Moon Hwan Lee

| CONTACT INFORMATION | Integrated Ph.D Candidate
Dept. Electrical Engineering and Computer Science (EECS)
Daegu Gyeongbuk Institute of Science and Technology (DGIST)
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RESEARCH INTERESTS	Biomedical ultrasound Acoustic hologram System development Deep learning applications

EDUCATION	**Integrated Ph.D in Dept. EECS**	
	·○ DGIST, Daegu, Korea	Mar. 2019 – present
	·○ Advisor: Prof. Jae Youn Hwang	
	B.S. in Electronic Engineering	
	·○ Kyungpook National University, Daegu, Korea	Mar. 2015-Feb. 2019

EXPERIENCES	**Researcher**	
	·○ DGIST, Daegu, Korea (alternative military service)	Dec. 2021 – Dec. 2024
	Lab manager	
	·○ MBIS Lab (Prof. Jae Youn Hwang), DGIST	Mar. 2022 – present

REFEREED PUBLICATIOINS
(1st: 7, co-author: 8)
(Domestic journal: 2)
(*Co-first author)

15) K. Lee, H. Lee, M.H. Lee, S. Kim, Y. Eun, Y. Eun, J.Y. Hwang, "Expert-Level Differentiation of Incomplete Kawasaki Disease and Pneumonia from Echocardiography via Multiple Large Receptive Attention Mechanisms", Computers in biology and medicine, 2025.

14) **M.H. Lee**, K. Lee, Y. Yoo, E. Chung, H. Cho and J.Y. Hwang, "Machine Learning-Enhanced Skull-Universal Acoustic Hologram for Efficient Transcranial Ultrasound Neuromodulation Across Varied Rodent Skulls", IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 2024.

13) K. Lee*, H. Lee*, **M.H.Lee**, J.H. Chang, C.-C. J. Kuo, SJ Oh, J. Woo, and J.Y. Hwang, "Multi-Scale Self-Attention Network for Denoising Medical Images", APSIPA Transactions on Signal and Information Processing, 2024.

12) K. Lee*, **M.H. Lee***, D. Kang, S. Kim, J.H. Chang, SJ Oh, J. Y. Hwang, *"Intelligent Bladder Volume Monitoring for Wearable Ultrasound Devices: Enhancing Accuracy through Deep Learning-based Coarse-to-Fine Shape Estimation"*, IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 2024. **[contributed equally]**

11) **M.H. Lee**, HY Park, K. Lee, S. Kim, J. Kim, J.Y. Hwang*, "Ultrasound-optical imaging-based multimodal imaging technology for biomedical applications", The Journal of the Acoustical Society of Korea, 2023.

10) **M.H. Lee**, H.M. Lew, S. Yoon, T. Kim, J.Y. Hwang, *"Deep learning-based framework for fast and accurate acoustic hologram generation"*, IEEE Transactions on Ultrasonics,

Ferroelectrics, and Frequency Control, 2022. **[Featured on the front cover]**

9) K. Lee, H.M. Lew, **M.H. Lee**, Jun-Young Kim, J.Y. Hwang, *"CSS-Net: Classification and Substitution for Segmentation of Rotator Cuff Tear"*, In Asian Conference on Computer Vision (ACCV), 2022.

8) H. Kim, S. Youn, J. Kim, S. Park, **M.H. Lee**, J.Y. Hwang, J.H. Chang, *"Deep laser microscopy using optical clearing by ultrasound-induced gas bubbles"*, Nature Photonics, 2022. **[Featured on the front cover]**

7) K. Lee*, J. Yang*, **M.H. Lee**, J.H. Chang, J. Kim, J.Y. Hwang, *"USG-Net: Deep Learning-based Ultrasound Scanning-Guide for an Orthopedic Sonographer"*, In International Conference on Medical image computing and computer-assisted intervention (MICCAI), 2022.

