Ukcheol Shin

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Research Interests

My research focuses on developing robust robot intelligence that can perceive and navigate the dynamic world in challenging conditions, with a specific interest in self-supervised learning of 3D geometry, semantic perception, deep reinforcement learning, and multi-sensor fusion.
I am interested in the following areas, but also open to other explorable/challenging domains.

- **3D Geometric Understanding In-the-Wild**
  - Self-supervised 3D Geometry (Depth, optical flow, scene flow, odometry, object pose, SLAM)
  - 3D Geometry in Adverse Conditions (rainy, snowy, dusty, over-exposed, low-lighted conditions)
  - Continual Learning for 3D Geometry
- **Scalable Representation Learning**
  - Learning from Self-supervision (Image, Video, Motion, Action)
  - Learning from Multi-modal Sensor Data (RGB, NIR, Thermal cameras, LiDAR, Radar)
- **Robust Visual Perception**
  - Deep Reinforcement Learning for Adaptive Robot Vision System
  - Multi-modal Sensor Fusion for Geometric/Semantic Perception

Research Experiences

Carnegie Mellon University — United States
Postdoctoral Associate, CMU Robotics Institute (RI) (Advisor: Jean Oh) — Sep.2023 - Current
- Research topics: Self-supervised 3D Geometry, Robotics, Reinforcement Learning.

Korea Advanced Institute of Science and Technology — Korea
Graduate Student Researcher, Robotics and Computer Vision Lab (Advisor: In So Kweon) — Sep.2017 - Aug.2023
- Research topics: Self-supervised 3D Geometry, Sensor Fusion, Robot Vision, Deep Learning.

Seoul National University of Science and Technology — Korea
Research Intern, Embedded System Lab (Advisor: Byoung Wook Choi) — Jan.2015 - Feb.2017
- Research topics: Embedded Linux, Real-time Operating System, Real-time Ethernet, Robotics.

Education

Korea Advanced Institute of Science and Technology — Korea
Ph.D. in Electrical Engineering, Advisor: In So Kweon — Sep.2019–Aug.2023
- Dissertation: "Self-supervised 3D Geometric Perception in Adverse Real-world Environments"

Korea Advanced Institute of Science and Technology — Korea
M.S. in Electrical Engineering, Advisor: In So Kweon, GPA: 3.81/4.30 — Sep.2017–Aug.2019
- Thesis: "Noise-Aware Camera Exposure Control for Robust Robot Vision"

Seoul National University of Science and Technology — Korea
B.S. in Electrical and Information Engineering, GPA: 4.20/4.50 — Mar.2011–Feb.2017
- Project: "Real-Time Ethernet Protocol based Omni Directional Mobile Robot"

Publications

- **20. Learning to Control Camera Exposure via Reinforcement Learning**
  - **Ukcheol Shin***, Kyunghyun Lee*, Byeong-Uk Lee (*Equal Contribution)
  - IEEE/CVF Conference on Computer Vision and Pattern Recognition (**CVPR**), 2024

- **19. Complementary Random Masking for RGB-T Semantic Segmentation**
  - **Ukcheol Shin**, Kyunghyun Lee, In So Kweon, Jean Oh
  - IEEE International Conference on Robotics and Automation (**ICRA**) (**Oral**), 2024

- **18. Learning Quadrupedal Locomotion with Impaired Joints Using Random Joint Masking**
  - Mincheol Kim, **Ukcheol Shin**, Jung-Yup Kim
  - IEEE International Conference on Robotics and Automation (**ICRA**) (**Oral**), 2024

- **17. Stable Surface Regularization for Fast Few-Shot NeRF**
  - ByeongIn Joung, Byeong-Uk Lee, Jaesung Choe, **Ukcheol Shin**, Minjun Kang, Taeyeop Lee, In So Kweon, Kuk-Jin Yoon
  - International Conference on 3D Vision (**3DV**), 2024

- **16. Bridging Spectral-wise and Multi-spectral Fused Depth Estimation: Geometry-guided Contrastive Learning and Attachable Feature Fusion**
  - **Ukcheol Shin**, Kyunghyun Lee, Jean Oh
  - IEEE Transactions on Intelligent Vehicles (**T-IV**, Under-review), 2024
  - Received **Samsung Humantech Paper Award (Honourable Mention)**

- **15. Empirical Study: Monocular Depth Estimation from RGB, NIR, Thermal Image in Adverse Weather Conditions**
  - **Ukcheol Shin**, Soonmin Hwang, Jean Oh
  - International Conference on Information and Communication Technology Convergence (**ICTC**) (**Oral**), 2023

- **14. Joint Self-supervised Learning and Adversarial Adaptation for Monocular Depth Depth Estimation from Thermal Image**
  - **Ukcheol Shin**, Kwanyong Park, Kyunghyun Lee, Byeong-Uk Lee, In So Kweon
  - Machine Vision and Applications (**MVA**), 2023

