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RFID based Human Following Load Carrier

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Abstract

Robots have come a long way and have been revolutionary in assisting humans in completing tasks. The communication of robot and the user is the most critical component to act independently. Our main goal was to design and build a robot that could not only track humans but also move towards them and assist them to carry loads while tracking them. To make things easier, a person who the robot must follow was given a one-of-a-kind handmade tag. Determining the target is the most difficult component of this type of operation. The object must be distinct in order for the robot to recognize it and execute the target. Another problem to solve is preventing the robot from colliding with the object. This is accomplished through the use of a sensor. The microprocessor handles all processing, and the controller handles motor control.

Keywords—Human following, load carrier, arduino, service robot, RFID.

I. Introduction

In the past few years, robotic technology has evolved substantially. To aid humans in their work, a robot must be able to recognize and follow them, necessitating the development of robots like the "RFID based Human Following Load carrier" that can interact and co-exist with them. Localizing the items in the surroundings as well as the robot itself is a significant problem in enabling the robot for executing a range of activities in the real-world. A robot need to be sophisticated to track a human through traffic regions, a vibrant atmosphere, and both indoors and out. The project's goal in building a following robot is for it to be able to carry objects alongside humans. It can be utilised in agriculture, construction, airports, and shopping malls. A microcontroller is the overall system's controlling device. The RF signal transmitted by the object can be used by RFID readers to identify the objects. Sensors such as ultrasonic sensors and infrared sensors aid in the recognition and location of objects. The microcontroller is connected to an RFID module and DC motors. The controller is loaded with a programme developed in the Embedded 'C' language to accomplish this operation.

II. RELATED WORK

A lot of researches have been conducted in the area related to RFID based Human Following Load Carrier.

Muhammad Sarmad Hassan et al. [1] focus on a system for a human-following robot that uses a camera to identify and recognize tags. The sensors helps the robot in making wise decisions using robot control unit. A system that provides real-time indoor position tracking was developed by Qian Ma et al. effectively and affordably using the M-RFID model, which includes RFID readers on moving objects (human beings) and RFID tags stationary in the monitoring area [2].

Few researchs have been accomplished in the system. Mobile robot applications using dual-directional antennas were developed by Myungsik et al. [6], which is a standalone-direction finding RFID reader.Inducing localization and searching phenomenon to the RFID, can help to get information on a fixed object. Thennavarajan Subramanian et al. [7] described the advancements in object following and obstacle avoidance and a miniature robot which can follow mobile objects was developed. The mobile camera or webcam is used to identify the various features of the mobile object with the help of a captured image.

III. SYSTEM COMPONENTS

Our robot is comprised of four-wheeled vehicle controlled by a microcontroller and various sensors, including ultrasonic and infrared sensors. To improve effectiveness, the sensor is vertically mounted on the robot at a specific height above the ground. The user controls this robotic vehicle using identification tag.

A. *Arduino*

The Arduino Uno is designed by Arduino.cc and uses ATmega328P. It is a microprocessor developed by Arduino.cc. There are several I/O pins, either digital or analog. This helps to connect the Arduino to external circuits. The Arduino microcontroller is shown in Fig. 1.

Fig. 1. Arduino UNO

B. RFID RC522

Radio Frequency Identification System (RFID) comprises of a tag or a card fixed on an object that needs to be tracked and a reader, a electronic chip. An antenna and a RF module emits a electromagnetic field with high frequency in a Tranceiver. The tag works without any kind of power supply. It features a chip which processes data, as well as an antenna that receives and transmits signals. Thus it is called as passive device. The RFID RC522 is shown in Fig. 2.

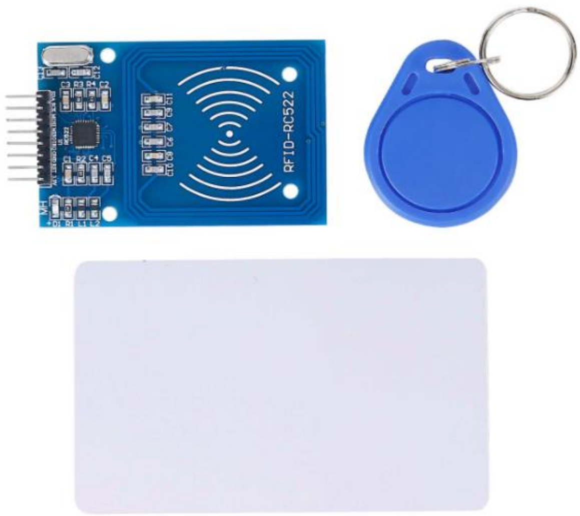

Fig. 2. RFID reader module with white card and key ring

C. Ultrasonic Sensor

A device that calculates the distance between two objects is called Ultrasonic sensor. It emits Ultrasonic sound waves to do the process. The proximity of an object is deduced by attaching a transducer module with the sensor. This helps in getting and emitting ultrasonic pulse. High-frequency sound waves reflect off boundaries, resulting in distinct echo patterns. This sensor module is shown in Fig. 3.

