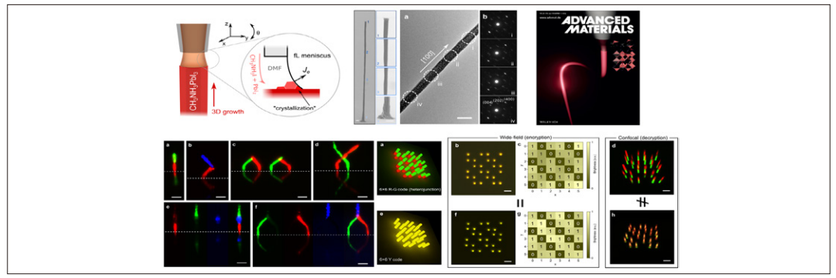
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https://sites.google.com/view/kimlabkaist

RESEARCH OVERVIEW

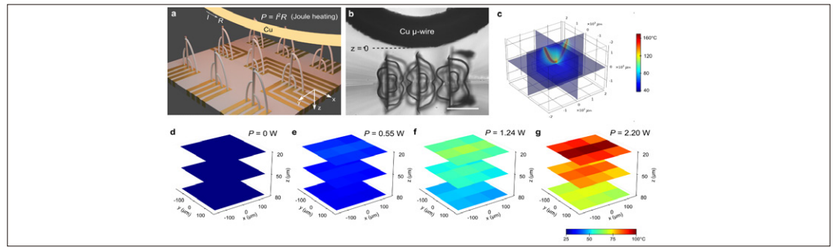
We aim to advance 3D printing technology into a real-manufacturing platform for next-generation electronic, photonic, and quantum integrated circuits (ICs). Although 3D printing has the potential to offer “More than Moore” routes for improving the integration density and circuit design freedom, the fundamental and technological challenges associated with coarse precision, limited material selection, and low throughput remain unresolved. Our research team focuses on the development of new paradigm 3D printing methods that enable (i) nanoscale precision, (ii) electronic, photonic, and quantum material selection, and (iii) parallel production. Our goal is to demonstrate the feasibility of “all 3D-printed IC devices”.

RESEARCH HIGHLIGHTS

Nanoscale 3D printing of metal halide perovskites. We for the first time developed a nanoscale 3D printing method for metal halide perovskites [1], which are emerging as the most powerful optoelectronic materials for energy harvesting and light-emitting diodes. The method enables freeform 3D structuring of crystalline perovskites with nanoscale precision, which has not been attainable in other manufacturing routes. This work provides a ground-breaking way for the customization of optoelectronic devices, and the possibility is being demonstrated by our ongoing research on nanopixel security displays [2,3] and nanolasers.



3D-printed thermoelectric micro-devices. We developed a bi-material additive manufacturing method that offers a first-of-its-kind strategy for constructing 3D thermocouple micro-devices [4]. The 3D-printed thermocouple array enables 4D thermometry with a hundred-micrometer spatial resolution and sub-millisecond temporal resolution. Using this device, microscale 4D temperature fields created by dynamic Joule heating or evaporative cooling have been directly imaged, whose studies only relied on theoretical modelling for a long time.



SELECTED PUBLICATIONS

[1] Chen M., Yang J., Wang Z., Xu Z., Lee H., Lee H., Feng S. -P., Pyo J, Seol S. K., Kim J. T., 3D Nanoprinting of Perovskites. Advanced Materials 31, 1904073 (2019)

[2] Chen M., Zhou Z., Huang N., Lee H., Liu Y., Yang J., Hu S., Huan X., Xu Z., Cao S., Cheng X., Wang T., Yu S.F., Chan B.P., Tang J., Feng S.-P. Kim J.T., 3D Printing of Arbitrary Perovskite Nanowire Heterostructures. Advanced Functional Materials 33, 2212146 (2023)

[3] Chen M., Hu S., Zhou Z., Huang N., Lee S., Zhang Y., Cheng R., Yang J., Xu Z., Liu Y., Lee H., Huan X., Feng S.-P., Shum H.C., Chan B.P., Seol S.K., Pyo J., Kim J.T., Three-Dimensional Perovskite Nanopixels for Ultra-High-Resolution Color Displays and Multi-Level Anticounterfeiting. Nano Letters 21, 5186 (2021)

[4] Lee H., Wang Z., Rao Q., Lee S., Huan X., Liu Y., Yang J., Chen M., Ki D.-K., Kim J.T., Additive Manufacturing of Thermoelectric Microdevices for Four-Dimensional Thermometry. Advanced Materials 35, 2301704 (2023)

Mobile Robotics and Intelligence Laboratory



Professor
KIM, Jinwhan

Ph.D., Stanford University [2007]

Research Interest
- Mobile robotics, marine robotics
- Vehicle intelligence and perception
- Dynamics and control of marine vehicles and floating structures

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RESEARCH OVERVIEW

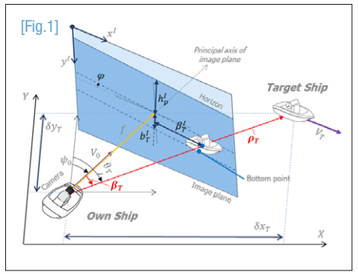
Mission Management and Planning for Cooperative Multi-Vehicle Systems

Mobile Robotics & Intelligence (MORIN) Laboratory is a research group focused on intelligent control and autonomy of vehicles and mobile robotic systems. We are conducting research on vehicle intelligence across the full range of manned and unmanned vehicle applications. We are also working on developing innovative algorithms and techniques which are applicable to all types of vehicles and mobile robotic systems.

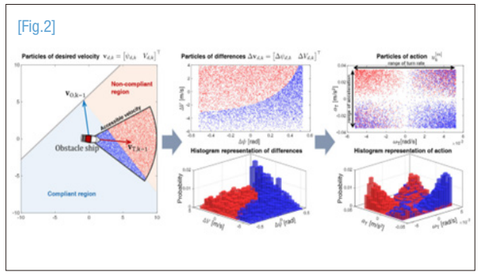
RESEARCH HIGHLIGHTS

Development of Autonomous Ship Technology
- Environmental Perception and Situational Awareness for Autonomous Ships [Fig.1]
- Probabilistic Approach to Intent Inference-Based Ship Collision Avoidance [Fig.2]

[Fig.1]

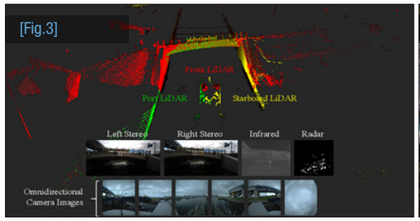


[Fig.2]



Autonomous Ship Navigation and Control in Restricted Water Environments
- Field experiment with an autonomous surface boat in Pohang Canal [Fig.3]
- Multimodal maritime dataset obtained in and around Pohang Canal [Fig.4]

[Fig.3]



[Fig.4]



SELECTED PUBLICATIONS

[1] Y. Cho, J. Kim and J. Kim*, "Intent Inference-Based Ship Collision Avoidance in Encounters with Rule-Violating Vessels", IEEE Robotics and Automation Letters (RA-L), Vol. 7, No. 1, pp. 518-525, 2022.

[2] J. Kim, C. Lee, D. Chung, and J. Kim*, "Navigable Area Detection and Perception-guided Model Predictive Control for Autonomous Navigation in Narrow Waterways", IEEE Robotics and Automation Letters (RA-L), Vol. 8, No. 9, pp. 5456-5463, 2023

[3] D. Chung, J. Kim, C. Lee, and J. Kim*, "Pohang Canal Dataset: A Multimodal Maritime Dataset for Autonomous Navigation in Restricted Waters", International Journal of Robotics Research, Vol. 42, Issue 12, pp. 1104-1114, October 2023

Biorobotics Laboratory



Professor
KIM, Jung

Ph.D., Massachusetts
Institute of Technology [2004]

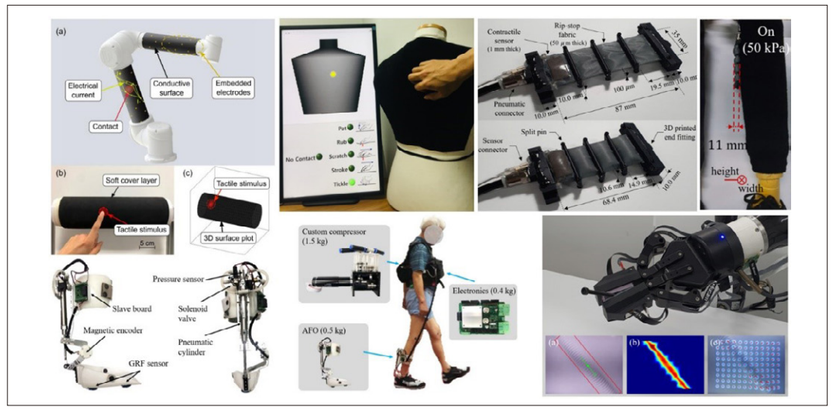
Research Interest

- Medical Robotics
- Physical Human Robot Interactions
- Soft Robotics
- Haptics

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RESEARCH OVERVIEW

The goal of Biorobotics Lab is to harness features of perception, sensing, actuation, mechanics, dynamics, and control strategies to expedite the technologies of dependable physical human robot interactions (pHRI). Research in the lab ranges from fundamental understanding of human haptic and motor science to novel sensor/actuator techniques for many applications including haptic interfaces, tactile sensors, exoskeleton robot, soft robots, orthotic devices, assistive devices, whole body tactile robotic sensors and human-robot cooperation. The students are diligently performing and constantly improving our research capabilities through keeping an open mind and through in-depth discussions. Our lab has had an active collaborative networks with other research institutions and labs in the biomechanics and robotics, and published papers in international journals.



RESEARCH HIGHLIGHTS

The paper “Compact Flat Fabric Pneumatic Artificial Muscle (ffPAM) for Soft Wearable Robotic Devices” received the best paper award of service robotics in ICRA 2021.
Prof Jung Kim won the Science and Technology of the Month Award given by the Ministry of Science and ICT in February 2024.
The paper "2.5D Laser-Cutting-Based Customized Fabrication of Long-Term Wearable Textile sEMG Sensor: From Design to Intention Recognition," received the best IEEE RA-L paper award in 2022

SELECTED PUBLICATIONS

[1] WD Kim, S Yang, W Kim, JJ Kim, CH Kim, Jung Kim, “Marker-Embedded Tactile Image Generation via Generative Adversarial Networks”, IEEE ROBOTICS AND AUTOMATION LETTERS (2023)

[2] H Jeong, Jung Kim, “Ossicle Reinforced Porous Structure for Variable Stiffness Soft Actuator Inspired from Echinoderms”, IEEE-ASME TRANSACTIONS ON MECHATRONICS (2023)

[3] K Park, H Yuk, M Yang, J Cho, H Lee, J Kim, “A biomimetic elastomeric robot skin using electrical impedance and acoustic tomography for tactile sensing” Science Robotics 7 (2022)

[4] U Heo, J Feng, SJ Kim, Jung Kim, “sEMG-triggered Fast Assistance Strategy for a Pneumatic Back Support Exoskeleton”, IEEE TRANSACTIONS ON NEURAL SYSTEMS AND REHABILITATION ENGINEERING (2022)

[5] H Jeong, J Feng, Jung Kim, “2.5 D laser-cutting-based customized fabrication of long-term wearable textile sEMG sensor: From design to intention recognition”, IEEE ROBOTICS AND AUTOMATION LETTERS (2022)

[6] K Park, H Lee, Katherine J Kuchenbecker, Jung Kim,” Adaptive Optimal Measurement Algorithm for ERT-based Large-area Tactile Sensors”, IEEE-ASME TRANSACTIONS ON MECHATRONICS (2022)

[7] H Park, K Park, S Mo Jung Kim, “Deep Neural Network Based Electrical Impedance tomographic sensing methodology for large-area robotic tactile sensing” IEEE Transactions on Robotics 37 (2021)

Ultra-Scale Photonic Control and Measurement Group



Professor
KIM, Jungwon

Ph.D., Massachusetts
Institute of Technology [2007]

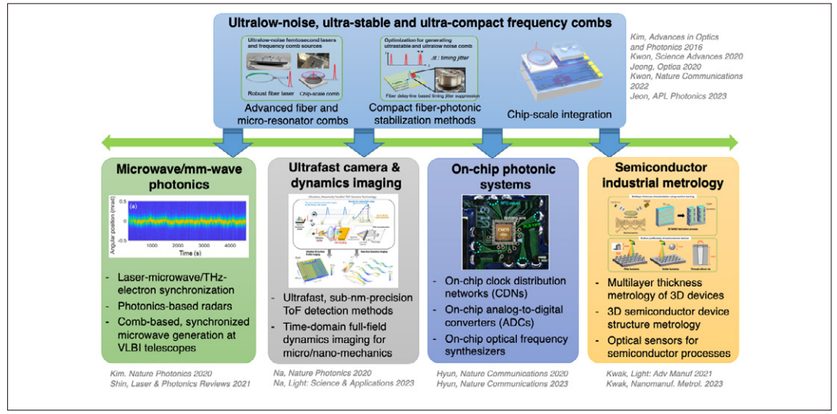
Research Interest

- Advanced laser engineering
- Sensors and imaging
- Photonic signal processing
- Industrial laser metrology

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RESEARCH OVERVIEW

Advanced ultrafast lasers and frequency combs enable us to explore ultrahigh-precision measurement and control capabilities. Our research objective is to achieve world-class performance in noise and stability of advanced lasers and microresonator-based light sources and develop new photonic technologies based on such light sources. We are also interested in developing more robust, compact, low-noise and ultra-stable laser sources, as well as expanding the range of their applications. Our recent research results have been not only published at high-impact journals, but also actively applied for high-tech industries including Quantum Technology, ICT & AI, Defense, and Semiconductor Manufacturing. Thanks to the multidisciplinary nature of our research, we also enjoy a wide range of domestic and international collaboration opportunities with academia, national labs, and industries. We believe that the rapid convergence of ultrafast and ultralow-noise lasers, precision measurement and control, and integrated photonic systems will open up interesting new paths in the coming years.



RESEARCH HIGHLIGHTS

A clock distribution network (CDN) is a ubiquitous on-chip element that provides synchronized clock signals to all different circuit blocks in the chip. To maximize the chip performance, today's CDN demands lower jitter, skew, and heat dissipation. We demonstrated femtosecond-precision distribution of electronic clocks using driver-less CDNs injected by photocurrent pulses. Femtosecond-level on-chip jitter and skew could be achieved for GHz-rate clocking of CMOS chips by combining ultralow comb-jitter, multiple driver-less metal-meshes, and active skew control. The elimination of clock drivers could significantly reduce on-chip heat dissipation from clock distribution as well. This work shows the potential of optical frequency combs for distributing high-quality clock signals inside high-performance integrated circuits, including 3D integrated circuits. This work was published at Nature Communications, and also featured in Research Highlights of May 2023 issue of Nature Electronics (entitled "Chips with a pulse").

SELECTED PUBLICATIONS

[1] Jeon, I., Ahn, C., Kim, C., Park, S., Jeon, W., Duan, L., and Kim, J., “Palm-sized, vibration-insensitive and vacuum-free all-fiber-photonic module for 10-14-level stabilization of CW lasers and frequency combs,” APL Photonics, vol. 8, article 120804, Dec. 2023.

[2] Hyun, M., Chung, H., Na, W., and Kim, J., “Femtosecond-precision electronic clock distribution in CMOS chips by injecting frequency comb-extracted photocurrent pulses,” Nature Communications, vol. 14, article 2345, Apr. 2023.

[3] Na, Y., Kwak, H., Ahn, C., Lee, S., Lee, W., Kang, C.-S., Lee, J., Suh, J., Yoo, H., and Kim, J., “Massively parallel electro-optic sampling of space-encoded optical pulses for ultrafast multi-dimensional imaging,” Light: Science & Applications, vol. 12, article 44, Feb. 2023.

[4] Kim, J., “(Perspective) Chip-scale power booster for light,” Science, vol. 376, page 1269, Jun. 2022.

[5] Kwon, D., Jeong, D., Jeon, I., Lee, H., and Kim, J., “Ultrastable microwave and soliton-pulse generation from fibre-photonic-stabilized microcombs,” Nature Communications, vol. 13, article 381, Jan. 2022.

Mechatronics, System and Control System Laboratory



Professor
KIM, Kyung-Soo

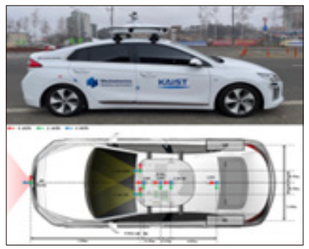
Ph.D., KAIST [1999]

Research Interest
- Control theories & applications
- Sensors and Actuators, Robotics
- Automotive technology

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RESEARCH OVERVIEW

MSC is composed of 2 research groups including Control theory and Application Group (CAG), and Semi-Robot Group (SRG). In CAG, we research Motor and battery for Hybrid electric vehicle development based on manual transmission, sensor fusion SLAM and autonomous driving.
In SRG, we research hybrid actuated quadruped robot, control strategy of prosthetic hand system and exoskeleton robotic system.







RESEARCH HIGHLIGHTS

[1] Autonomous Driving platform development using camera and 4D Radar, researching Mapping&Localization, Detection&Tracking, Planning&Control

[2] Battery management system with algorithm estimating the state of.

[3] Development of Quadruped Robot system and walking control strategy based on MPC, human interaction robot using quadruped robot

[4] Human interaction using Prosthetic Hand, robust intention estimation models.

SELECTED PUBLICATIONS

[1] Han*, Seungho, Kwon*, Junsu, and Kim, Kyung-Soo. "Position Uncertainty-Integrated Potential Function for Collision Avoidance Systems Based on Model Predictive Control", IEEE Transactions on Intelligent Vehicles (T-IV) (2024)

[2] Han, Seungho, Choi, Keun Ha, and Kim, Kyung-Soo. "Adaptive Safety Distance for Collision Avoidance Based on a Full Braking Activation Parameter", IEEE Transactions on Intelligent Transportation Systems (T-ITS) (2024)

[3] Yang*, Seunghoon, Choi*, Minseong, Han, Seungho, Keun-Ha Choi and Kyung-Soo Kim. "4D Radar-Camera Sensor Fusion for Robust Vehicle Pose Estimation in Foggy Environments." IEEE Access (2023)

[4] Han, Seungho, Yang, Seunghoon, Lee, Yeongseok, Lee, Minyoung, Park, Ji-il, and Kyung-Soo Kim. "The Leader-Follower Formation Control of Nonholonomic Vehicle With Follower-Stabilizing Strategy." IEEE Robotics and Automation Letters (2023)

[5] Choi, Minseong, Seunghoon Yang, Seungho Han, Yeongseok Lee, Minyoung Lee, Keun Ha Choi, and Kyung-Soo Kim. "MSC-RAD4R: ROS-Based Automotive Dataset With 4D Radar." IEEE Robotics and Automation Letters (2023)

[6] Choi, Minseong, Choi, Kyunghwan, Cho, Minsu, Lee, Minyoung, and Kyung-Soo Kim. "Chattering Reduction of Sliding Mode Control via Nonlinear Disturbance Observer for Anti-Lock Braking System and Verification with CarSim Simulation." International Journal of Automotive Technology 24.4 (2023)

[7] Cho, Minsu, Yeongseok Lee, and Kyung-Soo Kim. "Model Predictive Control of Autonomous Vehicles With Integrated Barriers Using Occupancy Grid Maps." IEEE Robotics and Automation Letters 8.4 (2023)

[8] Kang, Jeonguk, Hyunbin Kim, and Kyung-Soo Kim. "VIEW: Visual-Inertial External Wrench Estimator for Legged Robot." IEEE Robotics and Automation Letters (2023)

[9] Cho, Younggeol, Lee, Byungwook, Lee, Yeongseok, and Kyung-Soo Kim. "Simultaneous Sensory Feedback Strategy for Force and Position of Gripper based on TENS." IEEE Robotics and Automation Letters 8.9 (2023)

[10] Cho, Younggeol, Lee, Yeongseok, Kim, Pyungkang, Jeong, Seokhwan, Kyung-Soo Kim. "The MSC Prosthetic Hand: Rapid, Powerful, and Intuitive." IEEE Robotics and Automation Letters (2022)

Combustion Laboratory



Associate Professor
KIM, Nam Il

Ph.D., KAIST [2001]

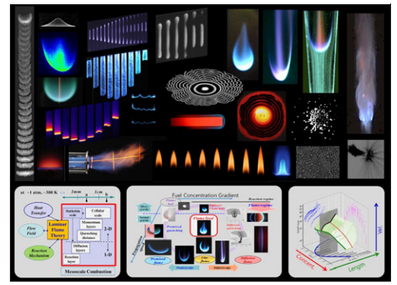
Research Interest
- Flame Structure and Theory
- Combustion Diagnosis and Modeling
- Combustion New Technology

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RESEARCH OVERVIEW

Flame Structure and Theory
Combustion studies have been developed based on flame structure theories. Flame structures and related theories are investigated at Combustion Lab in KAIST. Recently, structural transition and combustion instability affected by inherently different flame structures have been of interest to construct an advanced theory on the flame structure.

Combustion Diagnosis and Modeling
The combination phenomena and flame structures are investigated using advanced experimental techniques (MS, PIV, LIF, LII, etc.). Various combustion systems have been developed, and their performance was analyzed with theoretical and numerical methods.



Combustion New Technology
Recent new technologies related to combustion phenomena are investigated, and advanced systems for combustion applications are designed. Phenomena in small-scale or meso-scale combustion spaces could reveal hidden interactions between ordinary and heterogeneous combustion theories. Specific industrial burner systems such as gas-turbine combustors or oxy-combustor are developed.

RESEARCH HIGHLIGHTS

The stabilization characteristics of laminar and turbulent lifted flames were investigated experimentally with various characteristic configurational length scales under various conditions such as high/low pressures, oxy-combustion, and hydrogen enhancement. Such investigation and related mechanisms can provide essential knowledge for the burner design. The instability mechanism of an unsteady premixed flame propagation within a narrow combustion space was investigated with initial pressure, fuel dilution, and hydrogen concentration variation.
In addition, various practical combustion technologies have been investigated. Breakup characteristics of the water-in-oil emulsion structure were investigated, and valuable technologies that can control emulsion properties were developed. New technologies that can suppress fine dust emissions were developed based on Machine-learning. Burner design was modified for less combustion noise, and numerical analysis of a blast furnace has been investigated.

SELECTED PUBLICATIONS

[1] Hui Man Yang, Ji Hun Yeo, Nam Il Kim*, Optimized Global Reaction Mechanism for H2 + NH3 + N2 Mixtures, International Journal of Hydrogen Energy 73 (2024. 07) 749-760.

[2] Dong Seok Jeon, Gyu Jin Hwang, Nam Il Kim*, Lift-off characteristics of non-premixed jet flames of CH4 and cracked NH3 mixtures in laminar/turbulent transition, Combustion and Flame 265 (2024.07) 113462.

[3] Gyu Jin Hwang, Dong Seok Jeon, Nam Il Kim*, Characteristics of laminar lifted flames of pure ethane in a non-premixed jet under various pressures, Combustion and Flame 264 (2024.06) 113422.

[4] Dong Seok Jeon, Gyu Jin Hwang, Nam Il Kim*, Overall lift-off characteristics of CH4/H2 non-premixed jet flames in laminar/turbulent transition, Combustion and Flame 258 (2023.12) 113072.

[5] Jiseop Lee, Nam Il Kim*, Stabilization and soot/NOx emission of hydrogen-enriched methane flames in a turbulent jet with coaxial air under elevated pressures, International Journal of Hydrogen Energy 48 (2023.06) 37402-37414.

[6] Hun Young Kim, Nam Il Kim*, Optimized global reaction mechanisms for H2, CO, CH4, and their mixtures, International Journal of Hydrogen Energy 48 (62) (2023.07) 24101-24112.

[7] Gyu Jin Hwang, Dong Seok Jeon, Nam Il Kim*, Stabilization criteria of laminar lifted propane flames and their transition to turbulent lifted flames under extended pressures, Fuel 343 (2023.07) 127960.

[8] Sang Min Lee, Hye Jin Jang, Nam Il Kim*, Effects of oxidant composition on premixed propane flames in a narrow-gap disk burner at elevated pressures, Combustion and Flame 251 (2023.05) 112682.

Advanced Manufacturing and Surface Engineering Laboratory



Assistant Professor
KIM, Sanha

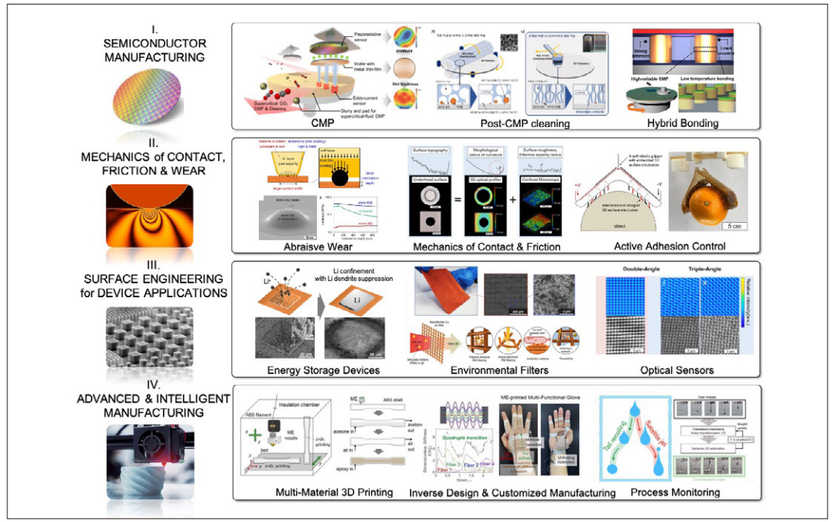
Ph.D., MIT[2013]

Research Interest
- Manufacturing
- Contact Mechanics
- Surface Engineering

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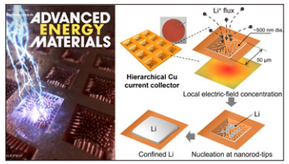
RESEARCH OVERVIEW

AMSElab@KAIST, led by Professor Sanha Kim, aims to advance and innovate manufacturing science and technologies via understanding the mechanics of solid-solid contact and engineering the involved surface phenomena, such as adhesion, friction, wear, material transfer and deformation. We also explore novel materials and processing methods to design and manufacture multi-functional engineered surfaces for multidisciplinary applications, including advanced manufacturing tools, robotics, energy storage devices, biosensors, and environmental system.



RESEARCH HIGHLIGHTS

A new structural surface design for anodes in next generation lithium batteries. We developed copper current collector with increased structural dimensions and hierarchy for high-performance lithium-metal battery anodes. The new surface enables inward nucleation of lithium, thus enhancing the cycle life of lithium-metal battery by 364%.



Advanced Energy Materials, vol. 13, no. 2, 2202321, 2023.
* Selected as KAIST Breakthrough 2023 Fall.

