INDIAN INSTITUTE OF INFORMATION TECHNOLOGY BHOPAL

"HUMAN FOLLOWING AND REMOTE-CONTROL SWITCHABLE CAR"

MINOR PROJECT REPORT

Submitted in partial fulfillment of the requirements for the award of the degree

of

BACHELOR OF TECHNOLOGY

in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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INDIAN INSTITUTE OF INFORMATION TECHNOLOGY BHOPAL

CERTIFICATE

This is to certify that **Adarsh Choutha (18U01026), Sandeep Thalluri (18U01030), Surya Teja K. V (18U01037) and Iswarya Ankupalli (18U01059)** students of B.Tech III year, VI semester, Department of Electronic and Communication Engineering, Indian Institute of Information Technology Bhopal have successfully completed their project work on "**Human Following and Remote-Control Switchable Car**" in partial fulfillment of the requirement of Minor Project Lab in Electronic and communication Engineering.

17/04/2021

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DECLARATION

We, hereby, declare that the work which is being presented in the report entitled **"Human Following and Remote-Control Switchable Car"** in partial fulfillment of the requirements of the III year, VI semester Minor Project Lab and submitted in the Department of Electronics and Communication Engineering of the Indian Institute of Information Technology Bhopal is an authentic record of our own work carried out under the supervision of Dr. Praveen Pawar (Supervisor) and Dr. Afreen Khursheed (Co-Supervisor) Department of Electronics and Communication Engineering, Indian Institute of Information Technology Bhopal. The work has been carried out entirely at Indian Institute of Information Technology Bhopal. The following project and its report, in part or whole, has not been presented or submitted by us for any purpose in any other institute or organization.

We, hereby, declare that the facts mentioned above are true to the best of our knowledge. In case of any discrepancies, we will be the ones to take responsibility.

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ABSTRACT

One of fundamental issues for service robots is human–robot interaction. To perform such a task and provide the desired services, these robots need to detect and track people in the surroundings. In this paper we present a shopping assistant system to be used in supermarkets, primarily for helping handicapped or elderly people for carrying a big load in hand. The proposed system is based in three main components: a) mobile devices, like mobile phones, that users carry with them, b) a set of mobile robots to assist supermarket users, c) the robotic assistant. This system will allow users to keep control in robot by communication with the robot, the robot will help the customer by handling all the product. In this work is also shown the acceptability studies for this kind of robot. There are two main issues associated with this problem. The first issue is to equip a robot with proper sensory devices so that it can identify and locate the target person in a crowd in real time. The second issue is to control and navigate the robot so that it follows the target person within a certain distance.

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1.	USB	:	Universal Serial Bus
2.	PWM	:	Pulse Width Modulation
3.	IR	:	Infrared
4.	LED	:	Light Emitting Diode
5.	PPM	:	Pulse Position Modulation
6.	DC	:	Direct Current
7.	TX	:	Transmitter
8.	RX	:	Receiver
9.	UART	:	Universal Asynchronous Receiver Transmitter
10.	FHSS	:	Frequency Hopping Spread Spectrum
11.	ISM	:	Industrial Scientific and Medical
12.	RF	:	Radio Frequency

Chapter 1

Introduction

Robotic technology has increased appreciably in past couple of years. Such innovations were only a dream for some people a couple of years back. But in this rapid moving world, now there is a need of robot such as “A Human Following Robot” that can interact and co-exist with them. The development of robot technology had increased significantly due to industrial and military applications. Most robots were used in industrial and military use but intelligent robots for general daily use is yet to be implemented. Human- Following Robot (HFR) is one of the applications that could be implemented under robot technology. Because of its human following capability, HFRs can work as assistants for humans in various situations and it can also acquire or monitor certain information associated with the human subject. Possible application scenarios include assistance for elderly people and general service robots for shopping centers or public areas. A key requirement for service robots is the ability to detect humans and to interact them in non-technical and natural fashion. The goal of our work is to move toward a more reliable and robust system, where human detection is viewed as a fundamental steppingstone.

