WASP Project Course 2025

Human-Aware Robot Navigation for Exploration Tasks

Background

In this project, we aim to integrate concepts from human-aware robot navigation into robotic exploration tasks in the context of search and rescue (SAR) operations. The developed methods should enable robots to adapt their exploration strategies by explicitly considering human actors' (such as rescue operators and potential victims) presence, behavior, and intentions [1]. This adaptation is expected to ensure that exploration tasks are carried out safely and efficiently while enabling effective collaboration with the humans involved in the SAR domain (i.e., improving cooperation with first responders or increasing the likelihood of successful victim detection and assistance).

Example research topics targeted in the project include vision-based human detection, tracking and activity recognition, multi-modal sensor fusion, temporal motion planning, trajectory prediction models of dynamic objects, SLAM with dynamic obstacles, and realistic human motion models. The starting point will be an existing 3D exploration method for large-scale environments available as a software module [2].

The project will be performed within the WARA-PS arena with the supervision of researchers from the AIICS division at Linköping University. Project results in the form of software modules are expected to be deployed and demonstrated in simulations, and in the field robotic experiments using one of the ground/air robotic systems, including Clearpath Husky/TurtleBot4, Boston Dynamic Spot, or DJI M 100/300.

Constraints: Much of the work can be carried out in simulation. Experimental initial testing on robot platforms can be performed in the AILAB Robotics lab at Linköping University.

Participants

Industrial partner: Combitech AB

Industrial supervisor: Katarina Iversen, katarina.iversen@combitech.com

Academic supervisor: Mariusz Wzorek (mariusz.wzorek@liu.se), Mattias Tiger (mattias.tiger@liu.se), Department of Computer and Information Science, Linköping University.

Coordinating WARA representative: Piotr Rudol (piotr.rudol@liu.se), WARA Public Safety

Suggested WASP PhD students: Emil Wiman

Challenges to investigate

- vision-based human detection and tracking
- tracking and activity recognition
- multi-modal sensor fusion
- temporal motion planning
- trajectory prediction models of dynamic objects
- SLAM with dynamic obstacles
- realistic human motion models

Resources

Clearpath Husky/TurtleBot4, Boston Dynamic Spot, DJI Matrice 100/300

Deliverables

- A project plan detailing the project focus, timeline, and list of project-specific deliverables that will be carried out during the project work
- Deliverables according to course requirements

References

[1] Kruse, T., Pandey, A.K., Alami, R. and Kirsch, A., 2013. Human-aware robot navigation: A survey. Robotics and Autonomous Systems, 61(12), pp.1726-1743.

[2] Wiman, E., Widén, L., Tiger, M. and Heintz, F., 2024, May. Autonomous 3D Exploration in Large-Scale Environments with Dynamic Obstacles. In 2024 IEEE International Conference on Robotics and Automation (ICRA) (pp. 2389-2395). IEEE.

Keywords

Robotics, Exploration, Motion Planning, Human-Aware Navigation, Perception