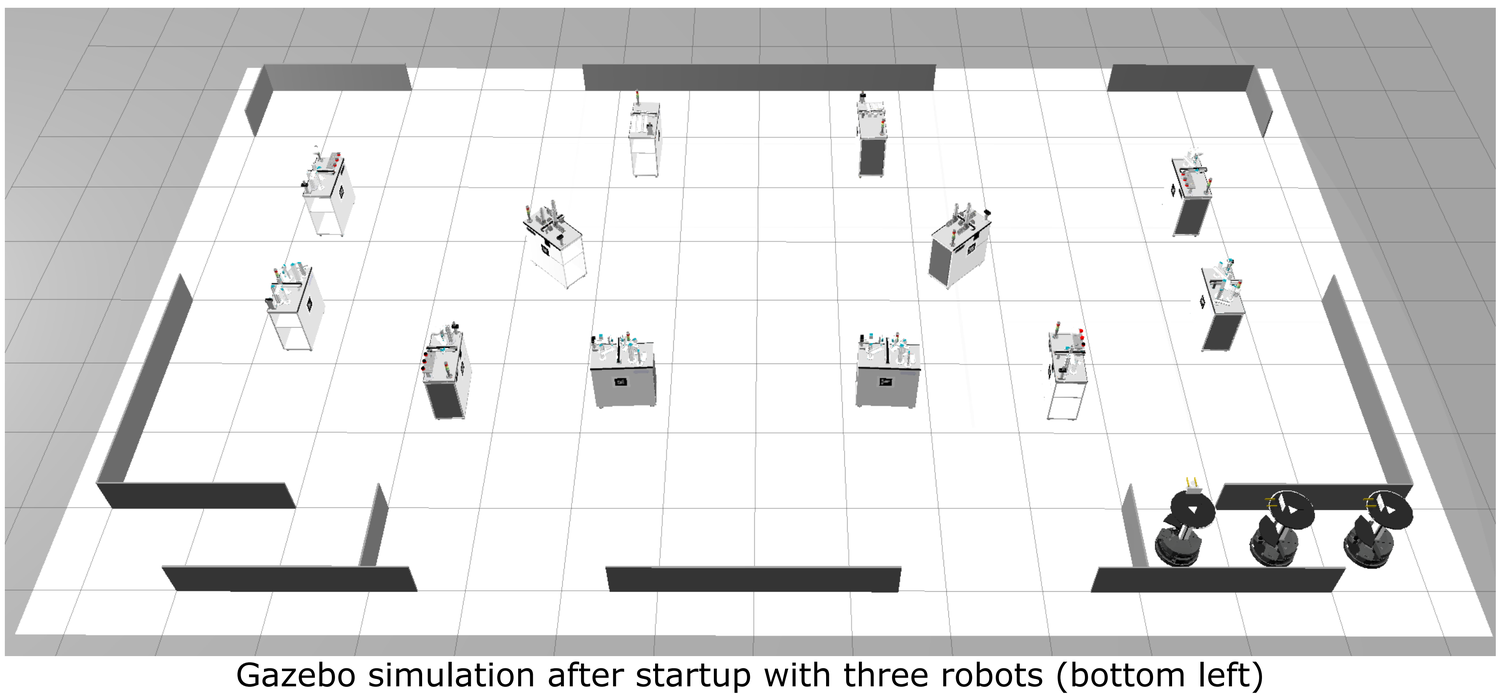
HSLU Hochschule Luzern

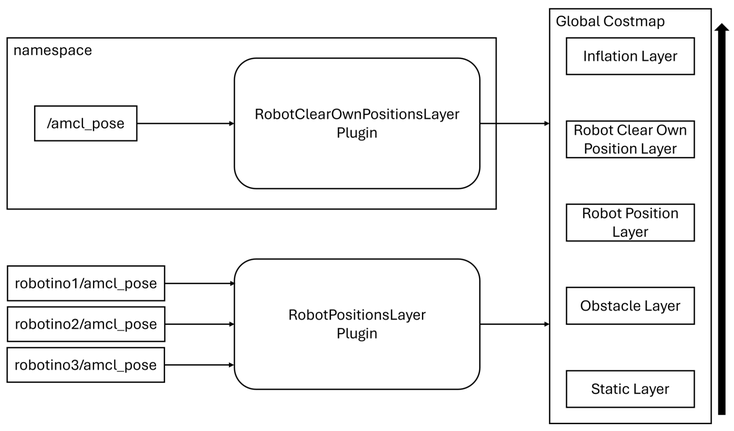
Technik & Architektur

Master-Thesis Automation and Robotics

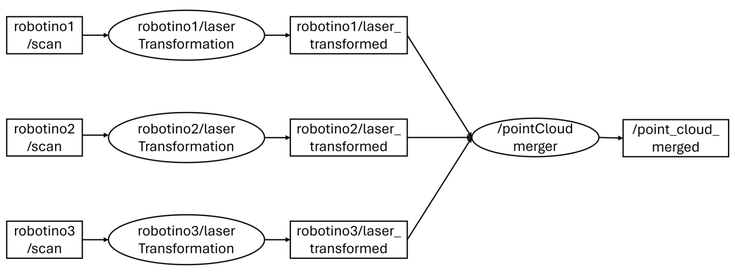
Multi-Robot Navigation in Logistics Applications



