TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Initial Design Document

Master course: 4SC020 Embedded Motion Control

Group 4

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Introduction

To complete the escape room and hospital challenge, PICO must be able to perform a number of tasks autonomously. This document describes all requirements, functions, components, specifications and interfaces that will be needed to solve these challenges. The focus in this document is on the escape room challenge, because not all information of the hospital challenge is known yet.

Requirements

A number of requirements is set to ensure PICO obeys the stated rules and completes the challenges.

- PICO should be able to execute all desired tasks autonomously.
- PICO should function in an arbitrary environment.
- PICO may not bump into obstacles.
- PICO must complete its goal within five minutes.
- PICO may not be stationary for more than 30 seconds (i.e. no deadlocks or errors may occur).
- PICO should be able to execute its task independent of starting conditions.
- PICO should be able to distinguish objects and features (i.e. doors/hallways from walls or cabinets from walls).

Functions

In order to complete the challenges, certain tasks need to be performed. These tasks can be divided into the following functions.

- Actuation: use available actuators to move the robot around its environment.
- Data acquisition: use available sensors to gather information about the environment.
- Data processing: recognize features from sensor data, i.e. walls, exits, unexpected (moving) objects, et cetera.
- Data logging: keep important data and make it easily accessible.
- Target localization: use processed information and programmed directives to determine target location
- Trajectory generation: generates the path the robot should take to reach its target location without bumping into known obstacles.
- Obstacle avoidance: allows the robot to steer clear of unexpected and/or moving objects.

Components

The following hardware and software of PICO is used in order to solve the challenges.

Table 1: Components required for the challenges

Component	**Description**
Laser Range Finder (LRF)	Scans the environment and determines the distance to the nearest point at angles with a constant interval.
Wheel encoders	The wheel encoders provide the position of the robot with respect to the initial position which can be used for localization (odometry).
Actuated omni-wheels	PICO has three holonomic wheels to move around. It can therefore move forwards or backwards, sideways, and rotate.
Speaker	Speaker that outputs predefined strings of text.
Computer	A computer running Ubuntu 16.04 shall be used to run our software.
Software	Ros, C++ executable (see structure in interfaces).

Specifications

The following specifications have been set to ensure safe operation of the robot and to be able to program it for all eventualities.

Table 2: Specifications

Scope	**Specification**
Global	Translational velocity cannot exceed 0.5 m/s. Rotational velocity cannot exceed 1.2 rad/s. LRF information: **Range:** 0.01 m to 10 m. **View angle:** -2 rad to 2 rad. **Angle increment:** 0.004 rad.
Escape Room	The room to be escaped is rectangular. The exit is approximately perpendicular to the walls of the escape room. The exit width is between 0.5 m and 1.5 m.
Hospital	A height map of the hospital is available, but exact dimensions are unknown. All potential pickup locations are known. Required pickup locations are not known until mission start. Additional obstacles may be present in the hospital. Moving objects may be present in the hospital.

Interfaces

A overview of the system architecture that is used within the project is shown below:

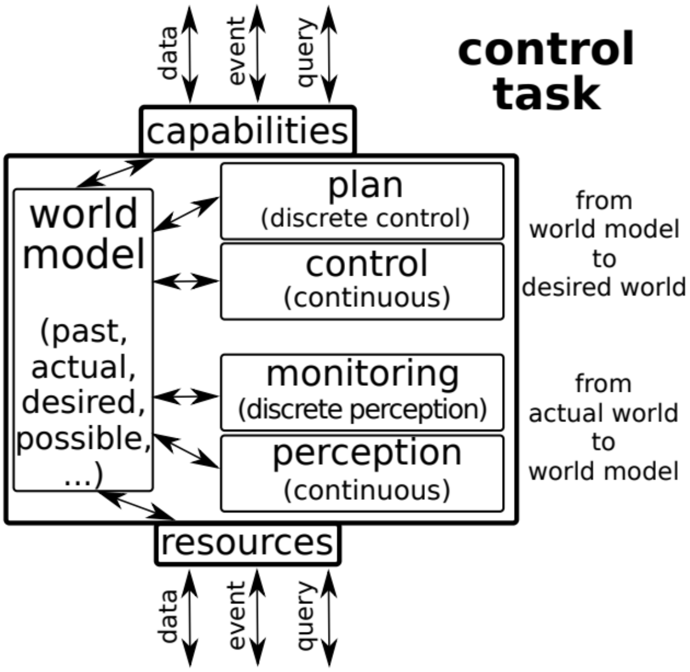

Figure 1: Interfaces present in the software architecture

The 'resources' are the data that is retrieved from the LRF sensor data and the odometry data. 'Capabilities' is the functionality of PICO that can be used with the architecture, such as the input that PICO needs to move. Below, the other given components of this architecture are explained.

World model

The world model stores the needed data and gives every other part its tasks. It communicates and mediates between priorities. How often things should be updated and which part comes first is determined here. All data goes through this component before it continues to another component.

Plan

Incoming data: Initialized, Door_Found, Door_Reached, Stopped_Moving.
Outgoing data: Initialize, Scan, Turn85, Goto_Door, Gothrough_Door, Reposition, Plan_Finished.
For the Escape Room Challenge a plan is made for the PICO to follow. This is visualized below:

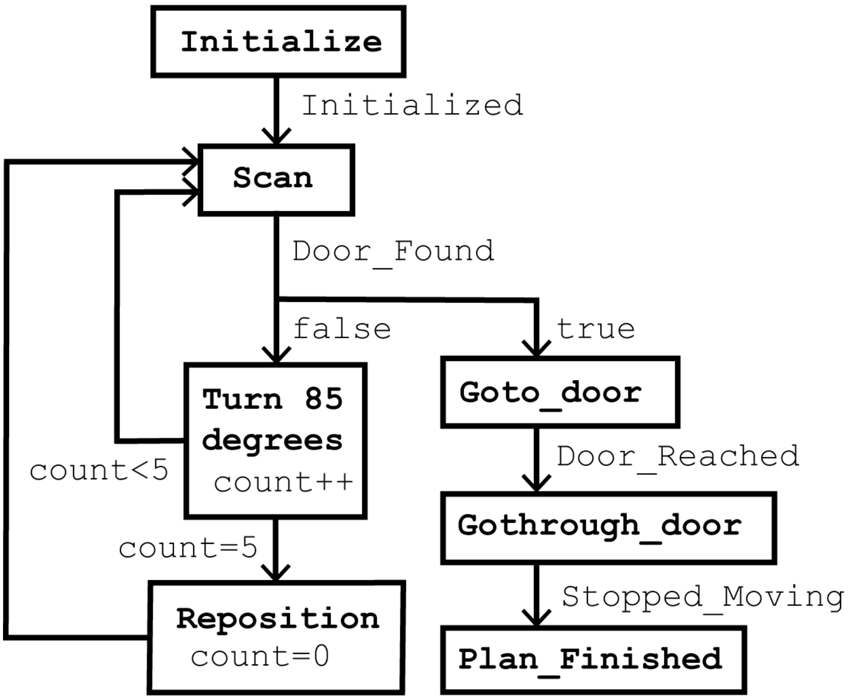

Figure 2: Schematic representation of the robot planning workflow

The 'relocate' of this plan can be just rotating the PICO at first, but if then still no exit is found also a movement should is added to create a new perspective for the PICO.

Control

Incoming data: Turn85, Goto_Door, Reposition, Gothrough_Door, Wallis_Close.
Outgoing data: Reference.
The control generates the motor input for the PICO. This is done by receiving the reference coordinates of the door with respect to the current orientation of the PICO.

Monitoring and perception

Incoming data: Sensor_data, Reference.
Outgoing data: Wallis_Close, Room_info.
These parts take care of the identification of the walls, exits and errors that are within the system.