OTHER SELECTED PUBLICATIONS

[1] **Accelerated deep-learning-based process monitoring of microfluidic inkjet printing,** Seong Jae Kim, Eunsik Choi, Dong Yeon Won, Gyuhyeon Han, Kunsik Ahn, Kyung-Tae Kang, Sanha Kim, CIRP Journal of Manufacturing Science and Technology, vol. 46, 65-73, 2023.

[2] **Pure metallic nanofibrillar membrane for high performance electrostatic air filtration with antimicrobial and reusable characteristics,** Seunghun Yoo, Inyeong Yang, Ji-hun Jeong, Jihae Chang, Sanha Kim, Environmental Science: Nano, vol. 10, 2437, 2023.

[3] **Additive manufacturing of flexible 3D surface electrodes for electrostatic adhesion control and smart robotic gripping,** Dong Geun Kim, Hyeongmin Je, A. John Hart, Sanha Kim, Friction, vol. 11, 1974-1986, 2023.

[4] **Tailoring elastomeric meshes with desired 1D tensile behavior using an inverse design algorithm and material extrusion printing,** Seounghee Yun, YoungKyun Ahn, Sanha Kim, Additive Manufacturing, vol. 60, 103254, 2022.

[5] **Predictive model for bearing torque in bolt fastening,** Sukkyung Kang, Somin Shin, Hyena Hwang, Sanha Kim, CIRP Annals-Manufacturing Technology, vol. 71, no. 1, 489-492, 2022.

Mechanical Design Lab. with Advanced Materials



Associate Professor
KIM, Seong Su

Ph.D., KAIST [2007]

Research Interest
- Multi-scale Design and manufacturing of composites
- Nano/Micro/Macro composite materials
- Energy storage system using composites
- Multi-functional materials

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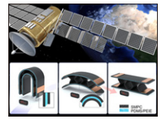
RESEARCH OVERVIEW

Our group is researching the composite manufacturing process and mechanical design using composite materials. We analyze the flow behaviors of polymer resin during the manufacturing process of fiber-reinforced composites and investigate the mechanical behaviors of the composites through appropriate mathematical models and computational simulation analysis. Subsequently, we verify them using various testing methods. Furthermore, we are exploring the application of composites in high-tech areas such as energy storage systems, mobility, and semiconductor packaging. The research efforts are focused on the following categories:

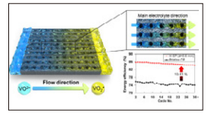
Manufacturing technology for composite materials
- Development of an optimization method for composite manufacturing processes that reflects various mechanical imperfections.
- Multiscale modeling to investigate the impregnation characteristics of composite materials across various manufacturing processes.



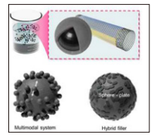
Composite structural analysis and design
- Mechanical design of shape memory polymer composite actuators for space deployable systems.
- Machine component design for various applications using composite materials in the fields of automobile, aerospace, shipbuilding, and robotics.



Energy conversion and storage systems
- Design of composite bipolar plates and carbon electrodes for vanadium redox flow battery (VRFB).
- Design of composite structural batteries to enhance load-carrying capacity and specific energy density.



Advanced packaging process for semi-conductors
- Enhancement of electronic packaging through the optimization of cure cycles for epoxy molding compounds and the development of Flash Electro-Thermal Carbon Fiber Heating Elements.
- Development of bimodal fiber-type sensors to monitor mechanical strain and temperature during the curing reaction of epoxy molding compounds.



RESEARCH HIGHLIGHTS

[1] HS. Hong, SS. Kim*, et al. "Structural optimization of an arch-structured epoxy/rubber composite vibration isolator using deep Q-value neural network reinforcement learning." Composite Structures, Volume 323(2023), 117506

[2] D. Kang, JM. Jeong, SS. Kim*, et al. "Improving the Deformability and Recovery Moment of Shape Memory Polymer Composites for Bending Actuators: Multiple Neutral Axis Skins and Deployable Core." ACS Appl. Mater. Interfaces, 2023(15) 28, 33944-33956.

[3] W.Kim, SS.Kim*, et al. "Optimum boundaries for maximum load-carrying capacity in water-lubricated composite journal bearings incorporating turbulences and inertial effects based on elastohydrodynamic analysis" Journal of Computational Design and Engineering, 2022(9), 2506-2523;

[4] "Core-shell structured fiber type strain sensor and method of manufacturing the same", US Patent Registered No. 11,280,688, 2022

[5] "Vibration isolator with bandgap structure and method of manufacturing vibration isolator", Korea Patent Registered No.10-2497329, 2023

[6] Development of shape memory polymer composite actuator for aerospace applications, Mid-Career Researcher program

[7] Development of the Innovative underfill process for semiconductor packaging with Ultrafine-pitch and its data-driven engineering platform building, National Research Foundation of Korea

HONORS/AWARDS

[1] Plenary, keynote, and invited talks at major international conferences

[2] Experimental Mechanics Academic Award, 2023 The Korean Society of Mechanical Engineers (KSME), Prof. Seong Su Kim

[3] Academic Achievement Award, 2022, The Korean Society for Composite Materials (KSCM), Prof. Seong Su Kim

[4] Best Paper Award, The Korean Society for Composite Materials (KSCM) 2022, Prof. Seong Su Kim

[5] Oral Presentation Award (First Place), The 6th International Conference on Active Materials and Soft Mechatronics, 2022, Jaemoon Jeong

Applied Heat Transfer Laboratory



Professor
KIM, Sung Jin

Ph.D., Ohio State University (1989)

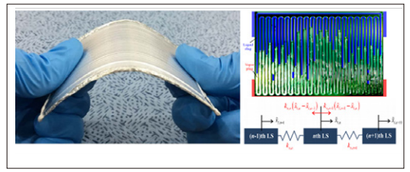
Research Interest
- Cooling Technology for Electronic Packages
- Microscale Heat Transfer and Fluid Flow
- Optimum Design of Heat Exchangers, Heat Pipes, and Heat Sinks
- Convection Heat Transfer in Porous Media
- Critical Heat Flux Mechanism in Pool Boiling

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RESEARCH OVERVIEW

Pulsating Heat Pipes

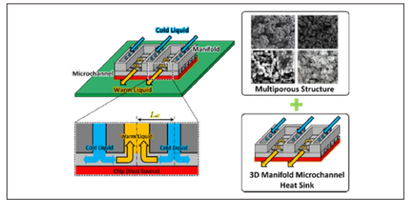
A pulsating heat pipe (PHP) transfers heat by the oscillating motion of the working fluid without wick structure (Fig. 1). It is easy to be fabricated due to the wickless structure and has high thermal performance compared to a conventional heat pipe. The goal is to optimize the thermal performance of a PHP and to fabricate a flexible PHP.



[Fig. 1]

Manifold Microchannel Heat Sinks

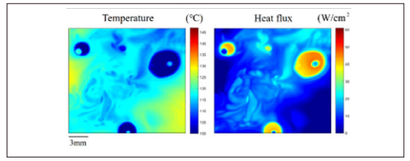
Ultra-high heat flux thermal management (> 1 kW/cm2) is one of the main challenges for the future of electronics. 3D multiporous cooling device is a novel cooling scheme which effectively promotes the liquid supply and the vapor venting at the heated surface (Fig. 2). The device will aid in solving critical challenges in the practical use of the two-phase cooling.



[Fig. 2]

CHF (Critical Heat Flux) Mechanism in Pool Boiling

Proper physics-based understanding of the mechanisms by which CHF (Critical Heat Flux) occurs is crucial to the development of high heat removal devices. The goal is to develop a new CHF model which is based on local temperature and heat flux information that has recently been acquired using an IR-based measurement technique in pool boiling (Fig. 3).



[Fig. 3]

RESEARCH HIGHLIGHTS (2022-2023)

[1] M. Kim, S.J. Kim, A mechanistic model of critical heat flux for pool boiling based on supply failure mechanisms depending on the contact angle, International Journal of Heat and Mass Transfer 209 (2023) 124090.

[2] C. Jung, S.J. Kim, Investigation into the effects of passive check valves on the thermal performance of pulsating heat pipes, International Journal of Heat and Mass Transfer 204 (2023) 123850.

[3] Y.J. Lee, S.J. Kim, Effects of the micro-post array on the maximum allowable input power for a micro pulsating heat pipe, International Journal of Heat and Mass Transfer 193 (2022) 122898.

Honors/Awards (2022-2023)

[1] Best Paper Award, International Heat Transfer Conference (IHTC 2023) (2023).

[2] Thermal Engineering Award, JSME (2022)

[3] KAIST Academic Excellence Award: Grand Prize (2022).

Environmental Fluid Mechanics Laboratory



Associate Professor
KIM, Sung Yong

Ph.D. Oceanography, Scripps Institution of Oceanography, University of California, San Diego, USA [2009]

Research Interest
- Geophysical fluid dynamics
- Boundary layer flows
- Air-sea and air-sea-land interactions
- Ocean BIG DATA
- Submesoscale processes
- Geophysical turbulent flows
- Ocean sensing
- Arctic science and engineering

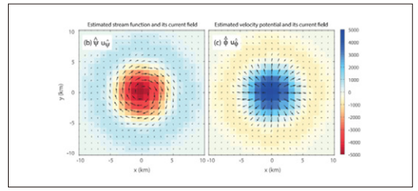
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RESEARCH OVERVIEW

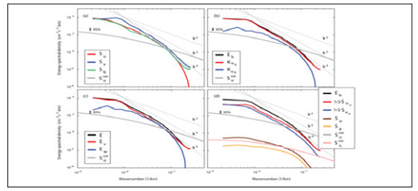
We study physical processes and geophysical turbulence in the ocean using observations, theories, and numerical simulations. We have observed the ocean with satellites, coastal radars, underwater/wave gliders, temperature-conductivity-depth sensors, and surface drifters. We have adapted statistical and dynamic data analysis (e.g., signal processing and big data analysis) and theoretical frameworks (e.g., momentum and advection-diffusion equations) to interpret the observations. We have derived practical and engineering problems, including tracking of water-borne materials (e.g., pollutants, search and rescue missions, and larvae transport), renewable energy using tides and winds, energy cascade via geophysical turbulent mixing, long-term climate changes, sensor fabrication, and spatial and temporal sampling designs. The ocean in coastal areas is a boundary-layer flow in the air-sea-land interface and a rotating frame. Our primary research focus is to understand geophysical fluids at the mesoscale [O(100 to 1000) km] and sub-mesoscale [O(1 to 100) km] and the waves and turbulent mixing below the O(1) km scale.

RESEARCH HIGHLIGHTS

Dynamical and statistical decompositions on ocean surface observations [Figs.1 & 2]
- Helmholtz physical decomposition and wave-vortex spectral decomposition on ocean surface currents and surface heights from upcoming satellite and remote-sensing missions (e.g., SWOT, COMPIRA, SKIM, WaCM).
- Observational limitations of SWOT to capture whole submesoscale processes.

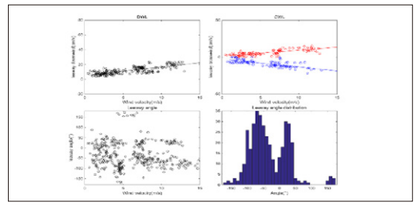


[Fig.1]

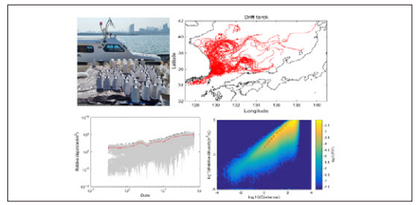


[Fig.2]

Wind leeway experiments for improving skill in ocean search and rescue [Figs.3 & 4]
- Derivations of downwind and cross-wind relationships of floating objects on wind speed
- Surface dispersion experiments using multiple surface drifters



[Fig.3]



[Fig.4]

PUBLICITY

[1] Professor Kim collaborated with Jaenam Kim on a contemporary art exhibition titled 'Sculptures of Air and Wind: 1,000 Days of Memories and Records'. Professor Kim believed that the general public can easily understand and appreciate natural phenomena if they are reinterpreted as works of art rather than figures in journal papers because the analyzed and visualized ocean observations contain aesthetic elements (2022.10.03).

[2] Professor Kim delivered a keynote speech at OCEANS FROM SPACE, a prestigious international remote sensing conference in ocean science held every ten years since 1980, recognizing his high-resolution ocean observation research around the Korean Peninsula. Professor Kim mentioned that my research on air-sea energy injection and transfer, which can understand ocean turbulence and affect climate change through high-resolution spatiotemporal remote observations of ocean turbulence, has been well received in the ocean remote observation community (2022.10.21).

[3] Professor Kim became the first Korean oceanographer to be invited to the program committee of the Ocean Sciences Meeting (OSM) of the American Geophysical Union (AGU) and the International Digital Twins of the Ocean Summit (DITTO Summit). Professor Kim has worked on DITTO, a program approved by the United Nations Decade of Ocean Science for Sustainable Development (UNDOS 2021-2030) in the working group on ocean observations. The DITTO is being led by Kiel University in Germany and GEOMAR Helmholtz Center for Ocean Research Kiel, and Professor Kim is participating as a co-researcher. (2023.05.10).

Advanced Packaging and Thin Film Laboratory



Professor
KIM, Taek-Soo

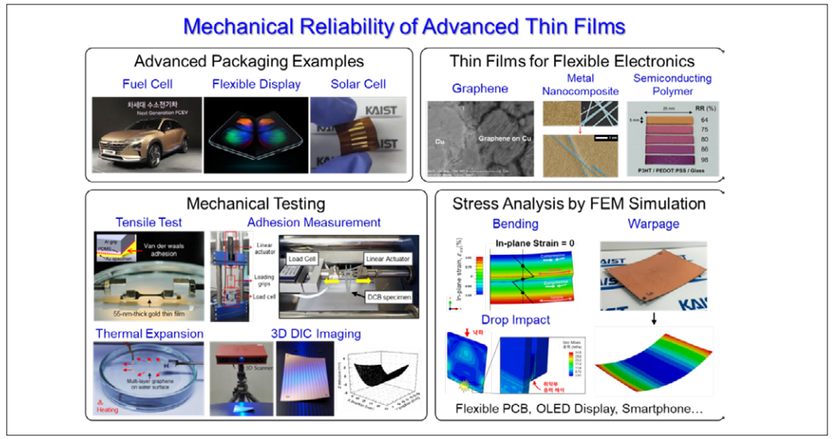
Ph.D., Stanford University
[2010]

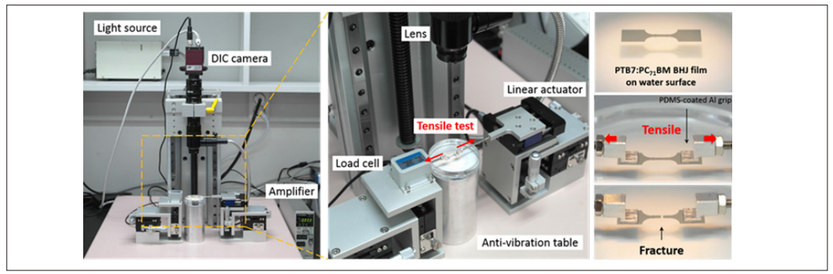
Research Interest
- Mechanical properties of advanced packaging and thin films

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RESEARCH OVERVIEW

Our main research interests center around the mechanics-related subjects of advanced packaging and thin films for emerging flexible display, fuel cell, solar cell, battery, and microelectronics technologies. We especially focus on experimental mechanics for the study of adhesion, deformation, fracture, fatigue, reliability, and stress/strain induced multiphysics phenomena.

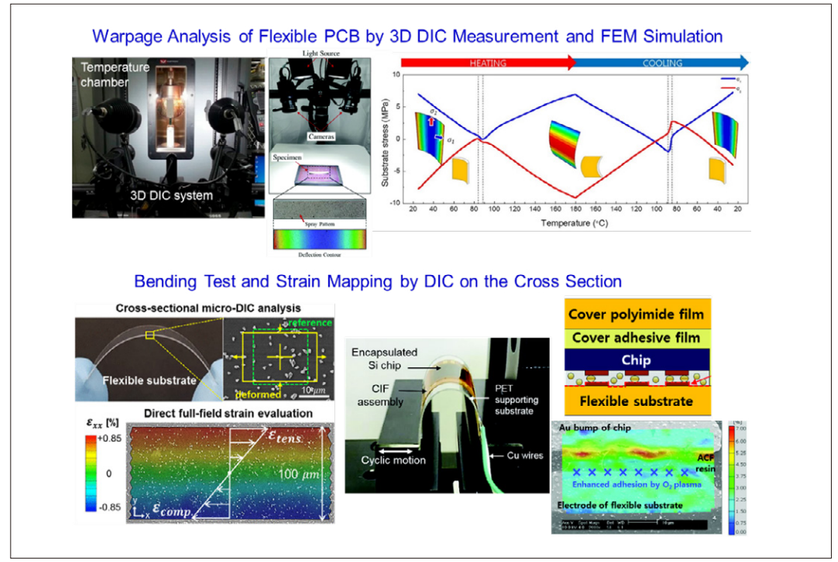




RESEARCH HIGHLIGHTS

The mechanical properties of thin films such as Young's modulus, yield strength, tensile strength, and ductility have been of paramount importance to many thin film applications including microelectronic, biological technologies and energy conversion devices. We have developed the pseudo free-standing tensile testing system and used it to investigate the mechanical properties of various thin and ultra-thin films. With this novel method, the mechanical properties of the most advanced thin and ultra-thin films, which cannot be measured by conventional methods, have been successfully measured.

Leveraging the adhesion and mechanical properties of various thin films, our work extends to stress/strain analysis in flexible electronics, soft actuators, and packaging. Utilizing 3D digital image correlation (DIC) for deformation measurement, finite element method (FEM) simulations, and mechanical tests (bending, folding, stretching), we aim to refine fabrication and device design. Additionally, precise measurement of semiconductor package materials (e.g., EMC, thinned-Si) across temperature variations enhances the accuracy of our predictive models, narrowing the gap between FEM simulations and 3D-DIC observations.



HONORS/AWARDS

[1] 제13회 해동젊은공학인상, 2022.11.10.

[2] Science and Technology Excellent Paper Award, the Korean Federation of Science and Technologies Societies, 2021.9.10.

[3] 2020 IEEE Transactions on Components, Packaging and Manufacturing Technology Best Paper Award, IEEE Electronic Packaging Society, 2021. 6.

[4] The 2020 Technology Innovation Award Outstanding Prize, KAIST College of Engineering, 2020.12.29.

[5] KAIST Outstanding Faculty Award for Academic Excellence, 2020.7.30.

[6] Member of the Young Korean Academy of Science and Technology, 2020.1.



Associate Professor
KIM, Young-Jin

Ph.D., KAIST [2008]

Research Interest

- Ultrafast Photonics
- Ultra-Precision Metrology
- Ultra-Precision Manufacturing

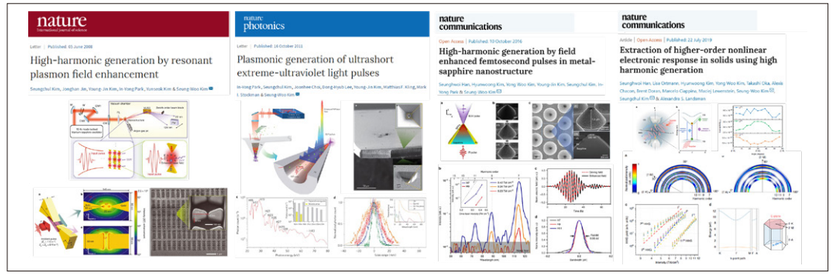
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Ultra-Precision Metrology and Manufacturing Laboratory

RESEARCH OVERVIEW

Ultrafast Photonics:

Development of ultrafast lasers for next-generation precision metrology/manufacturing



[Development of Ultrafast Lasers and Exploration of Nonlinear Photonics]

Ultra-Precision Metrology:

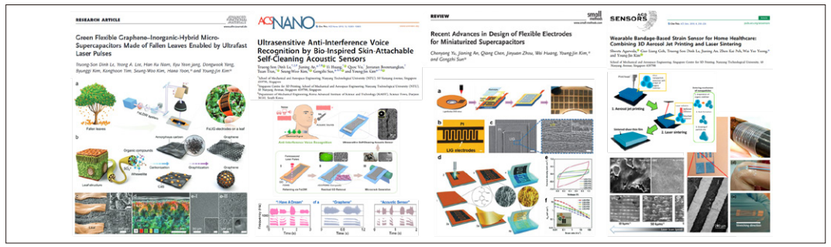
Ultra-precision laser ranging, surface topography, non-destructive internal defect inspection of semiconductor and flat panel display products



[Multi-scale Ultra-precision Metrology: From Kilometers down to Picometers]

Ultra-Precision Manufacturing:

Direct laser pattering of flexible/stretchable green electronics/optics



[Ultra-Precision Manufacturing of Flexible/Stretchable Opto-Electronics]

RESEARCH HIGHLIGHTS

[1] D.-C. Shin, B.S. Kim, H. Jang, **Young-Jin Kim* (corresponding author)**, and S.-W. Kim, "Photonic comb-rooted synthesis of ultra-stable terahertz frequencies," Nature Communications, 14, 790 (2023)

[2] Younggeun Lee, Mun Ji Low, Dongwook Yang, Han Ku Nam, Truong-Son Dinh Le, Seung Eon Lee, Hyogeun Han, Seunghwan Kim, Quang Huy Vu Hongki Yoo, Hyosang Yoon, Joohyung Lee, Suchand Sandeep, Keunwoo Lee, Seung-Woo Kim, and **Young-Jin Kim* (corresponding author)**, "Ultra-thin Light-weight Laser-Induced-Graphene (LIG) Diffractive Optics," Light: Science and Applications, 12:146 (2023)

[3] Dongwook Yang, Han Ku Nam, Truong-Son Dinh Le, Younggeun Lee, Young-Ryeul Kim, Seung-Woo Kim, Soongeun Kwon,* and **Young-Jin Kim* (corresponding author)**, "Multi-modal E-Textile Enabled by One-step Maskless Patterning of Femtosecond-Laser-Induced Graphene on Nonwoven, Knit, and Woven Textiles," ACS Nano, 17(19), 18893-18904 (2023)

[4] Jianing An, Van Thai Tran, Hai Xu, Wenshuai Ma, Xingkuan Chen, Truong Son Dinh Le, Hejun Du, Gengzhi Sun, and **Young-Jin Kim* (corresponding author)**, "High-throughput Manufacturing Multimodal Epidermal Mechanosensors with Superior Detectability Enabled by a Continuous Microcracking Strategy," Advanced Science, 11(4), 2305777 (2023)

[5] Tran Thanh Tung, Ana L. C. Pereira, Eric Poloni, Nhat-Minh Dang, James Wang, Truong-Son Dinh Le, **Young-Jin Kim**, Quoc Hue Pho, Md J. Nine, Volker Hessel, Dusan Losic*, "Irradiation Methods for Graphene-based Materials Production," Applied Physics Reviews, accepted for publication (2023)

[6] J. Yang, D.I. Lee, D.-C. Shin, J. Lee, B.S. Kim, H.J. Kang, **Young-Jin Kim* (corresponding author)** and Seung-Woo Kim, "Frequency comb-to-comb stabilization over a 1.3-km free-space atmospheric optical link," Light: Science and Applications, 11, 253 (2022)

[7] Truong-Son Dinh Le, Hoang-Phuong Phan, Soongeun Kwon, Sangbaek Park, Yeongju Jung, Jinki Min, Byung Jae Chun, Hana Yoon, Seung Hwan Ko, Seung-Woo Kim, and **Young-Jin Kim* (corresponding author)**, "Recent Advances in Laser-Induced Graphene: Mechanism, Fabrication, Properties, and Applications in Flexible Electronics," Advanced Functional Materials, 32(48), 2205158 (2022)

[8] J.S. Hwang, S. Arthanari, J.-E. Park, M. Yang, S. Kim, S.-W. Kim, H. Lee, and **Young-Jin Kim,* (corresponding author)**, "One-step Template-free Laser Patterning of Metal Microhoneycomb Structures," Small Methods, 2022, 2200150 (2022)

HONORS/AWARDS

[1] Best Paper Award, Korean Society of Mechanical Engineers (KSME) (2023)

[2] Young Research Award, Asian Society for Precision Engineering and Nanotechnology (ASPEN) (2023)

[3] Best Paper Award, International Symposium on Measurement Technology and Intelligent Instruments (ISMTII) (2023)

[4] Gold Medal, KSME-SEMES Open Enovation Challenge (2023)

[5] Best Paper Award, Optical Society of Korea (OSK) (2023)

[6] Best Paper Award, Korean Society of Mechanical Engineers (KSME) (2022)

[7] Best Paper Award, Asian Society for Precision Engineering and Nanotechnology (ASPEN) (2022)

[8] Director's Award, Korea Institude of Machinery & Materials (KIMM) (2022)

Exoskeleton Laboratory



Associate Professor
KONG, Kyoungchul

Ph.D., University of California, Berkeley [2009]

Research Interest
- Human assistive robotics
- Human power augmentation
- Design and control of wearable robots

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RESEARCH OVERVIEW

Wearable robots can assist human muscular power and mobility and have great potential in various fields from assisting and rehabilitating people with walking disabilities to enhancing the muscular power of people without disability, e.g., workers or soldiers.
The Exoskeleton Laboratory (EXO Lab) has studied promising and reliable solutions for developing wearable robots for assisting people in various applications.

RESEARCH HIGHLIGHTS

1. The Exo Lab has developed WalkON Suit, a wearable robot specialized for complete paraplegics. In 2020, professor Kyoungchul Kong and his research team won gold and bronze medals at the Cybathlon.
2. Soft Angel-Suit, a soft wearable robot specialized for stroke patients, has been developed. The robot is obtaining a medical device certification and in clinical trials.
3. Exo-booster, an exoskeleton for sprinting augmentation, has been developed. We verified that the robot exceeds the wearer's sprinting ability.
4. Angel-Suit, a wearable robot for people with partial impairments, was revealed at the Wearable Robotics Association Conference 2019 (WearRAcon19). A child with spina-bifida demonstrated walking and other various motions while wearing Angel-Suit.


WalkON Suit


Soft Angel-Suit


Exo-booster


Angel-Suit

HONORS/AWARDS

[1] Scientific and Technological Exhibition Achievement Award, 2022, Ministry of Science and ICT, Korea

[2] Republic of Korea Volunteer Service Award in Science Merit Award, 2022, the 7th KOREA AWARDS

[3] The 13th Asian Control Conference Host Contribution Award, 2022, Temasek Young Educator Award

[4] Special Issue Contribution Award, 2023, Control and Robotics Systems Society

[5] Robot Technology Award of The Control and Robotics Systems Society's Research and Development for Wearable Robots and Commercialization, 2023, ICROS

[6] Top 10 Representative Achievements of the Year, 2023, Ministry of Commerce Industry and Energy

Musculoskeletal BioDynamics Laboratory



Associate Professor
KOO, Seungbum

Ph.D., Stanford University [2006]

Research Interest
- Human Joint Movement
- Musculoskeletal Dynamics Simulation
- Orthopaedic Medical Devices

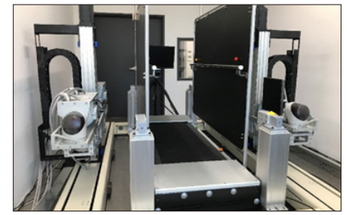
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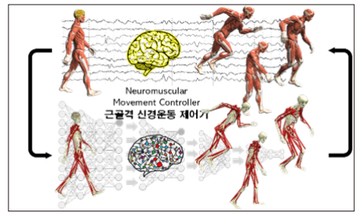
RESEARCH OVERVIEW

Movements and mechanical stresses in the human musculoskeletal system, including the skeleton, muscles, and connective tissues, are investigated through subject testing, medical imaging, and computer simulations. This research aims to understand the mechanical pathways that lead to joint injuries.

