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PIONEER 3-DX DISTANCE CONTROL USING DIFFERENT TYPE OF SENSORS

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Abstract: *In mechatronics education accuracy of sensors used in systems control is very important, as students should have to study on adequate examples. Demonstration of control algorithms is the most effective on simpler laboratory setups, or mobile robots, in comparison with simulation realizations of controlled system. As one of the problems of this concept are imperfect sensors used for feedback information. Mobile robot should be aware of its position in every moment, meaning that it should have correct information about the distance from a wall or obstacle. For example, if one wants to demonstrate P controller on a problem of keeping uniform distance from obstacle, sensor choice have influence on final results. This paper presents mentioned problem on distance control of Pioneer 3-DX mobile robot. It deals with problem using two different types of sensors. One is ultrasonic, as 3-DX has these types of sensors by default, and handmade photo sensor. Advantages and disadvantages of both types are presented on experimental results of distance task in different environmental conditions.*

Keywords: *mobile robot, ultrasonic sensors, photo sensors, SoaR*

INTRODUCTION

The main part of engineering education is laboratory work. It requires human, organisational and material resources [1-2]. Evendough it is practically inevitable, in Serbia is not well developed. Important segments of every good laboratory setup are accurate parts. If setup is not well-planed, measuring errors will appear during experiments. Laboratory for automation control at Faculty of Engineering at University of Kragujevac is equipped with various test-benches for student learning process.

One of the most used is Pioneer 3-DX mobile robot. The robot has two wheels drive, and eight ultrasonic sensors for measuring distance from obstacles. As its' sensors are not very accurate, additional part with photo-resistors is made, in order to make measurement more accurate. In this paper we will present performances of both types of sensors. Objective is to make useful comparison for future usage of robots in different environmental conditions. Second section will give robot structure, hardware and software communication. In third section measurement and experimental results will be presented, for maintaining the constant distance from the wall. In the last section focus will be on comparing results from different sensor types.

PIONEER 3-DX STRUCTURE

Mobile robot Pioneer 3-DX is commercial product, designed for educational and research purposes.

Figure 1. Pioneer 3-DX mobile robot

Robot drive is achieved by two separately controlled electromotors. It has two wheels attached to motors, and third which is just for balance. Maximum speed is 1.2 m/s, and it can carry up to 17 kg. Eight ultrasonic sensors are placed in front and overside the robot (Figure 1). On the main board it has additional AD and DA convertors for optional sensors and actuators. Communication is accomplished by serial RS-232 port, over SIP (Status Information Packets) protocol.

In order to achieve greater autonomy, beside the standard serial cable, WiFiRS-232 adapter is added. In that way user can control the robot over the computer with wireless connection.

Robot sensors can make errors during the runtime, so we have integrated the robot "head" with photoresistors as sensors (Figure 2), in order to see

which sensor will give better results. Video demonstration of driving robot over this type of sensor can be found at [3-4]. The "head" has role to lead the robot according to light which is driven to resistors. Analog outputs from robot's head, which are in range from zero to ten volts, are converted over the adequate electronics to range from zero to five volts, which is the adequate range for robot's AD convertor.

Manufacturer made detailed description of SIP, so the communication is made much easier. Software packet SoaR developed at MIT (Massachusetts Institute of Technology) is used for simulation, programming and monitoring the robot movement. Base for SoaR are Python and Tcl, and supported operating systems are Linux, Windows and Mac. Software is given in source code, so a user can make changes and add new types of robots.

In SoaR one can simulate robot's behaviour, or directly control the robot. Test environment („world") for robot can be selected from existing ones, or created by user, giving the coordinates of obstacles in „world".

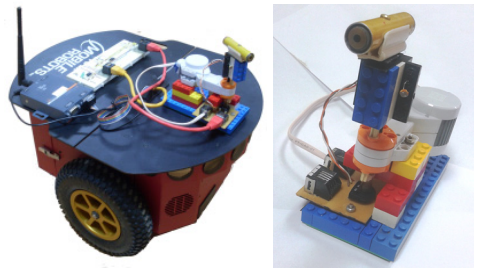

Figure 2. Robot with integrated "head"

EXPERIMENTAL RESULTS

As test example for distance sensors for Pioneer robot first we made simulation in SoaR for keeping the distance from a wall at 50 cm. SoaR environment is given on Figure 3. As the simulation is working with sonars (Figure 3), we run the same program on real system. Control algorithm was simple P controller, because there was no need for more complicated one in this type of testing. Results were different with every execution. Here we show the comparison between simulation results, and two real tests: one faulty, which has the error in measurement so big that the robot hit the wall, and the other one which shows values varying around desired position, with steady-state error because of P controller applied (Figure 4). For second type of sensors we could not use simulation, so we run the program separately for maintaining the same distance, but from the light source, as the sensors are based on photoresistors (Figure 5).

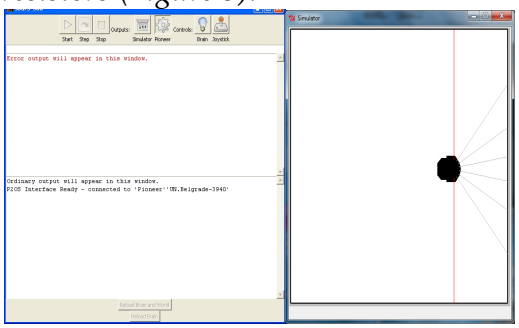

Figure 3. SoaR environment and simulation

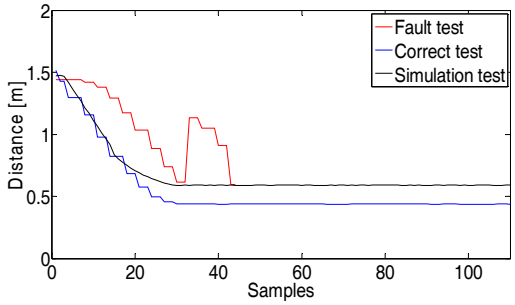

Figure 4. Testing the distance maintaining using sonars

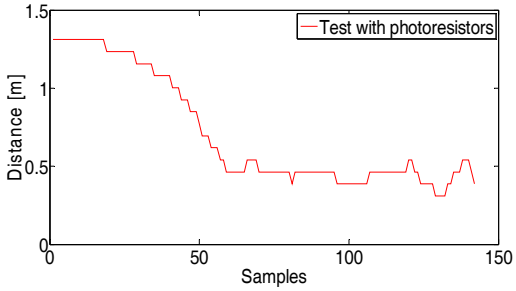

Figure 5. Testing the distance maintaining using photo-sensors

CONCLUSION

As one can see, non of these sensors have completely accurate measurements. Sometimes robot hits the obstacle when the error is too big. As for the photo-sensor, it depends from surrounding light, as well as from the source one. It requires additional tuning of parameters depending on environment. For more complex tasks the difference would be more obvious.

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