Jin-hyuk Yu

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Research Interests

Wave Energy Converter (WEC) control codesign, optimal control and Hardware In-the-Loop (HIL)

Education

University of Michigan in Ann Arbor *Ann Arbor, Michigan*
Ph.D. in Naval Architecture and Marine Engineering *Aug 2022 - Current*
- Degree info: Ph.D. pre-candidate
- Research area: WEC Control Codesign
- Advisor: Dr. Lei Zuo (profile link)
- Laboratory: Marine Renewable Innovations and Education (MARINE) Laboratory

Virginia Polytechnic Institute and State University *Blacksburg, Virginia*
Ph.D. in Mechanical Engineering *Aug 2021 - July 2022*
- Thrust Area: Robotics, Autonomous and Dynamics Systems (RADS)
- Hord Fellowship for graduate students *Jan 2022 – May 2022*

University of Florida *Gainesville, Florida*
Master of Science in Mechanical Engineering *May 2021*
- Thesis: Implementation of path tracking algorithms and trajectory optimization based on the extended Kalman filter.
- Advisor: Dr. Carl D. Crane (profile link)
- Laboratory: Center for Intelligent Machines and Robotics(cimar.mae.ufl.edu)
- Academic Achievement Award for Engineering Graduate Student *Aug 2019 – Dec 2020*

Kookmin University *Seoul, Korea*
Bachelor of Science in Mechanical Engineering. *Feb 2019*
- Completed ABEEK (Accreditation Board for Engineering Education in Korea)

Northeastern Illinois University *Chicago, Illinois*
Exchange student program in Computer Science. *Sep – Dec 2016*

Research Experience

Ph.D. Graduate Research Assistant *University of Michigan in Ann Arbor*
Department of Naval Architecture and Marine Engineering. *Aug 2022 - Current*
- Participated in SHARKS project and NSF LEAP- HI project as a research assistant.
- Participated in Dynamometer test-bench project as a research assistant.
- Currently working on thesis research proposal under Dr. Lei Zuo's lead.
- Focus area: WEC Control Codesign.
- Purpose of the research: Design of the real-time optimization in WEC control system based on control codesign approach to maximize the total converged electric power from the wave to apply for the large-scale WEC energy generation.

Ph.D. Graduate Research Assistant *Virginia Tech*
Department of Mechanical and Aerospace Engineering. *Feb 2022 – May 2022*
- Participated in Ocean-powered Robots for Autonomous Offshore Aquaculture project as a graduate researcher.
- Pursued the Ph.D. research under Dr. Lei Zuo's lead.
- Focus area: Marine energy control
- Purpose of the research area: By controlling the convergence process of the power take-off system (PTO system), maximize the energy convergence of the wave energy from the PTO system of the heaving WEC. Also, focused on the phase control of the PTO system to reduce the damage and increase the life of heaving WEC.

Graduate Student Researcher *University of Florida*
Department of Mechanical and Aerospace Engineering. *Aug 2020 – May 2021*

- Participated in INDY Autonomous Challenge project as a software programmer
- Pursued the Master's Degree Thesis under Dr. Carl D. Crane's lead
- Thesis: Implementation of path tracking algorithms and trajectory optimization based on the extended Kalman filter.
- Focus area: Path tracking algorithms and Kalman filtering.
- Purpose of the thesis: Based on three path tracking algorithms, Pure pursuit, PID Feedback, and Model Predictive Control, find out how we can enhance the performance of path tracking algorithms and optimize the trajectory of an autonomous vehicle in the autonomous driving simulation using the extended Kalman filter.

Research Assistant *Kookmin University*
School of Mechanical Engineering. *March – Aug 2018*

- Assisted the "Metals and Ceramics Structural Analysis Study for the automobile suspension part design" directed by principal investigator Professor Tae-woo Kim for Hyundai motors.
- Responsible for preparing experimental setup and analyzing mechanical properties of structure using finite element analysis.
- Responsible for designing samples' structures by using AutoCAD for experiments and preparing experimental setup.

Project Experience

"LEAP-HI: US-Ireland R&D Partnership: Control Co-Design for Ocean Wave Energy Conversion" *University of Michigan*
NSF *Jan 2023 – Current*

<Research Assistant>

- The member of the control codesign team in University of Michigan.
- Cooperating with Dr. John Ringwood's team from National University of Ireland, Maynooth.
- Responsible for designing the advanced control system based on the codesign approach and collaborating with Dr. John Ringwood's team to co-optimize and refine the PTO system and Control.

"Dynamometer test-bench workshop project" *University of Michigan*
ONR *Jan 2023 – Current*

<Research Assistant>

- The member of the control team of the project.
- Funded by Office of Naval Research (ONR)
- Responsible for designing the real-time optimal control system for the dynamometer test-bench and simulation of WEC system. And responsible for communicating with dynamometer companies and proceeding with the contract to purchase and assemble hardware.

"SHARKS project - Bio-Inspired Renewable Energy (BIRE) for highly-efficient low-cost riverine hydrokinetics" *University of Michigan*
DOE and ARPA-E *Aug 2022 – Current*

<Control programmer>

- The member of the control team of the project.
- Cooperating with the SNL control team.
- Responsible for designing the control system of the unique PTO system developed by Dr. Lei Zuo's laboratory to maximize the power absorption from the wave. Also, responsible for the connection and cooperation with the SNL control team to develop the controller to apply at the PTO system.

"Ocean-powered robots for Autonomous Offshore Aquaculture project". *Virginia Tech*
NSF and USDA *Feb 2022 – May 2022*

<Software Programmer>

- The member of the control team of the project.
- Cooperating with the Senior design team of the Energy Harvesting and Mechatronics Laboratory
- Responsible for designing the LQG controller of the PTO system to maximize the energy convergence of the heaving WEC and ensure the safety of the heaving movement of the WEC.