One of fundamental issues for service robots is human–robot interaction. To perform such a task and provide the desired services, these robots need to detect and track people in the surroundings. The proposed system is based in three main components:

a) mobile devices, like mobile phones, that users carry with them

b) a set of mobile robots to assist supermarket users

c) the robotic assistant. This system will allow users to keep control in

robot by communication with the robot, the robot will help the customer by handling all the product.

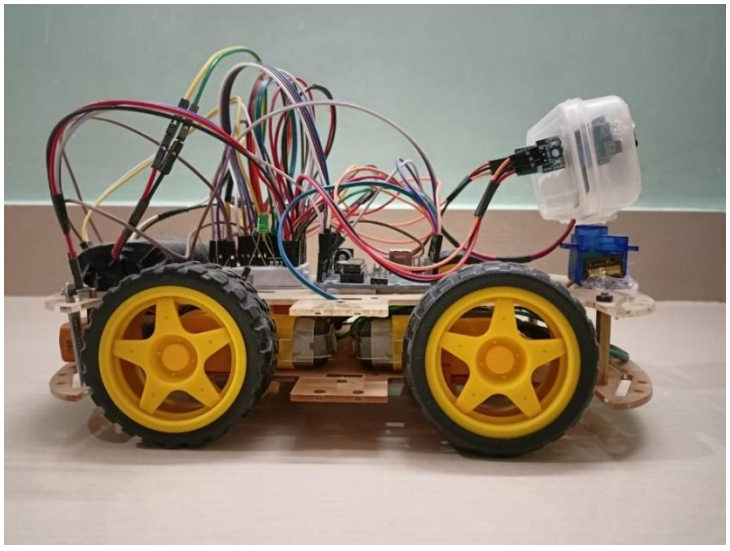

Figure 1.1: Human Following and Remote-Control Switchable Car

Chapter 2

2.1 Methodology & Work Description

The car can be controlled in three modes Remote-Control mode, Bluetooth Control mode, Automatic mode. At first the car would be in remote control mode we can use the remote control and close the switches to move the car in two ways forward, backward and rotate in two ways left or right. Any Bluetooth app that controls hc-06 Bluetooth Module can be used to connect to the Bluetooth module and make sure that the app sends the commands as shown in Table 2.1. The car works in automatic mode when it is switched to using Bluetooth control. As we move our hand in front of it, it moves according to it.

Command No.	Command	Command Description
1	T	Switches to Remote Control Mode
2	A	Switches to Bluetooth Control Mode
3	E	Switches to Automatic Control Mode
4	F	Moves Forward
5	L	Turns Left
6	R	Turns Right
7	B	Moves Back
8	S	Moves Back
9	X	Moves Forward
10	O	Stop

Table 2.1: Bluetooth Commands

In these commands ‘T’, ‘A’, ‘E’ are main commands that control the mode of the car after successful connection of Bluetooth we switch the modes and 4-10 commands work only in the Bluetooth control mode.

Any HC-06 Bluetooth Control app can be used, we used – **Arduino Bluetooth App**

2.2 COMMUNICATION

The communication proposed in this project is divided into two parts depending on the scenario in which they operate. The communication between the mobile device and the Arduino is performed via Bluetooth due the wide range of mobile devices that support of communication, on the other hand, the sensor of robot Detect the motion of the hand act accordingly the instructions of the user. Radio frequency is also used to communicate with the Arduino.

2.3 APPLICATIONS

Looking deeply into environment or our surroundings, we will be able interpret that "YES" there is need of such robot that can assist humans and can serve them. Such a robot can be used for many purposes. With a few changings, the robot can act as a human companion as well.

Some other applications of this robot are

- Can assist in carrying loads for people working in hospitals, libraries, airports, etc.
- Can service people at shopping centers or public areas.
- Can assist elderly people, special children, and babies.
- Can follow a particular Vehicle.