6) H. Lee*, **M.H. Lee***, S. Yoon, K. Lee, H.M. Lew, J.Y. Hwang, *"Speckle Reduction via Deep Content-Aware Image Prior for Precise Breast Tumor Segmentation in an Ultrasound Image"* IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 2022. **[contributed equally]**

5) M. Park, G.H. Hoang, T. Nguyen, E. Lee, H.J. Jung, Y. Choe, **M.H. Lee**, J.Y. Hwang, J.G. Kim, T. Kim, "*Effects of transcranial ultrasound stimulation pulsed at 40 Hz on Aβ plaques and brain rhythms in 5× FAD mice*", Translational neurodegeneration, 2021.

4) H.M. Lew, H. Shin, **M.H. Lee**, S. Youn, H.C. Kim, and J.Y. Hwang, *"Ultrasonic Blood Flowmeter with a Novel Xero Algorithm for a Mechanical Circulatory Support System"*, Ultrasonics, 2021.

3) **M.H. Lee** and J.Y. Hwang, *"Development of deep learning-based holographic ultrasound generation algorithm (Deep-HUG)"*, The Journal of the Acoustical Society of Korea, 41(2), 2021.

2) K. Lee*, J. Kim*, **M.H. Lee**, C. Choi, and J.Y. Hwang, *"Imbalanced Loss-Integrated Deep-Learning-Based Ultrasound Image Analysis for Diagnosis of Rotator-Cuff Tear"*, Sensors, 2021.

1) **M.H. Lee***, J. Kim*, K. Lee, C. Choi, and J.Y. Hwang, *Wide-field 3D Ultrasound Imaging Platform with a Semi-automatic 3D Segmentation Algorithm for Quantitative Analysis of Rotator Cuff Tears*, IEEE ACCESS, 2020. **[contributed equally]**

| NON-REFEREED PUBLICATIONS & CONFERENCES (1st: 7, co-author: 3) (*Co-first author) | 12) **M.H. Lee**, H.M. Lew, J.S. Kim, J. Park, S. Youn, J. Kim, and J.Y. Hwang, "Deep Learning-Based Fundamental Frequency Conversion for a Mechanically Rotating Dual-Element Ultrasound Endoscopic Probe", In the UFFC-Joint Symposium (poster presentation), 2024.

 11) **M.H. Lee**, and J.Y. Hwang, "Thickness-Only Acoustic Hologram for Precise Ultrasound Neuromodulation and its Validation via transcranial acoustic field measurement through a mice skull ex vivo", In the UFFC-Joint Symposium (lecture presentation), 2024.

 10) K. Lee, **M.H. Lee**, J.Y. Hwang, *"ViT-SPI: Vision Transformer with Volumetric Spatial Information for Precis Bladder Volume Measurement"*, In the IEEE International Ultrasonic Symposium (lecture presentation), 2023.

 9) **M.H. Lee**, Y. Yoo, E. Chung, H. Cho, J.Y. Hwang, *"Transcranial Acoustic Hologram Design with Machine Learning: A Universal Solution for All Skulls"*, In the IEEE International Ultrasonic Symposium (poster presentation), 2023.

 8) **M.H. Lee**, Y. Yoo, E. Chung, H. Cho, J.Y. Hwang, *"The way to deep learning (DL)-based fast transcranial acoustic hologram generation for flexible neuromodulation"*, In the |

Annual International Symposium on Therapeutic Ultrasound held by International Society for Therapeutic Ultrasound, 2023.

7) H. Lee, **M.H. Lee**, Lucy Y. Eun, Y. Eun, J.Y. Hwang, *"Diagnosis of Incomplete Kawasaki Disease using Deep Learning Techniques with Ultrasound Images of Coronary Artery Lesions"*, In International Congress on Acoustics, 2022.

6) **M.H. Lee**, H.M. Lew, S. Youn, J.Y. Hwang, *"Neural Network-based Acoustic Hologram Generation for Fast and Precise Neuromodulation"*, In IEEE International Ultrasonic Symposium (poster presentation), 2022.