Fig. 3. Ultrasonic sensor

D. *Infrared sensor*

An infrared sensor is a device that calculates infrared radiation in its surroundings. There are two categories in IR sensors. They are active and passive sensors. An active sensor, both produces and measures the IR radiation. The infrared sensor module is shown in Fig. 4.

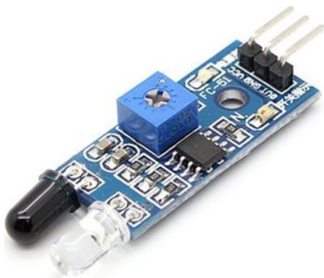

Fig. 4. Infrared sensor

E. *DC Motor*

Energy in electrical form is transferred into mechanical form using motors. DC motors requires DC current to convert electric power into mechanical transmission.

The current given to power the rotor creates a magnetic field. This field is used by the DC motors for rotation. The electrical inputs as well as the motor's design determine the output torque and speed. Fig. 5 shows the image of DC Motor.

Fig. 5. DC Motor

IV. METHODOLOGY

A systematic methodology is used with the primary aim of creating a complete functioning load carrier that is able to follow humans in mind.

The project is divided into several phases. All the steps were executed in organized way, beginning with discussions with various types of customers, and then inquiring about their problems. The problem statement was created after identifying the common problems encountered by various customers. A solution to the aforementioned problems was proposed, and the best solution was chosen. The design's basic concept has been chosen, and many journals and patents that are already available have been reviewed.

Following a review of the various papers, a key concept was raised. This resulted in a conceptual design with approximate parameters. Following the selection of the necessary materials and electronics, a detailed study was conducted, and precise parameters were established. The detailed design was then modelled and used for prototype design. Finally, the prototype was put through its paces in the workplace with the specified load. Fig. 6 depicts the methodology that was developed.

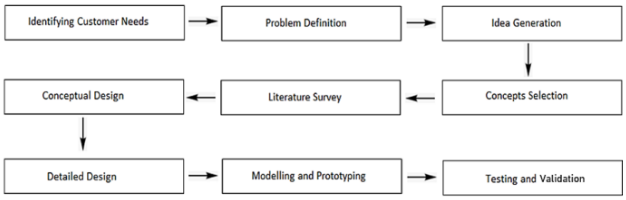

Fig. 6. Process flowchart

V. WORKING

This concept primarily uses ultrasonic and infrared sensors to track people. Authentication is done with the use of radio frequency identification technology. The RFID process serves as a control key for the robot. The robot can only be controlled by those who have a valid RFID tag.

Step 1: The RFID tag acts as the robot's key. The RFID tag's unique identification number is employed as an enable condition for the robot to follow the person in technical terms. The “for and if loops” are used to determine whether to run the code or not. The code instructs the robot to follow the person by using ultrasonic and infrared sensors after detecting a valid RFID tag.

Step 2: The programming to track the human begins to execute after the tag has been detected. To begin, the ultrasonic sensor identifies whether the subject being followed is in front of or behind. If the subject is on either side of the robot, the two infrared sensors identify it and direct it in that direction. Throughout the operation, the infrared and ultrasonic sensors operate together. They identify persons using ultrasonic and infrared technologies and communicate the data to the Arduino. The Arduino acts as a processor, providing information to the motor driver. The generalised system design, which incorporates the controllers with RFID, motors and various sensors and modules, is shown in Fig. 7.

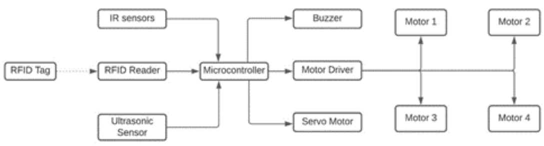

Fig. 7. Block diagram of the RFID Based Human Following Load Carrier

The circuit design developed using the block diagram is shown in Fig. 8.

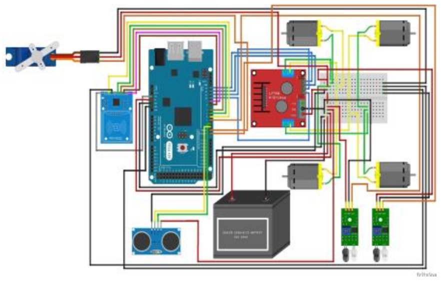

Fig. 8. Circuit diagram of the RFID Based Human Following Load Carrier

VI. CONCEPTUAL DESIGN

TinkerCAD was used to develop the conceptual design. On the basis of the derived design, the mechanical structure is created. The base's length and width are 400 mm and 250 mm, respectively. The length of the carrier is 300 mm, the width is 250 mm. The total height is calculated to be 150 mm. The prototype has a payload capacity of 1kg. Figs. 9, 10, and 11 show the 3D model's side, front, and top views.

