Eunsu **Baek**

Ph.D Student · Adaptive Sensing for DNNs / Reliable AI / Embodied AI

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Summary

Ph.D. student at **SNU GSDS** whose research focuses on building **reliable real-world AI** and **adaptive sensing for DNNs**—improving robustness by optimizing *sensor configurations* in *data acquisition*, beyond scaling models alone. This idea is inspired by how humans adapt perception via active sensing (e.g., corrective lenses or pupil dilation/constriction) in the wild. **To validate this concept**, my research spans robustness benchmarking, adaptive sensing frameworks, and a path toward next-generation AI, with first-author publications at **CVPR, ICLR, and NeurIPS**.

- **Benchmarks**: Built *ES-Studio*, a physically controllable testbed that manipulates environment and sensor factors to induce covariate shifts, and collected the *ImageNet-ES* series (*394K real-camera images*) to evaluate real-world robustness, demonstrating efficacy of **sensor control**.
- **Frameworks**: Developed *Lens*, an **adaptive sensing framework** that yields up to **50%** accuracy gains and enables **small models to match large-model performance (up to 50× larger) without retraining** under real-world shifts.
- **Embodied AI**: Proposed a *closed-loop adaptive sensing framework* that elevates sensing to a **first-class** component toward **robust, sustainable, and equitable AI**, integrating **active sensing agents** into perception–action loops to address sparse rewards under dynamic shifts.

I have also contributed to collaborative projects published at **UbiComp**, **ESWA**, **WACV**, and **MobiSys**, released research artifacts as **open-source contributions**, and **received awards** in competitions and top-tier venues. With experience spanning **AI system prototyping**, **reliable AI systems**, **generative models**, and **wearable AI applications**, I have **mentored 7+ students** across sensing, vision, and interaction. My long-term goal is to build **trustworthy embodied AI systems** that learn to perceive and act adaptively in the real world toward scalable, human-aligned intelligence.

Education

Seoul National University — *Seoul, Republic of Korea*

Ph.D. in Data Science (Advisor: Dr. Hyung-Sin Kim) — *Mar. 2022 – Present*

- Research Topic: Adaptive sensing for DNNs, Reliable AI, Embodied AI

Seoul National University — *Seoul, Republic of Korea*

M.S in Computer Science and Engineering (Advisor: Dr. Jinwook Seo) — *Mar. 2020 – Feb. 2022*

- Research Topic: Human-Computer Interaction, Explainable AI (XAI)

Sookmyung Women's University — *Seoul, Republic of Korea*

B.S. in Mathematics (double major in Computer Science) — *Mar. 2013 – Feb. 2018*

Publications

Conferences & Journals (*Co-first authors, †Corresponding authors)

[C.4] *Simulating Environment and Sensor Domain Perturbations via Generative Image Translation*
Jiyoon Kim, Eunsu Baek, Hyung-Sin Kim†
IEEE/CVF Winter Conference on Applications of Computer Vision (WACV) 2026, Tucson AZ, USA.

[C.3] *AI Should Sense Better, Not Just Scale Bigger: Adaptive Sensing as a Paradigm Shift*
Eunsu Baek, Keondo Park, Jeonggil Ko, Min-hwan Oh, Taesik Gong, Hyung-Sin Kim†
Conference on Neural Information Processing Systems (NeurIPS) 2025, San Diego CA, USA. (**Position**, Acceptance ratio: **8%**) [pdf] [poster]

[J.2] *ColonOOD: A Complete Pipeline for Optical Diagnosis of Colorectal Polyps Integrating Out-of-Distribution Detection and Uncertainty Quantification*
Sehyun Park*, Dongheon Lee*, Ji Young Lee, Jaeyoung Chun, Ji Young Chang, Eunsu Baek, Eun Hyo Jin, and Hyung-Sin Kim†
Expert Systems with Applications (ESWA), Vol. 295, Jan. 2026 (IF **Top 7%** in Operations Research) [pdf]