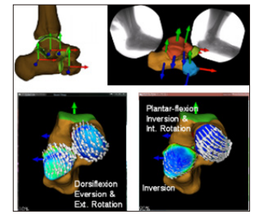
RESEARCH HIGHLIGHTS

- A custom dual X-ray fluoroscopic imaging system has been developed to obtain images of moving skeletons in a joint and calculate three-dimensional kinematics of it [Fig.1]
- In vivo kinematics of the foot have been measured non-invasively using the dual fluoroscopic imaging system and revealed the push-off mechanism during walking [Fig.2]
- Principle of human movement controller has been studied by developing a neuro-muscular controller for human dynamics simulation using reinforcement learning [Fig.3]
- The efficiency and effective control of assistive soft/hard robots have been studied, along with their impact on human joints, using a musculoskeletal human model equipped with walking and running controllers [Fig.4]

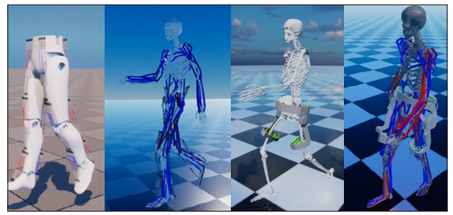

[Fig.1]



[Fig.3]



[Fig.2]


[Fig.4]

SELECTED PUBLICATIONS

[1] Son Y, Lee KM, Koo S, Increase in lateral contact force in the tibiotalar joint during walking in flatfoot patients with reduced stiffness of the spring ligament, Journal of Biomechanics, Vol. 157:111711, August 2023.

[2] Park G, Ryu S, Park SK, Yoon S, Koo S, Uncertainties of three-dimensional motion prediction from a single virtual accelerometer during walking and running, IEEE Sensors Journal, Vol. 23(21):26776-26785, November 2023.

[3] Koo Y, Hyangbo J, Koo S, Higher coactivations of lower limb muscles increase stability during walking on slippery ground in forward dynamics musculoskeletal simulation, Scientific Reports, Vol. 13, 22808, December 2023.

Human-Robot Interaction Laboratory



Associate Professor
KYUNG, Ki-Uk

Ph.D., KAIST [2006]

Research Interest
- Soft Robotics
- Medical/Rehabilitation Robots
- UI/UX: Haptics, Wearable Devices
- Intelligent Human-Robot Interaction

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RESEARCH OVERVIEW

1. SOFT ACTUATORS & SENSORS
- Development of Artificial Muscle, Shape Memory Alloy Actuators, Electro-active Polymer Actuator, Electrohydraulic Actuators, Stretchable Strain & Pressure Sensors

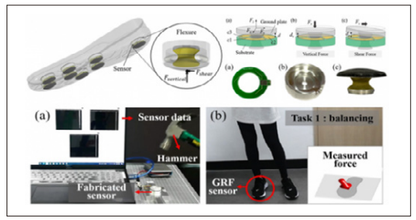
2. MEDICAL APPLICATIONS
- Wearable Rehabilitation Devices, 3DoF Force Sensors for Surgical Robot, Endoscopic Robot [Fig.3]

3. SOFT ROBOTICS APPLICATIONS
- Design of Soft Manipulators and Grippers

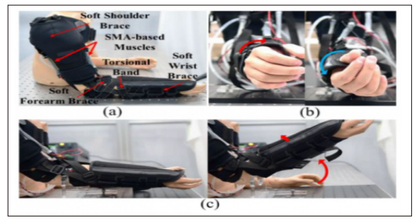
4. HAPTIC APPLICATIONS
- Soft Material based User Interface, Design of Wearable Interfaces providing User Experience, Automotive Applications

RESEARCH HIGHLIGHTS

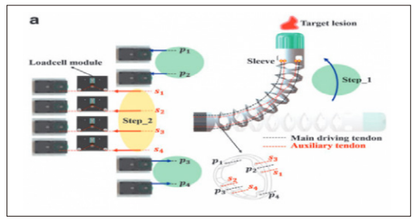
1. Development of a Three-axis Monolithic Flexure-based Ground Reaction Force Sensor for Various Gait Analysis (2022) [Fig.1]
2. Soft Wearable Robot With Shape Memory Alloy (SMA)-Based Artificial Muscle for Assisting With Elbow Flexion and Forearm Supination/Pronation (2022) [Fig.2]
3. Sigmoidal Auxiliary Tendon-Driven Mechanism Reinforcing Structural Stiffness of Hyper-Redundant Manipulator for Endoscopic Surgery (2022) [Fig.3]
4. Highly Efficient Long-lasting Triboelectric Nanogenerator Upon Impact and its Application to daily-Life Self-Cleaning Solar Panel (2022) [Fig.4]



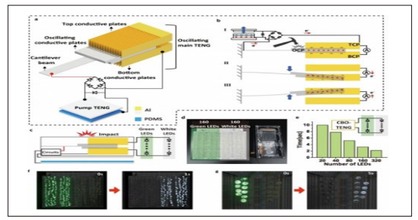
[Fig.1]



[Fig.2]



[Fig.1]



[Fig.2]

SELECTED PUBLICATIONS

[1] Hyeon, K; Chung, C; Ma, J; Kyung, KU; "Lightweight and Flexible Prosthetic Wrist with Shape Memory Alloy (SMA)-based Artificial Muscle and Elliptic Rolling Joint", IEEE ROBOTICS AND AUTOMATION LETTERS, vol. 8, no. 11, pp. 7849-7856, 2023

[2] Hyeon, K; Kyung, KU; "New Phase Diagram for Low Hysteresis Response of a Coiled Shape Memory Alloy Actuator", SMART MATERIALS AND STRUCTURES, vol. 32, pp. 115018, 2023

[3] Jeong, SM; Mun, H; Yun, S; *Kyung, KU; "Modeling dynamic behavior of dielectric elastomer muscle for robotic applications", FRONTIERS IN BIOENGINEERING AND BIOTECHNOLOGY, vol. 11, 2023

[4] Ji, S; Shin, J; Yoon, J.; Youn, JH; Ma, J; Kyung, KU; Kim, DH; Cho, H; *Park, J; " Triboelectric-Based Film-Type Soft Robot Driven via Low-Frequency Mechanical Stimuli", INTERNATIONAL JOURNAL OF PRECISION ENGINEERING AND MANUFACTURING-GREEN TECHNOLOGY, vol.10, pp.1027-1037, 2023

[5] Ma, J; Youn, JH; Cho, H; *Park, J; *Kyung, KU; “Highly Efficient Long-lasting Triboelectric Nanogenerator Upon Impact and its Application to daily-Life Self-Cleaning Solar Panel”, NANO ENERGY, vol. 103, pp. 107836, 2022

[6] Hyeon, K; Jeong, J; Chung, C; Cho, M; Hussain, S; *Kyung, KU; “Design of a Wearable Mechanism with Shape Memory Alloy (SMA)-based Artificial Muscle for Assisting with Shoulder Abduction”, IEEE ROBOTICS AND AUTOMATION LETTERS, vol.7, pp. 10635-10642, 2022

[7] Jeong, J; Hyeon, K; Jang, SY; Chung, C; Hussain, S; Ahn, SY; Bok, SK; *Kyung, KU; "Soft Wearable Robot With Shape Memory Alloy (SMA)-Based Artificial Muscle for Assisting With Elbow Flexion and Forearm Supination/Pronation", IEEE ROBOTICS AND AUTOMATION LETTERS, vol.7, pp.6028-6035, 2022

[8] Jang, SY; Youn, JH; Lim, SH; *Kim, SS; *Kyung, KU; “Development of a Three-axis Monolithic Flexure-based Ground Reaction Force Sensor for Various Gait Analysis“, IEEE ROBOTICS AND AUTOMATION LETTERS, vol.7, pp.4118-4125, 2022

Thermal Radiation Laboratory



Professor
LEE, Bong Jae

Ph.D., Georgia Institute of Technology [2007]

Research Interest
- Near-Field Thermal Radiation
- Heat Transfer Driven by Surface Plasmon Polaritons
- Micro/Nanoscale Thermometry

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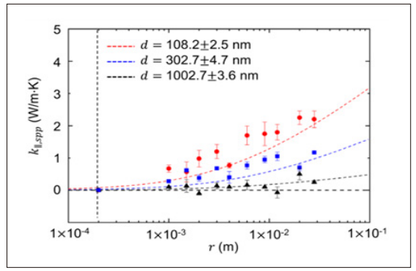
RESEARCH OVERVIEW

With a clear aim of contributing to future development of the energy conversion & generation technology, the ultimate goal of Thermal Radiation (TRAD) Laboratory is to conduct the 'Application-Driven Fundamental Research' on the thermal energy transport at the nanometer scale and make significant impact on future applications of nanoscale thermal radiation for energy conversion and utilization.

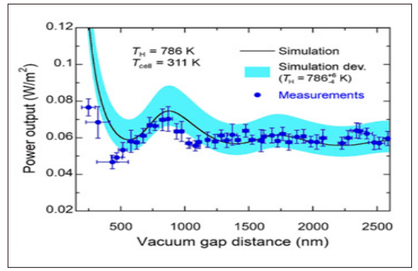
RESEARCH HIGHLIGHTS

Surface-Plasmon-Mediated Heat Transfer: [Fig.1]
As electronic devices become more integrated, there is a need to transcend traditional thermal management techniques and adopt an approach based on a fundamental understanding of heat transfer phenomena at the extreme scale. Recently, we discovered a new heat transfer mechanism driven by surface-plasmon polaritons (SPPs) generated in thin metal films deposited on a substrate. Using the long-range SPPs that can propagate across centimeters in the mid-infrared regime, we demonstrated an about 25% increase in thermal conductivity of a 100-nanometer-thick Ti film with a radius of about 3 cm.

Near-Field Thermal Radiation at Nanoscale Vacuum Gaps: [Fig.2]
When two objects are held at a separation distance less than the characteristic wavelength, the radiative heat transfer rate can exceed that between two blackbodies (i.e., Stefan-Boltzmann law) by several orders of magnitude. Due to difficulties in maintaining the nanoscale gap distance between the emitter and the receiver, experimental investigations of near-field radiative heat transfer are rather limited to relatively simple geometries, such as spherical or point-like emitters. Recently, we have demonstrated the thermophotovoltaic energy conversion at nanometer scale vacuum gaps and showed the oscillatory nature of near-field thermophotovoltaic energy conversion in the far-to-near-field transition regime (250–2600 nm), where evanescent and propagating modes are comparable due to the selective spectral response by the photovoltaic cell.



[Fig.1]



[Fig.2]

HONORS/AWARDS

- Fellow of AUTSE (Asian Union of Thermal Science and Engineering), 2023
- Best Paper Award, Thermal Engineering Division, KSME, 2022
- Best Paper Award, Micro/Nano Division, KSME, 2022
- Best Paper Award, The 24th Korean MEMS Conference, 2022

Robotics and Simulation Laboratory



Professor
LEE, Doo Yong

Ph.D., Rensselaer Polytechnic Institute [1993]

Research Interest
- Medical Robotics & Haptics
- Medical Simulation

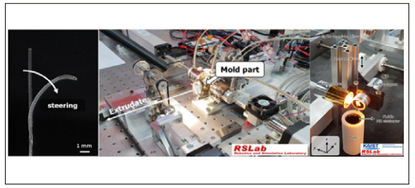
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RESEARCH OVERVIEW

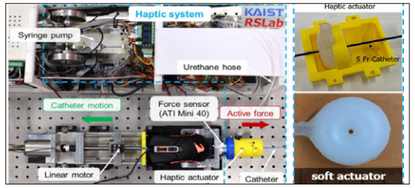
We specialize in robotics, high-fidelity simulation, and their application to healthcare. Our interests in the robotics include the tele-operation control systems and the haptic systems for robots and devices used in the surgery and medical intervention. Examples include various haptic masters for surgery robots and robotic catheters; and the active-steering micro catheters for vascular intervention. Simulation is a powerful tool for planning and training of surgery, intervention, and many medical procedures. We research technologies essential to the high-fidelity medical simulation. We have been developing simulations of various medical procedures including the upper & lower gastrointestinal endoscopy; ERCP (Endoscopic Retrograde Cholangiopancreatography); CRIF (Closed Reduction & Internal Fixation); interventions using needles and catheters; and emergency diagnosis of thoracic and abdominal trauma.

RESEARCH HIGHLIGHTS

Fig. 1 Active-steering medical guidewire and its manufacturing system.
Fig. 2 Haptic interface of the training simulation of cardiac catheters.
Fig. 3 Haptic interface of the training simulation of thoracic and abdominal trauma.
Fig. 4 Haptic interface of the AR training simulation of arterial injection.
Fig. 5 Real-time FEM simulation with haptic interface.



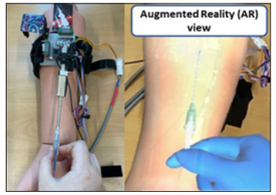
[Fig.1]



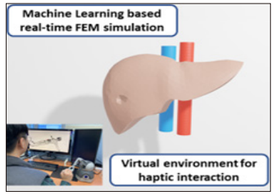
[Fig.2]



[Fig.3]



[Fig.4]



[Fig.5]

SELECTED PUBLICATIONS

[1] S. Kim and D. Y. Lee, "Control Design for Haptic Systems: Enhancing the Stability and Rendering Performance," Springer, 2024.

[2] C. Li and D. Y. Lee, "A Hydraulic Haptic Actuator for Simulation of Cardiac Catheters," IEEE Transactions on Haptics, Feb. 2024, online.

[3] S. Kang and D. Y. Lee, "Steerable guidewire and method for manufacturing steerable guidewire, steerable catheter and method for manufacturing steerable catheter," U.S. Patent 11 642 493 B2, May. 9, 2023.

[4] S. Kim and D. Y. Lee, "Control of Haptic Systems Based on Input-to-State Stability," IEEE Access, vol. 10, pp. 27242-27254, 2022.

[5] C. Kim and D. Y. Lee, "Adaptive Model-Mediated Teleoperation for Tasks Interacting with Uncertain Environment," IEEE Access, vol. 9, pp. 128188–128201, 2021.

[6] S. P. Byeon and D. Y. Lee, "Adaptive Surface Representation Based on Homogeneous Hexahedrons for Interactive Simulation of Soft Tissue Cutting," Computer Methods and Programs in Biomedicine, vol. 200, 105873, 2021.

[7] S. Kang and D. Y. Lee, "Hydraulically Steerable Micro Guidewire Capable of Distal Sharp Steering," IEEE Transactions on Biomedical Engineering, vol. 68, no. 2, pp. 728–735, 2021.



Innovative Design Optimization Laboratory



Professor
LEE, Ikjin

Ph.D., University of Iowa
[2008]

Research Interest
- Sampling-based Design under Uncertainty
- Surrogate Modeling
- Statistical Model Calibration
- Topology Optimization
- Optimization with Artificial Intelligence

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RESEARCH OVERVIEW

The IDOL lab explores various advanced methodologies for design and optimization. Our research focuses on design under uncertainties, topology optimization, surrogate modeling, and so on. Our research aims to develop accurate and efficient optimization and modeling methodologies that can be applied to various scenarios, including multi-fidelity, high- dimensional, and heterogeneous responses. Each research area can be further expanded by combining with deep learning methodologies, and this integration is currently underway.

RESEARCH HIGHLIGHTS

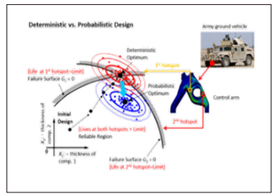
1. Sampling-based Design under Uncertainties [Fig.1&2]
- Reliability-based design optimization
- System reliability analysis and design optimization

2. Topology Optimization under Uncertainty [Fig.3]
- Modeling of geometric uncertainties via the shift of nodes

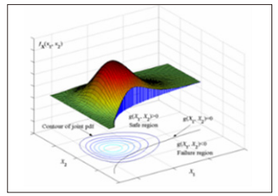
3. Surrogate Model Generation Method [Fig.4]
- Multi-fidelity based surrogate model generation
- Surrogate modeling for high dimension problems

4. Statistical Model Calibration [Fig.5]
- Model calibration under insufficient data environment

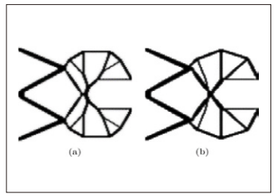
5. Optimization with Artificial Intelligent [Fig.6]
- Pattern generation with generative adversarial network



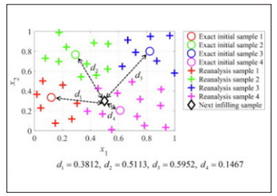
[Fig.1]



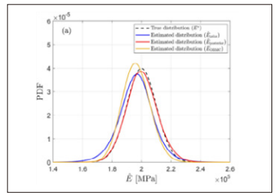
[Fig.2]



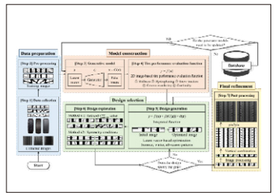
[Fig.3]



[Fig.4]



[Fig.5]



[Fig.6]

SELECTED PUBLICATIONS

[1] Lee, M., Jung, Y., Choi, J., & Lee, I. (2022). A reanalysis-based multi-fidelity (RBMF) surrogate framework for efficient structural optimization. Computers & Structures, 273, 106895.

[2] Park, J. W., & Lee, I. (2023). A new framework for efficient sequential sampling-based RBDO using space mapping. Journal of Mechanical Design, 145(3), 031702.

[3] Yang, S., Lee, M., & Lee, I. (2023). A new sampling approach for system reliability-based design optimization under multiple simulation models. Reliability Engineering & System Safety, 231, 109024.

[4] Lee, M., Noh, Y., & Lee, I. (2024). A novel sampling method for adaptive gradient-enhanced Kriging. Computer Methods in Applied Mechanics and Engineering, 418, 116456.

[5] Park, Y., & Lee, I. (2024). Consecutive adaptive Kriging method for high-dimensional reliability analysis based on multi-fidelity framework. Structural and Multidisciplinary Optimization, 67(1), 11.

[6] Yang, S., Lee, M., Jung, Y., Cho, H., Hu, W., & Lee, I. (2024). An effective active learning strategy for reliability-based design optimization under multiple simulation models. Structural Safety, 107, 102426.

[7] Lee, J., Lee, M., Lee, B. J., & Lee, I. (2024). A comprehensive multi-fidelity surrogate framework based on Gaussian process for datasets with heterogeneous responses. Knowledge-Based Systems, 295, 111827.

[8] Song, B. U., Huh, J. Y., Lee, S. K., & Lee, I. (2024). Modified Structure of Deep Neural Network for Training Multi-Fidelity Data With Non-Common Input Variables. Journal of Mechanical Design, 146, 101702-1.

Manufacturing and Instrumentation Laboratory



Associate Professor
LEE, Jungchul

Ph.D., Georgia Tech [2007]

Research Interest
- Unconventional Manufacturing
- Precision Instrumentation
- MEMS/NEMS

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RESEARCH OVERVIEW

Remember that only limited researchers have access to high-end micro-/nanofabrication facilitates worldwide. The processes and materials we are currently relying on may not be the best out of the available options. We look for better processes for conventional micro-/nanofabrication materials and better materials to realize high-performance transducers.

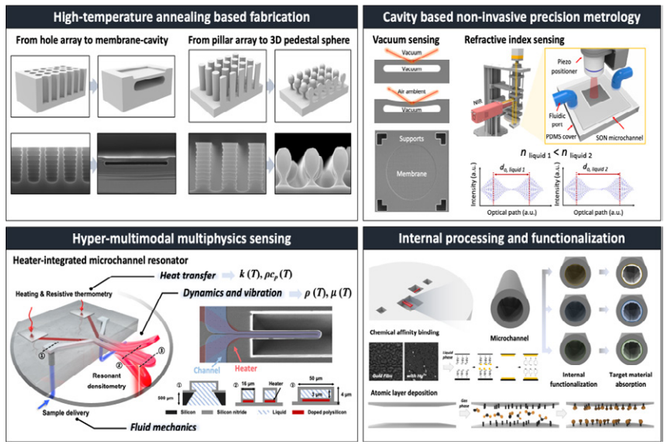
RESEARCH HIGHLIGHTS

[1] High-temperature annealing based unconventional micro-/nanofabrication for various semiconductor materials to make membrane-cavity and 3D spherical structures

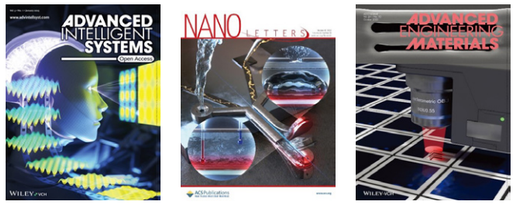
[2] Cavity based non-invasive precision optical metrology to measure liquid and gas properties

[3] Hyper-multimodal multiphysics sensing to measure multi-physical properties of liquid and gas under fast temperature modulation

[4] Internal processing and surface functionalization to provide highly specific affinity for various sensing applications



SELECTED PUBLICATIONS [Journals (6 out of 28)]



[1] J. Ko, B. J. Lee, J. Lee, "Advanced operation of heated fluidic resonators via mechanical and thermal loss reduction in vacuum", Microsystems and Nanoengineering, 9, 127 (2023). Selected as an Editor's Pick

[2] J. Jeong, T. Kim, B. Lee, J. Lee, "Predicting AFM topography from optical microscope images using deep-learning", Advanced Intelligent Systems, 5(1), 2200317 (2023). Selected as an Inside Back Cover

[3] J. Ko, F. Khan, Y. Nam, B. J. Lee, J. Lee, "Nanomechanical sensing using heater-integrated fluidic resonators", Nano Letters, 22(19), 7768-7775 (2022). Selected as a Front Cover

[4] J. Ko, B. J. Lee, J. Lee, "Towards highly specific measurement of binary mixtures by tandem operation of nanomechanical sensing system and micro-Raman spectroscopy", Sensors and Actuators: B-Chemical, 367, 132133 (2022).

[5] T. Kim, J. Ko, J. Lee, "Self-assembled silicon membrane resonator for high vacuum pressure sensing", Vacuum, 201, 111101 (2022).

[6] M. Jeong, T. Kim, B. Lee, J. Lee, "Subsurface imaging of microfabricated silicon membrane-cavity structure using near-infrared interferometry", Advanced Engineering Materials, 24, 2200531, (2022). Selected as a Back Cover

Patents

[7] 2023, A device and method for measuring the thermal properties of micro fluids using a microchannel resonance structure (10-2023-0014279)

[8] 2023, Pressure sensing device and pressure sensing method using the same (10-2022-0029553)

[9] 2022, Fabrication of semiconductor cavity wafer through high temperature annealing (10-2022-0099653)

[10] 2022, Microchannel resonator device for thermophysical properties measurement and its methodology (10-2022-0001182)

[11] 2022, Anti-counterfeiting tag, method of manufacturing the anti-counterfeiting tag and anti-counterfeiting system (10-2022-0099653)

SELECTED HONORS/AWARDS (7 out of 21)

[1] 2024, Bronze Prize at the 30th Samsung Humantech Paper Award

[2] 2023, Gold Award at the 8th KSME-SEMES Open Innovation Challenge

[3] 2023, Best Poster Presentation Award at the 14th JCK MEMS/NEMS Conference

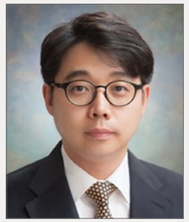
[4] 2023, Best Oral Presentation Award at the 18th IEEE NEMS Conference

[5] 2023, Outstanding Student Oral Presentation Award Finalist at the 36th IEEE MEMS Conference

[6] 2022, Silver Prize at the 28th Samsung Humantech Paper Award

[7] 2022, Silver Award at the 7th KSME-SEMES Open Innovation Challenge

Advanced Energy Conversion and Storage Laboratory



Associate Professor
LEE, Kang Taek

Member, ECS
Member, KECS
Member, KCERS

Ph.D., University of Florida
[2010]

Research Interest

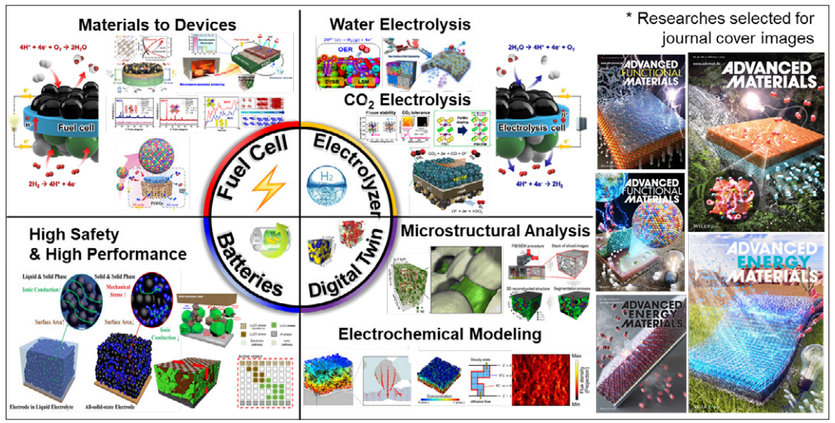
- Solid Oxide Fuel Cells
- Solid Oxide Electrolysis Cells
- Solid-state Batteries
- Multi-scale 3D reconstruction

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RESEARCH OVERVIEW

Recently, electrochemical devices capable of reversibly converting electrical energy and chemical fuels have garnered attention due to their low pollutant emissions, high efficiency, and fuel flexibility. In this context, our research focuses on advancing promising technologies such as solid oxide fuel cells, electrolyzers, batteries, and digital twinning. Technical challenges, such as harsh operating temperatures, atmospheric conditions, and the low catalytic activity of cell components, degrade the electrochemical performance and durability of these devices, limiting their broader applications. To tackle these issues, our research concentrates on the materials-to-cell design of energy conversion systems and understanding the electrochemistry within. We develop novel materials with high conductivity and catalytic activity, ensuring superior performance and long-term stability by integrating components into cells. Additionally, quantitative microstructural analysis is conducted using the digital twinning process to explore the impact of critical structural factors on the electrochemical reaction. Through this innovative 3D analysis platform and electrochemical modeling techniques, we gain insights into the microstructure and interfacial design of components. In conclusion, our studies aim to contribute to a highly efficient and eco-friendly energy society by leveraging next-generation energy conversion and storage applications.

