DESIGN AND DEVELOPMENT OF SMART SALES ROBOT FOR SUPERMARKET

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Abstract- This project is proposed to design the sales robot for supermarket stores. A robot is attached to the shopping cart to collect the user requested items in the supermarket. A database is provided with the RFID of different items available in the stores along with their corresponding location address. Based on the RFID tags the mobile robot identifies the items. These items were fetched by robot arm using pick and place mechanism. A dynamic path planning algorithm is provided to avoid obstacles and re-plan the path for gathering the requested items in the stores.

Keywords- Robotics, Pick and place mechanism, Zigbee communication, Mobile navigation, Embedded systems.

I. INTRODUCTION

Nowadays, robots are becoming a part of every industry. Most of the industries are using robot to increase the production and to reduce the labour costs. Robots are widely used to complete human task. Many researchers are working in this field to get a variety of robots to fulfill human needs. Supermarket is the place where customers search and gather the required items in the stores. The handicapped and old person finds difficulty in identifying the required items in the stores. Robotics can be implemented to help these people.

Matsuhira and Ozaki have proposed a shopping support mobile robot. In this model two robots are used, one for guide the user to user’s desired place in the shopping mall and another robot is cart robot which follows the guide robot. In this model the required items were picked and placed in the cart by the user.Emi Nakamori and Daiki Tsukuda has proposed an indoor position Estimation method by using RFID tags. In this model, the navigations of a continuous moving robot in-indoor environment are provided based on the RFID tags.Yen-Sheng Chen has proposed obstacle avoidance control strategy for a wheel mobile robot . In this paper two model studies have shown for obstacle avoidance of mobile robot.Tomizawa.T has proposed a shopping robot system to develop the mechanism for grasping fresh foods in supermarket. In this paper it is limited only to grasp the vegetables and fruits. The proposed technique involves a single robot to detect the user requested items in the stores based on the RFID tags and bring backs to the user. Obstacle avoidance mechanism is provided for navigation of robot.

II. SYSTEM OVERVIEW

This Mobile Robot is designed such that it follows the programmed path throughout the shop for gathering the items. All the items are classified according to their type and each type of items is provided with a separate RFID tags which indicates the location of items in the stores. The user(costumer) gives the list of items to the computer where the computer communicates with the robot through the Zigbee communication. A programmed path is provided for the robot such that it navigates directly to the desired item location. RFID tags of all the items are placed on the edges of the corresponding shelves. A RFID reader is provided in the arm to read the tags. The pick and place mechanism is provided to pick the items from the shelves. While navigating to detect the obstacles ultrasonic sensor is placed in front of the robot.

III. DESIGN MODULE:

The robot is designed with three different modules:

1. Data Base module :
   - In this a data base is designed with Graphical User Interface (GUI) for storing various items available in stores and their corresponding location address.

2. Mapping and navigation module:
   - The supermarket environment mapping and robot navigation is designed such that robot navigates to the desired location for fetching the items.

3. End Effectors module:
   - End effector is designed for pick the items from shelves and place them in the cart.

IV. SYSTEM DESCRIPTION

The fig.1 shows the block diagram of Transmitter section in which the GUI is maintained with the various items available in the stores along with their price and corresponding location address. Once the user selects the required items, the GUI transmits the item’s RFID code to the robot through Zigbee transmitter. Zigbee Transmitter is connected to the computer through MAX232.

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Fig. 2 shows the block diagram of receiver section attached to the robot. This robot is based on electro-mechanical concept. The robot is designed to move and fetch the user requested item in the stores. Five DC motors are used in this robot. Two of them are used to control the movement of the two wheels, the other two for extending the robot arm movements and the rest for gripper. The speed and the direction of the robot is controlled by PIC16F877A and is programmed using Embedded C.

Data base is created for the supermarket with GUI using visual basic 6.0 software. It is an event-driven programming language for the Integrated Development Environment (IDE) from Microsoft. This data base is maintained with the various items available in the stores along with price, location address with corresponding RFID’s. Fig.3 shows the algorithm for the transmitter section.

When a person (user) selects an item in the GUI, the selected item’s RFID code is transmitted to robot through Zigbee transmitter. Initially the transmitter and receiver port should be configured. The port setting should be done before selection of items as shown in fig4. It will configure both Zigbee transmitter and Zigbee receiver in the robot side.

