Embedded motion control

Initial design report

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May 2018

1 Requirements

Table 1 contains all the requirements, their specification and when possible a method to validate the requirement. Some of the requirements are for the system in general others are task specific. The aim was to have clear and direct requirements that can be quantified and easily validated.

Table 1: System Requirements for PICO

Requirements	**Specifications**	**Validation**
General		
The system shall detect walls	Wall is identified within range of laser	Visualize Detection
The system shall detect doors	Hole in a wall is identified as a door	Drive along wall with door on path
The system shall not touch the walls	PICO shall not move closer than 10cm to a wall	Place wall in path of PICO
The system shall respect speed limitations	Speeds shall be below 0.5 m/s translational and 1.2 rad/s rotational	
The system shall be active	PICO shall not stand still for more than 30 seconds	
The system shall navigate to the goal	Accurate following of fastest path to goal	PICO reaches goal
The system shall complete the task as fast as possible	The task is completed within 5 minutes	
The system shall stop once the finish line is crossed	PICO shall stop within half a meter	Drive across finish line
Escape Room		
The system shall identify the corridor as goal	Two walls close together are identified as a corridor and set defined as goal	PICO turns and enters corridor
Hospital		
The system shall map the complete environment	A real time map shall be created by PICO	Compare map to real room
The system determines its location within the environment	PICO can locate itself on the map	Location is visualized
The system shall be able to park backwards	PICO can drive backwards and park in the middle of corridor	PICO stops before hitting wall
The system shall detect the object and identify it as goal	A foreign object within the mapped environment is found	Detection is visualized

2 Functions Components and Interfaces

The software that will be deployed on PICO can be categorized in four different components: perception, monitoring, plan and control. They exchange information through the world model, which stores all the data. The software will have just one thread and it will execute the four components in a loop: first perception, then monitoring, plan, and control. Adding multitasking in order to improve performance is considered, and might be applied in a later stage of the project. Below, the functions of the four components are described. What these components will do is described for both the Escape Room Challenge (ERC) and the Hospital Challenge (HC).

The PICO robot has three different sensor types: a laser range finder (LRF), encoders on three wheels and control effort in three directions. The function of the LRF is to provide the detailed information of the environment distance readings of the laser. The LRF specifications are shown in the table below.

Specification	**Values**	**Units**
Detectable distance	0.01 to 10	meters
Scanning angle	-2 to 2	rad
Angular resolution	0.004004	rad
Scanning time	33	ms

Table 2: LRF Specifications

2.1 Interface

The diagram 1 provides a graphical overview of what the statemachine will look like. Not shown in the diagram is the case when the events Wall was hit and Stop occur. The occurence of these events will be checked in each state, and in the case they happened, the state machine will navigate to the state STOP. The state machine is likely to be more complex, since some states will comprise a sub-statemachine.

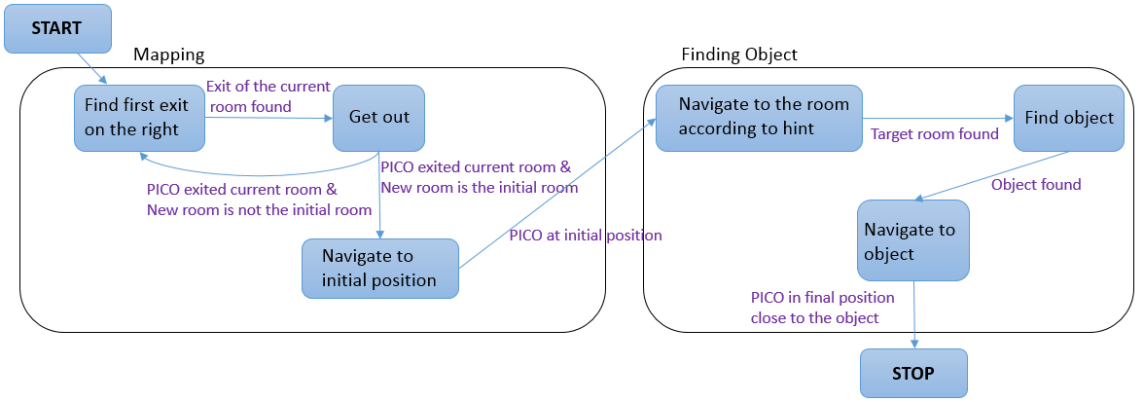

Figure 1: Overview of interfaces PICO

2.2 Components

At each scanning angle point a distance is measured with reference from the PICO. Hence an array of distances for an array of scanning angle points is obtained at each time instance with respect to the PICO.

