

Development of a RFID inter-office document's delivery system via mobile robot

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ABSTRACT – This paper presents an efficient method of a mobile robot navigation system in an indoor environment. The mobile robot able to reduce heavy lifting and the repetitive tasks by workers. However, the navigation of robot in an indoor environment is a challenging task due to the requirement to avoid obstacle when in motion. Therefore in this paper, the design and develop of a mobile robot for an inter-office environment using Radio Frequency Identification (RFID) tag is discussed. The motions of the mobile robot are validated using several the trajectory patterns. In addition, the mobile robot is able to avoid obstacles.

1. INTRODUCTION

Navigation of mobile robot has been widely discussed in the past few years and this issue can be considered as a huge challenge to be accomplished in the field of robotics. For localisation in outdoor environment, Global positioning System (GPS) has been widely used in tracking people and asset as well as a navigation system for transportation since it provides accurate coordinates and information about a certain place. However, GPS does not perform well in indoor localization because the satellite cannot penetrate through the building [1]. Based on the research, Radio Frequency Identification (RFID) is a most suitable system used for localization and navigation of mobile robot due to its ease of use, inexpensive cost and flexibility [2,3]. As a conclusion, two-wheeled chassis is design which is equipped with RFID system for evaluating the performances of the mobile robot.

2. EXPERIMENTAL SETUP & SYSTEM OVERVIEW

The overview of mobile robot is shown in Figure 1. The platform of the mobile robot is designed with two DC motor installed at the front of the platform and a castor installed at the back of the mobile robot to balance the robot structure. The mobile robot is equipped with RFID reader, ultrasonic sensor and line following sensor on the upperpart of the robot to follow the black line path while receiving commands from the passive tag and to navigate the mobile robot to reach the destination. Acrylic board is used as the basic structure of the mobile robot to hold the circuit board, sensors,

and motors. In Figure 1, the document delivery tray is not shown.

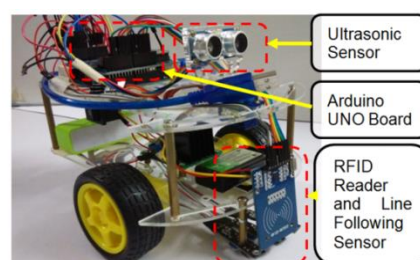


Figure 1 Overview of mobile robot prototype.

2.1 RFID system

The RFID system consists of three main components which are RFID reader (interrogators), RFID tags (transponders), and host computer with appropriate application software. The process flow of RFID system is shown in Figure 2.

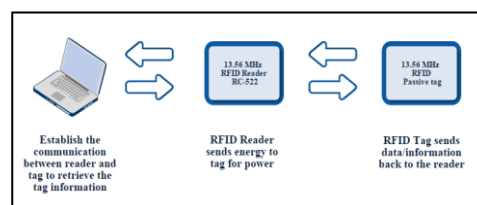


Figure 2 RFID system.

2.2 Navigation of mobile robot based on trajectory

In this setup, the mobile robot is equipped with the RFID reader and line following sensor on the upperpart of the robot which tracks the 18mm width black line path, while receiving commands from the passive tag to navigate the mobile robot to reach the destination. There are four types of trajectory patterns used for testing the performance of mobile robot; i.e. a) square-shaped, b) s-shaped, c) triangle-shaped and d) zigzag-shaped. Total of 25 passive RFID tags were install on the workspace in a grid-like pattern over an area measuring 120 cm × 120 cm, with a spacing of 20 cm. The experiments setup as shown in Figures 3.

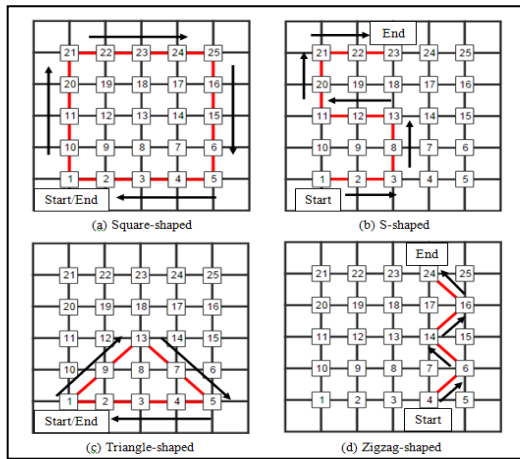


Figure 3 Trajectory pattern for mobile robot navigation.