RESEARCH HIGHLIGHTS



SELECTED PUBLICATIONS

[1] J. H. Kim#, D. Kim#, S. Ahn#, K. J. Kim, S. Jeon, D.-K, Lim, J. K. Kim, U. Kim, H.-N. Im, B. Koo, **K. T. Lee***, W. Jung*, "An Universal Oxygen-Electrode for Reversible Solid Oxide Electrochemical Cells at Reduced Temperatures", Energy & Environmental Science, 16, 9, (2023). (IF=32.5)

[2] S. Oh, D. Kim, H. J. Ryu*, **K. T. Lee***, "A Novel High-Entropy Perovskite Electrolyte with Improved Proton Conductivity and Stability for Reversible Protonic Ceramic Electrochemical Cells", Advanced Functional Materials, 2311426, (2023). (IF=19.0)

[3] H. Yu#, H.-N. Im#, **K. T. Lee***, "Exceptionally High-performance Reversible Solid Oxide Electrochemical Cells with Ultra-thin and Defect-free $Sm_{0.075}Nd_{0.075}Ce_{0.850.2-\delta}$ Interlayers", Advanced Functional Materials, 32, 49, (2022). (IF=19.0)

[4] D. Kim#, K. T. Bae#, K. J. Kim, H. -N. Im, S. Jang, S. Oh, S. W. Lee, T. H. Shin, **K. T. Lee***, "High-Performance Protonic Ceramic Electrochemical Cells", ACS Energy Letters, 7, 7, (2022). (IF=22.0)

[5] K. J. Kim#, C. Lim#, K. T. Bae#, J. J. Lee, M. Y. Oh, H. J. Kim, H. Kim, G. Kim, T. H. Shin*, J. W. Han*, **K. T. Lee***, "Concurrent promotion of phase transition and bimetallic nanocatalyst exsolution in perovskite oxides driven by Pd doping to achieve highly active bifunctional fuel electrodes for reversible solid oxide electrochemical cells", Applied Catalysis B: Environmental, 314, 121517, (2022). (IF=22.1)

[6] S. Lee, H. Ha, K. T. Bae#, S. Kim, H. Choi, J. Lee, J. H. Kim, J. Seo, J. S. Choi, Y-R. Jo, B-J. Kim, Y. Yang, **K.T Lee***, H. Y. Kim*, W. Jung*, "A Measure of Active Interfaces in Supported Catalysts for High-temperature Reactions" Chem, 8, 1, (2022). (IF=23.5)

Computational Mechanics and Structural Systems



Professor
LEE, Phill-Seung

Ph.D., Massachusetts
Institute of Technology [2004]

Research Interest

- Computational Mechanics
- Structural Systems
- Fluid-Structure Interaction

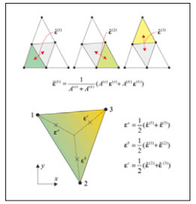
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RESEARCH OVERVIEW

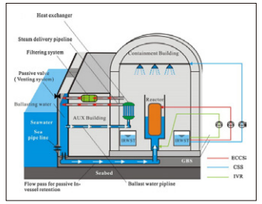
Computational Mechanics [Fig.1]
- Finite element method
- Topology optimization, Crack propagation
- Deep-learned finite elements, Self-updated FEM

Structural Systems [Fig.2]
- Offshore nuclear power plants
- Real-time strain estimation
- Flexible display

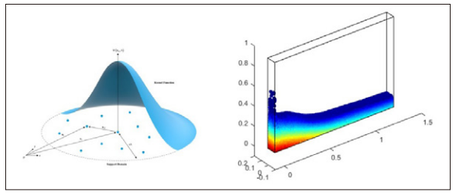
Fluid-Structure interaction [Fig.3]
- Smoothed particle hydrodynamics
- Hydroelastic analysis
- Underwater explosion



[Fig.1]



[Fig.2]



[Fig.3]

RESEARCH HIGHLIGHTS

[1] Shin S, Hyun C, Cho S, Lee PS. Multi-sensor data-based anomaly detection and diagnosis of a pumped storage hydropower plant, Structural Engineering and Mechanics, 88, 569-581, Dec 2023.

[2] Kim YH, Cho S, Lee PS. Wave height classification via deep learning using monoscopic ocean videos, Ocean Engineering, 288, 116002, Oct 2023.

[3] Choi HG, Lee PS. The simplified MITC4+ shell element and its performance in linear and nonlinear analysis, Computers & Structures, 290, 107177, Sep 2023.

[4] Kim G, Lee PS. Mesh coarsening using the phantom-node method in the phase field model, Finite Elements in Analysis and Design, 228, 104048, Sep 2023.

[5] Park M, Lee PS. Integrated hydrostatic and hydrodynamic analysis of flexible floating structures, Ocean Engineering, 288, 114945, May 2023.

[6] Lee SG, Kim D, Lee PS. Vehicle collision simulation for roadblocks in nuclear power plants using LS-DYNA(LS-DYNA를 이용한 원자력 발전소의 로드블록에 대한 차량 충돌 시뮬레이션), Journal of COSEIK, 36(2), 113-120, Apr 2023.

[7] Jung H, Lee C, Lee PS. Strain-smoothed polygonal finite elements, Structural Engineering and Mechanics, 86, 311-324, Mar 2023.

[8] Kim G, Lee PS. Towards improving the computational efficiency of the phase field model, Computers & Structures, 276, 106951, Mar 2023.

[9] Choi HG, Lee PS. Towards improving the 2D-MITC4 element for analysis of plane stress and strain problems, Computers & Structures, 275, 106933, Oct 2022.

[10] Lee C, Lee DH, Lee PS. The strain-smoothed MITC3+ shell element in nonlinear analysis, Computers & Structures, 265, 106768, Jun 2022.

[11] Jung J, Jun H, Lee PS. Self-updated four-node finite element using deep learning, Computational Mechanics, 69, 23-24, Jan 2022.

HONORS/AWARDS

[1] Outstanding Faculty Award in Research in Commemoration of the 52nd Anniversary of Founding, KAIST, 2023.

[2] Editor, Structural Engineering and Mechanics, 2011-present.

[3] Chair, COSEIK academic symposium. Apr 2023.

Micro Mechanical System Technology Laboratory



Professor
LEE, Seung S.

Ph.D., University of California, Berkeley [1995]

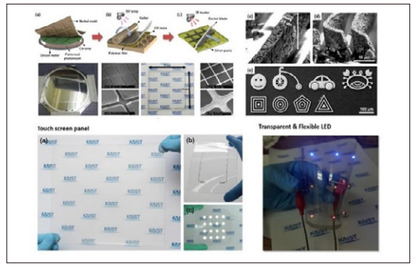
Research Interest
- Polymer-based MEMS
- Bio-MEMS,
- Harsh-MEMS
- Various Applications

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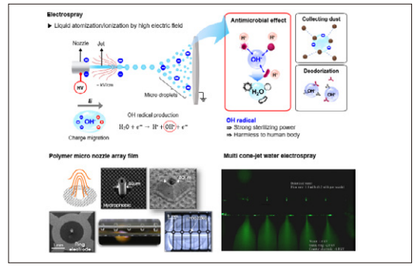
RESEARCH OVERVIEW

1) Transparent conductive film using metal mesh [Fig. 1]
Metal mesh is comprised of microscale patterns consisting of metal such as gold, silver, or copper. The design of the mesh pattern, which is expressed as the line width, pitch, and height, enables adjustments to its performance. The metal mesh is fabricated by using UV embossing and doctor blading process. These processes are relatively simple and do not require high temperature, vacuum environment, and expensive.

2) Micro nozzle array for electrospray air purification [Fig. 2]
Electrospray technique has been widely used due to its uniform and fine droplets generation with highly charged. The electrospray also shows excellent air purification, fine dust collection and antibacterial function, when the spray liquid is water. However, it is extremely difficult to spray water electrically due to its high electrical conductivity and surface tension. Micro nozzle array made of dielectric material is being developed to produce large amount of water nano-droplets in a stable electrospray condition. With the help of MEMS technology, high aspect ratio of micro nozzle can be fabricated uniformly and is expected to be applied in commercial air purifier and humidifier.



[Fig.1]



[Fig.2]

RESEARCH HIGHLIGHTS

[1] J. Jeong, K. S. Park, H. S. Kim, I. Y. Park, J. Y. Choi, S. S. Lee, “Multiplexed electrospraying of water in cone-jet mode using a UV-embossed pyramidal micronozzle film”, Microsystem and Nanoengineering, Vol. 8, 110, 2022.

[2] J. S. Kim, D. J. Kim, Seung. S. Lee, “Development of a doctor blade printing method for fabrication of neutron activation foil arrays”, Journal of Radioanalytical and Nuclear Chemistry, 330(1), 385-394, 2021.

[3] J. Jang, J. Song, Seung S. Lee, S. Jeong, B. J. Lee, and S. Kim, “Analysis of temperature-dependent IV characteristics of the Au/n-GaSb Schottky diode”, Materials Science in Semiconductor Processing, 131, 105882, 2021.

[4] J. Song, J. Jang, M. Lim, J. Lee, S. S. Lee and B. J. Lee, “Near-field electroluminescent refrigeration system consisting of two graphene Schottky diodes”, Journal of Heat Transfer, 142, 072101-1, 2020.

[5] J. Jeong, H. Choi, K. Park, H. Kim, J. Choi, I. Park, and S. S. Lee, “Polymer micro-atomizer for water electrospray in the cone jet mode”, Polymer, 122450, 2020.

[6] M. Jo, S. Bae, I. Oh, J. Jeong, B. Kang, S. J. Hwang, S. S. Lee, H. J. Son, B. Moon, M. J. Ko, and P. Lee, “3D Printer-Based Encapsulated Origami Electronics for Extreme System Stretchability and High Areal Coverage”, ACS Nano 13, 11, pp.12500-12510, 2019.

[7] G. Panama and S. S. Lee, “Catalytic Thermoelectric Hydrogen Sensor with CoSb3 Thermopile by Single-Step Deposition on Bare/Textured Glass,” Surfaces and Interfaces, 2024

[8] G. Panama, J. T. Jin, D. J. Kim, and S. S. Lee, “Plane Heating with a Transparent Heater Film in a Fish Tank,” Heliyon, 2024.

[9] G. Panama and Seung S. Lee, “Thermoelectric Sensor with CuI Supported on Rough Glass,” Nanomaterials, Vol. 14, 105, 2024.

[10] G. Panama, M. H. Jo, S. S. Shim, M. S. Kim, and and S. S. Lee, “Hydrogen Sensor with a Thick Catalyst Layer Anchored on Soda-lime Glass,” International J. of Hydrogen Energy, Vol. 55, pp. 875-881, 2024

PUBLICITY(MEDIA+NEWS)

[1] “초미세 물방울로 코로나19 바이러스 제거”, https://news.kbs.co.kr/news/view.do?ncd=5026145&ref=A, 2020

[2] “대구시-카이스트, 물 이용한 대중이용시설 공기정화 시스템 개발”, https://news.imaeil.com/page/view/2021111115080132863, 2021

[3] [단독] “KAIST 일냈다” 마법의 물방울…가습기 살균제 일거에 해결- 헤럴드경제 (heraldcorp.com) 2024. 5. 4
https://news.heraldcorp.com/view.php?ud=20240503050670

[4] 안테나·열선·발광' 동시에…KAIST '투명 스마트 복합필름' 상용화 - 헬로디디 (hellodd.com), 2022. 10. 19
https://www.hellodd.com/news/articleView.html?idxno=98399

Industrial Artificial Intelligence Laboratory



Associate Professor
Lee, Seungchul

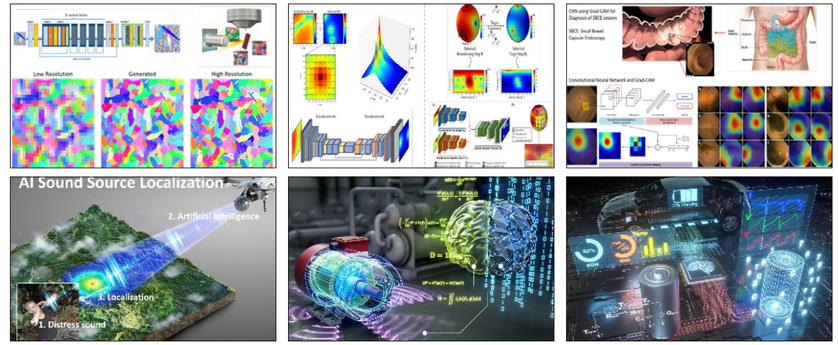
Ph.D., University of Michigan, Ann Arbor [2010]

Research Interest
- AI Applications to Mechanical Systems
- Manufacturing
- Material Science
- Healthcare
- Robotics

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RESEARCH OVERVIEW

AI revolutionizes mechanical engineering and industry by optimizing manufacturing, predicting equipment failures, and enhancing product design through machine learning algorithms. The Industrial AI lab, led by Professor Seungchul Lee, focuses on solving research problems in various engineering domains, including manufacturing systems, material science, healthcare, and robotics. By leveraging domain knowledge in multidisciplinary applications, machine learning not only enhances the accuracy and efficiency of predictive models but also ensures the relevance and practicality of the insights derived, thus fostering more impactful and sustainable solutions for complex real-world problems.



RESEARCH HIGHLIGHTS

[1] Juwon Na, Se-Jong Kim, Heekyu Kim, Seong-Hoon Kang, and Seungchul Lee*, 2023, "A Unified Microstructure Segmentation Approach via Human-In-The-Loop Machine Learning," Acta Materialia.

[2] Iljeok Kim, Juwon Na, Jong Pil Yun*, and Seungchul Lee*, 2023, "Deep Feature Selection Framework for Quality Prediction in Injection Molding Process," IEEE Transactions on Industrial Informatics.

[3] Taewan Kim and Seungchul Lee*, 2022, "A Novel Unsupervised Clustering and Domain Adaptation Framework for Rotating Machinery Fault Diagnosis," IEEE Transactions on Industrial Informatics.

[4] Soo Young Lee, Jihun Lee, Joong Seok Lee*, and Seungchul Lee*, 2022, "Deep Learning-based Prediction and Interpretation of Physical Phenomena for Metaporous Materials," Materials Today Physics.

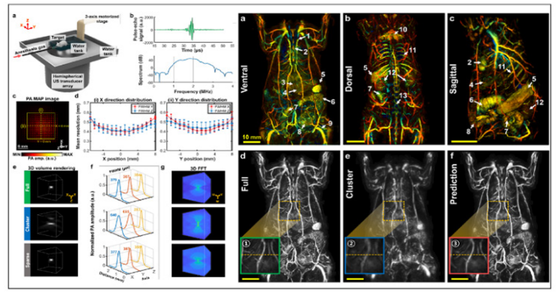
[5] Seongwook Choi+, Jinge Yang+, Soo Young Lee+, Jiwoong Kim, Seungchul Lee*, and Chulhong Kim*, 2022, "Deep Learning Enhances Multiparametric Dynamic Volumetric Photoacoustic Computed Tomography in Vivo (DL-PACT)," Advanced Science.

[6] Soo Young Lee, Choon-Su Park, Keonhyeok Park, Hyung Jin Lee*, and Seungchul Lee*, 2022, "A Physics-informed and Data-driven Deep Learning Approach for Wave Propagation and its Scattering Characteristics," Engineering with Computers

PUBLICITY (MEDIA+NEWS)

[1] Development of AI-enabled 3D volumetric photoacoustic imaging





NEMS-Based Semiconductor Quantum Photonics (NEST) Lab



Associate Professor
NAM, Donguk

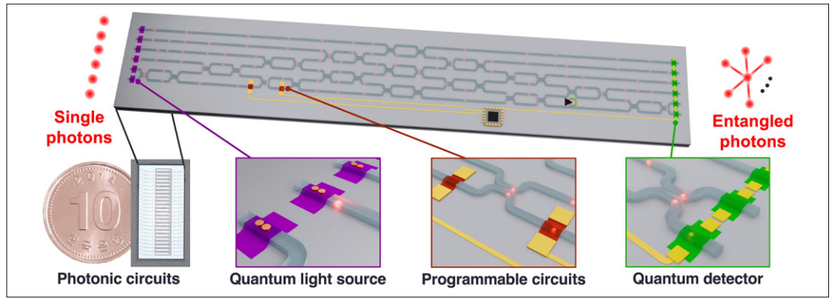
Ph.D., Stanford University [2014]

Research Interest
- NEMS/MEMS
- Strain engineering
- Semiconductor fabrication
- Photonic quantum computing

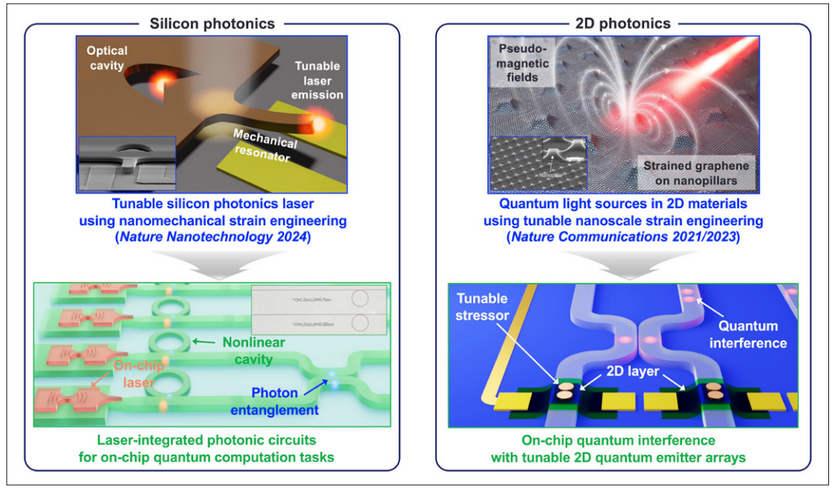
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RESEARCH OVERVIEW

The research objective of our lab is to develop quantum photonic devices and circuits, aiming to realize integrated photonic quantum computers. For example, as shown in the figure below, we invent a new class of quantum light sources, programmable circuits, and quantum detectors. Particularly, we harness nanomechanical strain engineering to enable unprecedented functionalities in semiconductor devices.



RESEARCH HIGHLIGHTS



SELECTED PUBLICATIONS

[1] H. Joo, J. Liu, M. Chen, D. Burt, B. Chomet, Y. Kim, X. Shi, K. Lu, L. Zhang, Z. Ikonic, Y. Sohn, C. Tan, D. Gacemi, A. Vasanelli, C. Sirtori*, Y. Todorov*, D. Nam*, "Actively tunable lasing in GeSn nanomechanical oscillators," ***Nature Nanotechnology***, Published Online (2024)

[2] Y. Kim, S. Assali, H. Joo, S. Koelling, M. Chen, L. Luo, X. Shi, D. Burt, Z. Ikonic, D. Nam*, and O. Moutanabbir*, "Short-wave infrared cavity resonances in a single GeSn nanowire," ***Nature Communications*** 14, 4393 (2023)

[3] K. Lu, M. Luo, W. Gao, Q. Wang, H. Sun* and D. Nam*, "Strong second-harmonic generation in non-uniformly strained monolayer graphene," ***Nature Communications*** 14, 2580 (2023)

[4] D. Kang, H. Sun, M. Luo, K. Lu, M. Chen, Y. Kim, Y. Jung, X. Gao, S. Parluhutan, J. Ge, S. Koh, D. Giovanni, T. Sum, Q. Wang, H. Li, and D. Nam, "Pseudo-magnetic field-induced slow carrier dynamics in periodically strained graphene," ***Nature Communications*** 12, 5087 (2021)

Multiscale Energy Laboratory



Associate Professor
NAM, Youngsuk

Ph.D., University of California, Los Angeles [2010]

Research Interest
- Multiscale phase change physics
- Intelligent thermal management
- Novel thermal materials

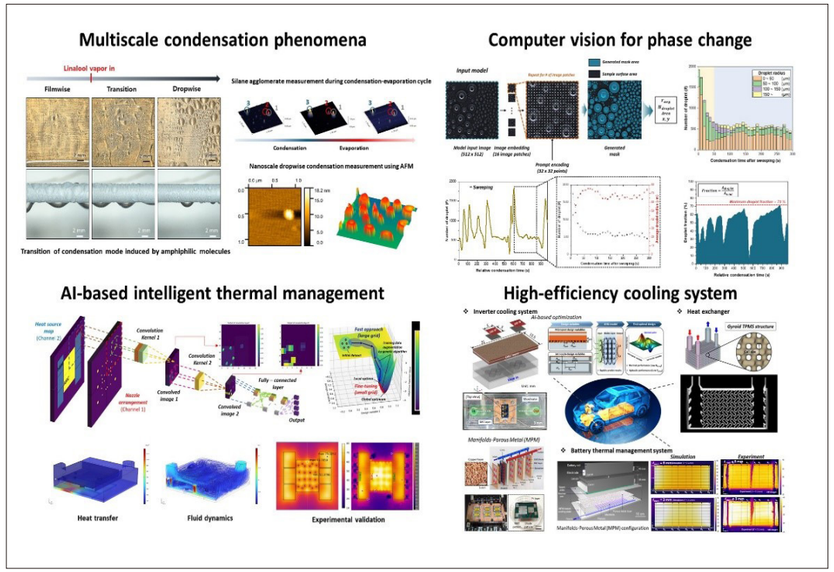
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RESEARCH OVERVIEW

We aim to tackle the pressing energy challenges confronting our global community. Within our energy grid system, ~70% of the total energy input is dissipated as heat. The burgeoning demand for emerging technical platforms, coupled with a marked rise in power density of semiconductors, presents unparalleled challenges in thermal management. To navigate these obstacles, we integrate a comprehensive understanding of phase change physics with the development of innovative thermal materials, data-driven optimization and intelligent vision, leveraging cutting-edge modeling and experimental techniques.

MULTISCALE PHASE CHANGE PHYSICS
- **Multiscale condensation phenomena:** We investigate and tailor multiscale condensation behaviors utilizing novel experimental platform and new methodologies to enable more effective energy conversion and thermal management.
- **Computer vision for phase change:** We investigate dynamic condensation phenomena by applying computer vision algorithms to understand and predict complicated phase change processes.

INTELLIGENT THERMAL MANAGEMENT & CONVERSION
- **AI-based intelligent thermal management for chiplet semiconductors:** We develop effective thermal packaging for chiplet semiconductors by combining the surrogate model-based optimization, novel thermal materials, and experimental validation.
- **High-efficiency cooling for datacenters, electric vehicles and weapon systems:** We develop advanced cooling solutions with an extreme energy efficiency.



RESEARCH HIGHLIGHTS

An energy-efficient battery thermal management system incorporating a porous metal-based multiscale flow manifold: By incorporating a porous metal layer into the optimized manifold flow distributor, we achieved significant enhancements in both the heat exchange area and the uniformity of flow distribution within a battery thermal management system. This innovative thermal design utilizes a flow rate that is 4.2 times lower than that reported in previous studies, while providing a maximum cell temperature of ~43°C and a cell temperature variation of less than 2°C.[1]

A Scalable Haze-Free Antireflective Hierarchical Surface with Self-Cleaning Capability:
Self-cleaning surfaces often face the challenge of maintaining both high transparency and clarity. Our study introduces double-layered hierarchical surfaces obtained via a scalable spray process that permits precise control over the coating morphology to attain the desired optical and wetting properties. The coating provides an unprecedented transparency rate over 97% and record-high self-cleaning capabilities. When the coating is applied to photovoltaic cells, it significantly boosts power conversion efficiency, particularly in the environments subject to contamination.[2]

Long-lasting ceria-based anti-frosting surfaces: We introduced a robust ceria-based anti-icing surface utilizing spontaneous hydrocarbon adsoprtion, circumventing the need for surface coatings that pose durability risks. This coating demonstrated a notable decrease (up to ~90%) in both frost propagation speed and ice adhesion strength, compared to untreated surfaces. Even following 200 cycles of frosting/de-frosting and
exposure to 15,000 cycles of acidity/salinity tests, the coating sustained its high anti-icing performance. [3]

SELECTED PUBLICATIONS

[1] S. Ki, J. Lee, S. Kim, J. Seong, J. Shim, S. Oh, S. Cho, S. Bang, D. Seo, J. Kim, Y Nam, An energy-efficient battery thermal management system incorporating a porous metal-based multiscale flow manifold, Passive Anti-Flooding Superhydrophobic Surfaces, Energy Conversion and Management, 269, 116147 (2022)

[2] S. Oh, J. Cho, J. Lee, J. Han, S. Kim, Y. Nam, A Scalable Haze-Free Antireflective Hierarchical Surface with Self-Cleaning Capability, Advanced Science, 9(27), 2202781 (2022)

[3] J. Shim, S. Oh, S. Kim, D. Seo, S. Shin, H. Lee, Y. Ko, Y. Nam, Long-lasting ceria-based anti-frosting surfaces. International Communications in Heat and Mass Transfer, 140, 106550 (2023)



Assistant Professor
NOH, Minkyun

Ph.D., MIT [2018]

Research Interest

- Electric motors and drives
- Magnetic levitation systems
- Control, instrumentation, and robotics
- Mobility electrification
- Advanced manufacturing systems

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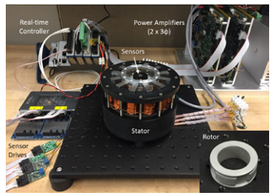
Precision Mechatronics Laboratory

RESEARCH OVERVIEW

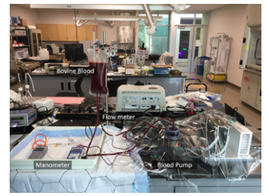
The Precision Mechatronics Laboratory at KAIST conducts research to develop novel & useful mechatronic systems via precise integration of mechanical design, electromechanics, controls, and electronics. We are enthusiastic about the approach of design for control. That is, instead of designing a mechatronic system sequentially from the hardware to control, we design the feedback system as a whole with consideration of control from the beginning. This approach enables us to create innovative mechatronic solutions with improved performance. Our research on precision mechatronics explores creative breakthroughs in various industrial applications, such as future mobility, energy conversion, and advanced manufacturing systems.

RESEARCH HIGHLIGHTS

Magnetically levitated blood pumps for life support: We developed a bearingless blood pump whose rotor-impeller assembly is magnetically levitated and rotated by a single stator unit. The contact-free operation reduces heat and stress imposed on the blood cells, thereby preventing hemolysis and thrombosis. A novel aspect of the pump is that the rotor does not include permanent magnets. This reduces the unit cost of the pump head which should be disposed for each patient each time.

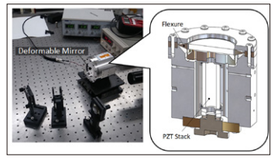


[Figure 2]
Bearingless motor control system.



[Figure 1]
In-vitro blood pumping test.