5) **M.H. Lee**, H.M. Lew, J.S. Kim, S. Youn, J.Y. Hwang, *"Monitoring of spatially selective calcium response to holographic ultrasound stimulation using fluorescence imaging"*, In SPIE Photonics West (poster presentation), 2022.

4) H.M. Lew, **M.H. Lee**, S. Youn, H.C, Kim and J.Y. Hwang, *Ultrasonic Blood Flow Meter using an Advanced Zero-crossing Technique for Measuring Blood Flow Rates of an Extracorporeal Membrane Oxygenation Device*, The Korean Society of Medical & Biomedical Engineering (lecture presentation), 2021. **(Best paper award)**

3) J.S.Kim, S.Youn, **M.H. Lee**, H.M. Lew, and J.Y. Hwang, *Ultrafast Detection-based Acoustic Trapping Technique for Measurement of Viscoelasticity of a Single Cell*, The Acoustical Society of Korea (poster presentation), 2021. **(Best presentation award)**

2) **M.H. Lee**, S. Youn, and J.Y. Hwang, *Development of a multimodal necklace for continuous monitoring of cardiopulmonary functions*, In SPIE Photonics West (poster presentation), 2021.

1) **M.H. Lee**, H.M. Lew, and J.Y. Hwang, *Intelligent Wearable Bladder Monitoring Device with an Inertial Measurement Unit for Robust Measurement of Bladder Volume*, In the IEEE International Ultrasonic Symposium (poster presentation), 2020.

PATENT

12) J.Y. Hwang, **M.H. Lee,** "CELL CULTURE PLATE APPARATUS USING ULTRASONIC HOLOGRAM" (Application (KR), 10-2024-0066916, 2024.05.23)

11) J.Y. Hwang, **M.H. Lee,** "Ultrasound imaging device for endoscope mounting" (Application (KR), 10-2024-001309, 2024.01.30)

10) J.Y. Hwang, **M.H. Lee,** "APPARATUS AND ULTRASONIC STIMULATION AND METHOD FOR OPERATION FOR THE SAME" (Application (KR), 10-2023-0132379, 2023.10.05)

9) J.Y. Hwang, H. Kwon, D. Kim, **M.H. Lee,** "Brain ultrasonic stimulation and visual monitoring system" (Application, PCT-KR2023-001888, 2023.02.09)

8) J.Y. Hwang, **M.H. Lee**, "CELL STIMULATION AND CULTURE PLATFORM USING ULTRASONIC HOLOGRAM" (Application (US), 17-960999, 2022.10.06 / **Granted**, 10-2579381, 2023.09.12)

7) J.Y. Hwang, **M.H. Lee**, H.M. Lew, "Bladder monitoring apparatus and method for controlling bladder monitoring apparatus" (Application (US), US20220133259A1, 2022.05.05)

6) J.Y. Hwang, H. Kwon, D. Kim, **M.H. Lee,** "Brain ultrasonic stimulation and visual monitoring system" (Application, 10-2022-0017344, 2022.02.10 / **Granted**, 10-2716510, 2024.10.08)

5) J.Y. Hwang, **M.H. Lee**, "CELL CULTURE AND STIMULATION PLATFROM BASED ON ULTRASOUND HOLOGRAM" (Application (KR), 10-2021-0132152, 2021.10.06 / **Granted**, 10-2579381, 2023.09.12)

4) J.Y. Hwang, **M.H. Lee**, et al. "SMART HIP JOINT IMPLANT WITH LINEAR WEAR MONITORING" (Application (KR), 10-2021-0092344, 2021.07.14)

3) J.Y. Hwang, C.Y. You, **M.H. Lee,** "Hollow cylindrical ultrasound imaging system for analyzing body composition and operation method of the ultrasound imaging system" (Application (US), US20220071598A1. 2022.03.10 / **Granted**, US11717267B2, 2023.08.08)

