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Design Document - Escape Room Challenge

Mobile Robotics Control Group 7

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1 Requirements

The requirements for the challenge are shown in figure 1.1. The primary requirement is safety that we need to fulfill by avoiding collision. All other requirements shall be treated equally.

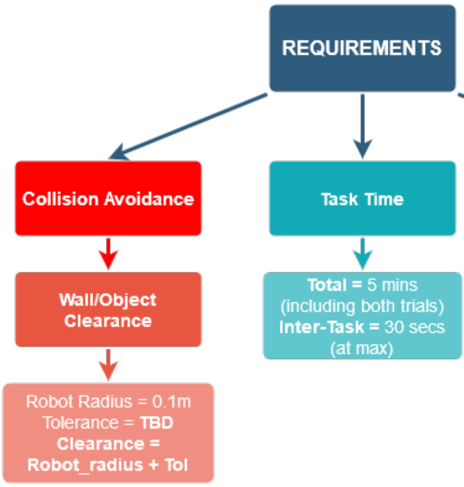

Figure 1.1: Requirements of the Escape Room Challenge

2 Functions

Once the robot is deployed in the room, it should sense around the room and try to find the exit corridor. If it cannot find the corridor, it should move around the room in an attempt to find it. Once the corridor is found it should position itself in front of the corridor and proceed through it until crossing the finish line.

The functions that the robot needs to perform these tasks are described in Figure 2.1. These functions are divided into three main components: Sense, which allows the robot to perceive and quantify its world; Reasoning, where the robot makes a decision based on its perception; and Act, which determines what action the robot performs based on its reasoning information.

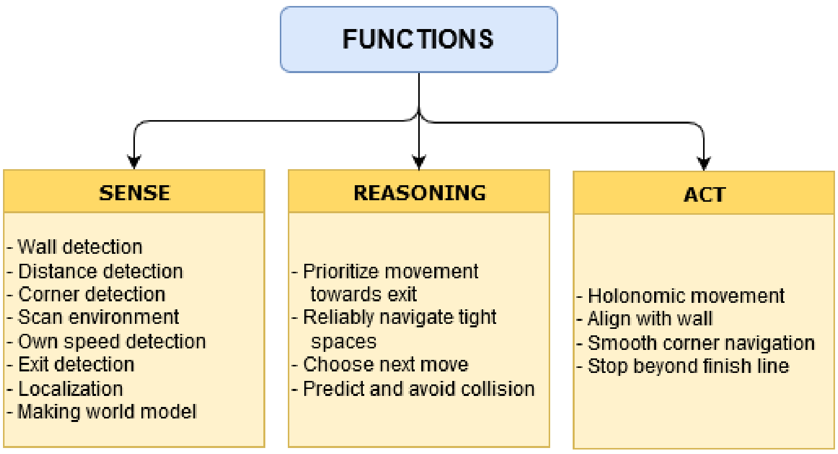

Figure 2.1: Functions of the Escape Room Challenge

3 Hardware Components

3.1 Sensors

3.1.1 Laser Range Finder

The laser range finder measures the distance from the robot to the closest obstacle for a range of angles around the direction the robot is facing. The sensor data is stored in a structure called LaserData, which is described in table 3.1. There are 1000 measurements in total.

Property	Description
`range_max`	The maximum range that can be measured is 10 meters
`range_min`	The minimum range that can be measured is 0.01 meters
`angle_max`	2 radians from the direction straight ahead
`angle_min`	-2 radians from the direction straight ahead
`angle_increment`	Each angle is 0.004004 radians away from the next one
`timestamp`	Timestamp of the measurement in UNIX

Table 3.1: Properties of the laser range finder data structure

3.1.2 Odometry

The odometry data measures the distance the robot has traveled in all 3 degrees of freedom in the horizontal plane. This data is obtained through encoders on the wheels of the holonomic base, which are stored in a structure called OdometryData, described in table 3.2. Small errors could accumulate over time due to measurement errors and wheel slip. To combat this, the positional data of the robot will be updated using the difference between the current and previous odometry measurement. This data is then corrected with the use of the world model and the data obtained from the laser range finder.

Property	Description
`x`	distance travelled in horizonal direction since start of measurement
`y`	distance travelled in vertical direction since start of measurement
`a`	angle rotation since start of measurement
`timestamp`	Timestamp of the measurement in UNIX time

Table 3.2: Properties of the Odometry data structure

3.2 Actuators

The robot is built on a holonomic base, which means that it has three degrees of freedom in its horizontal plane: two translational, and one rotational. The robot is able to move in these ways using its omnidirectional wheels, which are placed in a triangular formation on the base. Besides being able to provide a force in the driving direction, unlike normal wheels, the omnidirectional wheels also do not constrain movement in the direction orthogonal to the driving direction. Because of this, the robot is able to move with a given max velocity in all possible directions of the horizontal plane.

