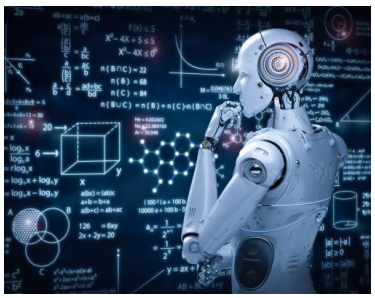
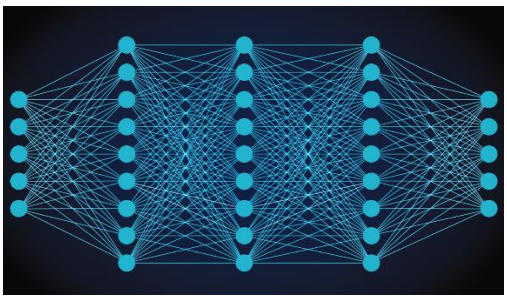
Master thesis abroad **Deep Reinforcement Learning for Slip-Aware Navigation in Skid-Steer Robots**

Karlsruhe (Germany) – Edmonton (Canada), Earliest start date: April 2025

Machine learning, reinforcement learning, human-machine interaction, autonomous robots, real-world experiments

International Research Collaboration

We are offering an exciting Master's thesis opportunity abroad as part of a research collaboration between the NODE lab of the University of Alberta (UofA), Canada, and the Institute of Control Systems (IRS) at KIT, Germany. The project focuses on motion planning for autonomous mobile robots in crowded environments, addressing challenges in planning among pedestrians and Human-Machine Interaction. The thesis will begin at IRS in Germany, focusing on developing and refining the motion planning controller. Following this initial phase, the student will relocate to Canada (Alberta) for 4-6 months to work in the NODE lab at the UofA, working on deploying a motion planning algorithm on the robot. This position provides a unique opportunity to gain international research experience while working on cutting-edge autonomous robotics and machine learning technologies.

Research Objective

In pedestrian-rich environments, autonomous robots face the challenge of navigating efficiently while avoiding collisions with humans and obstacles. **Machine learning techniques** are employed to **learn optimal navigation policies** that enable robots to move and navigate efficiently through such environments while respecting human social behavior. However, one of the significant challenges is to develop a **generalized navigation policy** that can adapt to various dynamic situations and handle the uncertainty inherent in these environments.

The project focuses explicitly on deploying a robust navigation policy on the **Husky skid-steer robot** from **Clearpath Robotics**. Like the Husky, skid-steer robots face unique challenges due to their **highly nonlinear kinematics** and **slip-dependent behavior**. When the robot executes an action to transition to a new position, the actual movement may differ from the expected trajectory, especially if the slip factor varies from the prediction. This discrepancy between expected and actual movement introduces a significant hurdle in creating reliable and adaptive navigation systems that perform well in real-world scenarios and account for human interactions.

The objective is to **develop a robust navigation policy** that adapts to various soil types, ensuring efficient movement across different terrains. Additionally, the project will **investigate the impact of action-induced state transitions on human interaction behavior**, enhancing the robot's safety and predictability in crowded environments. To achieve these objectives, your tasks will be:

- **Become familiar with Reinforcement Learning (RL), the existing training environment, and ROS architecture for deployment.**
- **Research on slip-dynamic models for skid-steer robots and RL policy development for robust sim-to-real deployment.**
- **Integrate skid-steer dynamics and kinematics into the training environment.**
- **Develop a robust navigation policy that adapts to varying slip values and terrains.**
- **Integrate the trained navigation policy into the ROS framework on the Husky robot.**
- **Evaluate the navigation performance in a lab setup while focusing on human-machine interaction.**

Requirements

- **High motivation and a strong interest in robotics and machine learning.**
- **Fluent in English (both written and spoken).**
- **Strong background in Machine Learning and Reinforcement Learning.**
- **Strong analytical thinking and goal-oriented working**
- **Experience with ROS and Linux is a plus.**

What we offer

- We value motivated and competent support, taking time for you, and providing helpful feedback.
- Work alongside our researchers in state-of-the-art research labs
- Gain exciting insights into our research and valuable practical experience for your career.

Additional Information

- The Networked Optimization, Diagnosis, and Estimation (NODE) Lab's research programs aim to advance safe decision-making and motion planning for cyber-physical systems and shared human-autonomy controls, focusing on intelligent and cooperative systems in unstructured and dynamic environments. For more information, scan or click on the QR code.
- Your host supervisor and contact person at UofA will be Prof. Ehsan Hashemi
- There is no registration fee for international visiting researchers coming to UofA. Computing facility and full access to testing equipment will be provided in the NODE lab. You will also have full access to libraries, sports facilities, and amenities.

Application

- Motivation letter explaining your interest in the position
- CV (Curriculum Vitae)
- Transcript of records (academic grades)

Have we got you interested?

Then send us your application: https://karriere.fzi.de/Vacancies/1136/Description/1

We look forward to getting to know you!

Daniel Flögel
daniel.floegel@kit.edu

Do you have questions on specialist topics? Then talk directly to one of our employees!