- **13. Deep Depth Estimation from Thermal Images**
  - **Ukcheol Shin**, Jinsun Park, In So Kweon
  - IEEE/CVF Conference on Computer Vision and Pattern Recognition (**CVPR**), 2023

- **12. Self-supervised Monocular Depth Estimation from Thermal Images via Adversarial Multi-spectral Adaptation**
  - **Ukcheol Shin**, Kwanyong Park, Byeong-Uk Lee, Kyunghyun Lee, In So Kweon
  - IEEE/CVF Winter Conference on Applications of Computer Vision (**WACV**) (**Oral**), 2023
  - Received **Best Student Paper Award** in WACV 2023

- **11. UDA-COPE: Unsupervised Domain Adaptation for Category-level Object Pose Estimation**
  - Taeyeop Lee, Byeong-Uk Lee, Inkyu Shin, Jaesung Choe, **Ukcheol Shin**, In So Kweon
  - IEEE/CVF Conference on Computer Vision and Pattern Recognition (**CVPR**), 2022

- **10. DRL-ISP: Multi-objective Deep Camera ISP with Deep Reinforcement Learning**
  - **Ukcheol Shin***, Kyunghyun Lee*, In So Kweon (*Equal contribution)
  - IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**) (**Oral**), 2022

- **9. Maximizing Self-supervision from Thermal Image for Effective Self-supervised Learning of Depth and Ego-motion**
  - **Ukcheol Shin**, Kyunghyun Lee, Byeong-Uk Lee, In So Kweon
  - IEEE Robotics and Automation Letters (**RA-L** and **IROS**) (**Oral**), 2022

- **8. MS-UDA: Multi-spectral Unsupervised Domain Adaptation for Thermal Image Semantic Segmentation**
  - Yeong-Hyeon Kim, **Ukcheol Shin**, Jinsun Park, In So Kweon
  - IEEE Robotics and Automation Letters (**RA-L**), 2021

- **7. Self-supervised Depth and Ego-motion Estimation for Monocular Thermal Video using Multi-spectral Consistency Loss**
  - **Ukcheol Shin**, Kyunghyun Lee, Seokju Lee, In So Kweon
  - IEEE Robotics and Automation Letters(**RA-L** and **ICRA**) (**Oral**), 2021

- **6. An Efficient Asynchronous Method for Integrating Evolutionary and Gradient-based Policy Search**
  - Kyunghyun Lee, Byeong-Uk Lee, **Ukcheol Shin**, In So Kweon
  - Neural Information Processing Systems (**NeurIPS**) (**Oral**), 2020

- **5. Vehicular Multi-camera Sensor System for Automated Visual Inspection of Electric Power Distribution Equipment**
  - Jinsun Park, **Ukcheol Shin**, Gyumin Shim, Kyungdon Joo, Francois Rameau, Junhyeok Kim, Dong-Geol Choi, In So Kweon
  - IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**) (**Oral**), 2019

- **4. Camera Exposure Control for Robust Robot Vision with Noise-aware Image Quality Assessment**
  - **Ukcheol Shin**, Jinsun Park, Gyumin Shim, Francois Rameau, In So Kweon
  - IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**) (**Oral**), 2019

- **3. Performance Evaluation of Real-time Mechanisms on Open Embedded Hardware Platforms**
  - **Ukcheol Shin**, Byoung Wook Choi
  - Journal of Institute of Control, Robotics, and Systems (**ICROS**), 2017

- **2. Development and Control of an Omnidirectional Mobile Robot on an Ethercat Network**
  - Raimarius Delgado, **Ukcheol Shin**, Chang Hwi Hong, Byoung Wook Choi
  - International Journal of Applied Engineering Research (**IJAER**), 2016

- **1. Implementation and Performance Analysis of an Ethercat Master on the Latest Real-time Embedded Linux**
  - Raimarius Delgado, Chang Hwi Hong, **Ukcheol Shin**, Byoung Wook Choi
  - International Journal of Applied Engineering Research (**IJAER**), 2015

Skills

- **Programming Language:** C, C++, Python, Matlab
- **ML/CV/RO Library:** Pytorch, OpenCV, ROS
- **Embedded Linux:** Linux Programming, Device Driver, Real-time Operating System, Embedded System.
- **Deep Learning:** 3D Geometry, Self-supervised Learning, Domain Adaptation, Reinforcement Learning
- **Sensors:** RGB Camera, NIR Camera, Thermal Camera, Motor, Wheel Encoder, IMU, LiDAR

Invited Talk

- **Seoul National University (SNU)** Feb. 2024
  Title: Robust Semantic and Spatial Perception in Adverse Weather and Lighting Conditions
- **Gwangju Institute of Science and Technology (GIST)** Sep. 2023
  Title: Robust Geometric Perception in Adverse Weather and Lighting Conditions
- **Ulsan National Institute of Science and Technology (UNIST)** July 2023
  Title: Robust Geometric Perception in Adverse Weather and Lighting Conditions
- **Pusan National University** July 2023
  Title: Robust Visual Perception from Thermal Spectrum Band in Challenging Conditions