2) J.Y. Hwang, **M.H. Lee**, H.M. Lew, "BLADDER MONITORING APPARATUS AND METHOD FOR CONTROLLING BLADDER MONITORING APPARATUS" (Application (KR), 10-0145463. 2020.11.03 / **Granted**, 10-2460829, 2022.10.26)

1) J.Y. Hwang, C.Y. You, **M.H. Lee**, "ULTRASOUND IMAGE SYSTEM AND METHOD FOR OPERATING OF ULTRASOUND IMAGE SYSTEM FOR ANALYZING BODY COMPOSITION" (Application (KR), 10-0113043. 2020.09.04)

FUNDED **R**ESEARCH **E**XPERIENCES	9) Development of Snapshot Multispectral/Holographic Ultrasound Endoscopic Imaging Platform for Three-Dimensional Unlabeled Detection of Gastrointestinal Cancer (NRF, Korea)	2024 -

- ○ **Objective**:
  - Development of multimodal endoscopic probe (snapshot multispectral + holographic ultrasound) for 3D unlabeled detection of GI cancer
- ○ **What I did/am doing**:
  - Participated in the research grant proposal
  - Development of holographic ultrasound imaging algorithm inspired by structured illumination ultrasound imaging
  - Design of endoscope probe integrating two different modalities
  - Custom connector and cables for 1D linear array inserted into the endoscope probe

8) Development of SoC for Multi-Channel Ultrasound Catheters and a Probe for Intracardiac Echocardiography Using It (MOTIE, Korea)   2024 -

- ○ **Objective**:
  - Development of 3D ICE imaging system with low channel count by adopting a row-column-addressed array that integrated to ultrasound pulser-receiver ASIC
- ○ **What I did/am doing**:
  - Participated in the research grant proposal
  - Simulation of custom row-column-addressed array designs to find proper designs
  - Implementation of convex lens-based larger FoV RCA imaging solution

7) Development of acupoint stimulation core technology of Korean Medicine and ICT convergence for the treatment of chronic pain and comorbidities (NRF, Korea)   2023 - 2024

- ○ **Objective**:
  - Development of non-invasive acupoint stimulation method exploiting ultrasound, especially acoustic hologram

- ○ **What I did**:
  - Participated in the research grant proposal
  - Design of a programmable single-channel ultrasound stimulator
  - Development of optimization-based acoustic hologram design for desired phase- or amplitude-field generation

6) Intractable Pain Treatment based on a Novel Gliopathic Paradigm from Bench to Market (MSIT, Korea)

2021 - 2024

- ○ **Objective**:
  - Development of non-invasive brain stimulation method exploiting ultrasound, especially acoustic hologram for pain reduction
- ○ **What I did**:
  - Participated in the research grant proposal
  - Development of custom connectors and cable for a 2D matrix array transducer
  - Deep learning-based computer-generated hologram algorithm for the 2D array transducer
  - Construct a custom acoustic intensity measurement system for measuring holographic acoustic field
  - Design of the hologram lenses based on the developed algorithm
  - Blood brain barrier opening experiment on mice with the designed hologram lens

5) Development of an elderly-friendly wearable smart healthcare system and service for real-time quantitative monitoring of urination and defecation disorders (MOTIE, Korea)

2021 - 2023

- ○ **Objective**:
  - Development of wearable ultrasonic system for quantitative monitoring of urinary bladder volume
- ○ **What I did**:
  - Participated in the research grant proposal
  - Preliminary work on IMU-assisted bladder monitoring accuracy enhancement (Implementation of IMU + LabView control program)
  - Development of intelligent bladder monitoring algorithm

4) Development of a low-voltage driving CMUT-based ring-type ultrasound imaging sensor for a next-generation medibot (National Research Foundation, Korea)