[C.2] *Adaptive Camera Sensor for Vision Model* [Lens]
Eunsu Baek, Taesik Gong†, Hyung-sin Kim†
International Conference on Learning Representations (ICLR) 2025, Singapore [pdf] [poster], [github]

[C.1] *Unexplored Faces of Robustness and Out-of-Distribution: Covariate Shifts in Environment and Sensor Domain* [ImageNet-ES]
Eunsu Baek, Keondo Park, Jiyoon Kim, Hyung-sin Kim†
IEEE/CVF Computer Vision and Pattern Recognition Conference (CVPR) 2024, Seattle WA, USA [pdf] [poster] [video] [github]

[J.1] *MIRROR: Towards Generalizable On-Device Video Virtual Try-On for Mobile Shopping*
Dong-sik Kang, Eunsu Baek, Sungwook Son, Youngki Lee, Taesik Gong, Hyung-sin Kim†
PACM IMWUT, Vol. 7, No. 4, Dec 2023; presented at UbiComp 2024, Melbourne [pdf] [video1] [video2]

Demos

[D.1] *On-Device Video Virtual Try-On for Mobile Shopping* (People's Choice Demo Runner-up Award)
Dongha Ahn, Dong-sik Kang, Eunsu Baek, Hyung-sin Kim†
ACM International Conference on Mobile Systems, Applications, and Services (MobiSys) 2024, Tokyo, Japan [pdf] [video]

Ongoing Manuscripts

[O.2] *"Annoymized"*
Eunsu Baek, Dayeon Woo, Jinmo Yang, Hong-Jun Kim, Rian Kim, Woojin Jang, Taesik Gong, Hyung-Sin Kim†
To be submitted to ECCV 2026

[O.1] *"Annoymized"*
Eunsu Baek, Jiyoon Kim, Keondo Park, Sojung Kim, Taesik Gong, Hyung-Sin Kim†
Under review at CVPR 2026

Research Experience

AIoT Lab at SNU (Advisor: Hyung-sin Kim) — *Seoul, Republic of Korea*
Ph.D. student — *Jul. 2022 – Present*

- **Team leader of Adaptive sensing for DNNs** — Improved robustness to covariate shifts by *optimizing sensor parameters* in a novel paradigm.
- **Lead author & developer of *ImageNet-ES (Luminous & Diverse)*** — Built a controllable testbed (***ES-Studio***), collected 202K/192K covariate-shifted images in environment & sensor domains; revealed limits of training-based robustness; validated camera sensing as an effective remedy.
- **Lead author & developer of *Lens*** — *The first sensing framework* adapting to model and scene for robust prediction under real-world noise.
- **Lead author of *NeurIPS Position*** — *Advocated a paradigm shift* in AI from scaling models to *adaptive sensing*, toward sustainable, robust, and equitable intelligence; proposed *Closed-Loop Adaptive Sensing Framework*; conducted in *collaboration with four domain-expert* across AI, systems, RL and edge intelligence.
- **Co-author *MIRROR*** — Designed system & user scenarios for a *generalizable on-device VTO*; contributed to manuscript writing and visuals.
- **Co-author of *ColonOOD*** — Developed reliable CAD pipeline and co-wrote manuscript on a *polyp diagnosis system* with OOD and uncertainty modeling.
- **Co-author *ImageNet-sES*** — Defined simulation strategies for *ImageNet-ES*; mentored a master's student on generative modeling and analysis.
- **Co-authored proposals & served as a core researcher in national projects** — *Surveillance AI, Embodied AI, XR interaction* (NRF/IITP).
- **Mentored 7 students** in adaptive sensing, robustness benchmarking, generative models, virtual try-on (VTO) applications, and industrial vision.
- **Committee member of *GSDS VLM dataset challenge*** — Contributing to dataset creation and competition logistics.

