Youngjin Kim

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EDUCATION

University at Buffalo (UB), The State University of New York   Buffalo, NY

- **Ph.D.**, Mechanical Engineering, **Advisor** : Dr. Tarunraj Singh   *Aug 2024*
  Thesis: Advanced Motion Planning Strategies for Wheeled Mobile Robots: Performance, Efficiency, and Safety **[Link]**
- **M.S.**, Mechanical Engineering, **Advisor** : Dr. Tarunraj Singh, **Award**: 3rd Place- Department Research Competition   *June 2020*
  Thesis: Optimal Control of a Differential-Drive Mobile Robot **[Link]**
- **B.S.**, Mechanical Engineering, **Award**: Magna Cum Laude, Dean's List   *June 2018*

RESEARCH EXPERIENCE

Distributed Robotics and Networked Embedded Sensing (DRONES) Laboratory: UB-Computer Science   Buffalo, NY
Postdoctoral Research Associate (Supervisor: Dr. Karthik Dantu)   *Sep 2024 – Present*

- Designed a robust and provably safe motion planning algorithm for a quadruped robot to optimize performance in off-road and rugged environments, combining advanced model-based control methods with reinforcement learning algorithms.
- Designed and deployed an autonomous culvert inspection system using a legged robot with an active low-light illumination control, field-tested in the Erie Canal, NY. Invited to give a spotlight presentation (ICRA-2025).
- Supervised a research team of 10+ students and researchers in developing full-stack autonomous solutions for an excavator, in collaboration with industry partner Moog, Inc., for construction vehicle applications. Submitted a comprehensive project report to the Workshop on Field Robotics (ICRA-2025).
- Developed a safe and computationally efficient path planning algorithm for high-performance vehicles, MDOF robotic arms, and mobile manipulators.

Control, Dynamics, and Estimation (CoDE) Laboratory: UB-Mechanical Engineering   Buffalo, NY
Research Assistant (Supervisor: Dr. Tarunraj Singh)   *Aug 2018 – Aug 2024*

- Strong mathematical background and analytical skills, applied to develop exact analytical solutions for optimal path/motion planning in autonomous systems. Successfully achieved a 100% convergence rate using a nonlinear root-finding approach, outperforming conventional numerical algorithms.
- Developed a feedback controller using Lyapunov theory and Tikhonov regularization to enhance tracking performance and system stability. Validated through extensive simulations and experiments, achieving a 50% improvement in tracking accuracy, effectively overcoming initial state uncertainties, and ensuring smooth, continuous control profiles.
- Integrated control barrier functions with optimal control to ensure system safety and energy efficiency. Leveraged a re-planning strategy to minimize energy consumption, achieving an 85% improvement in energy efficiency.
- Designed model-based control for high-speed trajectory tracking for car-like robots. Enhanced tracking performance by 15% compared to NMPC while reducing the required compute by more than 50%. Participated in the 2023 IROS Grand Prix racing car competition.
- Skilled in leveraging various simulation tools for virtual testing and algorithm validation to ensure system performance and reliability. Experienced in hardware design, experimental testing, and algorithm refinement to bridge the gap between simulation and real-world applications.

INDUSTRY EXPERIENCE

Volvo Construction Equipment   Shippensburg, PA
Internship/Co-op   *Jan 2023 – May 2023*

- Applied signal processing and frequency domain analysis to develop advanced estimation and control algorithms for asphalt compactors, effectively reducing vibration and noise. Submitted for a European/China/United States patent.
- Developed a GUI to facilitate communication with the onboard Battery Management System (BMS) of electric construction vehicles, enhancing operational efficiency.
- Designed a high-fidelity prototype electric dual-drum asphalt compactor apparatus to synthesize and experimentally validate the control algorithm and conducted hardware-in-the-loop (HIL) testing.
- Contributed to the onboarding process for incoming interns, ensuring seamless integration into the work environment and offering essential insights into ongoing projects.

TECHNICAL SKILLS

- **Software/Simulation Tools:** Matlab, Python, CasADi, Simulink, ROS, LabView, Maple, Amesim, V-REP, Gazebo, IPOPT, CVX, Creo, Fusion 360
- **Hardware:** Speedgoat, CAN protocol, Raspberry Pi, Arduino, BLDC Motor, Servo Motor, Stepper Motor, Hall-Effect Sensor, Optical Encoder, IMU
- **Productivity/Development Tools:** Git, VS Code, Linux, Window, LaTex, MS Office

PUBLICATIONS

Journal Articles

J5. K. Singh, Y. Kim, K. Dantu, **CART: Context-Aware Terrain Adaptation for Stable Locomotion**, IEEE Robotics and Automation Letters (Submitted)