2.3 Obstacle avoidance of mobile robot

In this setup, a stationary obstacle is placed in a particular location for the mobile robot to detect and avoid obstacle in order to reach the destination without collision. The experiment setup for obstacle avoidance is shown in Figure 4.

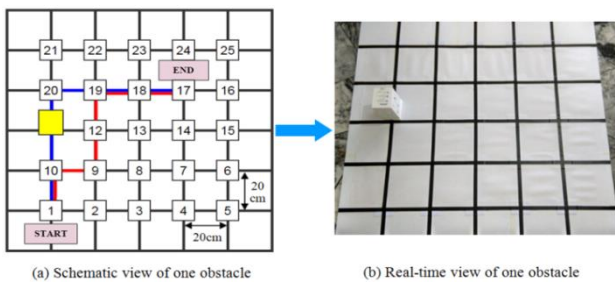


Figure 4 The workspace of mobile robot for one obstacle avoidance.

3. RESULTS & DISCUSSION

3.1 Analysis trajectory patterns

Figure 5 shows the bar chart illustrating the distance and average time taken to complete the path for different types of trajectory patterns; i.e. a) square-shaped, b) s-shaped, c) triangle-shaped and d) zigzag-shaped. This implies that the farther the distance, the longer the average time takes for the mobile robot to complete the path and vice versa. Based on the findings, it can conclude that the mobile robot performed stably and consistently even in different types of trajectory patterns.

3.2 Obstacle avoidance

The results of obstacle avoidance are shown in Figure 6. The graphs show fluctuations in between period 2.2 seconds to 3.5 seconds due to the number of turning of mobile robot, thus the motor oscillation increases. The time take to reach the end point is 6.6 seconds. In conclusion, the mobile robot is able to navigate itself from the start to reach the target destination without collision with the obstacle.

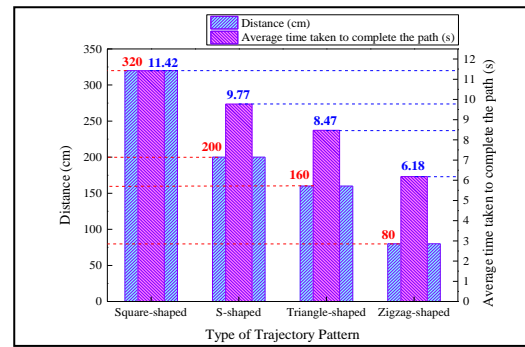


Figure 5 The distance and average time taken for different type trajectory pattern.

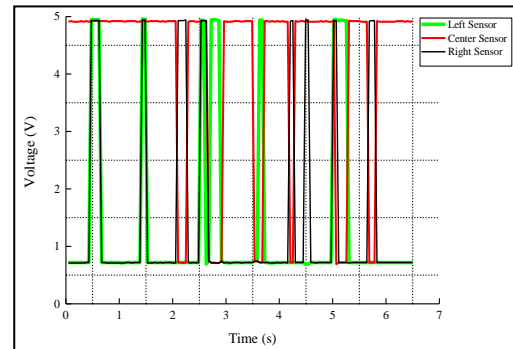


Figure 6 Test for one obstacle avoidance.

4. CONCLUSIONS

In this paper, an effective method to navigate the mobile robot in an inter-office environment using RFID tag was discussed. In addition, the results show that the mobile robot able to reach the target destination successfully without the collision with obstacles based on several trajectory patterns and avoiding obstacle. For future recommendations, the oscillation of the mobile robot can be eliminated by designing a Proportional-integral-derivative (PID) controller, which able to stabilize the motor performances of the mobile robot.

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