The three encoders provides the odometry data (i.e) position of the PICO in x, y and θ directions at each time instance. The LRF and Odometry observers' data plays a crucial role in mapping the environment. The mapped environment is preprocessed by two major blocks **Perception** and **Monitoring** and given to the **World Model**. The control approach to achieve the challenge is through Feedforward, since the observers provide the necessary information about the environment so that the PICO can react accordingly.

The figure 2 shows the inputs, processes and outputs of the different blocks for both the escape room challenge and hospital challenge.

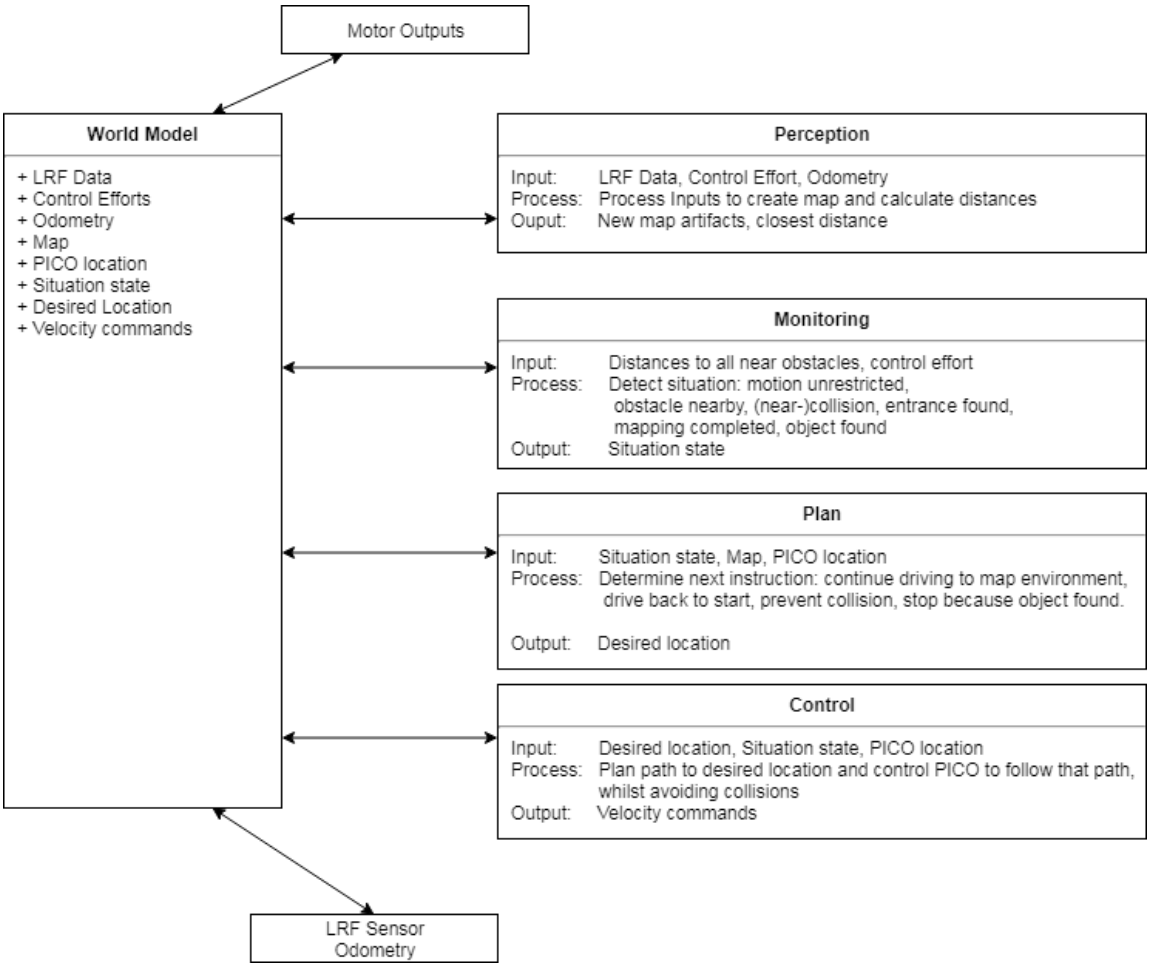

Figure 2: Overview of the function Input and Ouput