J4. Y. Kim, T. Singh, **Energy Optimal Path Planning for Wheeled Mobile Robots with Circular Obstacle**, Optimal Control Applications and Methods (2024) **[Link]**

J3. Y. Kim, T. Singh, **Energy-Time Optimal Trajectory Tracking Control of Wheeled Mobile Robots**, IEEE/ASME Transactions on Mechatronics (2023) **[Link]**

J2. Y. Kim, T. Singh, **Energy-Time Optimal Control of Wheeled Mobile Robots**, Journal of the Franklin Institute (2022) **[Link]**

J1. Y. Kim, T. Singh, **Minimum Energy Control of a Unicycle Model Robot**, Journal of Dynamic, Systems, Measurement, and Control (2021) **[Link]**

Conference Proceedings

C7. Y. Turkar, Y. Kim, K. Dantu, **Active Illumination Control in Low-Light Environments using NightHawk**, International Symposium on Experimental Robotics (In- Press)**[Link]**

C6. C. Aluckal, R. Lal, S. Courtney, Y. Turkar, Y. Dighe, Y. Kim, J. Gemerek, K. Dantu, **TERA: Simulation Environment for Terrain Excavation Robot Autonomy**, IEEE International Conference on Simulation, Modeling, and Programming for Autonomous Robots (2025) **[Link]**

C5. Y. Kim, C. He, T. Singh, **Control Barrier Function based Energy Optimal Obstacles Avoidance for Point-to-Point Maneuvers**, Modeling, Estimation and Control Conference (2024) **[Link]**

C4. Y. Kim, T. Singh, **Energy Optimal Obstacle Avoidance Motion Planning for Wheeled Mobile Robots**, American Control Conference (2024) **[Link]**

C3. Y. Dighe, Y. Kim, S. Rajguru, Y. Turkar, T. Singh, K. Dantu, **Kinematics-Only Differential Flatness based Trajectory Tracking for Autonomous Racing**, IEEE International Conference on Intelligent Robots and Systems (2023) **[Link]**

C2. Y. Kim, T. Singh, **Minimum-Time Energy-Optimal Path Following Control for a Wheeled Mobile Robot subject to Velocity Constraints using Linear Programming**, IEEE Conference on Control Technology and Applications (2023) **[Link]**

C1. Y. Kim, T. Singh, **Minimum Energy-Time Optimal Control of Wheeled Mobile Robots: Application to Parallel Parking**, American Control Conference (2022) **[Link]**

Workshop & Presentation

W2. K. Singh, Y. Turkar, Y. Kim M. Lengel, K. Dantu, **Autonomous Culvert Inspection on the Erie Canal using Legged Robots**, IEEE International Conference on Robotics and Automation-Workshop on Field Robotics (2025) **[Link]**

W1. Y. Turkar, S. Sreedharan, C. Aluckal, I. Malhotra, R. Lal, J. Jain, Y. Dighe, Y. Kim, J. Gemerek, K. Dantu, **Excavation Autonomy with Resilient Traversability and Handling**, IEEE International Conference on Robotics and Automation-Workshop on Field Robotics (2025) **[Link]**

Patent

P1. A. Zeid, H. Xu, P. Adani, Y, Kim, **Computer system for detecting and controlling a relative position of two rotating eccentric shafts, vehicle comprising such a computer system, method, and storage medium for performing such a method**, EP4380037A1,US20250050743A1, CN119483355A (Pending) **[Link]**

PROFESSIONAL SERVICES

Teaching

- **MAE 443/543: Continuous Control Systems** (Dr. Tarunraj Singh) - Fall 2019, Fall 2020, Fall 2021, Fall 2022, Fall 2023
- **EAS 207: Statics** (Dr. Alice Nightingale) - Spring 2021
- **EAS 208: Dynamics** (Dr. Alice Nightingale and Dr. Mostafa Nouh) - Spring 2022, Spring 2024
- **MAE 670: Nonlinear Control** (Dr. Tarunraj Singh) - Spring 2020
- **MAE 476/576: Mechatronics** (Dr. Jiyeon Kang) - Fall 2019
- **MAE 334: MAE Laboratory** (Dr. Aaron Estes) - Spring 2019
- **MAE 444/544: Digital Control System** (Dr. Aaron Estes) - Spring 2019

Journal/Conference Reviewer

- ASME Journal of Dynamic Systems, Measurement and Control
- IEEE Conference on Control Technology and Applications
- IEEE Robotics and Automation Letters
- IEEE International Conference on Robotics and Automation
- Control Engineering Practice
- American Control Conference