Deformable mirror for laser wavefront precision control: We developed a new type of piezo-actuated deformable mirror for the laser interferometer gravitational-wave observatory (LIGO). This is a system that can precisely change the curvature of a mirror for mode matching between a laser beam and an optical filter cavity, thereby reducing the optical quantum noise. Since the LIGO mirrors need to be super-polished for the required surface figure, we cannot use a thin mirror (< 1mm) as in typical adaptive optics. Instead, we developed a novel flexure mechanism that holds a thick mirror (6mm) and applies a distributed moment on the mirror barrel with a piezo actuator.



[Figure 3]
Piezo-actuated precision deformable mirror.



[Figure 4]
Photo of the Laser Interferometer Gravitational-wave Observatory (LIGO).

SELECTED PUBLICATIONS

[1] B. S. Weinreb, M. Noh, D. C. Fyler, and D. L. Trumper, “Design and implementation of a novel interior permanent magnet bearingless slice motor,” IEEE Transactions on Industry Applications, vol. 57, no. 6, pp. 6774–6782, Nov/Dec. 2021.

[2] M. Noh and D. L. Trumper, “Homopolar bearingless slice motor with flux-biasing Halbach arrays,” IEEE Transactions on Industrial Electronics, vol. 67, no. 9, pp. 7757–7766, Sep. 2020.

[3] M. Noh, D. P. Mooney, and D. L. Trumper, “Magnet-assisted hydraulic bougienage for correction of long-gap esophageal atresia,” IEEE Transactions on Biomedical Engineering, vol. 65, no. 10, pp. 2178–2189, Oct. 2018.

[4] M. Noh, W. Gruber, and D. L. Trumper, “Hysteresis bearingless slice motors with homopolar flux-biasing,” IEEE/ASME Transactions on Mechatronics, vol. 22, no. 5, pp. 2308–2318, Oct. 2017.

[5] M. Noh, S. W. Kim, S. An, J. S. Koh, and K. J. Cho, “Flea-inspired catapult mechanism for miniature jumping robots,” IEEE Transactions on Robotics, vol. 28, no. 5, pp. 1007–1018, Oct. 2012.

Soft Robotics and Intelligent Materials Laboratory



Professor
OH, Il-Kwon

Ph.D., KAIST [2001]

Research Interest

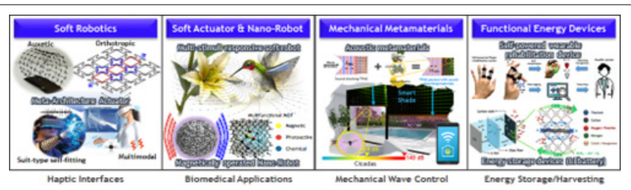
- Soft Robotics
- Soft Actuators & Nano-Robots
- Mechanical Metamaterials
- Functional Energy Devices

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RESEARCH OVERVIEW

In our cutting-edge research, we develop next-generation mechanical engineering devices, which can address engineering challenges in the field of **(1) Soft Robotics, (2) Soft Actuators & Nano-Robots, and (3) Functional Energy Devices.**

(1) Soft Robotics Soft robotics encompasses a range of technologies that are characterized by their softness, including a wearable haptic technology that provides physical tactile and kinesthetic feedback when worn on the body. Our implementation includes metastructure-based soft haptic interfaces for teleoperation of unmanned aerial vehicles, robots and intuitive interaction in digital virtual environments.
(2) Soft Actuators & Nano-Robots Soft actuators are an innovative technology that enables the creation of artificial muscles capable of replicating the intricate movements of natural muscles. Nano-robots are advanced technologies that enable precise navigation at ultra-miniature sizes. They play a crucial role in the healthcare sector, such as targeted drug delivery and minimally invasive surgery.
(3) Mechanical Metamaterials Mechanical metamaterials are a technology that enables structural inno-vations beyond the inherent limitations of conventional materials. Our goal is to design structures with functionalities such as wave control and noise attenuation through technological advancements.
(4) Functional Energy Devices Functional energy devices encompass various energy-related technologies, including energy harvesting techniques, storage solutions (such as batteries and supercapacitors), and structural batteries with the load-bearing capabilities. Our research aims to enhance the energy density, efficiency, and longevity of these systems to effectively address the increasing global energy demands.



RESEARCH HIGHLIGHTS



Il-Kwon Oh's lab reports an electronically conjugated polysulfonated covalent organic framework (pS-COF) used as a common electrolyte-electrode host for 1-ethyl-3-methylimidazo-lium cation embedded into a Nafion membrane. The pS-COF–based soft electrochemical actuator exhibits remarkable bending deflection at near-zero voltage (~0.01V) and previously unattainable blocking force, which is 34 times higher than its own weight. (Sci. Adv. 2023 9, 50, eadk975)



Il-Kwon Oh's lab unveils an easy-to-wear, multimodal, wearable haptic auxetic fabric prepared by knotting shape-memory alloy wires into an auxetic architecture fabric. Incorporating meta-design allows the WHAF to seamlessly adapt to skin contours, and surface electrical properties of the WHAF are modulated to deliver zone-specified tactile feedback to users, bridging between the real and virtual worlds. (Adv. Mater. 2023 35, 47, 2304442)

SELECTED PUBLICATIONS (2022-2023)

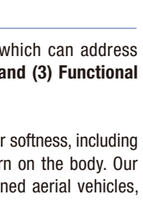
[1] "Functionally Antagonistic Polyelectrolyte for Electro-Ionic Soft Actuator", Nature communications 2023, 15, 435

[2] "Polysulfonated Covalent Organic Framework as Active Electrode Host for Mobile Cation Guests in Electrochemical Soft Actuator", Science Advances 2023, 9, 50, eadk975

[3] "Easy-To-Wear Auxetic SMA Knot-Architecture for Spatiotemporal and Multimodal Haptic Feedbacks", Advanced Materials 2023, 35, 47, 2304442

[4] "A Dual-Responsive Magnetoactive and Electro–Ionic Soft Actuator Derived from a Nickel-Based Metal–Organic Framework", Advanced Materials 2022 34, 35, 2203613

Photonic Imaging Laboratory



Professor
OH, Wang-Yuhl

Ph.D. KAIST [1997]

Research Interest

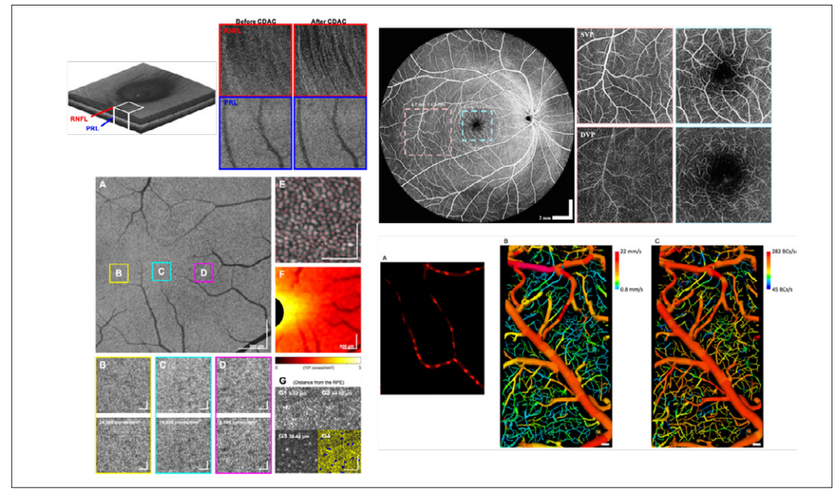
- Multifunctional OCT
- Ultrahigh-speed OCT
- Cardiovascular Optical Imaging
- Ophthalmic Optical Imaging
- Studies on animal disease models

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RESEARCH OVERVIEW

The main research interests of our laboratory are focused on the development of advanced optical imaging techniques for various applications, such as clinical medicine, biological research and industrial inspection. To address and solve important problems in medicine, biology, and industrial inspection, inter/multidisciplinary collaboration integrating our top-notch photonic imaging capability with expertise in medicine, biology, and industry is critical. Current research projects include development of ultrahigh-speed multifunctional optical coherence tomography (OCT) system and its application to ophthalmic imaging, imaging study on various animal disease models and new drug development, and industrial inspection.
Active clinical collaborations are going on in major hospitals around the world including Korea University Guro Hospital, Seoul, Korea, Seoul National University Bundang Hospital, Bundang, Harvard Medical School, Massachusetts General Hospital, Boston, USA, and various industrial partners.

RESEARCH HIGHLIGHTS



Recent research has focused on (1) the development of multi-MHz ultrahigh-speed OCT light source and system, (2) their application to 3D depth-invariant cellular-resolution imaging and ultrawide-field OCT angiography, and (3) direct imaging of blood cell flow.

SELECTED PUBLICATIONS

[1] G. Kim, H.S. Park, P. Shin, T. Eom, J.H. Yoon, Y. Jeong, and W.Y. Oh, "Direct Blood Cell Flow Imaging in Microvascular Networks," Small 19, 2302244 (2023).

[2] B.K. Lee, S. Jeong, J. Lee, T.S. Kim, B. Braaf, B.J. Vakoc, and W.Y. Oh, "Wide-Field Three-Dimensional Depth-Invariant Cellular-Resolution Imaging of the Human Retina," Small 19, 2203357 (2023).

[3] B.K. Lee, W. Kang, S.H. Oh, S. Cho, I. Shin, E.J. Oh, Y.J. Kim, J.S. Ahn, J.M. Yook, S.J. Jung, J.H. Lim, Y.L. Kim, J.H. Cho, and W.Y. Oh, "In vivo imaging of renal microvasculature in a murine ischemia-reperfusion injury model using optical coherence tomography angiography," Sci. Rep. 13, 6396 (2023).

[4] J.H. Yoon, P. Shin, J.Y. Joo, G.S. Kim, W.Y. Oh, and Y. Jeong, "Increased capillary stalling is associated with endothelial glycocalyx loss in subcortical vascular dementia," J. Cereb. Blood Flow Metab. 42, 1383 (2022).

Dynamic Robot Control and Design Laboratory



Associate Professor
PARK, Hae-Won

Ph.D., University of Michigan [2012]

Research Interest
- Control and design of dynamic robot systems
- Legged locomotion robots
- Bio-inspired robots

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RESEARCH OVERVIEW

The central objective of my research is to make fundamental contributions to the understanding of legged systems to grant high efficiency, extreme agility, and remarkable versatility to robot systems. The robots with such high-performance features will possess extreme mobility capable of navigating in unstructured, dynamic, and complex environments. To enable the extreme mobility, my approach offers a vertically integrated research strategies across mechanical design, modeling, simulation, and control of legged systems. My group investigates novel hardware design and control framework for legged robot systems utilizing approaches from design optimization, geometric methods for robotics, optimal control, and reinforcement learning. We aim to propose a unified and systematic design method for control and planning algorithm and hardware systems of legged robots.

RESEARCH HIGHLIGHTS

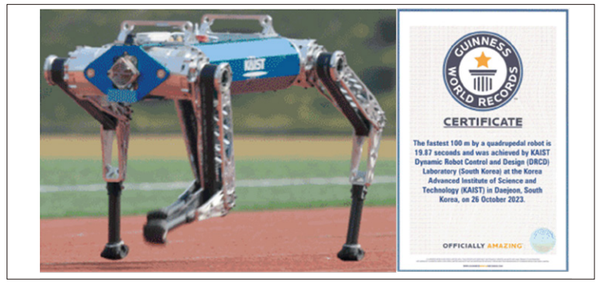
Our lab has achieved significant breakthroughs in developing legged robots, from hardware design to control systems. In hardware, we designed the quadrupedal robot HOUND by optimizing gear teeth to enhance energy efficiency, torque, and speed for high-speed running. Additionally, we developed MARVEL, a robot capable of agile locomotion on steel structures, utilizing an electro-permanent magnet (EPM) to sustain magnetic force without continuous electricity to the robot's feet. This achievement was published on the cover of Science Robotics, the most cited journal in robotics. We've delved into both model-based and learning-based methods for various legged robot applications. For instance, we developed a Model Predictive Control (MPC) method that eliminates singularity issues by utilizing orientation representation on the SO(3) manifold. This innovative approach was applied to the MARVEL control system, enabling stable movements even on upright or reverse walls. Moreover, we pioneered a contact-implicit MPC framework for generating motion without predefined contact planning. In learning-based approaches, we set a new Guinness World Record for the 100m run of a legged robot powered by an electric motor, achieved through a reinforcement learning controller applied to HOUND. Furthermore, leveraging motion data obtained from Single Rigid Body Trajectory Optimization, HOUND learned various skills such as climbing stairs, crossing gaps, and jumping over obstacles. Our research on state estimation includes applying a slip rejection algorithm to the Invariant smoother, enabling robust state estimation even when the foot slides. This work was published in IEEE-TRO, further contributing to the advancement of legged robot technology.

SELECTED PUBLICATIONS

[1] Agile and versatile climbing on ferromagnetic surfaces with a quadrupedal robot, Science Robotics (7(73), eadd1017) , 2022

[2] Invariant Smoother for Legged Robot State Estimation With Dynamic Contact Event Information, IEEE Transactions on Robotics (40(1), 193-212), 2023

[3] Seamless Reaction Strategy for Bipedal Locomotion Exploiting Real-Time Nonlinear Model Predictive Control, IEEE Robotics and Automation Letters (8(8), 5031-5038), 2023



[그림 1] 100m 트랙을 고속보행하는 Hound와 기네스 세계기록



[그림 2] science robotics 표지

Neuro-Rehabilitation Engineering Laboratory



Professor
PARK, Hyung-Soon

Ph.D., KAIST [2004]

Research Interest
- Rehabilitation Robotics,
- Brain-Machine Interface,
- Orthopedic Biomechanics

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RESEARCH OVERVIEW

Our mission is to improve quality of life of those who suffer from physical impairments due to injuries. We apply engineering principles to enhance the effectiveness of rehabilitation after injuries and to improve reliability and accuracy of clinical assessments. We try to understand the mechanism of recovery to suggest optimal rehabilitation program after injuries. These research themes not only improve the quality of life of patients and disabled people but also help build better healthcare systems for our increasingly aging society.

RESEARCH HIGHLIGHTS

Brain-Computer Interface [Fig.1]

Electroencephalography (EEG)-based brain-computer interface (BCI) have been actively studied due to their high time resolution, convenient use, and portability. To implement a robust and high-accuracy BCI, we developed an EEG-Electromyography (EMG) hybrid intention recognition system and an intention recognition system using the ultra-high density EEG. The EEG-EMG hybrid system is able to classify four grasping intentions that are frequently used in daily life. It is more robust and accurate than conventional EEG BCI systems. Furthermore, in our study to decode accurate body movements, such as finger movements, we observed focal post-queue activation related to each finger movement using the high spatial resolution of the Ultra high density EEG.

Prosthetic Hand for Dexterous Motion [Fig.2]

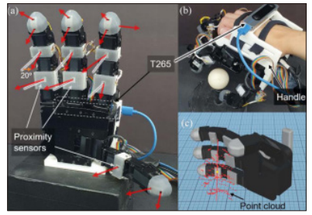
For the dexterous motion of a human-like prosthetic hand, we developed a biomimetic three-layer skin structure mimicking the unique stiffness characteristics of the human palm, and a biomimetic carpometacarpal joint with 2 degrees of freedom to enable dexterous motions like scrolling. Furthermore, we developed a novel shared autonomy grasping control system: Proximity Perception-based Grasping Intelligence (P2GI). Using proximity sensors embedded in the prosthetic hand, the algorithm estimates the object's shape and pos, and infers the intended grasp posture. This system allows the user to utilize various grasp postures using a single-channel surface electromyography (sEMG) signal.

Muscle Synergy [Fig.3]

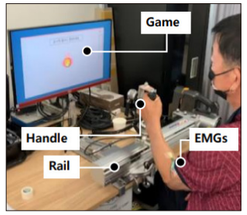
Abnormal intermuscular coordination limits the motor capability of stroke-affected upper limbs. We investigated the impact of stroke on the control of upper limb endpoint force during isokinetic exercise and its association with muscle synergies. Collecting three-dimensional upper limb endpoint force and electromyography of shoulder and elbow muscles from chronic stroke survivors and neurologically intact adults, the relevance of muscle synergies on endpoint force control were analyzed. Based on this relevance, we developed isokinetic training to correct the abnormal synergy activation patterns post-stroke.



[Fig.1]



[Fig.2]



[Fig.3]

SELECTED PUBLICATIONS

[1] Park, Jeong-Ho, Joon-Ho Shin, Hangil Lee, Jinsook Roh, and Hyung-Soon Park. “Relevance of Upper Limb Muscle Synergies to Dynamic Force Generation: Perspectives on Rehabilitation of Impaired Intermuscular Coordination in Stroke.” IEEE Transactions on Neural Systems and Rehabilitation Engineering 31 (2023): 4851-4861.

[2] Heo, Si-Hwan, and Hyung-Soon Park. “Proximity Perception-Based Grasping Intelligence: Toward the Seamless Control of a Dexterous Prosthetic Hand.” IEEE/ASME Transactions on Mechatronics (2023).

[3] Bae, Sungjin, and Hyung-Soon Park. “Development of Immersive Virtual Reality-Based Hand Rehabilitation System Using a Gesture-Controlled Rhythm Game With Vibrotactile Feedback: An fNIRS Pilot Study.” IEEE Transactions on Neural Systems and Rehabilitation Engineering (2023).

[4] Su, Huimin, Kyoung-Soub Lee, Yusung Kim, and Hyung-Soon Park. “A Soft, Wearable Skin-Brace for Assisting Forearm Pronation and Supination with a Low-Profile Design.” IEEE Robotics and Automation Letters 7.4 (2022): 12078-12085.

[5] Cho, Seongyun, Kun-Do Lee, and Hyung-Soon Park. “A Mobile Cable-Tensioning Platform to Improve Crouch Gait in Children with Cerebral Palsy.” IEEE Transactions on Neural Systems and Rehabilitation Engineering 30 (2022): 1092-1102.

[6] Kim, Dong Hyun, Kun-Do Lee, Thomas C. Bulea, and Hyung-Soon Park. “Increasing motor cortex activation during grasping via novel robotic mirror hand therapy: a pilot fNIRS study.” Journal of NeuroEngineering and Rehabilitation 19.1 (2022): 1-14.

[7] Bhatia, Divij, Kyoung-Soub Lee, Muhammad Umer Khan Niazi, and Hyung-Soon Park. “Triboelectric nanogenerator integrated origami gravity support device for shoulder rehabilitation using exercise gaming.” Nano Energy 97 (2022): 107179.

[8] Kim, Yusung, and Hyung-Soon Park. “The Switchable Cable-Driven Mechanism to Control Multiple Cables Individually Using a Single Motor.” IEEE Robotics and Automation Letters 7.2 (2022) 4376-4383.



Professor

Park, Inkyu

Ph.D., University of California, Berkeley [2007]

Research Interest

- Micro/Nano Manufacturing
- Smart Sensors for Environment & Energy
- Smart Sensors for Biomedical, Clinical & Healthcare
- Wearable Sensors for HMI & Metaverse

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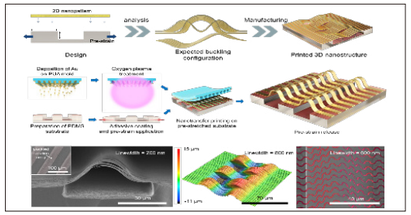
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http://mintlab1.kaist.ac.kr

Machine Intelligence and Novel-sensor Technology (MINT) Laboratory

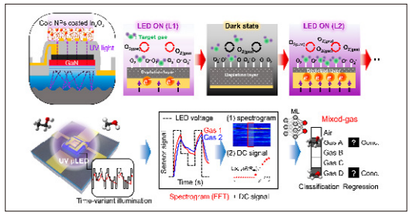
RESEARCH OVERVIEW

The needs for smart sensors are rapidly growing in the Industry 4.0 era. The main research directions for KAIST MINT Lab are to develop smart sensors based on the functional micro/nanostructures and artificial intelligence (AI) towards environmental monitoring, healthcare, biomedical, and robotics applications. We rigorously use machine learning not only to find optimal designs for physical and chemical sensors, but also to process complex data produced by the sensors. We have developed several core sensor technologies such as (1) ultra-low-power micro-LED based gas sensors for smart electronic nose systems, (2) AI-based high-accuracy gas sensing systems, (3) large scale pressure sensor array for real-time patient monitoring, (4) multi-functional wound healing patch, (5) wireless, battery-free platform for multiplexed skin condition monitoring, etc. **(Research Achievements: 37 International Journal Articles & 18 Cover Articles (2022-2023))**

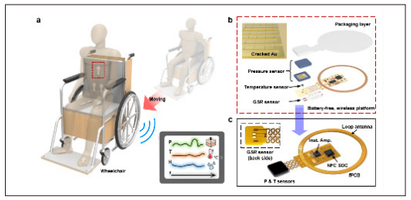
- Multiscale and Hybrid Micro/Nano Manufacturing [Fig 1]
- Micro/Nano Sensors for Environment & Energy Monitoring [Fig 2]
- Micro/Nano Sensors for Biomedical, Clinical & Healthcare Applications [Fig 3]
- Wearable Sensors for Human-Machine Interface & Metaverse Applications [Fig 4]



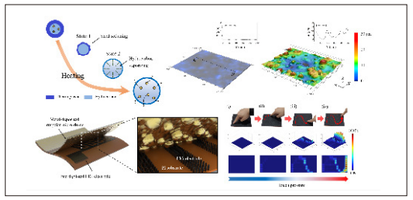
[Fig.1]



[Fig.2]



[Fig.3]



[Fig.4]

Research Highlights (Media Coverage)

[1] KAIST develops ultra low-power electronic nose system using micro LED based monolithic semiconductor gas sensor array (Dong A Science, Feb 14, 2023)

[2] KAIST develops novel printed electronics manufacturing process for the next generation 3D semiconductor device fabrication (Chosun Ilbo, April 4, 2023)

SELECTED PUBLICATIONS (* as a corresponding author)

[1] J. Ahn, **I. Park***, “Micro/nano hierarchical structures physically engineered on surface: analysis and perspectives”, *Adv. Mater.* 2300871 (2023)

[2] I. Cho, **I. Park***, “Deep-learning-based gas identification by time-variant illumination of a single micro-LED-embedded gas sensor”, *Light Sci. & Appl.* 12, 95 (2023)

[3] J. Ahn, **I. Park***, “Nanoscale three-dimensional fabrication based on mechanically guided assembly”, *Nat. Commun.* 14, 833 (2023)

[4] J. Ahn, **I. Park***, “All-recyclable triboelectric nanogenerator for sustainable ocean monitoring systems”, *Adv. Ener. Mater.* 12, 2201341 (2022)

Biomechanics Laboratory



Professor
PARK, Sukyung

Ph.D., University of Michigan, Ann Arbor [2002]

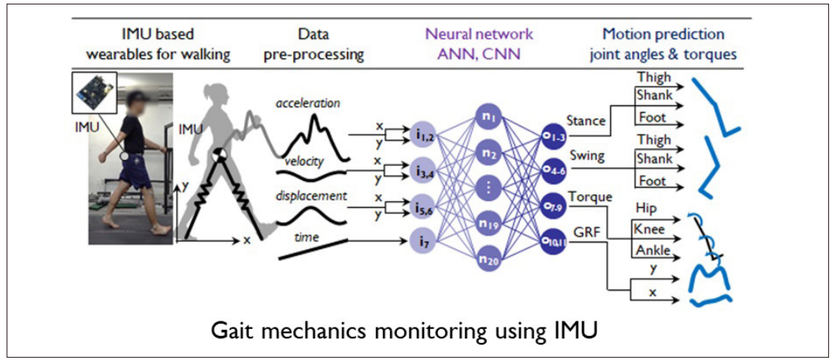
Research Interest

- Dynamic Walking
- Sports Biomechanics
- Wearable sensor systems
- Postural Control
- Sensory Integration

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RESEARCH OVERVIEW

Biomechanics Lab aims to contribute to understand the mechanics of human movement and to develop the engineering applications of biomechanics. Recent research interests focus on the mechanics of human walking and running, the sports biomechanics, the wearable device research for motion monitoring and analysis, and the motion estimation using machine learning. The dynamics of body center of mass of human during walking and running has been known to share compliant mechanics represented by a spring-loaded inverted pendulum. Thus, we proposed a compliant bipedal model that reproduces the human walking and running dynamics and joint kinematics. This simple but representative gait model could be used to reduce the system complexity of wearable devices for human motion analysis and monitoring. During human locomotion, we can estimate kinetic and kinematic data, as well as mechanical work and energy expenditure, which are key indicators for performance monitoring and health care, using simple wearables like a smartwatch. Recently, we have addressed several technical issues that needed to be resolved for inertial sensor-based human motion monitoring. Specifically, we proposed a novel coordinate transformation method that converts the relative coordinates of inertial sensors into absolute coordinates based on the kinematic characteristics of a golf swing, using an IMU sensor worn on the wrist. Additionally, we proposed a method to reduce drift errors occurring during integration. Two PhD students from our lab previously founded a startup called BEFLEX, developing a microchip incorporated into earphones that analyzes biomechanical characteristics during exercise based on head acceleration. BEFLEX has successfully secured Series A funding and launched a home training app called '32Go,' which enables exercise analysis using earphones.



Gait mechanics monitoring using IMU



Estimate Energy Expenditure for outdoor running



RESEARCH HIGHLIGHTS

[1] Myeongsub Kim, and Sukyung Park, Enhancing Accuracy and Convenience of Golf Swing Tracking with a Wrist-Worn Single Inertial Sensor, Scientific Reports, 2024

[2] Sukyung Park, **Keynote Lecture at the International Society of Biomechanics 2023** (ISB2023) conference held in Fukuoka, Japan. The title of the keynote lecture was "Complementary Roles of Biomechanics and Machine Learning in Human Motion Monitoring".

[3] Bumjoon Kim, and Sukyung Park, Improving estimation accuracy of energy expenditure during running from a single IMU by estimating mechanical power via estimating ground reaction force, International Society of Biomechanics, 2023

[4] Myeongsub Kim, and Sukyung Park, Tracking golf swing trajectory using a single imu by applying biomechanics and machine learning, International Society of Biomechanics, 2023

Human-Machine Interaction Laboratory



Associate Professor
PARK, Yong-Hwa

Ph.D., KAIST [1999]

Research Interest

- High-fidelity Vibration Analysis and Condition Monitoring
- Auditory Intelligence and Sound-based Event Detection
- Human Sound and Vibration for Health Monitoring
- 3D Optical Measurement (Lidar) and Remote Sensing

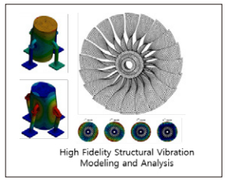
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RESEARCH OVERVIEW

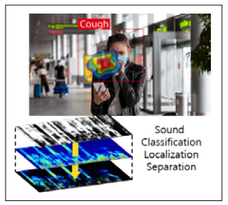
HUMAN lab's research goal is to understand the dynamical behavior of systems to identify the conditions of human and machines through vibration, sound, and optical means. The focused research topics include high-fidelity vibration analysis, auditory intelligence, health monitoring and 3D optical measurement (Lidar) with applications to deep learning-based condition monitoring. Machine condition monitoring and fault diagnosis are strongly pursued through the vibration and acoustic domain-knowledge in conjunction with physics-informed deep learning. We consider the human body as a complex dynamical system to predict the health conditions in a non-invasive way. 3D optical measurement (Lidar) is developed for the remote-sensing-monitoring problems. The state-of-the-art physics-informed deep learning architectures are intensively developed as a platform algorithm for the inference of the conditions and aiming for the attractive industrial applications under interdisciplinary collaborations as follows:

RESEARCH HIGHLIGHTS

High-fidelity Vibration Analysis and Vibration-based Condition Monitoring: As theoretical foundation, vibration analysis of the structures focusing on inverse problem is studied. High-fidelity finite element simulation framework of multi-dimensional problems (time-frequency-parameter dimensions) is developed using a novel domain decomposition (PGD). Experimental modal analysis, finite element model updating, and parameter identification methods are studied as key building blocks. These provide a novel computational framework so-called high-fidelity digital twin for condition monitoring and prognostics and health management (PHM) in conjunction with the unique vibration knowledge-based deep learning architecture.