4 Specifications

The information about what the system can do are written down in the specification tree, which can be found in figure 4.1.

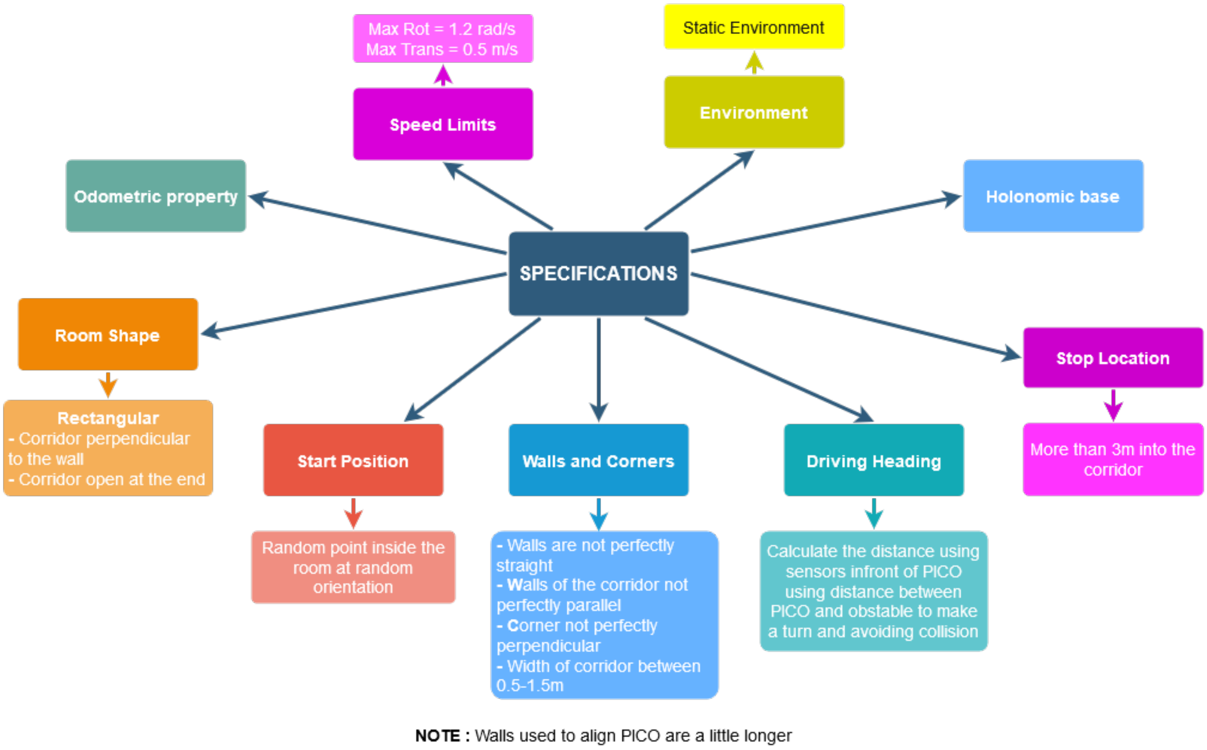

Figure 4.1: Specifications of the Escape Room Challenge

5 Software Infrastructure

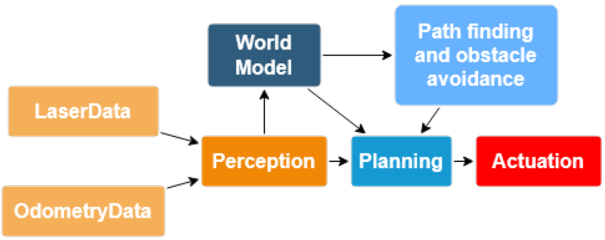

Figure 5.1: Software components and interfaces of the Escape Room Challenge

The software will be divided into components, which are connected through certain interfaces. Major components are seen in Figure 5.1, and their interfaces are specified with the arrows. Perception is the component where the PICO uses sensor data from LaserData and OdometryData to get an idea of it's current location. This data is interfaced with the World Model, which stores map and localization data, including the exit location once found. The Planning component takes care of decision making and control planning, including path finding and obstacle avoidance. The actuation component will actuate the holonomic base in order to carry out the movement plan.

6 Towards the Hospital Challenge

The escape room challenge is limited in scope compared to the hospital challenge. In addition to exit (or opening) detection, cabinet detection and visiting routines are needed. The end condition of the challenge is also different. The world model becomes more complex as not just wall, but object detection is also necessary. Navigation around clutter will have to be considered as well. Additional states are required in the FSM to visit cabinets in the correct order and take these new requirements into account.