HCI Lab at SNU (Advisor: Jinwook Seo) — *Seoul, Republic of Korea*
M.S. student & Research Intern — *Oct. 2019 – Feb. 2022*

- **Lead author & developer of *MRViz*** — Visual analytics system for CNN reliability; user studies & adversarial case analysis for robustness insights.
- **Lead author & developer of *NutriSeeON*** — Vision-based assistive app with wearables enabling blind-friendly interaction for grocery shopping.
- **Involved in IITP-funded collaborative projects** — *XAI-based neuro-signal analysis (ECG)* and *FPGA-accelerated visualization*.
- **Collaborator of *Tangible Illusion*** — Ran user studies validating a VR system simulating gravity.

HCS Lab at SNU (Advisor: Young-ki Lee) — *Seoul, Republic of Korea*
Research Intern — *May. 2019 - Sep. 2019*

- **Main author & developer of *SilverStone*** — Developed *homomorphic encryption* with layer-wise computation for offloaded DNN inference.

Honors & Awards

2024	**Best Paper Award**, ImageNet-ES (for CVPR 2024 paper) — $755	*SNU BK21+*
	People's Choice Demo Runner-up, On-Device VTO Demo	*Mobisys 2024*
	Travel Grant, Conference Attendance Support — $400	*CVPR 2024*
2023–2024	**Medical AI Scholarship**, — $3,805 / semester	*SNU AIMED*
2023	**1st Place (212 teams) at Samsung AI Challenge**, Camera-Invariant Domain Adaptation — $7,611	*SAIT*
2022	**1st Place at Coral Competition**, NaviBl: Navigation for Blinds [slides], [video] — $1,522	*Google & SNU*
	GSDS Development Fund, Software Globalization Support — $7,611	*SNU GSDS*
2017	**Outstanding Award**, Debate Competition: "AI Apocalypse"	*SMWU*
2016	**Leadership Scholarship**, President, College of Natural Sciences; Emergency Council (GSC vacant) — $3,805 / semester	*SMWU*
2015–2018	**Samsung SW Scholarship**, Academic Excellence in CS — $266 (×5)	*Samsung*
	Academic Excellence, 1st in 21 major courses (GPA 4.07/4.3) — $2,891 (×3)	*SMWU*
2014	**Club Innovation Award**, Captain, Natural Science Research Society — $380	*SMWU*

Academic & Open-source Contributions

2025 – Present	**Committee of GSDS Dataset Challenge for Language Models**, Organizing dataset creation and competition logistics.
2025	**Reviewer, NeurIPS 2025 Workshop on Learning to Sense**, Invited Program committee member [L2S]
2025	**Invited Reviewer**, Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT).
2025	**ImageNet-ES Diverse Release**, ImageNet-ES variant of non-luminous scenes under diverse environment settings (192K)
2024	**ImageNet-ES Integration to OpenOOD Framework**, Contribute to provide standardized OOD evaluation. [openOOD]
2024	**ImageNet-ES Release**, Sensor control & Robustness benchmark with 202K perturbed images in ES domain [gitHub]

Representative Coursework Projects

Crowd2Crowd (C2C) — Bidirectional dataset platform for custom requests with automatic QC — *2023*
Led & built full-stack development of dataset marketplace with bidirectional match & automated quality control. [github] [slides][video] — *SNU GSDS*

NaviBl — Navigation System for Blinds ***(1st Place Award)*** — *2022*
Led & Built AI-driven auditory guidance system for real-time crosswalk navigation on Coral board. [slides] [video] — *Google Coral Competition*

TamrAtlas — Visual Explorer of Instagram Trends in Jeju — *2021*
Led full-stack D3/React development on 200K crawled posts; built custom UI for search & trend exploration. [github] [slides] [video1] — *SNU CSE*

NutriSeeON — Virtual eyes to shop healthy groceries — *2020*
Led & built vision-based Android app with wearable haptic-auditory feedback for blind-friendly grocery shopping. [github] [video] — *SNU CSE*

