HYUNWOO RYU

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RESEARCH INTEREST

Physics-inspired Geometric Deep Learning for Robotics

$SE(3)$-Equivariant Robotic Manipulation Diffusion Models for Robotics Neural Fields for Robotics

EDUCATION

M.S. in Artificial Intelligence, Yonsei University (Advisor: Prof. Jongeun Choi) Mar. 2022 - Feb. 2024

B.S. in Mechanical Engineering, Yonsei University Mar. 2015 - Feb. 2022

- 2-year absence due to military service (Aug. 2016 - May 2018).
- **Selected Courseworks in Physics**:
  Advanced Quantum Mechanics (A+), Elementary Particle Physics (A+), Introduction to General Relativity (A+)

PUBLICATION

Conference Papers

- **Hyunwoo Ryu**, Jiwoo Kim, Junwoo Chang, Hyunseok An, Joohwan Seo, Taehan Kim, Yubin Kim, Chaewon Hwang, Jongeun Choi, Roberto Horowitz, "Diffusion-EDFs: Bi-equivariant Denoising Generative Modeling on $SE(3)$ for Visual Robotic Manipulation" (CVPR 2024)
- **Hyunwoo Ryu**, Hong-in Lee, Jeong-hoon Lee, Jongeun Choi, "Equivariant Descriptor Fields: $SE(3)$-Equivariant Energy-Based Models for End-to-End Visual Robotic Manipulation Learning" (ICLR 2023)

Workshop Papers

*: Equal Contribution

- Junwoo Chang*, **Hyunwoo Ryu* (Equal Contribution)**, Jiwoo Kim, Soochul Yoo, Joohwan Seo, Nikhil Potu Surya Prakash, Jongeun Choi, Roberto Horowitz, "Denoising Heat-inspired Diffusion with Insulators for Collision Free Motion Planning" (NeurIPS 2023 Workshop on Diffusion Models)
- Jiwoo Kim*, **Hyunwoo Ryu* (Equal Contribution, Oral Presenter)**, Jongeun Choi, Joohwan Seo, Nikhil Potu Surya Prakash, Ruolin Li, Roberto Horowitz, "Robotic Manipulation Learning with Equivariant Descriptor Fields: Generative modeling, Bi-equivariance, Steerability, and Locality"
  (RSS 2023 Workshop on Symmetries in Robot Learning, **Oral** (Video), **Best Paper**)

ACHIEVEMENT

Best Technical Demonstration Award Oct. 2023
The 5th Yonsei University Mechanical Engineering Graduate Student Academic Conference

Best Paper Award July 2023
Robotics: Science and Systems (RSS) Workshop on Symmetries in Robot Learning

Advanced Quantum Computing Certificate Dec. 2020
IBM Quantum Challenge 2020

3rd Prize & Technical Report S-Rank (top 4 out of 68 universities worldwide) May 2019
International Conference on Robotics and Automation (ICRA) Robomaster AI Challenge 2019

ACADEMIC SERVICE

- International Conference on Robotics and Automation (ICRA) Reviewer 2024

PROJECT EXPERIENCE

Technical Demonstration of Diffusion-EDFs (Project Website) Aug. 2023 - Oct. 2023
Team Leader

- Demonstrated real robot manipulation with *Diffusion-EDFs*.
- Won Best Technical Demonstration Award at Yonsei University M.E. Graduate Students' Conference.

Undergraduate Capstone Project Mar. 2021 - June 2021
Visual-SLAM Engineer

- Developed tracking and monitoring system for individuals with fever using quadcopter drones.
- Developed visual-SLAM (simultaneous localization and mapping) and aerial motion planning pipelines.
- Developed computer-vision based target invidual localization and filtering algorithm.

ICRA Robomaster AI Challenge 2019 (Video) Sep. 2018 - May 2019
System Architect, ROS Engineer, Motion Planning Engineer

- Designed overall system architecture with Robot Operating System (ROS), integrating computer-vision based perception system and reinforcement learning based intelligent decision-making system.
- Developed motion planning algorithms and navigation pipeline for our omnidirectional mobile robots.
- Successfully deployed simulation-trained reinforcement learning (RL) agents to our real robots.
- S-rank in technical reports (top 4 out of 68 universities worldwide); 3rd Prize in main competition.

RESEARCH EXPERIENCE

Machine Learning and Control Systems (MLCS) Lab, Yonsei University Jan. 2022 - Present
Advisor: Prof. Jongeun Choi

- $SE(3)$-equivariant robotic manipulation learning
- Diffusion models for robot learning

Undergraduate Thesis Aug. 2021 - Dec. 2021
Advisor: Prof. Jongeun Choi

- Title: *Learning Discrete State Abstraction for Task Planning with Contrastive Predictive Coding*

TEACHING EXPERIENCE

MEU2105-01 Mechanical Engineering Laboratory I
Head Teaching Assistant (TA)

- Served as head teaching assistant (TA), leading 7 other fellow TAs.
- Designed hardware experiments and programming sessions for analog and digital measurement class.

ADDITIONAL EXPERIENCE

CogSci:IN (Yonsei University Students' Academic Club for Cognitive Science) Aug. 2019 - Feb. 2021

- Served as president in 2020.
- Gave two public presentations on sustained attention (2019) and on spiking neural networks (2020) at Synapse: National Symposium on Brain and Cognitive Science for College Students in South Korea.

SCC (Yonsei University Students' Academic Club for Physics) Sep. 2019 - Aug. 2020

- Gave public presentation on ML + Physics (Speech title: "Boltzmann Machines: The Intersection of Statistical Physics and Artificial Intelligence")

Military Service Aug. 2016 - May. 2018

- Republic of Korea Army, 702nd Commando Regiment.

LEADERSHIP

- Mentored four undergraduate research interns, successfully guiding two of them to publish workshop proceedings.
- Successfully led CogSci:IN, the Yonsei University's cognitive science academic club, as the president, through the challenges of the COVID-19 pandemic in 2020.

SKILL

Machine Learning	Geometric/Equivariant Deep Learning, Graph Neural Networks, Computer Vision
Robotics	Robotic Manipulation, Motion Planning, Visual-SLAM, Reinforcement Learning
Programming	PyTorch, Tensorflow, ROS, Qiskit, Python, C++, Shell, Linux
Mathematics	Riemannian Geometry, Lie Group & Lie Algebra, Representation Theory
Interdisciplinary	Theoretical Physics, Neuroscience, Quantum Computing

REFERENCE

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