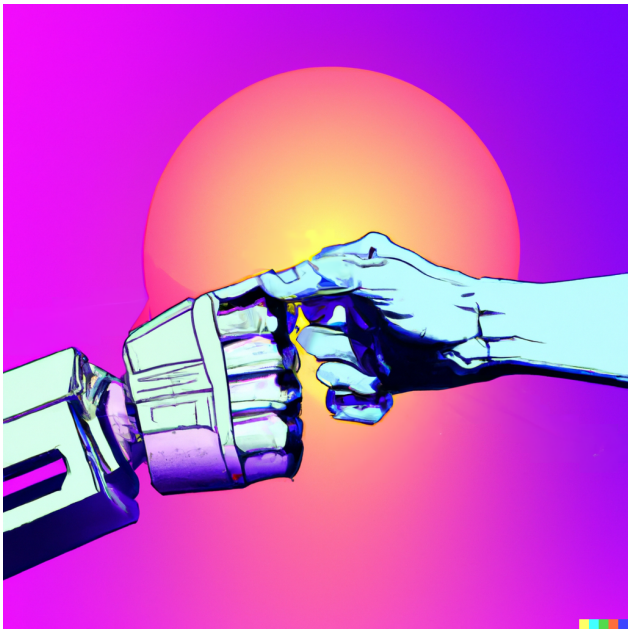
Ensuring Human Safety for AI-based Robot Control in ROS 2

Background

In the near future, we would like robots to be fully integrated into our everyday life. This requires robots to actively make dynamic decision based on the current desires of humans. Such an intelligent behavior cannot be hard-coded into a classical controller. Ideally, the robot should learn the correct motions from human input over time. Recent advances in AI, such as reinforcement learning (RL), show promising first results in dynamic robot control. However, AI-based methods are notoriously unreliable in safety-critical scenarios due to their black-box character. It would therefore be irresponsible to deploy an AI agent on a real robot, such as a full-scale manipulator, when working together with humans.

Our group has developed a sophisticated safety shield for robotic manipulation in human environments in the past years. Recently, we extended this shield to ensure safety during training of arbitrary AI agents on manipulators [1]. With the drastic improvements to ROS 2, it is now possible to ensure real-time execution of code in robotics. We therefore want to deploy our safety shield in ROS 2. For this, we are looking for a talented master's thesis student, who is interested in robotics, safety, and control.



Description

In this thesis, you will first conduct a thorough literature review on safe control on manipulators in human environments. You will then decide on a suitable sensor setup and software structure for this project. Your first main task will be the implementation of the safety shield in ROS 2 and the testing in simulation. You will then deploy the safety shield on a real-world manipulator. To show the suitability for AI-based methods, you will test the safety shield with an RL agent on the real hardware. This project is in close cooperation with our project partners from Fraunhofer Italia and Istituto Italiano di Tecnologia. Depending on the progress of the thesis, you will have the opportunity to travel to Italy and test your software on a cutting-edge modular robot.

References

[1] Jakob Thumm and Matthias Althoff. Provably safe deep reinforcement learning for robotic manipulation in human environments. In *Proc. of the IEEE Int. Conf. on Robotics and Automation (ICRA)*, pages 6344–6350, 2022.

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Research project:
CONCERT

Type:
MA

Research area:
Safe AI, ROS2, Human–Robot Coexistence, Robot Control, Human Safety

Programming language:
C++, ROS2

Required skills:
Knowledge of working in Linux
C++ experience
Experience in ROS2 is beneficial

Language:
English

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