High Fidelity Structural Vibration Modeling and Analysis

Auditory Intelligence and Sound-based Event Detection: Targeting human-like robust sound event detection against harsh listening conditions in real world, we utilize knowledge of the human auditory systems for sound classification, localization, and separation in conjunction with the state-of-the-art neural network in time-frequency-spatial domain. We pursue the binaural (2-ears) sound recognition for humanoid robot applications by in-depth functional analysis of human auditory system including head related transfer function (HRTF), various auditory filters and auditory cortex neural responses. Machine diagnosis, person/risk identification, health sensors, humanoid robot and metaverse are relevant project applications.

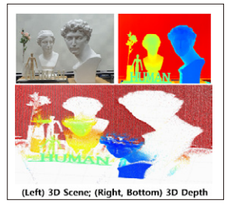


Human Sound and Vibration for Health Monitoring: Non-invasive health monitoring methodology by means of human sound and vibration is studied including cardiovascular health monitoring (blood pressure, vascular age), continuous glucose monitoring, and respiratory diseases detection (Covid-19). Intensive coupled-field finite element analysis, bio mimicking hardware prototyping (virtual patient) and time-frequency signal analysis are articulated in an interdisciplinary fashion. To effectively model the nonlinear vibration of the human body, the deep-operational neural net (Deep-O-Net)-based architecture is intensively studied and utilized. Wearable, non-invasive, continuous monitoring health sensors are expected outcomes.



3D Optical Measurement(Lidar) and Remote Sensing: As the Human lab's unique and well-established measurement technology, 3D Lidar sensors are developed as key enabling technology for the remote sensing of human and machine conditions. The target is miniaturization of the system tackling various crucial problems in 3D sensing

Lidar products, by providing compact, low-cost, with high-resolution utilizing patented novel optical system and parallel-phase demodulation architecture in conjunction with 3D-recognition deep learning algorithms. High-precision 3D measurement for autonomous vehicles; robots; manufacturing process; machine diagnosis; and human condition monitoring are project applications.



(Left) 3D Scene; (Right, Bottom) 3D Depth

SELECTED PUBLICATIONS

Journals

[1] Gil-Yong Lee and Yong-Hwa Park, “Reduced-order modeling via proper generalized decomposition for uncertainty quantification of frequency response functions”, Computer Methods in Applied Mechanics and Engineering, Vol.401, 2022

[2] Gyeong-Tae Lee, H.W. Nam, S.H. Kim, S.M. Choi, Y.K. Kim, Yong-Hwa Park, “Deep learning based cough detection camera using enhanced features”, Expert Systems with Applications, 2022

[3] Jae-Hak Jeong, B. Lee, J. Hong, C. Min, A.P. Ria, T.H. Yang, Yong-Hwa Park, “Cardiovascular hardware simulator and artificial aorta-generated central blood pressure waveform database according to various vascular ages for cardiovascular health monitoring applications”, Computers in Biology and Medicine, 108224, 2024

[4] Bomi Lee, J.H. Jeong, J. Hong, Yong-Hwa Park, “Correlation analysis of human upper arm parameters to oscillometric signal in automatic blood pressure measurement”, Scientific Reports, Vol.12, 2022

[5] Sung-Hyun Lee, W.H. Kwon, Y.S. Lim, and Yong-Hwa Park, “Highly precise AMCW time-of-flight scanning sensor based on parallel-phase demodulation”, Measurements, 2022

Multiscale Mechanics and Materials Modeling Laboratory



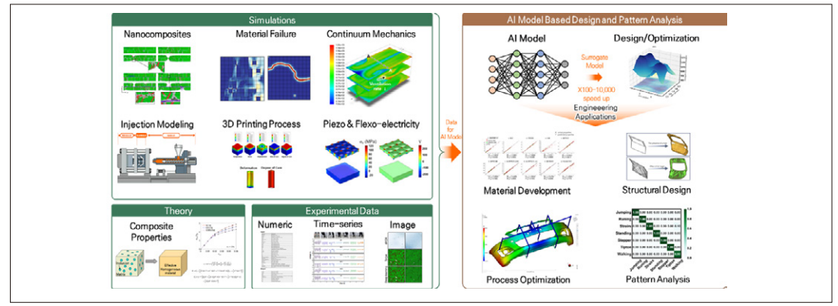
Professor
RYU, Seunghwa

Ph.D., Stanford University
[2011]

Research Interest

- AI based Design of Materials, Shape, and Process
- Computational Multiscale Mechanics of Materials.
- Mechanical Reliability Test of Composites
- Homogenization Theory

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RESEARCH OVERVIEW

Application of AI to Manufacturing Processes

With the advancement of machine learning (ML) techniques, extensive efforts are underway to establish alternative data-driven design frameworks for finding the optimal microstructure, external shape, and processing condition of composite materials and structures. We establish systematic design strategies using machine learning by accounting for the size of design space, size and fidelity of the dataset.

Understanding Material Properties With Multiscale Modeling and Theory

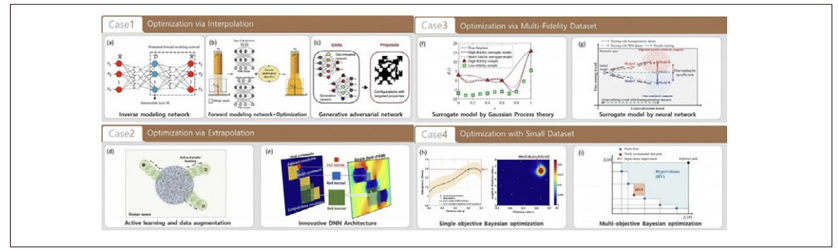
Properties of nano/micro materials and composites can be accurately predicted and optimized, provided that one has fundamental understanding of the mechanical properties. By combining multiscale simulations and theoretical modeling, we aim to fundamentally understand and characterize the mechanical properties of technologically important materials.

Composite Theory, Numerical Modeling, and Experiments

For optimized synergy between reinforcement and matrix, man-made and biological composites are assembled with different microstructures to meet specific requirements: first, particulate-reinforced composites in which particulate reinforcements are randomly dispersed in a matrix; second, composites with relatively periodic and regular microstructures that can often be found in natural composites made with self- assembly process and biomimetic composites; and third, composites with fully random microstructures. For facile design and application of composites, we aim to develop theoretical and numerical methods for three different composite configurations to predict effective composite properties in terms of shape, volume fraction, and spatial distribution of the reinforcements.

RESEARCH HIGHLIGHTS

Machine learning-based inverse design methods considering data characteristics and design space size in materials design and manufacturing: a review



SCHEMATIC OF STRATEGIC DATA-DRIVEN DESIGN CATEGORIZED IN FOUR CASES.
The landscape of material science and manufacturing has transformed significantly with the advent of machine learning (ML). This toolkit of data driven methods accelerated the discovery and production of new materials by accurately predicting the complicated physical processes and mechanisms that are not fully described by existing material theories. Yet, with an array of intricate ML models at our disposal, the pressing question remains: Which ML algorithm is best suited for our needs? In this review, we aim to provide insights to strategically select appropriate models aligned with specific design challenges. [Materials Horizons 10, 5436 (2023).

SELECTED PUBLICATIONS

[1] "Machine learning-based inverse design methods considering data characteristics and design space size in materials design and manufacturing: a review", Materials Horizons 10, 5436 (2023).

[2] "Multi-objective Bayesian optimization for the designing of nacre-inspired composites: optimizing and understanding the biomimetics through AI", Materials Horizons 10, 4329 (2023).

[3] "Free-form optimization of pattern shape for improving mechanical characteristics of a concentric tube", Materials & Design 230, 111974 (2023).

[4] "Configurable crack wall conduction in a complex oxide", Nano Letters 23, 398 (2023).

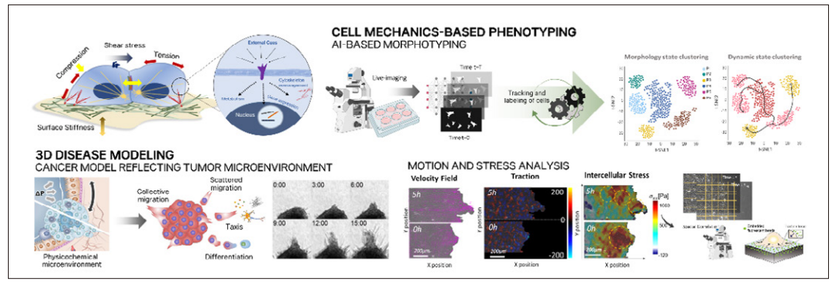
[5] "Optimization of Injection Molding Process using Multi-objective Bayesian Optimization and Constrained Generative Inverse Design Networks", International Journal of Intelligent Manufacturing 34, 3623 (2023).

[6] "Machine Learning-enabled Development of High Performance Gradient-index Phononic Crystals for Energy Focusing and Harvesting", Nano Energy 103, 107846 (2022).

[7] "Improved incrementally affine method for viscoelastic-viscoplastic composite by utilizing an adaptive scheme", Composite Structures 297, 115982 (2022).

[8] “Deep Neural Network-Based Structural Health Monitoring Technique for Real-time Crack Detection and Localization using Strain Gauge Sensors”, Scientific Reports 12, 20204 (2022).

Soft Biomechanics and Biomaterials Laboratory





Professor
SHIN, Jennifer Hyunjong

Ph.D., Massachusetts Institute of Technology [2004]

Research Interest

- Cell mechanics,
- Cellular mechanobiology,
- In vitro disease models,
- AI-based cell classifications & phenotyping

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http://softbm.kaist.ac.kr

RESEARCH OVERVIEW

Cells are continuously subjected to physical stimuli, leading to changes in functions like shape, movement, and survival. Our mission is to elucidate the physical principles that govern these cellular dynamics, employing quantitative experiments and analyses within controlled environments. At the core of our work is the interdisciplinary realm of mechanobiology, where we aim to uncover the connection between mechanical stressors—be it tension, shear, electrical fields, or structural topography—and subsequent cellular responses. Our research endeavors to 1) delineate the influence of physical forces on cell physiology within **cell mechanics,** 2) explore how cells interpret and convert mechanical signals into critical physiological events in **cellular mechanobiology**, and 3) harness **AI-based analytics** to classify cells, advancing diagnostics and therapeutic strategies. To support these endeavors, we engineer various experimental platforms designed to assess mechano-responses at the cellular scale. We develop 3D spheroid disease models that more closely replicate in vivo tissue properties than traditional 2D cultures, providing a more faithful representation for our investigations. We gain profound insights into cellular functions through gene and protein assays, complemented by mechanical stress evaluations via traction force and monolayer stress microscopy. This integrative mechanical framework, paired with high-capacity imaging, sharpens our understanding of cellular distinctions, enhancing our predictive power over disease progression and therapeutic efficacy to ultimately contribute to the advancements in medical science.

SELECTED PUBLICATIONS

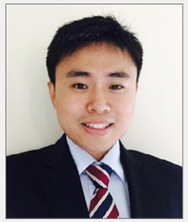
[1] Ung Hyun Ko, Jinseung Choung, Junho Lee, Suk-Hee Park, and Jennifer H Shin. Surface tension-induced biomimetic assembly of cell-laden fibrous bundle construct for muscle tissue engineering. Biomedical Materials, 18(5), 055031, (2023).
[2] Eunyoung Park, Song Ih Ahn, Jin-Sung Park, Jennifer H Shin. Shear-induced phenotypic transformation of microglia in vitro. Biophysical Journal, 122(9), 1691-1700, (2023).
[3] Somayadineshraj Devarasou, Minwoo Kang, Tae Yoon Kwon, Youngbin Cho, Jennifer H Shin. Fibrous Matrix Architecture-Dependent Activation of Fibroblasts with a Cancer-Associated Fibroblast-like Phenotype. ACS Biomaterials Science & Engineering, 9(1), 280-291, (2022).
[4] Stephani Edwina Lucia, Hyuntae Jeong, Jennifer H Shin. Cell segregation via differential collision modes between heterotypic cell populations. Molecular Biology of the Cell, 33(13), ar129, (2022).
[5] Eunyoung Park, Minseok Lee, Mong Lung Steve Poon, Eunjung Lee, Sung Gap Im, Jennifer H Shin. Wettability–Based Cell Sorting: Exploring Label−Free Isolation Strategy for Mixed Primary Glial Cell Population. Advanced Materials Interfaces, 9(22), 2200388, (2022).
[6] Avelino Dos Santos Da Costa, Ramesh Subbiah, Seung Ja Oh, Hyuntae Jeong, Jung-Im Na, Kwideok Park, In-Suk Choi, Jennifer H Shin. Fibroblasts close a void in free space by a purse-string mechanism. ACS applied materials & interfaces, 14(36), 40522-40534, (2022).
[7] Jiwon Kim, Kun-Young Park, Sungwoo Choi, Ung Hyun Ko, Dae-Sik Lim, Jae Myoung Suh, Jennifer H Shin. Ceiling culture chip reveals dynamic lipid droplet transport during adipocyte dedifferentiation via actin remodeling. Lab on a Chip, 22(20), 3920-3932, (2022).

HONORS/AWARDS

[1] The Hyung-Gyu Lim LINKGENESIS Best Teacher Award, 2022, KAIST

[2] Academic Award, 2023, Korean Society for Precision Engineering

in-situ Characterization and Reliability Evaluation Laboratory



Associate Professor
SIM, Gi-Dong

Ph.D., KAIST [2012]

Research Interest

- Mechanical Properties of Materials
- Thin Film Mechanics
- Fracture and Fatigue
- Deformation Mechanism of Materials in Extreme Environments

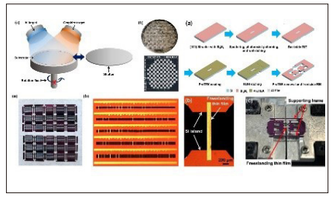
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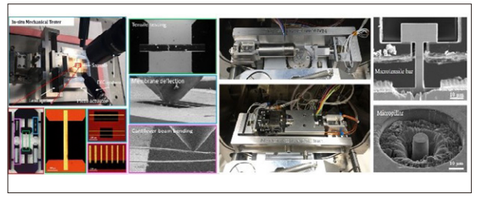
RESEARCH OVERVIEW

[1] Instrumentation and Sample Design for Mechanical Evaluation of Thin Films
- High-Throughput Sample Fabrication & Characterization [Fig.1]
- Development of Micro/Nano-scale Mechanical Testing Methods [Fig.2]

[2] Advanced Metallic Alloys Development for Extreme Environments
- Nanotwinned Metal MEMS Films with Unprecedented Strength and Stability
- Mechanical Properties and Reliability of Al-C Thin Films in Extreme Environments
- High-Temperature Mechanical Characterization of Shape Memory Alloy Thin Films

[3] Multi-scale Mechanical Characterization of Additively Manufactured Metal Alloys





RESEARCH HIGHLIGHTS

[1] Experimentally measured the material length scale parameters required for higher-order deformation theories (Materials & Design 2022, International Journal of Plasticity 2023).

[2] Developed high-throughput mechanical characterization methods for studying advanced metallic alloys including Al-C and NiTi (Journal of the Mechanics and Physics of Solids 2023, International Journal of Plasticity 2023).

[3] Investigated the mechanical properties and deformation mechanisms of additively manufactured metal alloys (Extreme Mechanics Letters 2023).

SELECTED PUBLICATIONS

[1] J.-H. Choi, H. Ryu, K.-H. Lim, J.-Y. Kim, H. Kim, G.-D. Sim, Effect of Strain Gradient on Elastic and Plastic Size Dependency in Polycrystalline Copper, International Journal of Plasticity 171 (2023) 103824.

[2] J.-H. Choi, B.-C. Lee, G.-D. Sim, Mixed finite elements based on superconvergent patch recovery for strain gradient theory, Computer Methods in Applied Mechanics and Engineering 411 (2023) 116053.

[3] K.-H. Lim, K. Ryou, J.-H. Choi, G. Choi, W.S. Choi, J.-H. Lee, C.-S. Oh, P.-P. Choi, G.-D. Sim, Effect of titanium nitride inclusions on the mechanical properties of direct laser deposited Inconel 718, Extreme Mechanics Letters 61 (2023) 102009.

[4] J.-H. Choi, W. Zaki, G.-D. Sim, Size-dependent constitutive model for shape memory alloys based on couple stress elastoplasticity, Applied Mathematical Modelling 118 (2023) 641-664.

[5] H. Kim, J.-H. Choi, Y. Park, S. Choi, G.-D. Sim, Mechanical characterization of thin films via constant strain rate membrane deflection experiments, J Mech Phys Solids 173 (2023) 105209.

[6] I. Oh, H. Kim, H. Son, S. Nam, H. Choi, G.-D. Sim, Combinatorial experiments for discovering Al-C thin films with high strength and ductility, International Journal of Plasticity 161 (2023) 103515.

[7] J.-H. Choi, H. Kim, J.-Y. Kim, K.-H. Lim, B.-C. Lee, G.-D. Sim, Micro-cantilever bending tests for understanding size effect in gradient elasticity, Materials & Design 214 (2022) 110398.

Biomedical Optics and Optical Metrology Laboratory



Associate Professor
YOO, Hongki

Ph.D. KAIST [2007]

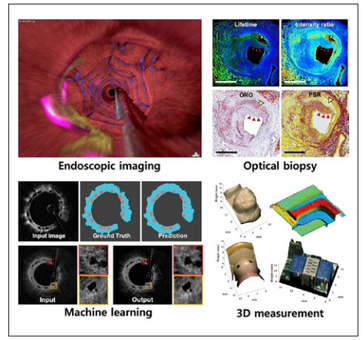
Research Interest

- Optical System Design
- Biomedical Optics
- Optical Metrology

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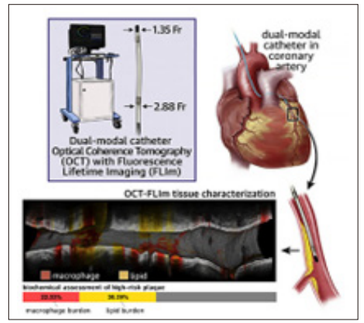
RESEARCH OVERVIEW

Research interests at the Biomedical Optics and Optical Metrology (BOOM) Lab. focus on the development of new optical imaging techniques and its applications to solve medical problems and industrial challenges. We strive to develop new optical instrumentations and methods based on advanced optical technology.
The Biomedical Optics team develops new optical instrumentations such as endoscopic imaging catheters and multimodal microscopes and translates these new technologies into preclinical and clinical research. This study will improve patient care by providing advanced diagnostic and therapeutic methods. The Optical Metrology team is developing optical imaging technologies, including confocal microscopy, spectroscopy and 3D microscopy, and solving industrial challenges by providing high-precision and high-speed metrology.
Overall, our research objective is to focus on developing novel optical systems for medical diagnostics and precision industry applications by visualizing the previously unseen.



RESEARCH HIGHLIGHTS

Synergizing optical imaging and machine learning to diagnose coronary artery disease accurately, featured in KAIST Breakthroughs, Spring 2022.
Dual-modal optical imaging and machine learning are combined to diagnose coronary artery disease accurately via a comprehensive assessment of high-risk coronary plaque without labels. Valuable images lend insight into coronary artery disease as a promising diagnostic method toward cardiovascular therapeutics.



SELECTED PUBLICATIONS

[1] J. Han, S. Kim, et al., “Label-Free Characterization of Atherosclerotic Plaques Via High-Resolution Multispectral Fluorescence Lifetime Imaging Microscopy,” Arterioscler Thromb Vasc Biol, 43:129501307, 2023

[2] S. Kim, H. S. Nam, et al., “Comprehensive Assessment of High-Risk Plaques by Dual-Modal Imaging Catheter in Coronary Artery,” JACC: Basic to Translational Science, 6(12): 948-960, 2021

[3] W. Lee, et al., “Robust autofocusing for scanning electron microscopy based on a dual deep learning network,” Scientific reports, 11: 20933, 2021

[4] J. W. Song, H. S. Nam, J. W. Ahn, et al., “Macrophage targeted theranostic strategy for accurate detection and rapid stabilization of the inflamed high-risk plaque,” Theranostics, 11(18): 8874-8893, 2021

[5] J. Kang, et al., “Label-free multimodal microscopy using a single light source and detector for biological imaging,” Optics Letters, 46(4):892-895, 2021

Computer-Aided Net Shape Manufacturing



Professor
YOON, Jeong Whan

Fellow, The Korean Academy of Science and Technology

Associate Editor, Int. J. Plasticity

Ph.D., KAIST [1997]

Research Interest
- Mechanics & Materials
- Materials Processing & Characterization

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RESEARCH OVERVIEW

The theme of research at CANESM is high reliability design and manufacturing for lightweight materials and structures. Lightweight material processing including forming and joining are the main area for research. The research goal is provide the linkages between materials science and production engineering design by developing advanced material & process (multi-scale) models for the uses in aerospace, defence, automotive, and rigid-packaging applications. The research areas cover advanced manufacturing including forming, machining and 3D printing and various structural optimization based on the finite element method. Especially we have developed the pioneering areas for various constitutive and failure modeling in plasticity including non-associated flow plasticity and stress-based failure prediction. The high impact papers have been published in the areas of fundamental plasticity and new finite element method. The proposed theories have been implemented into various commercial software material and element libraries.

RESEARCH HIGHLIGHTS

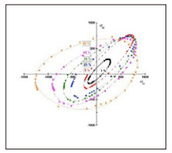
Light Weight Materials Characterization and Processing [Fig.1]
- DIC-based materials characterization
- Multi-scale modeling of constitutive behavior and fracture criteria for the direct application to production engineering

Intelligent Forming [Fig.2]
- Forming limit and fracture considering nonlinear strain paths
- Incremental sheet formimg
- AI-based forming control
- Modeling of instability including PLC effect, wrinkling, and necking

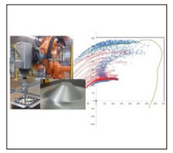
High Strain-rate Fracture [Fig.3]
- Ballistic and blast modeling
- Architecture design for armor plate
- Development of high strain-rate fracture model

Residual Stress[Fig.4]
- Prediction of distortion from residual stress
- Machining considering residual stress

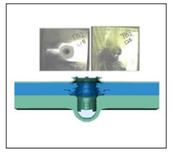
High Strain-rate characterization [Fig.5]
- Automated testing method
- DIC-based material modeling



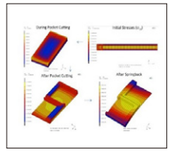
[Fig.1]



[Fig.2]



[Fig.3]



[Fig.4]



[Fig.5]

SELECTED PUBLICATIONS

[1] H. Choi, J.W., Yoon, “A new simplified distortional hardening model for nonlinear strain paths”, Int. J. of Plasticity 165, 103617 (2023).

[2] P Fazily, J.W. Yoon, “Machine learning-driven stress integration method for anisotropic plasticity in sheet metal forming”, Int. J. of Plasticity 166, 103642 (2023).

[3] C.S. Lee, J.W. Yoon, S.H. Woo, L.J. Park, “Thermal softening behavior up to fracture initiation during high-rate deformation”, Int. J. Mech. Sci., 251, 108321 (2023)

[4] Y Lou, C Zhang, S Zhang, J.W. Yoon, “A general yield function with differential and anisotropic hardening for strength modelling under various stress states with non-associated flow rule”, ”, Int. J. of Plasticity 158 103414 (2022).

[5] Q Hu, J.W. Yoon, “Anisotropic distortional hardening based on deviatoric stress invariants under non-associated flow rule”, Int. J. of Plasticity 151, 103214 (2022).

[6] H Choi, P Fazily, J Park, Y Kim, J.H. Cho, J Kim, J.W. Yoon, “Artificial intelligence for springback compensation with electric vehicle motor component”, International Journal of Material Forming 15 (3), 22 (2022).

Visual Intelligence Laboratory



Associate Professor
YOON, Kuk-Jin

Ph.D., KAIST [2006]

Research Interest
- Event-Based Computer Vision
- Label-efficient learning
- Vision-based ADAS for autonomous driving of vehicles / drones / robots
- Multi-Sensor Fusion
- 3D computer vision
- Multi-object detection and tracking

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RESEARCH OVERVIEW

At Visual Intelligence Laboratory, we target a variety of issues in the field of computer vision and machine learning. Our research focuses on creating perception algorithms that can be applied to various systems and machines such as autonomous cars, drones, medical applications, and any other AI systems. Furthermore, we target various vision tasks by using various vision sensors to improve machine perception.

RESEARCH HIGHLIGHTS

1. EVENT-BASED COMPUTER VISION [Fig.1]
- Omnidirectional Event Cameras, Event-based Image Reconstruction, Event-based Super Resolution, Stereo Depth Estimation using Events, Deblurring using Events

2. LABEL-EFFICIENT LEARNING [Fig.2]
- Weakly-supervised Semantic Segmentation, Vision Foundation Model, Domain Adaptation

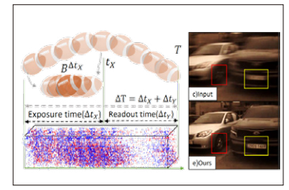
3. VISION-BASED ADAS FOR VEHICLES / DRONES / ROBOTS [Fig.3]
- Driving Scene Understanding combining 3D Sensing, Object Detection and Tracking, SLAM and Visual Odometry, Road Surface Profile Estimation, Road Segmentation

4. MULTI-SENSOR FUSION
- IMU and Camera Calibration, Indoor 3D Scene Reconstruction with Color and Depth Cameras, Fusion of a Camera and In-vehicle Sensors (IMU, Wheel Speed Sensors)

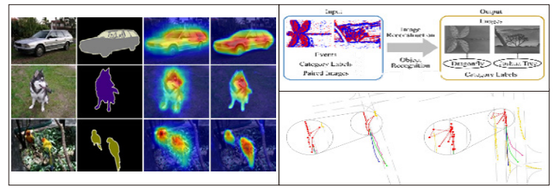
5. VISUAL SLAM, VISUAL ODOMTRY, OPTICAL FLOW ESTIMATION
- Visual Odometry, Visual-Inertial Odometry, Feature-based and Direct VO, Spatio-temporal Consistent Scene Flow Estimation

6. 3D COMPUTER VISION [Fig.3]
- Multi-view Stereo Vision, 3D Scene Flow Estimation, Visual SLAM, Structure-from-motion, Novel View Synthesis, Lidar Semantic Segmentation

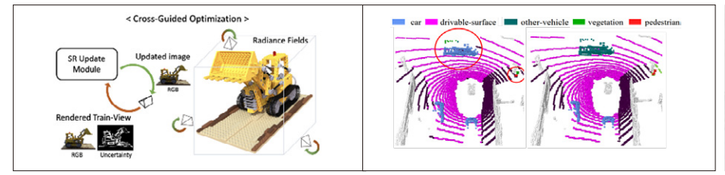
7. MULTI-OBJECT DETECTION AND TRACKING [Fig.4]
- Deep-learning-based Object Detection, Object Tracking with Relative Motion Network, Appearance Learning with Deep Learning



[Fig.1]



[Fig.2]



[Fig.3]



[Fig.4]

SELECTED PUBLICATIONS

[1] KIM, Taewoo, et al. Event-based video frame interpolation with cross-modal asymmetric bidirectional motion fields. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2023. p. 18032-18042.