Talks & Presentations

NeurIPS 2025 Poster Presentation — *Dec. 2025*
AI Should Sense Better, Not Just Scale Bigger: Adaptive Sensing as a Paradigm Shift — *San Diego, USA*

ICLR 2025 Poster Presentation — *Apr. 2025*
Adaptive Camera Sensor for Vision Models — *Singapore*

ResearchTrend Connect Invited Talk — *Mar. 2025*
Vision-Language Meetup: Sensing for DNNs — *Online*

Ubicomp 2024 Oral Presentation — *Sep. 2024*
MIRROR: Towards Generalizable On-Device Video Virtual Try-On for Mobile Shopping. — *Melbourne, Australia*

Trustworthy AI Workshop Invited Talk — *Sep. 2024*
MIRROR: Towards Generalizable On-Device Video Virtual Try-On for Mobile Shopping. — *Melbourne, Australia*

CVPR 2024 Poster Presentation — *Jun. 2024*
Unexplored Faces of Robustness and Out-of-Distribution: Covariate Shifts in Environment and Sensor Domains (CVPR 2024) — *Seattle, USA*

Mobisys 2024 Demo Presentation (Runner-up Award) — *Jun. 2024*
On-Device Video Virtual Try-On for Mobile Shopping — *Tokyo, Japan*

Teaching Experience

Coursework

Summer 2025	**Head Instructor**, 7-week Project Mentoring Program, Data Analysis Boot Camp	*HYUNDAI MOTORS*
2024–2025	**Head Lab Instructor**, On-device AI Program (4 semesters)	*SAMSUNG*
Summer 2024	**Head Lab Instructor**, Advanced Expert Course in Big Data, Fintech, and AI	*SNU KDT*
Winter 2023	**Lab Instructor**, Ambient AI Boot Camp [video]	*SNU GSDS*
Fall 2022	**Head Lab Instructor**, Ambient AI Platforms and Practice (M3239.005900) [video]	*SNU GSDS*
Fall 2021	**Lab Instructor**, Digital Computer Concept and Practice (035.001)	*SNU CSE*
Fall 2019	**Lab Instructor**, Computer Programming (M1522.000600)	*SNU CSE*

Mentored Students

2025	**Jun-Won Park (Lead Manager, KIA)**, E2E Vehicle Inspection Pipeline Development
2025	**Jin-Hwan Kim (Manager, KIA)**, Out-of-Distribution Data Generation for Vehicle Inspection
2025	**Rian Kim (Undergrad, SNU)**, Adaptive Sensing for DNNs
2025	**Claire Shin (Undergrad, Princeton)**, Adaptive Sensing for DNNs
2023 – 2025	**Jiyoon Kim (Master, SNU)**, Real perturbation simulation
2024	**Dong-ha Ahn (Undergrad, SNU)**, Adaptive Sensing for DNNs, Virtual Try-On
2023	**Mingyun Seo (Undergrad, SNU)**, Adaptive Sensing for DNNs

Skills

AI / ML	Computer Vision, Edge AI, Generative Models, VLMs, Representation Learning, Reinforcement Learning; Reliability & Robustness
Systems & Prototyping	Linux, Android, Jetson, Coral, BLE, FPGA, Arduino; Testbed Construction, Rapid Prototyping
Programming	Python, C/C++, JavaScript, Java, SQL, R, Mathematica, Matlab
Frameworks & Tools	PyTorch, TensorFlow, Docker, Git; Flask, React, Vue; MongoDB, Neo4j, BigQuery; OpenOOD
Research & Analysis	Dataset Curation, XAI, HCI, Data Visualization (D3, Vega, Matplotlib), Model Debugging, User Studies, Signal Processing
Math Foundations	Linear Algebra, Real Analysis, Probability & Statistics, Differential Equations, Cryptography
Languages	Korean (Native), English (Fluent)