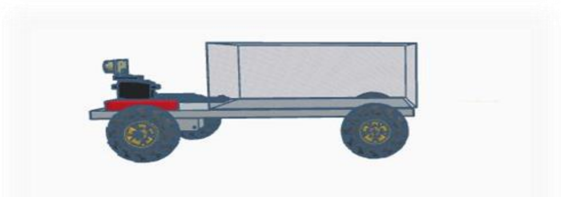

Fig. 9. Side view of the 3D model

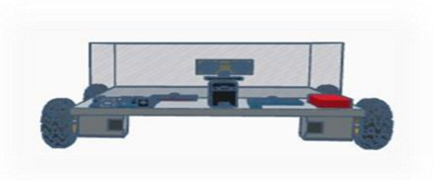

Fig. 10. Front view of the 3D model

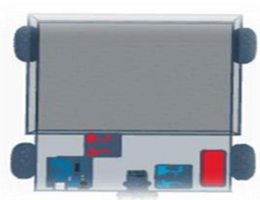

Fig. 11. Top view of the 3D model

VII. CODING

The programming portion of this project is critical in order to complete all of the operations. First, we include the necessary libraries for the RFID reader, servo, and motors. RFID readers and ultrasonic sensors pins are defined. The fig. 12 represents the initialization of the code.

```
#include<NewPing.h>
#include <SPI.h>
#include <MFRC522.h>
#include<Servo.h>
#include<AFMotor.h>
#define SS_PIN 10
#define RST_PIN 9
MFRC522 mfrc522(SS_PIN, RST_PIN);
#define RIGHT A2
#define LEFT A3
#define TRIGGER_PIN A1
#define ECHO_PIN A0
#define MAX_DISTANCE 100
```

Fig. 12. Header files and Pin configurations

In the void loop, the RFID reader checks for the correct RFID tag, and deny access to the other tags. Fig 13. shows the programming part of RFID.

```
if ( ! mfrc522.PICC_IsNewCardPresent())
{
  return;
}
if ( ! mfrc522.PICC_ReadCardSerial())
{
  return;
}

Serial.print("UID tag :");
String content= "";
byte letter;
for (byte i = 0; i < mfrc522.uid.size; i++)
{
   Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
   Serial.print(mfrc522.uid.uidByte[i], HEX);
   content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
   content.concat(String(mfrc522.uid.uidByte[i], HEX));
}
```

Fig. 13. Code for RFID

If the correct tag is found, “authorized access” is printed in the serial monitor, and it enters into the human following algorithm using ultrasonic sensors. Fig. 14 depicts the RFID and ultrasonic sensor code.

```
  if (content.substring(1) == "BD 31 15 2B")
    Serial.println("Authorized access");
    Serial.println();
    delay(3000);
 unsigned int distance = sonar.ping_cm();
Serial.print("distance");
Serial.println(distance);


int Right_Value = digitalRead(RIGHT);
int Left_Value = digitalRead(LEFT);

Serial.print("RIGHT");
Serial.println(Right_Value);
Serial.print("LEFT");
Serial.println(Left_Value);

if((Right_Value==1) && (distance>=10 && distance<=30)&&(Left_Value==1)){
  Motor1.setSpeed(120);
  Motor1.run(FORWARD);
  Motor2.setSpeed(120);
  Motor2.run(FORWARD);
  Motor3.setSpeed(120);
  Motor3.run(FORWARD);
  Motor4.setSpeed(120);
  Motor4.run(FORWARD);
}else if((Right_Value==0) && (Left_Value==1)) {
  Motor1.setSpeed(200);
```

Fig. 14. Code for RFID and ultrasonic sensor

VIII. IMPLEMENTATION

The implementation was carried out with the assistance of a block diagram and a circuit diagram. The hardware and software were interfaced. The working prototype is completed. The figure depicts a human-following load carrier prototype based on RFID. Figs. 15, 16, 17 illustrate the side, front, and top views of the working prototype.