[2] CHO, Hoonhee; CHO, Jegyeong; YOON, Kuk-Jin. Learning adaptive dense event stereo from the image domain. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2023. p. 17797-17807.

[3] YOON, Youngho; YOON, Kuk-Jin. Cross-Guided Optimization of Radiance Fields with Multi-View Image Super-Resolution for High-Resolution Novel View Synthesis. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2023. p. 12428-12438.

[4] KIM, Hyeonseong, et al. Single domain generalization for lidar semantic segmentation. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2023. p. 17587-17598.

[5] KWEON, Hyeokjun; YOON, Sung-Hoon; YOON, Kuk-Jin. Weakly supervised semantic segmentation via adversarial learning of classifier and reconstructor. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2023. p. 11329-11339.

[6] CHO, Hoonhee, et al. Label-free event-based object recognition via joint learning with image reconstruction from events. In: Proceedings of the IEEE/CVF International Conference on Computer Vision. 2023. p. 19866-19877.

[7] CHO, Hoonhee, et al. Non-Coaxial Event-guided Motion Deblurring with Spatial Alignment. In: Proceedings of the IEEE/CVF International Conference on Computer Vision. 2023. p. 12492-12503.

[8] KIM, Jihun, et al. Learning Point Cloud Completion without Complete Point Clouds: A Pose-Aware Approach. In: 2023 IEEE/CVF International Conference on Computer Vision (ICCV). IEEE, 2023. p. 14157-14167.

Just Do it Laboratory



Associate Professor

YOON, Yong-Jin

Ph.D., Stanford University
[2009]

Research Interest

- Additive Manufacturing
- Advanced 3DP research
- Novel Clean Energy
- Fuel Cell
- Dynamical analysis

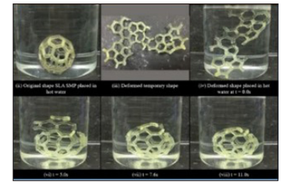
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RESEARCH OVERVIEW

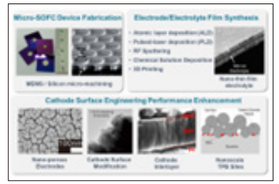
1. Additive Manufacturing [Fig.1]
- Design for Additive Manufacturing, Process parameter optimization of 3D printing, 4D printed Shape memory polymer, Ceramic 3D printing
- Metal 3D printing with Topology Optimization and Lattice structure

2. Novel Clean Energy [Fig.2]
-Semiconductor Fab Silicon Solid-oxide Fuel cell, Drone power, Military portable emergency power

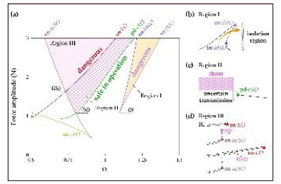
3. Dynamical analysis & simulations [Fig.3]
- Nonlinear dynamics for vibration and shock controls



[Fig.1]



[Fig.2]



[Fig.3]

RESEARCH HIGHLIGHTS

***: Corresponding Author**

[1] Kim, Insup, Alberto Andreu, and Yong-Jin Yoon. "A digital light processing 3D printing approach for tuning the interfacial properties of pore forming agents for porous ceramics." Materials & Design 233 (2023): 112247.

[2] Andreu, Alberto, et al. "Hybrid material extrusion 3D printing to strengthen interlayer adhesion through hot rolling." Additive Manufacturing 55 (2022): 102773.

[3] Lee, Jiho, et al. "Average-Accumulated Normalized Dose (A-AND) predicts ultimate tensile strength and elastic modulus of photopolymer printed by vat photopolymerization." Additive Manufacturing 55 (2022): 102799.

[4] Kim, Sanglae, et al. "Continuously varied infill pattern (ConVIP): improvement of mechanical properties and printing speed of fused filament fabrication (FFF) 3D printing." Journal of Materials Research and Technology 18 (2022): 1055-1069.

[5] Noh, Jinhong, et al. "Harmonic balance analysis of magnetically coupled two-degree-of-freedom bistable energy harvesters." Scientific Reports 12.1 (2022): 6221.

[6] Kim, Insup, et al. "Influence of dispersant concentration toward enhancing printing precision and surface quality of vat photopolymerization 3D printed ceramics." Additive Manufacturing 52 (2022): 102659.

[7] Andreu, Alberto, et al. "Self-Healing Materials for 3D Printing." Advanced Functional Materials (2024): 2315046.

[8] Noh, Jinhong, Pilkee Kim, and Yong-Jin Yoon. "Bistable shock isolator tuned to zero-frequency singularity for platform protection." Mechanical Systems and Signal Processing 210 (2024): 111158.

[9] Andreu, Alberto, et al. "Processing Challenges and Delamination Prevention Methods in Titanium-Steel DED 3D Printing." International Journal of Precision Engineering and Manufacturing-Green Technology (2024): 1-17.

[10] Lee, Taehyub, et al. "Prediction of curing depth dependence on CNT nanofiller dispersion for vat photopolymerization 3D printing." Chemical Engineering Journal 482 (2024): 149110.

PUBLICITY(MEDIA+NEWS)

[1] 카이스트, 방산 특화 첨단 드론 개발연구소 선정 (https://news.kbs.co.kr/news/pc/view/view.do?ncd=7625506)

[2] [2023 GGGF] 윤용진 카이스트 교수 "AI 드론 개발 없이 K방산 경쟁력 갖기 어려워"
(https://www.ajunews.com/view/20230907085847497)

[3] KAIST 방산특화 개발연구소 윤용진 교수, 제 15회 착한 성장 좋은 일자리 글로벌 포럼 (2023 GGGF) Keynote Speech로 "초격차 방위산업을 위한 AI 첨단 드론" 내용 발표 (https://me.kaist.ac.kr/news/news_020100.html?bmain=view&uid=715)

Smart Manufacturing Systems Laboratory



Assistant Professor
Yun, Huitaek

Ph.D., Purdue University
[2021]

Research Interest
- Smart Manufacturing
- Manufacturing AI
- Virtual Manufacturing
- Robotic Manufacturing

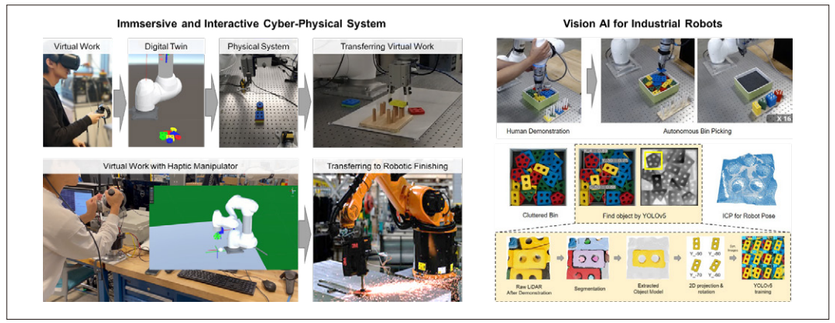
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RESEARCH OVERVIEW

We conduct research on flexible and autonomous manufacturing systems: 4th industrial revolution based on the advancement of information technologies such as artificial intelligence, big data, and computer graphics. The goal of smart production is to respond flexibly to complex and volatile environments and to minimize human intervention by autonomously judging and controlling systems. Our research focuses on developing cyber-physical production systems (CPPS) in which humans, artificial intelligence, and systems collaborate and develop together.

RESEARCH HIGHLIGHTS

Digitalizing Human Skills in Digital Twin via Mixed Reality Interface
The shortage of manpower in the manufacturing industry has become a recent issue due to the retirement of skilled workers and population decline. Our research focuses on virtual manufacturing as an intuitive manufacturing interface. We utilize mixed reality and digital twin technologies, allowing humans work in virtual space. The digitalized information is then converted to machine's automation and artificial intelligence in manufacturing. We proposed an Immersive and Interactive Cyber-Physical System (I2CPS) [1] to transfer virtual pick and place tasks to industrial robots. This interface will be applied to material finishing, garment production, and spraying that still rely on manual processes and are challenging for automation by robots.



Artificial Intelligence (AI) for Autonomous Manufacutirng
Manufacturing is transitioning from mass production to mass customization, and factories need to become more agile, resilient, and flexible to keep up with the trend. AI is a promising research area for self-cognition, self-adoption, and self-decision making in autonomous manufacturing. Our work focuses on manufacturing AI for process monitoring: anomaly detection [2], quality inspection, and estimating machining states. Additionally, we have leveraged deep learning-based vision intelligence in industrial robots to directly pick up items from uncluttered bins [3-4]. We are also expanding our research about manufacturing AI to the industrial robot's intelligence, product design, and process planning.

SELECTED PUBLICATIONS

[1] Yun, H. and M.B.G. Jun. "Immersive and Interactive Cyber-Physical System (I2CPS) and Virtual Reality Interface for Human Involved Robotic Manufacturing," Journal of Manufacturing Systems 62 (2022): 234-248.

[2] Yun, H., H. Kim, Y. Jeong, and M.B.G. Jun. "Autoencoder-based anomaly detection of industrial robot arm using stethoscope based internal sound sensor," Journal of Intelligent Manufacturing (2021): 1-18.

[3] Park, J., M.B.G. Jun, and H. Yun. "Development of robotic bin picking platform with cluttered objects using human guidance and convolutional neural network (CNN)," Journal of Manufacturing Systems 63 (2022): 539-549.

[4] Park, J., C. Han, M.B.G. Jun, and H. Yun. "Autonomous robotic bin picking platform learning from human demonstration and YOLOv5." ASME Journal of Manufacturing Science and Engineering: 1-33 (2023).

Emeritus Professors



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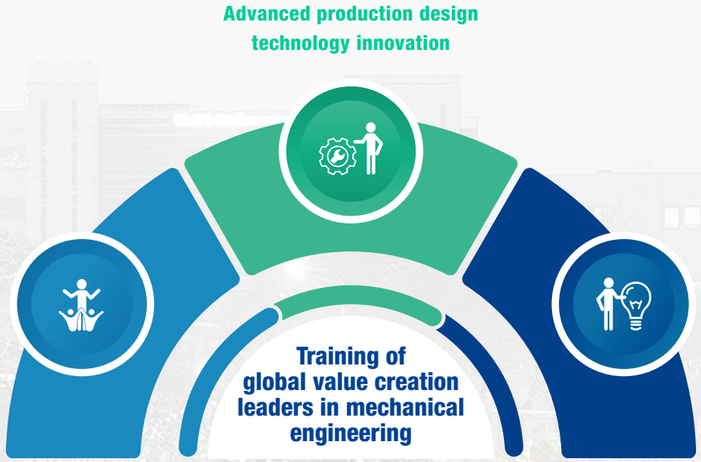
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ME BK21 Programs

KAIST Value-creative Mechanical Engineering



Professors	Graduate students	Annual budget (approximate)	Best Institute
63	603	840 million won	1999-2012
			Highest ranking 2006-2012

Brain Korea 21 [BK21]

The Brain Korea 21 (BK21) Program is a higher education human development program that intensively supports master's and Ph.D. student and up-and-coming research personnel(Post-doctoral researchers) for the purpose of developing world-class graduate schools and nurturing excellent research human.

The School of Mechanical, Aerospace and Systems Engineering at KAIST has been selected to host BK21 under the title the "KAIST Value-creative Mechanical Engineering" for the period of September 2020 to August 2027. Our goal is to foster elites for "value-creative" in mechanical engineering for human society and to produce experts in the fields of (1) advanced production design technology innovation, (2) sustainable welfare social technology innovation (3) national strategic system technology innovation. We are the largest mechanical engineering institute in Korea, with 63 professors and 603 graduate students. Our annual budget is roughly 840 million won, supported by the government and industries. Our department was selected as the Best Institute by the President of Korea based on our achievements during the first stage of the BK21 program [1999~2005]. During the second stage, we were commended with the highest ranking from among nine universities for three consecutive years in mechanical engineering [2008-2010] and were selected as the Best Institute in the overall evaluation [2006-2012].

We are making every effort to achieve our goal of becoming the world's best graduate school.

Undergraduate Program

Course Requirements

1 Graduation Credits: At least 136 credits in total

- Applicable to students entering KAIST in 2016 and thereafter
- Students entering KAIST before 2016 is at least 130 credits in total
- A cumulative grade point average of 2.0 or higher out of a possible 4.3 in all coursework
- Students must apply for at least one out of Advanced major, minor, double major or individually Designed major (applicable to students entering KAIST in 2016 and thereafter)

2 General Courses: At least 28 credits and 8AU

- Applicable to students enrolled in 2018 and thereafter
- For students enrolled before 2018, refer to course completion requirements by year of admission
- Mandatory General Courses: 7 credits /Elective General courses in Humanities & Social Sciences: at least 21 credits



3 Basic Courses: At least 32 credits

- Applicable to students entering KAIST in 2012 and thereafter; for those who have entered KAIST in and before 2011, refer to the Course Completion Requirements by Year of Admission

• Mandatory Basic Courses: 23 credits

① 1 course among Fundamental Physics I (3), General Physics I (3), and Advanced Physics I (3)
② 1 course among Fundamental Physics II (3), General Physics II (3), and Advance Physics II (3)
③ 1 course of General Physics Lab I (1)
④ 1 course of Basic Biology (3) or General Biology (3)
⑤ 1 course of Calculus I (3) or Honor Calculus I (3)
⑥ 1 course of Calculus II (3) or Honor Calculus II (3)
⑦ 1 course among Basic Chemistry (3), General Chemistry I (3), and Advanced Chemistry (3)
⑧ 1 course of General Chemistry Lab I (1) or Advanced Chemistry Lab (1)
⑨ 1 course of Basic Programming (3) or Advanced Programming (3)

- Students having entered KAIST in 2007 or before : 23 credits (①~⑨)
- Students having entered KAIST between 2008 and 2011: 26 credits((①~⑨), Freshman Design Course: Introduction to Design and Communication)(3))

• Elective Basic Courses: at least 9 credits

- Take over 9 credits including at least 2 courses among Introduction to Linear Algebra, Differential Equations and Applications, and Applied Mathematical Analysis.
- Students admitted in and before 2011 should take more than 6 credits

※ Students having a double major take at least 3 credits
※ Students entering KAIST through the admission for the special talented are required to take 12 credits in the mandatory basic courses and to take the remaining credits in the elective basic courses. (applicable to students entering KAIST in 2015 and thereafter)

Undergraduate Program

4 Completion of Major Courses

- Students admitted in 2015 or before: at least **59 credits**

• Mandatory Major Courses

: **12 credits** (for students entering KAIST in 2014 and thereafter)

Basic Mechanical Practice(3), Mechanical Engineering Laboratory(3), Capstone Design I(3), Engineering Design(3)

: Students entering KAIST in 2012 and before: 9 credits

Basic Mechanical Practice(3), Mechanical Engineering Laboratory(3), Capstone Design I(3)

: Students entering KAIST in 2013 and thereafter: 9 credits

Basic Mechanical Practice(3), Mechanical Engineering Laboratory(3), Capstone Design I(3)

• Elective Major Courses

: at least **47 credits** (for students entering KAIST in 2014 and thereafter)

: Select at least **7 courses** from below 9 courses

- Applied Electronics(3), Dynamics(3), Fluid Mechanics(3), Heat Transfer(3), Mechanical Vibrations(3), Modeling and Control of Engineering Systems(3), Solid Mechanics(3), Thermodynamics(3), Understanding of Materials and Processing(3)

※ Up to 10 major course credits taken from other departments can be approved.

: Students entering KAIST in 2012 and before: at least **40 credits**

- Select at least **6 courses** from below 8 courses

: Applied Electronics(3), Dynamics(3), Fluid Mechanics(3), Engineering Design(3), Modeling and Control of Engineering Systems(3), Solid Mechanics(3), Thermodynamics(3), Understanding of Materials and Processing(3)

: Students entering KAIST in 2013 and thereafter: at least **40 credits**

- Select at least **6 courses** from below 8 courses

: Applied Electronics(3), Dynamics(3), Fluid Mechanics(3), Engineering Design(3), Modeling and Control of Engineering Systems(3), Solid Mechanics(3), Thermodynamics(3), Understanding of Materials and Processing(3)

※ Students entering KAIST in 2013 and thereafter must take over 59 major course credits including 10 credits from KAIST

① Minor: At least **21 credits** (Applicable to students from other major/department)

- Must include mandatory major courses 'Basic Mechanical Practice(3), Mechanical Engineering Laboratory(3), Capstone Design I(3)' and at least 4 courses from 9 ME Basic(core) Elective major courses

② Double Major: At least 40 credits (Applicable to students from other major/department)

- At least **40 credits** including mandatory major courses

※ In the event that major courses and double-major/minor courses overlap, up to 9 credits can be applied to both courses of study.

※ Completion of minor/double major courses is subject to the requirement of admission year, minor/double-major application period, or the graduation assessment period

-Students admitted in 2016 and after: at least **48 credits**

• Mandatory Major Courses : **12 credits**

: Basic Mechanical Practice(3), Mechanical Engineering Laboratory(3), Capstone Design I(3), Engineering Design(3)

• Elective Major Courses : at least **36 credits**

: Select at least 5 courses from below 9 courses

- Applied Electronics(3), Dynamics(3), Fluid Mechanics(3), Heat Transfer(3), Mechanical Vibrations(3), Modeling and Control of Engineering Systems(3), Solid Mechanics(3), Thermodynamics(3), Understanding of Materials and Processing(3)

※ Major courses in other departments are recognized up to 10 credits as major choices in mechanical engineering including 3 credits in the elective major course (CoE code) of the College of Engineering.

★ Must choose and complete at least one of Advanced Major, Double Major, Minor and Individually Designed Major other than general major.

① Advanced Major: At least **15 credits**

- At least 15 credits from major courses excluding completed courses from general major
- Should take all 9 Basic(core) Elective major courses

② Individually Designed Major: At least **12 credits**

- At least 12 credits from major courses of two or more departments except for the affiliated department

③ Minor: At least **21 credits** (Applicable to students from other major/department)

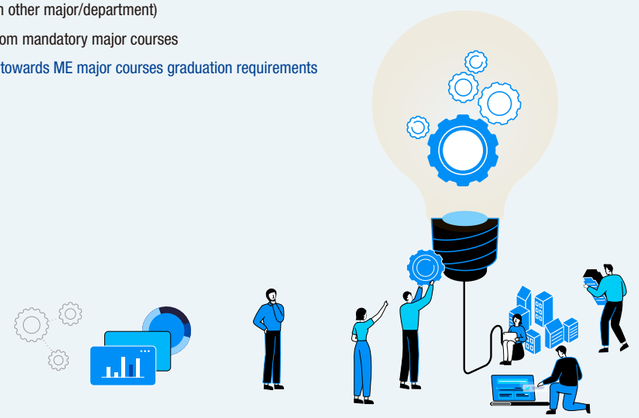
- At least 21 credits from major courses including over 2 mandatory major courses

※ Credits taken for minor and double major will not be counted towards ME major courses graduation requirements

④ Double Major: At least **40 credits** (Applicable to students from other major/department)

- At least 40 credits from major courses including 12 credits from mandatory major courses

※ Credits taken for minor and double major will not be counted towards ME major courses graduation requirements



5 Completion of Research Courses: At least 3 credits

- Taking at least 3 credits of Graduate Research is mandatory, but may replace with Capstone Design II(3) (Not applicable for double major students)
- Up to 4 Individual Study credits are approved as Research Course credits. Seminar credits are approved as Elective Course credits
- Up to 9 credits earned by completing the 24 week Internship program ME Co-op1(INT482, INT495) can substitute for the Graduation Research(3), Electives Major courses(3) and Elective courses(3) toward graduation credits. Up to 3 credit earned by completing the ME Co-op2(INT492, INT495) can substitute for the Elective courses(3) toward graduation credits.

6 Completion of Elective Courses: Take mandatory and elective major courses from other departments

7 English Proficiency Requirements upon Graduation

- Before entering or during studying at KAIST, students should obtain the minimum required score or higher from one of the following : TOEFL, TOEIC, TEPS and IELTS.
- Students who have hearing impairment level 3 or above should obtain the minimum required score or higher, excluding listening.

A.Students who have submitted past scores for TOEIC (before April 2006) or TEPS (before February 28, 2007)

- Students admitted in 2008 or later

Classification	iBT TOEFL	PBT TOEFL	CBT TOEFL	TOEIC	TEPS	IELTS
General qualification score	83	560	220	775	690	6.5
Qualification score for hearing impairment level 3 or above	62	372	146	387	414	4.8

- Students admitted in 2007 or earlier

Classification	iBT TOEFL	PBT TOEFL	CBT TOEFL	TOEIC	TEPS	IELTS
General qualification score	83	560	220	760	670	6.5
Qualification score for hearing impairment level 3 or above	62	372	146	380	402	4.8

B.Students who have submitted NEW TOEIC score taken after May 2006 or TEPS score taken after March 1, 2007

Classification	iBT TOEFL	PBT TOEFL	CBT TOEFL	TOEIC	TEPS 1)	NEW TEPS 2)	IELTS
General qualification score	83	560	220	720	599	326	6.5
Qualification score for hearing impairment level 3 or above	62	372	146	360	359	196	4.8

1) TEPS: 2007.3.1. ~ 2018.4.7. Conducted Test
2) New TEPS: 2018.5.12. After Conducted Test

8 Graduation requirements for international students: TOPIK (Test of Proficiency in Korean)

- Undergraduate international students are required to obtain level 2 or higher score in TOPIK before entering or during studying at KAIST.

※ Applies to students entering KAIST in 2013 and thereafter

Table of Curriculum

Classification	Subject No.	Subject Name	Lecture	Lab	Credit	Semester
Elective Basic Course	ME106	Human and Machine	3.0	0.0	3.0	Fall
Mandatory Major course	ME200	Basic Mechanical Practice	2.0	3.0	3.0	Spring
	ME303	Mechanical Engineering Laboratory	2.0	3.0	3.0	Spring, Fall
	ME340	Engineering Design	2.0	3.0	3.0	Fall
	ME400	Capstone Design Ⅰ	1.0	6.0	3.0	Spring
Elective Major Course (Basic Course)	ME207	Applied Electronics	2.0	3.0	3.0	Spring
	ME211	Thermodynamics	3.0	0.0	3.0	Spring
	ME221	Fluid Mechanics	3.0	0.0	3.0	Fall
	ME231	Solid Mechanics	3.0	1.0	3.0	Spring
	ME251	Dynamics	3.0	0.0	3.0	Fall
	ME311	Heat Transfer	3.0	0.0	3.0	Spring
	ME351	Mechanical Vibrations	3.0	0.0	3.0	Spring
	ME361	Modeling and Control of Engineering Systems	3.0	0.0	3.0	Spring or Fall
	ME370	Understanding of Materials and Processing	3.0	0.0	3.0	Spring
Elective Major Course (Advanced Course)	ME203	Mechatronics system design	2.0	3.0	3.0	Fall
	ME301	Numerical Analysis	3.0	0.0	3.0	Spring
	ME302	Creative Problem Solving	2.0	3.0	3.0	Spring
	ME305	Electronics Laboratory for Mechanical Engineers	2.0	3.0	3.0	Spring, Fall
	ME312	Energy and Environment	3.0	0.0	3.0	Fall
	ME313	Applied Thermodynamics	3.0	0.0	3.0	Fall
	ME320	Applied Fluid Mechanics	3.0	0.0	3.0	Spring
	ME330	Foundation of Stress Analysis	3.0	0.0	3.0	Spring
	ME341	Mechanical Component Design	3.0	0.0	3.0	Fall
	ME342	Mechanism Design	3.0	0.0	3.0	Fall
	ME371	Advanced Materials Engineering and its Application	3.0	0.0	3.0	Fall
	ME401	Capstone Design Ⅱ	1.0	6.0	3.0	Fall
	ME403	Introduction to Naval Architecture and Ocean Engineering	3.0	0.0	3.0	Spring, Summer, Fall, Winter
	ME404	Introduction to Simulation of Medical Procedures	3.0	1.0	3.0	Spring
	ME405	Design Thinking and Entrepreneurship	2.0	3.0	3.0	Spring, Fall
	ME411	Energy System Design and Optimization	3.0	0.0	3.0	Fall
	ME413	Engine Technology	3.0	0.0	3.0	Spring
	ME414	Applied superconductivity and Thermal Engineering	3.0	0.0	3.0	Fall
	ME416	Vehicle Dynamics	3.0	0.0	3.0	Spring
	ME421	Microfluidics	3.0	0.0	3.0	Fall
	ME422	Fluids and Environment	3.0	0.0	3.0	Spring
	ME430	Introduction to Reliability in Mechanical Engineering Design	3.0	0.0	3.0	Fall
	ME431	Introduction to Continuum Mechanics	3.0	0.0	3.0	Fall
	ME432	Deformation, Fracture and Strength of Materials	3.0	0.0	3.0	Spring
	ME433	Introduction to Thin Film Mechanics	3.0	0.0	3.0	Spring
	ME440	Engineering Design via FEM	3.0	1.0	3.0	Spring
	ME450	Fundamentals and Applications of Wave Energy	3.0	0.0	0.0	Fall
	ME452	Noise Control Engineering	3.0	0.0	3.0	Fall
	ME453	Introduction to Robotics Engineering	3.0	0.0	3.0	Fall
	ME454	Dynamics System Programming	2.0	3.0	3.0	Spring
	ME455	Autonomous Mobile System Programming	2.0	3.0	3.0	Fall
	ME458	Programming for Signal and Image Processing	2.0	3.0	3.0	Spring
	ME459	Introduction to Visual Intelligence	3.0	0.0	3.0	Spring
	ME460	Automatic Control	2.0	3.0	3.0	Spring or Fall
	ME461	Introduction to Fuel Cell Systems	3.0	0.0	3.0	Spring
	ME475	Mechanical Engineering and Applied Mathematics	3.0	0.0	3.0	Fall
	ME480	Introduction to Biomedical Optics	3.0	0.0	3.0	Fall
	ME481	Introduction to Electromagnetism & Optics	3.0	1.0	3.0	Spring
	ME484	Structure & Function of Human Body	3.0	0.0	3.0	Fall
	ME487	Introduction to Cell Mechanics	3.0	0.0	3.0	Spring
	ME488	Introduction to biomedical machine technology	3.0	0.0	3.0	Fall
	ME489	Special Topics in Mechanical Engineering Practice Ⅰ	2.0	3.0	3.0	Spring or Fall
	ME491	Special Topics in Mechanical Engineering	3.0	0.0	3.0	Spring, Fall
	ME492	Special Topics in Mechanical Engineering Practice	1.0	6.0	3.0	Spring, Fall
	ME493	Special Topics in Mechanical Engineering Ⅰ	1.0	0.0	1.0	Summer,Winter
	ME494	Special Topics in Mechanical Engineering Ⅱ	2.0	0.0	2.0	Summer,Winter
Research	ME490	Thesis Study	0.0	6.0	3.0	Spring, Fall
	ME495	Individual Study	0.0	6.0	1.0	Spring, Fall
	ME496	Seminar	1.0	0.0	1.0	Spring, Fall

* Note: 400 level courses open to both undergraduate and graduate students.