"INDY Autonomous Challenge". *University of Florida*
Energy Systems Network, Central Indiana Corporate Partnership. *Aug 2020 – Dec 2020*
<Software Programmer>

- The member of the software team of Indy GoKart Project for INDY Autonomous Challenge.
- Cooperating with the simulation software team of Machine Intelligent Laboratory, led by Dr. Eric M. Schwartz from Department of Electrical and Computer Engineering
- Responsible for Implementation of Ackerman Steering Algorithm to control vehicle steering similar to the real vehicle movement.
- Responsible for Simulation of Engine delay to match the output of the plugin with the output of the engine delay for Indy GoKart Gazebo Simulation.

***"*Seoul Lego Mindstorms Segway Contest".** *Seoul, Korea*
Korean Government-Engineering Development Center. *Sep – Dec 2013*
< Project leader>

- Designed for Lego Mindstorms Segway for better balance control on slopes, programming in Matlab and ROBOTC.
- Measured the Segway movement on slopes by controlling the Segway gain factors, such as position value in Mindstorms system, and designating the proper site for visual sensors.
- Won "1st place in balance division" among 36 teams.

"Miniature Catapult Design and Shooting Contest". *Kookmin University*
School of Mechanical Engineering. *March – June 2013*
< Project leader>

- Designed and manufactured the miniature catapult, suggesting academic theories and formulas including the "Newton's Second Law" and "fluid resistance".
- Special feature: applying standardized tension coil springs for accurate aiming estimate.
- Won "Best sharpshooter (every 10 meters)" and "Second long distance (55 meters)".

"Creative and Innovative Photovoltaic Generator Competition". *Kookmin University*
School of Mechanical Engineering. *March – May 2016*
< Project leader>

- Designed and manufactured a photovoltaic generator, suggesting mechanical engineering technology and theories, such as Thermoelectric effect, and Peltier effect.
- Special feature: utilized the greenhouse effect to preserve heat, equipped funnel shaped air blower with weathervane to focus and continue a wind blow for coolant.
- Generated 132 mV electric powers and won "Best Idea Prize" among 42 teams.

Computer Program Skills

- Programming Languages
  : MATLAB, Python, LabVIEW. ROS, Gazebo, C++ and Java
- 3D simulation programs and CADs.
  : WEC-sim, Wecopttool, Ansys AQWA, AutoCAD, SolidWorks, ONSIMULATION, and Abaqus

Presentations

"2018 Capstone Design Competitive Exhibition". *Seoul, Korea*
Korean Government-Engineering Development Center. *Nov 22 2018*

- Designed and manufactured a fire extinguisher with as an automatic glass demolition gadget with impellent spring (tungsten nail hammer) in emergency situations, considering the materials' properties and manufacturing processes.
- Qualified for the final round.
- Registered patent for a utility model of the Korean Intellectual Property Office (2018)

"2018 Mechanical Design Drawing Exhibition". *Kookmin University*
Korean Ministry of Education and Science Technology. *Nov 6 to 9 2018*

- Presented the final exhibition of the drawings of mechanical components, explaining the movements of complex structures, such as robot hands, watch, car, and exoskeletons.
- Discussed with the Committee of Education and Science Technology that robot hand fingers should have one more joint than those of humans for more precise and accurate movements.

Awards

Award at Department of Mechanical Engineering in Virginia Tech	*Jan 2022 – May 2022*
Award at Herbert Wertheim College of Engineering in University of Florida	*Aug 2019 – Dec 2020*
Award at Kookmin University (Fellowship).	*March 2017*
Award at Kookmin University for Honored student (Scholarship).	*March 2016*
Award at 2017 National Creatively Manufactured R/C Aviation Competition	*Sep 2017*
Award at Creative and Innovative Photovoltaic Generator Exhibition	*June 2016*
Award at Seoul Lego Mindstorms Segway Exhibition	*Dec 2013*
Award at Miniature Catapult Design and Shooting Contest	*June 2013*
Award at Korean Military Army Artillery Division	*Sep 2015*

Extracurricular Activities

International Network on Offshore Renewable Energy "INORE" *University of Michigan*
< Member > *Dec 2022 - Current*

- INORE: an associate for postgraduate students, postdoctoral researchers and professionals for the broad connection about Offshore Renewable Energy research.
- Joined for the broad communication and discussion about the Ocean Renewable Energy research and the current trend.
- Objective: Have a broad connection with Ocean Renewable Energy researchers around the world and learn about the current WEC control and Control Co-design research direction for Ph.D. research.

Unmanned Aircraft and Drone Manufacturing Club "Krone". *Kookmin University*
< President > *March – Sep 2017*

- Applied and modified the concept of "Canard Wing" for lift force and mobility.
- Resourced and coordinated the manufacturing of the aircraft and ran test flights with external experts.
- Won runner-up prize among the 64 university teams in Korea in "2017 National Creatively Manufactured R/C Aviation Competition".

Korean Language Tutoring *Northeastern Illinois University*
<Volunteer tutor> *Sep – Dec 2016*

- Assisted students in pronunciation correction and proofreading as a tutor for a Korean language class for non-native Korean students

References

Lei Zuo, Professor in Department of Naval Architecture and Marine Engineering at University of Michigan in Ann Arbor

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Carl D. Crane, Professor in Department of Mechanical Engineering at University of Florida

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Warren E. Dixon, Newton C. Ebaugh Professor and Department Chair in Department of Mechanical Engineering at University of Florida

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