EINDHOVEN UNIVERSITY OF TECHNOLOGY

Mobile Robot Control

4SC020

Design Document
Group 1

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1 Requirements

The main objective of the system is to autonomously complete two challenges. The first challenge is to escape from a room and the second challenge is to deliver medicines from one cabinet to another in a hospital. To successfully complete both challenges the system has to meet certain requirements. These requirements are divided in to general requirements, requirements specific to the first challenge and requirements specific to the second challenge.

General

- The system should not exceed the maximum transnational speed of 0,5 m/s and rotational speed of 1,2 rad/s.
- The system should not bump into walls.
- The system should make a sensible decision within 30 seconds.

Escape room challenge

- The system should be able to find the exit of the rectangular room from an unknown position within 5 minutes.

Hospital challenge

- The system should be able to pick up medicines from a cabinet by standing in front it and facing towards it, signal its arrival and taking a snapshot of the laser data. Delivering the medicine to another cabinet goes by the same sequence.
- The system should avoid all static and dynamic objects.
- The system should plan its trajectory based upon an array of integers corresponding to cabinets which should be supplied to the executable in a predefined format.

2 Architecture

2.1 Global overview

This figure covers the proposed internal information exchange. From input by means of LRF- and odometry data to output in the form of motor actuation. The system is divided into 5 subsystems that on its turn can be divided into multiple sections. Below the figure, the subsystems, or components, and its functions are further explained.

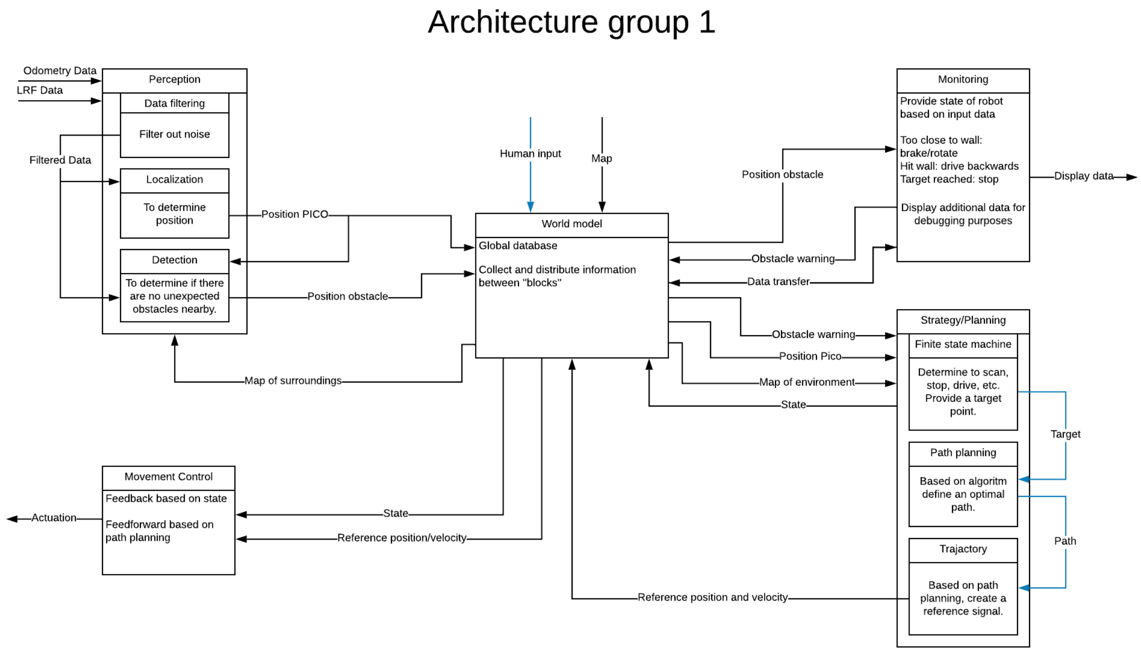

Figure 1: Architecture of the system

2.2 World model

The world model will function as a global database for the entire system. It will keep track of PICO's state, position, the environment and all other data that is shared within the system.

2.3 Strategy

The strategy block is the brain of PICO. Here the finite state machine will decide high level action it will take (set target destination, explore environment, etc). It decides the state and action based on the position of PICO, the world map and detected obstacles. The state and target will be fed through to path planning. Here an (optimal) path is found which is fed through to it's trajectory block which will be used to create a reference signal. This reference and PICO's state will be send back to the world model.

2.4 Perception

The perception block is the vision for PICO. Here the incoming data from the LRF and the odometry data will be filtered and processed. The perception block will also receive a map of the surroundings which is used to localize PICO. The detection function is used to detect possible obstacles in it's direct neighbourhood. PICO's position and possible obstacles are outputted back to the world model.

2.5 Movement control

In the movement control block PICO's state and the reference trajectory get converted to an output signal for the motors. This way, PICO can actually move around in it's environment.

2.6 Monitoring

The monitoring block has multiple purposes: monitoring obstacles, sending out obstacle warnings and displaying data for debugging. Positions of the unexpected obstacles are sent in via the world model from the perception block. The monitoring block will then sent out a warning to the strategy so it can react accordingly. These unexpected obstacles can be either an actual obstacle or a wall. A wall in this case could also be unexpected, since drift could cause the robot to drive to a wall without it being the reference trajectory. Lastly the monitoring block will display data for debugging purposes. The data will be transferred from the world model.

3 Specifications

This chapter will be used to describe the specs and limitations of the hardware components of the PICO robot which will be used during the competition. All information is gathered from the datasheet of the Jazz robot, the Embedded Motion Control Wiki page and the simulation data provided by the TU/e.

The first hardware component is the holonomic wheel base which consists of three omni-wheels, which provide the ability to move in any direction from any angle the robot is facing. The speed of the robot is restricted within the simulator to a translation speed of 0.5 m/s and a rotation speed of 1.2 rad/s. When rotating PICO in the simulation the robot rotates around the midpoint of the body. All the wheels are equipped with encoders which can be used to read the translation and rotation since the start (boot) of the software.

Another piece of the hardware is the langer range finder. It can be used to indentify and measure the distance to objects in the field of view of the LRF. The FOV is around 229° measured over 1000 points equally spread over the FOV range. The range of the sensor is from 0.01 m to 10 m. Since the measurements contain noise or the measurements can be out of the range of the sensor the data should be filtered before usage.

The last specification is the dimension of the robot. From the datasheet of PICO the size of the base is 0.41 m wide and 0.35 m in depth seen from above. These dimensions can be used to avoid collision while rotating and translation of PICO.