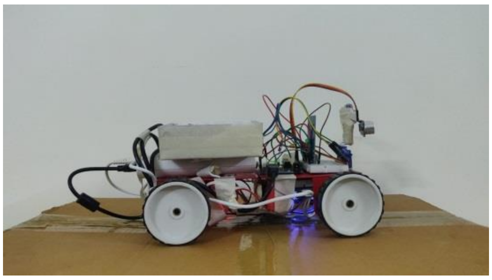

Fig. 15. Side view of the RFID based human following load carrier

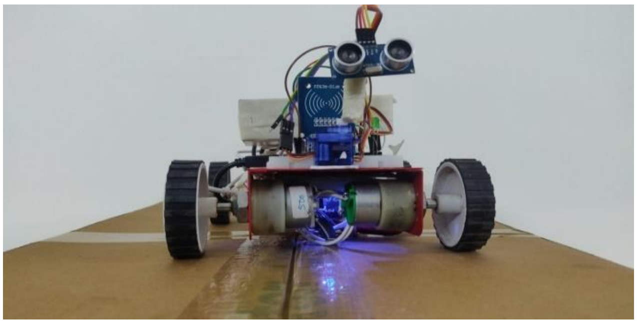

Fig. 16. Front view of the RFID based human following load carrier

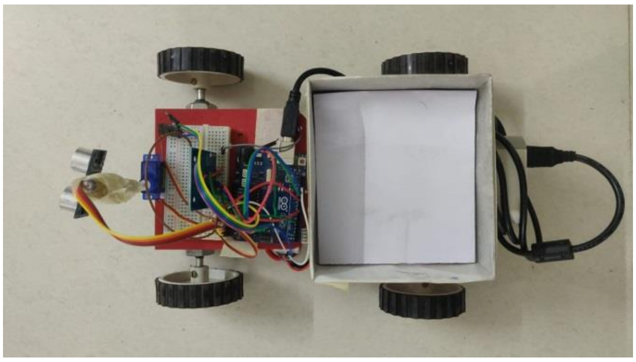

Fig. 17. Top view of the RFID based human following load carrier

IX. APPLICATIONS

Human following load carrier will benefit people in a variety of applications. Some applications for this robot include:

- Helping farmers to carry heavy loads.
- Assisting people working in hospitals, libraries, airports, and so on in carrying loads.
- Able to serve consumers in retail malls and public places.

X. CONCLUSION

This research demonstrates the effective installation of an RFID-based human following load carrier. Not only can this robot identify things, but it can also track and follow them. The tag is utilized to detect the proprietor, and depending on that detection, the robot follows. The many sensors installed within the robot were intended to improve detection accuracy. It was also thought that the robot's "following" capabilities should be as efficient as feasible. The tests were conducted under a range of circumstances in order to identify and rectify algorithmic faults.

XI. FURTHER WORKS

There are numerous intriguing applications in various fields, including military and medical. To make the robot more versatile and controllable from a distance, wireless communication functionality can be added. We can monitor the surroundings by mounting a camera on the top. We can also make changes to the algorithm and structure to make it suitable for other purposes. There arevarious other applications where we can apply this mechanism for following the object or a human. Further use of Vision based sensors such as video sensors and processing them increases the accuracy.

REFERENCES

1. Muhammad Sarmad Hassan, Mafaz Wali Khan, “Design and Development of Human Following Robot”, Student Research Paper Conference., vol. 2, no. 15, July 2015.
2. Qian Ma , Xia Li, Guanyu Li, Bo Ning, Mei Bai and Xite Wang, “Mobile RFID-Based Localization for Indoor Human Tracking”, MDPI(Multidisciplinary Digital Publishing Institute)., March 2020.
3. Ileni Abhinav Theja, Gudur Chandrakanth, Ravvula Akhil, Shaik Areef, “Human Following Robot”, International Journal of Advance Research, Ideas and Innovations in Technology., vol. 7.
4. Ashutosh Gujar, Kalyanee Jadhav, “Bluetooth Based and GPS Based Follow Me Robot”, International Research Journal of Engineering and Technology (IRJET), April 2021.
5. W. W. Tai, B. Ilias , S.A. Abdul Shukor, N. Abdul Rahim, “A Study of Ultrasonic Sensor Capability in Human Following Robot System”, IOP Conference Series.
6. Kim, Myungsik, Chong, Nak Young, Ahn, Hyo-Sung, Yu, Wonpil, “RFID-enabled Target Tracking and Following with a Mobile Robot Using Direction Finding Antennas”, IEEE International Conference on Automation Science and Engineering., 2007.
7. Thennavarajan Subramanian, Rahul Madbhavi, Shreepad Potadar, Sylvester Jerome D’souza, K V Gangadharan, “Object Follower and Barrier Escaping Robot Using Image Processing”, International Journal of Innovative Research in Science, Engineering and Technology., July 2015.
8. Muhammad B. Akbar, David G. Taylor, Gregory D. Durgin, “Two-Dimensional Position and Orientation Estimation Using a 5.8 GHz RFID System”, IEEE Xplore., December 2020.