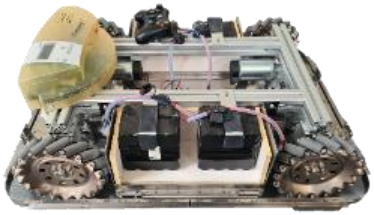
Design and Development of a Control and Navigation System with Hierarchical Sim2Real Planning Routines for an Automated Guided Vehicle

Description

Instead of learning in the real-world from scratch by using a multitude of robots, training transferrable AI agents via digital twins associates with using less resources while realizing massive parallelization. Transferability of the AI models lies on reducing the gap between the simulation and the real environments, and the first step to realize that is a consistent framework design. Hence, the focus of this project is on implementing and providing the necessary tools to facilitate training of state-of-the-art AI algorithms within simulations and transferring them to the real environment. For reliable sim2real model transfer, a consistent framework for the simulated software and real software/hardware should be developed in order to reproduce the simulated behavior by conserving the same level of control from the simulation to the real environment. The framework should implement hierarchical levels for a navigation control mechanism that can serve as a tool to compare baseline optimization(or search)-based path planning methods vs. learning-based approaches.

For the project work, a specially developed driverless transport vehicle “FESTO Robotino” will be used for testing purposes. In order to fulfill the conditions of the research project, the automated guided vehicle “Robotino” has to be adjusted. Hence, strong skills in engineering of embedded control systems is needed.



Tasks

- Conceptual design and development of an innovative hierarchical control system for the “Robotino” – from motor level control to task space control
- Development of an OpenAI gym-based simulation to model kinematics and dynamics of the “Robotino” w.r.t. the working environment
- Conceptual design and development of an energy supply system with innovative battery charging options
- Development of an odometry algorithm based on inertial measurements
- Development of a hierarchical navigation system based on 2D maps for robust sim2real transfer
- Implementation and execution of a validation test

References

[1] R. Siegwart, I. R. Nourbakhsh, and D. Scaramuzza, Introduction to Autonomous Mobile Robots, 2nd ed. The MIT Press, 2011.

[2] Sutton, R. S., & Barto, A. G. (2018). Reinforcement Learning: An Introduction. A Bradford Book.

[3] J. R. Sánchez-Ibáñez, C. J. Pérez-del Pulgar, and A. García-Cerezo, “Path Planning for Autonomous Mobile Robots: A Review,” Sensors, vol. 21, no. 23, 2021, doi: 10.3390/s21237898

Technical University of Munich

TUM School of Computation, Information and Technology

Chair of Robotics, Artificial Intelligence and Real-time Systems

---

Supervisor:
Prof. Dr.-Ing. Alois C. Knoll

Advisor:
Mohammadhossein Malmir, M.Sc.

Research Project:
Comparative Sim2Real Path Planning for AGV Navigation

Type:
Bachelor/Master Thesis
Guided Research
Interdisciplinary Project

Research Area:
Path Planning,
Mobile Robot Navigation,
Reinforcement Learning

Programming Languages:
Python, C++

Required Skills:
Strong Knowledge in Electrical Engineering,
Experience with ROS, Python, and Robot Simulation Frameworks,
Familiar with Robot Kinematics/Dynamics

Language:
English

For more information please contact:

E-Mail: hossein.malmir@tum.de

Internet: www.ce.cit.tum.de/air