Instituto Superior Técnico
Mestrado em Engenharia de Informática e Computadores
Estratégias básicas de navegação para robôs móveis

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1 Introduction

The main objective of the second lab is to resolve problems related to movement, orientation and strategies used for the locomotion of the Pioneer P3DX robot. As such it was necessary to develop a strategy for the robot to be able to reach its destination with acceptable performance during his trajectory.

2 Problems

The problems found during the development of the lab are listed as follows.

2.1 Sensors

There were several occasions where the use of sensors led to unexpected behaviour which either forced us to rethink our code or restart the test.

2.2 Movement

Main problems that interfered with the movement of the robot were people passing in the hallways, semi-open doors and misplaced random objects, which either forced us to stop the test or interfered with the sensors.

2.3 Resource Shortage

Due to the large number of groups and shortage of robots, the last week of testing forced the groups to share the few remaining robots with other groups, which slowed down the tests with idle time or constant need for re-calibration of different robots.

2.4 Robot Calibration

To be able to adjust the robot to get the best performance out of him, we had to find test the robot. We sometimes measured distances using the sonars, we also measured the time it took for the robot to complete a corridor, and we used trial and error for small parts of the trajectory, such as curves and getting in and out of the lab.

3 Algorithm

We divided the problem in 3 parts, separated by the different movement of the robot.

-The first part is the whole path until the robot leaves the room.

-The second part is the whole path until the robot reaches the room again, it's the whole of the 4 corridors.

-The third and last part is the path until the robot re-enters the room.

On the first part, our approach consisted on having its movement fully pre-programmed. We fixed an initial position and tested what were the best parameters of velocity and time. Due to the fact that the path is short and the error the sensors would have because of reflections on the objects, we think this approach was reasonable and would not induce many errors.

On the second part, we use the sensors to measure how close we are to the walls. We use the first two sensors and the law of cosines, by knowing the angle between the two sensors and the measures given by the two sensors we can then discover the angle the robot does with the wall (orange angle in the fig.1).

Whenever the robot is to close to one of the walls we add angular velocity with value 1, until it reaches a secure distance from the wall and then we correct its orientation by giving it angular velocity in the opposite direction until the angle with the wall is near 90º.

We only give it 1 in the angular velocity because we try to avoid having the robot too inclined since it does not allow a proper reading of the sensors and consequently, it does not allow the robot to be correctly positioned. We could have used other sensors, but due to the chairs on some of the corridors, we would also have reading problems.

Due to reading errors that exist, we have a safe verification that when the robot is very close to the door, an angular velocity of 6 is applied during a brief period of time, just to ensure that it does not collide.

Regarding the curves, we make sure that the robot has the correct orientation and depending on the distance to the wall we adjust the parameters of time and angular velocity. These parameters were defined through experimental work. After the curve is done we repeat the orientation adjustment.

Although the final position of the robot after the curve might not be exactly the one desired, the use of the sensors ensure that it will return a secure distance, eliminating the propagation of new errors.

We chose this approach, since after the robot does one correction the robot returns to a secure distance, and everything repeats. Besides, we noticed that the robot does not need many corrections, and therefore we tried to limit this correction by having a big secure distance.

Finally, when approaching the entering door, the robot corrects its orientation and given its distance to the wall, different velocity and time are applied. Once again, this velocity and time were defined with experiments.

Once the robot ends the curve the same movement of part one is repeated, although in the opposite way.

3.1 Strong Points

- No propagation of errors since after each correction it returns to the 'initial state';
- Movement of the robot is very smooth.

3.2 Weak Points

- Robot cannot be too inclined because then the distance cannot be measured accurately;
- Needs to have the robot start at a defined position.