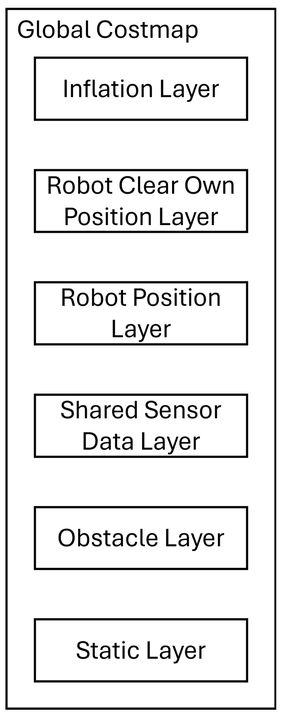
Gazebo simulation after startup with three robots (bottom left)



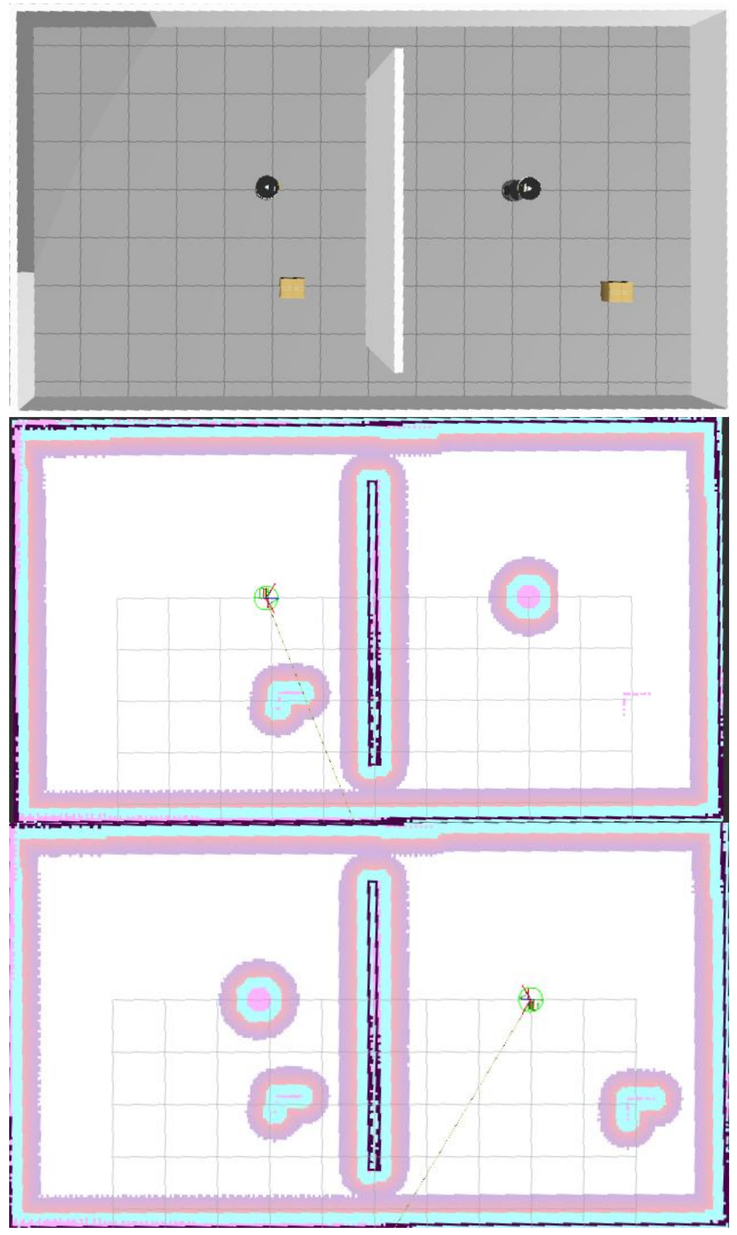
Flowchart of the position sharing plugin



Flowchart of the sensor sharing plugin



Layering of the global costmap with the position Sensor sharing plugin



Position and Sensor sharing plugin.

From top to bottom:

Gazebo environment with inserted boxes, robot 1 (left), robot 2 (right).

Costmap of robot 1.

Costmap of robot 2.

Problem Statement

An increased number of companies are seeking automation solutions, to complement or replace their human workforce. A primary driver for this shift is the shortage of workers. Furthermore, by using Autonomous Mobile Robots (AMR) processing times and error rates are reducted. Finally, logistics workers are susceptible to various physical and mental health risk.

However, AMRs still face significant challenges that must be addressed. Especially, the coordination and cooperation between multiple robots needs to be explored further. To ensure a safe and smooth operation mechanisms such as collison avoidance and information sharing systems are required.

The Robocup Logistics League (RCLL) offers a platform for exploring and addressing these challenges. The league simulates a smart factory environment where two teams of three AMRs transport workpieces from and to various machines.

Solution Concept

To facilitate development and allow remote work, a simulation environment for the RCLL is created. Additionally, it offers a safe and risk-free environment for testing new strategies.

For improved coordination and navigation position and sensor sharing plugins are proposed. Lastly, two centralised collision avoidance algorithms are compared.

Results

The first implementation of the simulation was successful. The simulation allows to spawn a predefined RCLL environment with 1 – 6 AMRs that can navigate in this environment. Performance tests were conducted to determine the hardware requirement of the simulation. The results showed that moderate modern hardware can run a simulation with 3 robots, however for 6 robots the CPU and RAM were not sufficeently powerful.

Additionally, the implementation of the position and sensor sharing plugins was successful. The robots are now aware of the location of their teammates and sensor information is shared with the entire team.

Finally, the comparison between the two collision avoidance algorithms was inconclusive due to an error which was only discovered at a later date.

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