Academic Activities

- Journal Reviewer 2021–Current
  T-IV, T-CYB, T-OMM, RA-L, NPL, PR, Sensors, Applied Sciences
- Conference Reviewer 2021–Current
  NeurIPS, ICML, ICLR, AAAI, CVPR, ICCV, ECCV, ACCV, WACV, ICRA, IROS, RSS

Awards and Honors

- **Honorable Mention**, 29th HumanTech Paper Award, Samsung Electronics Co., Ltd ($2000). Feb. 2023
- **Best Student Paper Award**, IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)
  - Out of 641 accepted papers, out of 1577 submissions Jan. 2023
- **KAIST Scholarship**, Scholarship for the Ph.D. program Sep. 2019 - Aug. 2024
- **KAIST Government Scholarship**, Scholarship for the M.S. program Sep. 2017 - Aug. 2019
- **Graduation with Honors (Top 3%)**, SNUST in Electrical and Information Engineering Feb 2017
- **Honorable Mention**, All-semester Design Based Learning (ADBL) Capstone Contest June 2016
- **Second Prize**, Robot Open Academy Feb 2016
- **Grand Prize**, All-semester Design Based Learning (ADBL) Capstone Contest Dec 2015
- **Military Service**, Army Sergeant, Honorable discharge May 2013 - Nov. 2014
- **Scholarship for Academic Excellence**, Scholarship for the entire B.S. program 2011-2012, 2015-2016

Research Projects

- **AI System for Traffic and Hit-and-Run Accidents with Multi-Band Images** (2022 - 2023)
  - Partners: KAIST, Miru Systems.
  - My role: Research Director
  - Objective: Develop multi-band sensor system (Visible, NIR, LWIR) and video analysis algorithms (object detection, super-resolution, video summarization, anomaly detection) for traffic and hit-and-run accidents.
- **Real-time Masking/Unmasking System for Personal Information in Public CCTV Services** (2021 - 2023)
  - Partners: KAIST, Hanbat National University, Miru Systems, Hanulsoft, Datamaker, Deajeon Transportation Corporation, Telecommunications Technology Association (TTA).
  - My role: Research Director
  - Objective: Develop deep stenography algorithm to mask/unmask personal information (faces, car license plates).
- **SWIR Camera based Navigation for UAV in Indoor Environments** (2021 - 2023)
  - Partners: KAIST, University of Picardy Jules Verne (UPJV), University of Burgundy.
  - My role: Research Director, Research Associate
  - Objective: Develop data-driven Structure-from-Motion or SLAM algorithms for SWIR camera.
  - Related to the publications ([7], [9], [12]).
- **Automated Visual Inspection System for Electric Power Distribution Equipment** (2017 - 2021)
  - Partners: Five Labs in KAIST, Korea Electric Power Corporation (KEPCO), NexChal.
  - My role: Research Associate(2017-2020), Research Director (2020-2021)
  - Objective: Develop vehicular multi-camera sensor system (8 color cameras, 2 thermal cameras, 6 motors, 1 GPS/IMU), its control algorithm, and perception models (detection, segmentation) for automated visual inspection from a moving vehicle. Also, integrate all developed hardware and software with Robot Operating System (ROS) platform in vehicle platform.

  - Related to the publications ([4], [5]).

- **Real-Time Embedded Linux and Device Driver Development for Mobile Robot** (2016 - 2017)
  - Partners: Seoul National University of Science and Technology, KIST.
  - My role: Research Associate
  - Objective: Develop real-time device driver (motor, encoder, LRF, IMU) and I2C based control system.
  - Related to the publications ([1], [2], [3]).

- **Real-Time Ethernet Protocol Development for Low-power Embedded System** (2015 - 2016)
  - Partners: Seoul National University of Science and Technology, KIST.
  - My role: Research Assistant
  - Objective: Develop real-time embedded system (Xenomai) and real-time ethernet protocol (EtherCAT) for real-time distributed motor control.
  - Related to the publications ([1], [2], [3]).

Teaching

- **Teaching Assistant** at KAIST — Spring 2019
  Electronics Design Lab. <Network of Smart Things> (EE405C)
- **Teaching Assistant** at KAIST — Spring 2018
  Programming Structures for Electrical Engineering (EE209)

References

- **Prof. In SO Kweon (M.S. and Ph.D. advisor at KAIST)**
  KEPCO Chair Professor, School of Electrical Engineering, KAIST
  Email: iskweon77@kaist.ac.kr

- **Prof. Jean Oh (Postdoc supervisor at CMU RI)**
  Associate Research Professor, Robotics Institute, CMU
  Email: hyaejino@andrew.cmu.edu