This document describes a Master Thesis to be performed at Group Trucks Operations, GTO, Göteborg, during 2021.

Master thesis: Formation control of autonomous transport robots

The Volvo Group is one of the world's leading manufacturers of trucks, buses, construction equipment, and marine and industrial engines under the leading brands Volvo, Renault Trucks, Mack, UD Trucks, Eicher, SDLG, Terex Trucks, Prevost, Nova Bus, UD Bus, Sunwin Bus, and Volvo Penta.

Volvo Group Trucks Operations encompasses the production of state-of-the-art products for the Volvo Group's truck brands and Volvo Group engines and transmissions through an international world-class industrial environment.

With Volvo Group Trucks Operations, you will be part of a global and diverse team of highly skilled professionals working with energy, passion, and respect for the individual to become the world leader in sustainable transport solutions.

Background of the thesis project

At the final assembly line at Volvo's manufacturing plants, assembly details are provided as an assembly kit to the assembly stations. The reason is that there is not enough space for the storage of materials at each assembly station. Therefore materials are placed in a storage rack away from the assembly station but still in the vicinity. The required components for the specific product variant shall be picked by hand or by a robot from smaller bins and placed on an ATR (Autonomous Transport Robot) that takes the kit to an assembly station where components are assembled on the engine. To minimize the number of ATR types, two ATRs working together carrying larger or heavier objects. Ceiling-mounted RGB-cameras will be used to sense the environment, e.g., humans and forklifts, in which the ATRS are moving. We have built an initial demonstrator of the cameras and ATRs but would like to enhance the capabilities of the systems by including more advanced control methods that allow, for example, formation control of multiple ATRs.

Thesis project task

The ATRs work in an environment where humans and other moving objects, for example, forklifts, are doing tasks. The overall goal is to use the camera-system together with control methods to give the ATRs a behavior that will be safe for the people but, at the same time, completes it tasks on time. This involves planning an obstacle-free trajectory as well as controlling the robot to follow the trajectory. In this project, we consider controlling two ATRs that collaborate to move a large object. This means that the control algorithm should ensure that the robots are at a constant distance between each other, but the angle between them might change. An approach to solve this problem is to formulate it as a nonlinear model-predictive control problem solved in real-time during the operation of the ATR. In a master thesis, spring 2020, that this approach was shown feasible. In this thesis project, we would like to combine solving the trajectory planning problem and the formation control problem at once and implementing a physical demonstrator with physical robots.

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Suitable background

Master program in Systems, Control and Mechatronics, or similar. Knowledge about Model-Predictive Control and embedded systems. Interest in programming (mainly Python) and learning ROS (Robot Operating System).

Methodology

- Literature studies.
- Formulation of model-predictive control problems for trajectory planning and formation control.
- Implementation of the solution on physical ATRs.
- Run demonstration to validate the result

Thesis Level

Master

Language

English

Starting date

January 2021

Number of students

Two (2)

Tutors

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