2019 - 2021

- ○ **Objective**:
  - Development of miniaturized CMUT-based ultrasound imaging sensor
- ○ **What I did**:
  - Implementation of the single-element transducer-based synthetic aperture imaging algorithm for CMUT and PZT-based sensor
  - Design of transimpedance amplifier circuit for CMUT linear array

sensor and its test with the CMUT array

3) Development of Prototype of Ultrasonic Capsule Endoscopy and testbench (ENDOLFIN Co., Korea)
- ·○ **Objective**:
  - Development of ultrasound capsule endoscopy using single element US transducer or CMUT and its testbench
- ·○ **What I did**:
  - Development of single-channel ultrasound pulser/receiver circuit for the ultrasonic capsule endoscope (schematic, PCB, FPGA)
  - Implementation of coded-excitation methods for the capsule endoscope
  - Fabricate tissue-mimicking phantom and evaluate the endoscope's image quality
  - Porcine in-vivo experiment of the ultrasound capsule endoscope

2019
-
2021,
2023
-
2024

2) Development of ultrasound-assisted confocal microscopy for deep tissue imaging (Samsung Science & Technology Foundation)
- ·○ **Objective**:
  - Development of ultrasound-assisted confocal microscopy for deep tissue imaging (utilize ultrasound-induced bubble to see deeper)
- ·○ **What I did**:
  - Construct custom confocal microscopy (controller part – Configuration of DAQ board, galvo resonant mirror, etc – Programmed with LabView)

2019
-
2022

1) Smart Monitoring System for Hip Implant Liner (MOTIE, Korea)
- ·○ **Objective**:
  - Development of implantable liner thickness monitoring system based on ultrasound
- ·○ **What I did**:
  - Test various frequency range and excitation pulse for measuring a liner thickness with high resolution
  - Collaborate with ASIC group (KAIST) to make micro, wireless ultrasound NDT system for the liner thickness measurement
  - Cadaver experiment to demonstrate the efficiency

2019
-
2020

NON-**F**UNDED **R**ESEARCH **E**XPEREINCES

8) Deep learning-based transcranial acoustic hologram generation for rapid and flexible neuromodulation strategy (on-going)

7) Differentiable hologram lens-based multi-focal ultrasound neuromodulation tool and its demonstration via BBB opening and pain reduction in mice (on-going)

6) Differentiable physical hologram lens optimization framework for high fidelity between simulation and experiment (IUS 2024, on-going)

5) Dual-frequency ultrasound endoscopic imaging system and application of deep learning (IUS 2024, on-going)

4) Wearable blood flow/SpO2 monitoring system (SPIE Photonics West 2021)

3) Transit-time flow meter for ECMO (Ultrasonics, 2021)

2) Continuous bladder volume monitoring system (IUS 2020, IEEE T-UFFC, 2024)

1) 3D wide-field ultrasound imaging system based on commercial system and segmentation algorithm for the diagnosis of rotator cuff tears (IEEE ACCESS, 2020)

Professional **S**ervices	■ External Journal & Conference Reviewer Experience

- ○ IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control
- ○ IEEE Transactions on Computational Imaging
- ○ Scientific Reports
- ○ Applied Physics Letters
- ○ SPJ Research
- ○ MICCAI
- ○ Medical Image Analysis

SKILLS

Programming (Intermediate)
FPGA (VHDL), Python, Tensorflow, Pytorch, MATLAB, LabView

Physical Computing (Intermediate)
Zynq (Vivado, Vitis), 3D Printing, Circuit & PCB design (Altium), Soldering, Lathe, Ultrasound transducer design & fabrication (single-element transducer)

3D Graphics (Intermediate)
Fusion 360, 3Ds Max

Language
- Korean: native language
- English: fluent (worked with international students in MBIS lab)

HONORS AND **A**WARDS

2) Gliopathic Pain Research Center of Joint Research Project of Institutes of Science and Technology, "Outstanding Poster Award", 2022.
1) DGIST ICE Student Conference, "Best Speech Award", 2021.

Teaching /**M**entoring /**O**utreach

■ Mentoring @ DGIST

2021 – present: Lab manager

2024 winter internship (for undergraduate student)

2024 summer internship (for undergraduate student)

■ Teaching Assistant @ DGIST

Python Programming (2020, Spring semester)