Graduate Program

Course Requirements

1 Master's Program

Mandatory General	Mandatory Major	Elective	Research	Total
3 Credits + 1AU	-	21	12	36

① Graduation Credits: Required to complete a total of more than **36 credits**

② Mandatory General Courses : **3 credits and 1AU**

- 'CC010 Special Lecture on Leadership'

  : Non-credit, this applies to students entering KAIST in 2002 and thereafter; general scholarship students, international students, and Changwon-KAIST program students are excluded

- 1AU: 'CC020 Ethics and Safety I'

- 3 credits: Choose 1 course among below

Course No.	Course Name	Course No.	Course Name
CC500	Scientific Writing	CC512	Introduction to Materials and Engineering
CC510	Introduction to Computer Application	CC522	Introduction to Instruments
CC511	Probability and Statistics	CC530	Entrepreneurship and Business Strategies

※ CC532 Collaborative System Design and Engineering credits are recognized as CC courses to only Renaissance Program students, Changwon-KAIST program students and general scholarship students.

③ Mandatory Major Courses : None

④ Elective Courses: at least **21 credits**

- Should take more than 12 credits offered by the ME department. For dual degree students (excluding KAIST-TUB dual degree), credits approved by home universities can be transferred to Elective courses offered by ME department. (Please note that not all Elective course are available. Must seek prior approval for credit recognition)

⑤ Research Courses: **at least 12 credits (Must include 2 Seminar credits)**

- International students, Changwon-KAIST program students and general scholarship students admitted in 2009 and thereafter are exempt from seminar credits.

2 Doctoral Program

Mandatory General	Mandatory Major	Elective	Research	Total
3 Credits + 1AU	-	30	30	63

① Graduation Credits: Required to complete a total of more than **63 credits**

② Mandatory General Courses : **3 credits and 1AU**

- 1AU: 'CC020 Ethics and Safety I'

- 3 credits: Choose 1 course among below

Course No.	Course Name	Course No.	Course Name
CC500	Scientific Writing	CC512	Introduction to Materials and Engineering
CC510	Introduction to Computer Application	CC522	Introduction to Instruments
CC511	Probability and Statistics	CC530	Entrepreneurship and Business Strategies

③ Mandatory Major Courses : None

④ Elective Courses: **at least 30 credits**

⑤ Research Courses: **at least 30 credits**

- Course credits earned during master's course may be accumulated. (excluding research credits)
- Course requirements for Ph.D. candidates who have graduated from universities other than KAIST or other majors varies, thus must be decided by the recommendation of Academic Advisor, Curriculum Committee and the department head's approval.

3 MS-PhD Intergrated Program

- Will abide by the existing master's and Ph. D program requirements..
- Course credits and research credits earned during master's course may be accumulated.

Table of Curriculum

Classification	Subject No.	Subject Name	Lecture	Lab	Credit	Semester	Remark
Mandatory General Course	CC010	Special Lecture on Leadership					Required
	CC020	Ethics and Safety I					
	CC500	Scientific Writing					Choose1
	CC510	Introduction to Computer Application					
	CC511	Probability and Statistics					
	CC512	Introduction to Materials Science and Engineering					
	CC522	Introduction to Instruments					
	CC530	Entrepreneurship and Business Strategies					
Elective Course	ME500	Mathematical Methods in Mechanical Engineering	3.0	0.0	3.0	Spring	
	ME502	Introduction to Finite Element Method	3.0	0.0	3.0	Spring	
	ME505	Measurement Instrumentation	3.0	0.0	3.0	Fall	
	ME510	Advanced Fluid Mechanics	3.0	0.0	3.0	Spring	
	ME511	Advanced Thermodynamics	3.0	0.0	3.0	Spring	
	ME512	Advanced Heat Transfer	3.0	0.0	3.0	Fall	
	ME513	Advanced Combustion	3.0	0.0	3.0	Fall	
	ME514	Multiphase Flow I	3.0	0.0	3.0	Fall	
	ME515	Cryogenic Engineering	3.0	0.0	3.0	Spring	
	ME516	Experimental Thermo-Fluid Engineering	2.0	3.0	3.0	Fall	
	ME517	Interfacial flow	3.0	0.0	3.0	Spring	
	ME518	Mechanical Engineering Principles in Biological Systems	3.0	0.0	3.0	Fall	
	ME521	Viscous Fluid Flow	3.0	0.0	3.0	Fall	
	ME526	Introduction to Nanotech Processing	3.0	0.0	3.0	Fall	
	ME530	Advanced Mechanics of Solids	3.0	0.0	3.0	Spring	
	ME533	Fracture Mechanics	3.0	0.0	3.0	Fall	
	ME534	Fatigue Fracture and Strength	3.0	0.0	3.0	Spring	
	ME536	Mechanics of Plastic Deformation	3.0	0.0	3.0	Fall	
	ME537	Optimal Design of Composite Structures	3.0	0.0	3.0	Spring	
	ME543	Optimal Design	3.0	1.0	3.0	Fall	
	ME545	Theory of Hydrodynamics Lubrication	3.0	0.0	3.0	Spring	
	ME547	Knowledge - Based Design System	3.0	1.0	3.0	Fall	
	ME549	Reliability in Microsystems Packaging	3.0	1.0	3.0	Fall	
	ME550	Advanced Dynamics	3.0	0.0	3.0	Fall	
	ME551	Linear Vibration	3.0	0.0	3.0	Spring	
	ME552	Introduction to Acoustics	3.0	0.0	3.0	Spring	
	ME553	Robot Dynamics	3.0	0.0	3.0	Spring, Fall	

Classification	Subject No.	Subject Name	Lecture	Lab	Credit	Semester	Remark
	ME554	Future energy-utilization engineering	3.0	0.0	3.0	Spring, Fall	
	ME561	Linear System Control	3.0	0.0	3.0	Spring	
	ME562	Digital System Control	3.0	0.0	3.0	Fall	
	ME564	Artificial Neural Network: Theory and Applications	3.0	0.0	3.0	Spring	
	ME567	Introduction to Statistical Thermodynamics	3.0	0.0	3.0	Fall	
	ME570	Advanced Manufacturing Systems	3.0	0.0	3.0	Spring	
	ME572	Design and Implementation of Nano Actuation System	2.0	3.0	3.0	Spring	
	ME573	Adhesion and Adhesive Technology	3.0	0.0	3.0	Spring	
	ME574	Joining Engineering	3.0	1.0	3.0	Fall	
	ME576	Vehicle Dynamics and Control	3.0	1.0	3.0	Spring	
	ME582	Introduction to Microfabrication Technology	3.0	0.0	3.0	Spring	
	ME583	MEMS Design and Experimental Microfabrication	2.0	3.0	3.0	Fall	
	ME585	Mechanics and Control of Human Movement	3.0	0.0	3.0	Spring	
	ME587	Optomechatronics	3.0	0.0	3.0	Fall	
	ME589	Applied Optics	3.0	1.0	3.0	Spring	
	ME591	Random Data: Analysis and Processing	3.0	1.0	3.0	Fall	
	ME592	Laser: Principles and Applications	3.0	0.0	3.0	Fall	
	ME600	Mechanical System Design Project 1	0.0	9.0	3.0	Spring	
	ME601	Mechanical System Design Project 2	0.0	9.0	3.0	Fall	
	ME604	Metrology	2.0	3.0	3.0	Spring	
	ME606	Creative Knowledge Creation Process and Application	3.0	0.0	3.0	Fall	
	ME607	Computational Linear Algebra	3.0	1.0	3.0	Spring	
	ME611	Convective Heat Transfer	3.0	0.0	3.0	Spring	
	ME612	Transport Phenomena	3.0	0.0	3.0	Spring	
Elective Course	ME613	Computational Fluid Mechanics and Heat Transfer	3.0	0.0	3.0	Fall	
	ME615	Nanoscale Heat Transfer	3.0	0.0	3.0	Spring	
	ME616	Automobile Technology and Environment	3.0	0.0	3.0	Fall	
	ME617	Advanced Vehicle Control Design	3.0	0.0	3.0	Fall	
	ME621	Turbulence	3.0	0.0	3.0	Spring	
	ME623	Rotating Flow	3.0	0.0	3.0	Fall	
	ME632	Theory of Viscoelasticity	3.0	0.0	3.0	Fall	
	ME633	Mechanical Behavior of Polymeric and Composite Materials	3.0	0.0	3.0	Fall	
	ME635	Plastic Analysis and Design of Structures	3.0	0.0	3.0	Fall	
	ME636	Probabilistic Engineering Design	3.0	0.0	3.0	Fall	
	ME638	Axiomatic Design of Composite Structure	3.0	0.0	3.0	Spring	
	ME639	Introduction to Elasticity and Micromechanics	3.0	0.0	3.0	Fall	
	ME642	Medical Biomechanics	3.0	0.0	3.0	Fall	
	ME643	Rehabilitation Engineering for Analysis and Treatment of Movement Disorders	3.0	0.0	3.0	Spring	
	ME644	Tribology	3.0	0.0	3.0	Spring	
	ME647	STEP for Electronic Commerce	3.0	1.0	3.0	Spring	
	ME653	Mechanical Signature and System Analysis	3.0	1.0	3.0	Fall	
	ME654	Noise Control	3.0	0.0	3.0	Fall	
	ME655	Robotics Engineering	3.0	1.0	3.0	Fall	
	ME656	Vehicle NVH	3.0	1.0	3.0	Fall	
	ME662	Design of Precision Actuation System	3.0	0.0	3.0	Spring	
	ME674	Optical Imaging System Design	3.0	0.0	3.0	Fall	
	ME675	Ultrafast Optic Technology	3.0	0.0	3.0	Fall	
	ME683	Human Robot Interaction: Haptics	3.0	0.0	3.0	Fall	
	ME684	Soft Robotics: Bioinspired Systems	3.0	0.0	3.0	Fall	
	ME692	Wave Propagation	3.0	0.0	3.0	Spring	

Classification	Subject No.	Subject Name	Lecture	Lab	Credit	Semester	Remark
	ME711	Radiation Heat Transfer	3.0	0.0	3.0	Spring	
	ME722	Computational Turbulence Modeling	3.0	0.0	3.0	Spring	
	ME731	Nonlinear Computational Mechanics of Solid	3.0	0.0	3.0	Spring	
	ME732	Reliability in Strength Design	3.0	0.0	3.0	Fall	
	ME752	Structure-borne Sound	3.0	0.0	3.0	Fall	
	ME761	Nonlinear System Control	3.0	0.0	3.0	Spring	
	ME771	Analysis and Design of Metal Forming Processes	3.0	1.0	3.0	Fall	
Elective Course	ME781	Molecular Dynamics and Nanomechanics	3.0	0.0	3.0	Spring	
	ME800	Special Topics in Mechanical Engineering	3.0	0.0	3.0	Spring, Fall	
	ME801	Special topics in Mechanical Engineering Ⅰ	1.0	0.0	1.0	Summer, Winter	
	ME802	Special topics in Mechanical Engineering Ⅱ	2.0	0.0	2.0	Summer, Winter	
	ME810	Special Topics in Thermal & Fluid Engineering	3.0	0.0	3.0	Fall	
	ME830	Special Topics in Design Engineering	3.0	0.0	3.0	Fall	
	ME850	Special Topics in Dynamics and Control	3.0	0.0	3.0	Spring, Fall	
	ME870	Special Topics in Production Engineering	3.0	0.0	3.0	Spring, Fall	
	ME960	M.S. Thesis	0.0	0.0	0.0	Spring, Fall	
	ME964	Individual Research M.S.	0.0	3.0	1.0	Spring, Summer, Fall, Winter	
	ME966	Seminar (M.S. Program)	1.0	0.0	1.0	Spring, Fall	
Research	ME967	Individual Research M.S.	0.0	6.0	2.0	Spring, Fall	
	ME980	Ph.D. Thesis	0.0	0.0	0.0	Spring, Fall	
	ME985	Individual Research Ph.D.	0.0	3.0	1.0	Spring, Summer, Fall, Winter	
	ME986	Seminar (Ph.D.)	1.0	0.0	1.0	Spring, Fall	

* Note: 500 level courses open to both undergraduate and graduate students.

Graduate School of Ocean Systems Engineering Program

Course Requirements(Graduate School of Ocean Systems Engineering)

1 Master's Program

Mandatory General	Mandatory Major	Elective	Research	Total
3 Credits + 1AU	-	21	12	36

① Graduation Credits: Required to complete a total of more than **36 credits**

② Mandatory General Courses : **3 credits and 1AU**

- 'CC010 Special Lecture on Leadership'

  : Non-credit, this applies to students entering KAIST in 2002 and thereafter; general scholarship students, international students, Changwon Univ- KAIST students are excluded

- 1AU: 'CC020 Ethics and Safety I'

③ Mandatory Major Courses : None

④ Elective Courses: **at least 21 credits**

- Among the 21 credits, at least 12 credits should be taken in our department's courses

⑤ Research Courses: **at least 12 credits**

- Must include 1 Seminar credit.
- International students, Changwon-KAIST program students and general scholarship students are exempt from seminar credits.

2 Doctoral Program

Mandatory General	Mandatory Major	Elective	Research	Total
3 Credits + 1AU	-	30	30	63

① Graduation Credits: Required to complete a total of more than **63 credits**

② Mandatory General Courses : **3 credits and 1AU**

-1AU: 'CC020 Ethics and Safety I'

③ Mandatory Major Courses : None

④ Elective Courses: **at least 30 credits**

⑤ Research Courses: **at least 30 credits**

- Course credits earned during master's course may be accumulated. (excluding research credits)
- Course requirements for Ph.D. candidates who have graduated from universities other than KAIST or other majors varies, thus must be decided by the recommendation of Academic Advisor, Curriculum Committee and the department head's approval.

3 MS-PhD Intergrated Program

- Will abide by the existing master's and Ph. D program requirements.
- Integrated master's/doctoral program students should take more than 60 credits including completed courses credits from master's program and should qualify the courses requirement of doctoral degree program of the department.
- Course credits and research credits earned during master's course may be accumulated.

Table of Curriculum(Graduate School of Ocean Systems Engineering)

Classification	Subject No.	Subject Name	Lecture	Lab	Credit	Semester	Remark
Mandatory General Course	CC010	Special Lecture on Leadership					Required
	CC020	Ethics and Safety I					
	CC500	Scientific Writing					Choose1
	CC510	Introduction to Computer Application					
	CC511	Probability and Statistics					
	CC512	Introduction to Materials Science and Engineering					
	CC522	Introduction to Instruments					
	CC530	Entrepreneurship and Business Strategies					
Elective Course	ME509	Engineering Mechanics in Ocean Systems	4.0	0.0	4.0	Spring	
	ME522	Flow Instability	3.0	0.0	3.0	Fall	
	ME523	Introduction to Fluid-Structure Interactions	3.0	0.0	3.0	Fall	
	ME524	Ocean Hydrodynamics	3.0	0.0	3.0	Spring	
	ME532	Advanced analysis of solids and structures	3.0	0.0	3.0	Spring	
	ME535	Finite Element Analysis of Structures	3.0	0.0	3.0	Fall	
	ME538	Ocean Systems Design	3.0	0.0	3.0	Spring, Fall	
	ME539	Design of Energy Plants and Systems	3.0	0.0	3.0	Fall	
	ME540	Stochastic Theory of Structure System	3.0	0.0	3.0	Spring	
	ME541	Reliability and Risk Analysis for Energy Systems	3.0	0.0	3.0	Spring	
	ME548	Knowledge - Based Design System for Ocean System	3.0	1.0	3.0	Spring	
	ME555	Vibration of Offshore Structures	3.0	0.0	3.0	Fall (in an even year)	
	ME556	Underwater Acoustics	3.0	0.0	3.0	Fall	
	ME558	Dynamics of Offshore Structures	3.0	0.0	3.0	Spring, Fall	
	ME559	Dynamics and Control of Ocean Vehicles	3.0	0.0	3.0	Spring, Fall	
	ME568	Ocean VR Simulation	3.0	0.0	3.0	Fall	
	ME571	Marine Production Systems Engineering	3.0	0.0	3.0	Spring	
	ME590	Ocean System Innovation	3.0	0.0	3.0	Spring, Fall	
	ME593	Harbor Engineering	3.0	0.0	3.0	Fall	
	ME594	Ocean Systems Engineering	3.0	0.0	3.0	Spring	
	ME595	Ocean Systems Management	3.0	0.0	3.0	Spring	
	ME596	Shipbuilding and Offshore Plants Management System	3.0	0.0	3.0	Spring	
	ME597	Renewable ocean energy system	3.0	0.0	3.0	Spring	
	ME598	Ocean Nuclear Power: A Challenging Pursuit for Energy Solution	3.0	0.0	3.0	Spring	
	ME620	Advanced Ocean Wave Mechanics	3.0	0.0	3.0	Spring, Fall	
	ME622	Floating Body Dynamics	3.0	0.0	3.0	Spring	
	ME624	Simulation of Ship Hydrodynamics and Waves	3.0	0.0	3.0	Spring	
	ME630	Deepsea Petroleum production Engineering	4.0	0.0	4.0	Fall	
	ME634	Functional Materials and Structures	3.0	0.0	3.0	Fall	
	ME652	Mobile Robotics	3.0	0.0	3.0	Spring	
	ME658	Engineering System Identification	3.0	0.0	3.0	Spring, Fall	
	ME670	Construction of Offshore Structures	2.0	0.0	2.0	Summer, Winter	
	ME671	Product Lifecycle Management System for Ocean System	3.0	1.0	3.0	Spring	
	ME803	Special Topics in Ocean Systems Engineering	3.0	0.0	3.0	Spring, Fall	
	ME804	Special Topics and Design Laboratory of Ocean Systems Engineering	2.0	3.0	3.0	Summer, Winter	
Research	ME960	M.S. Thesis	0.0	0.0	0.0	Spring, Fall	
	ME966	Seminar (M.S. Program)	1.0	0.0	1.0	Spring, Fall	
	ME968	Seminar of Career Planning for Ocean Engineering	1.0	0.0	1.0	Spring, Fall	
	ME980	Ph.D. Thesis	0.0	0.0	0.0	Spring, Fall	
	ME986	Seminar (Ph.D.)	1.0	0.0	1.0	Spring, Fall	

* Note: 500 level courses open to both undergraduate and graduate students.

ME Building and Facilities

ME Facilities



Lobby



Lecture Room



ME Meeting Room



Computer Room



Shower Room



Discussion Room



Meeting Space



SWK-INTEK Meeting Room



ME Study Cafe



Faculty Lounge



Administrative/BK21 Office



Narae Practice Building



Manufacturing Lab



SWK-INTEK Hall



Roof-Top Garden



Conference Hall

ME Building





HAEDONG Hall



Machining Room



ME Garden



SHI-KAIST Seminar Room

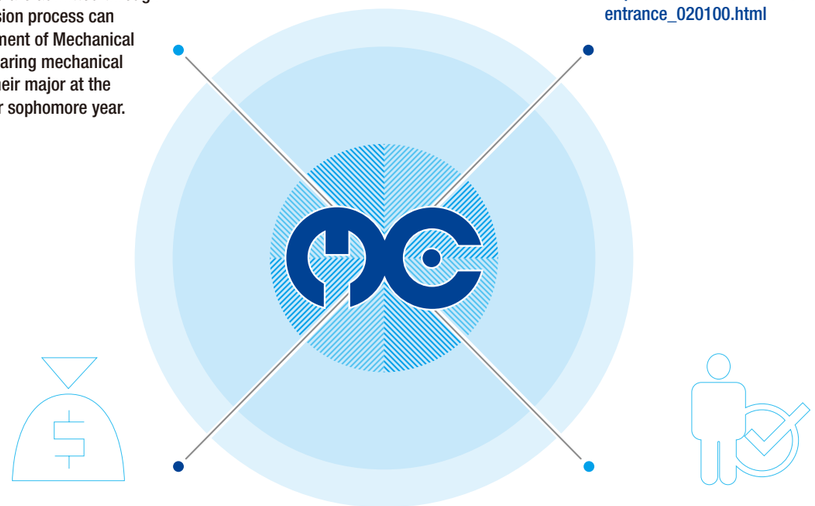


Windows in ME

Admissions

Undergraduate Program

The students who are admitted through the KAIST admission process can enter the Department of Mechanical Engineering, declaring mechanical engineering as their major at the beginning of their sophomore year.



Graduate Program

- The admission procedure includes documented evaluations with English scores (TOEFL, TOEIC or TEPS) and an interview of qualified applicants by faculty members.
- Graduates of other majors, such as the electrical engineering, computer science and material science, may apply for the program as well.
- For more information, please visit https://me.kaist.ac.kr/entrance/entrance_020100.html

Scholarships for Graduate Students

Every graduate student at KAIST is eligible for one of the following scholarships:

* **Government Scholarship**(sponsored by the government)
* **KAIST Scholarship** (sponsored by the research funds of a faculty member or by industry-funded education programs)
* **General Scholarship** (sponsored by outside organizations)

Advisor Assignment

- A student with a government scholarship shall be assigned a faculty member in the department.
- A student with a KAIST scholarship shall be assigned a faculty member who has in advance requested students under special education programs. The field of the student's research may have been pre-determined if the student is supported by the research funds of a faculty member.
- A student with a general scholarship shall be assigned a faculty member in the field of research specified by the sponsoring organization.

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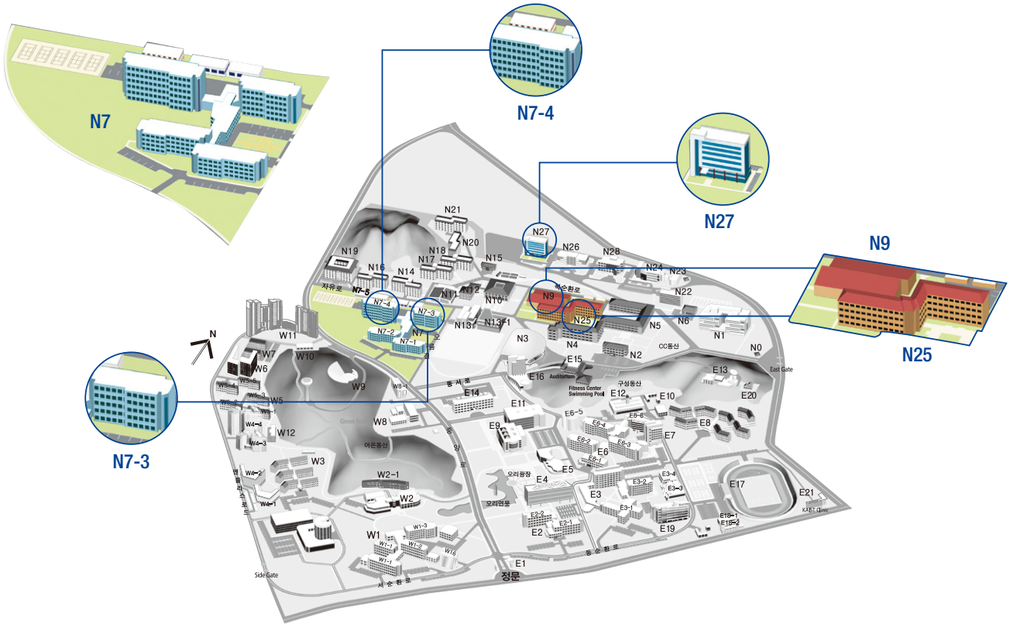


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MAP



East Campus Map

E1	Main Gate
E2	Industrial Engineering & Management B/D
E3	Information&Electronics B/D
E4	KAIST Institutes B/D
E5	Faculty Club
E6	Natural Science B/D
E7	Biomedical Research Center
E8	Sejong Hall
E9	Academic Cultural Complex
E10	Storehouse
E11	Creative Learining B/D
E12	Energy Plant
E13	Satellite Technology Research Center
E14	Main Administration B/D
E15	Auditorium
E16	ChungMoonSoul B/D
E17	Stadium
E18	Daejeon Disease-model animal center
E19	National Nano Fab Center
E20	Kyeryong Hall
E21	KAIST Clinic. Pharmacy

West Campus Map

W2	Student Center-1
W3	Galilei Hall
W4	Yeoul Hall, Nad hall, Dasom Hall, Heemang Hall
W5	Married Students Housing, Startup Village, International Village A,B,C
W6	Mir Hall, Narae Hall
W7	Nanum Hall
W8	Educational Support B/D
W9	Outdoor Theater
W10	Wind Tunnel Laboratory
W11	International Faculty Apartment
W12	West Energy Plant
W16	Geotechnical Centrifuge Testing Center

North Campus Map

N1	Kim Beang-Ho&Kim Sam-Youl ITC B/D	N16	Somang Hall
N2	Branch Administration B/D	N17	Seongsil Hall
N3	Sports Complex	N18	Jilli Hall
N4	School of Humanities&Social Science B/D	N19	Areum Hall
N5	Basic Experiement and Research B/D	N20	Silloe Hall
N6	Faculty Hall	N21	Jihye Hall
N7	Mechanical Engineering B/D	N22	Alumni Venture Hall
N7-1	Dept. of Nuclear and Quantum Engineering	N23	FMRI Center
N7-2	Dept. of Aerospace Engineering	N24	LG Innovation Hall
N7-3,4	Dept. of Mechanical Engineering	N25	Dept. of Industrial Design B/D Narae Practice Building
N7-5	Automobile Technology Laboratory B/D	N26	Center for High-Performance Integrated Systems
N9	Practice B/D	N27	Eureka Hall
N10	Undergraduate Branch Library	N28	Energy&Environment Research Center
NI1	Cafeteria		
N12	Student Center-2		
N13	Tae Wul Gwan		
N14	Sarang Hall		
N15	Staff accommodation		

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MECHANICAL ENGINEERING

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