Once the port is configured successfully as shown in fig 5, GUI opens another window in which it shows various available items in the stores as shown in fig. 6. When the user selects the item and click on the send button, the GUI transmits the item code to the robot.

Forms are created using drag – and – drop techniques. Tool ---> Editor is used to place controls (e.g., text boxes, buttons, etc.) on the form (window). Controls have attributes and event handlers associated with them. Default values are provided when the control is created; it can be changed by the programmer. Many attribute values are modified during run time based on user actions or changes in the environment, providing a dynamic application.
Transmitter section:
The transmitter section consists of computer in which GUI is maintained and is connected with Zigbee transmitter through MAX232 serial communication. The interface of Zigbee transceiver to computer through MAX232 is shown in Fig. 7. The interface of Zigbee transceiver in the transmitter section is shown in Fig. 8.

Receiver section:
The receiver section is attached to the robot. PIC microcontroller acts as a main control unit. Zigbee transceiver is interfaced to PIC microcontroller to receive command from the computer. LCD display of type HD44780 is provided to show the status of the robot.

Ultrasonic sensor is placed in front of the robot to calculate the distance of the obstacle. RFID reader is placed at the gripper of the end effector so that it will read the tags which are placed at edges of the shelves. Two DC motors are interfaced to controller for navigation of robot. Fig. 9 shows the receiver section of the robot.

The Fig. 10 shows the flow chart of system’s functionality. When the user provides the desired items in GUI, a command is received from computer to robot through Zigbee transceiver. Based on the RFID code received, the robot start navigates towards the requested item. Each type of item is provided with corresponding navigation path. Once the robot reaches the desired location, the arm of the robot which is provided with RFID reader starts reading the tags which are placed on the edges of shelves.

![Fig 7: Interfacing of Zigbee transceiver to computer through MAX232](image)

![Fig 8: Interface of Zigbee in transmitter side](image)

![Fig 9: Receiver section](image)

![Fig 10: flow chart of system functionality](image)
Microcontroller compares RFID reader output code and desired RFID code of item. If both the ID’s are matched then the gripper opens and close to hold the item from the shelves.

**Obstacle avoidance:**
Obstacle avoidance is necessary for a mobile robot for navigation. Ultrasonic sensor is placed in front of the robot as shown in Fig.11 to detect the obstacles while navigating from starting point to the desired location. Microcontroller initiates sonar sensor, in which the sonar emits sound pulses continuously. Timer in the microcontroller starts running once the sonar emits pulses. A delay is provided such that sonar receives the return echoes. Once sonar detects the return echo, microcontroller stops timer. Fig 13 shows the algorithm for distance calculation. The distance of obstacle is calculated by using the equation shown below. Where S is referred to speed of sound transmitted and received by ultrasonic sensor and T is referred to time paused by microcontroller while the sound is transmitted and received by sensor.

\[
\text{Distance from object} = \frac{S \times T}{2} 
\]

Based on the distance of obstacle from the calculated distance the robot identifies the obstacle. Based on the distance of obstacle present, the robot plans its path to avoid the obstacle. The Fig.12 shows the simulation done for driving the various motors by controlling the switches in Proteus switches. One switch is used to drive the robot wheel motors and another switch is used to drive the robot arm motors.

**CONCLUSION**

The prototype of the mobile robot is designed and tested to collect the items requested by the customer.
in the supermarket. When the user gives the list of required items, the robot navigated to the targeted location where required items are available and identified the corresponding item through RFID tag. An end effector is designed for picking the items from the shelves and places them in the cart.

REFERENCES

[1] Matsuhira, Nobuto; Ozaki, Fumio; Tokura, Seiji; Sonoura, TakaFumi; Tasaki, Tuyoshi; Ogawa, Hideki; Sano, Masahito; Numata, Akiko; Hashimoto, Naohisa; Komoriya, Kiyoshi, "Development of robotic transportation system - Shopping support system collaborating with environmental cameras and mobile robots -", Robotics (ISR), 2010 41st International Symposium on and 2010 6th German Conference on Robotics (ROBOTIK), vol., no., pp.1, 6, 7-9 June 2010.


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