Chapter 3

Tools and Technology Used

Block Diagram:

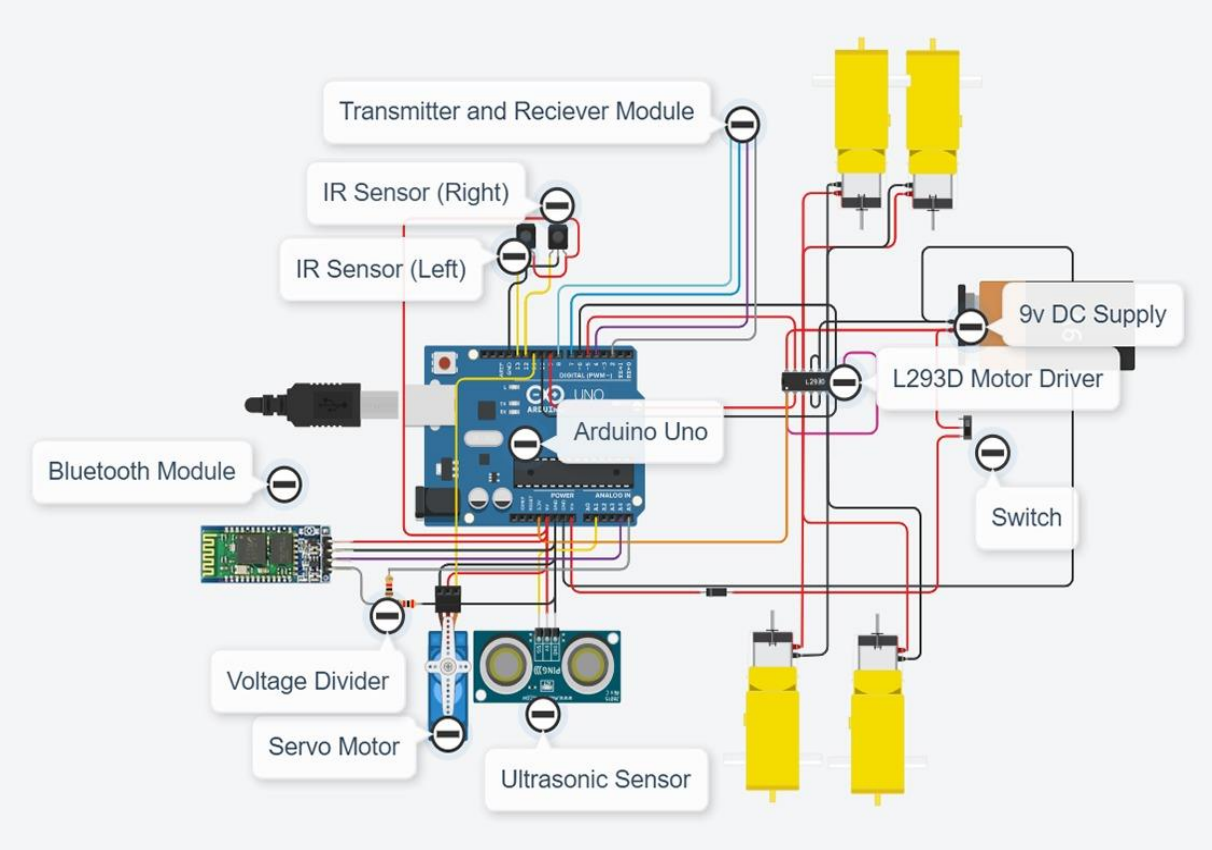

Figure 2.1: Block Diagram

Arduino Uno:

Figure 2.2: Arduino Uno

Arduino Uno is a programmable microcontroller board based on ATmega328p. We can add a programming code into, and Arduino Uno runs the program and works according to it. It has its own IDE software where we can write code and upload it to Arduino Board using a USB cable. It uses C language for programming.

It has 6 × analog input pins, 2 × transmit and receive pins, 12 × digital input/output pins out of which 6 can be used as PWM pins, 6 × Gnd pins, 1 × V_{in} pin, 1 × 3.3v V_{out} pin, 1 × 5v V_{out} pin, 1 × USB port, 1 × V_{in} port.

Its operating voltage is 5v DC, we can give a recommended $7-12$v DC input and input voltage limit is $6-20$v DC.

IR Sensor:

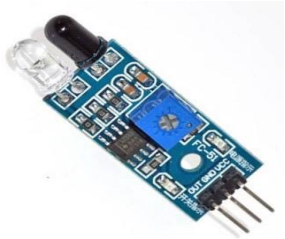

Figure 2.3: IR Sensor

IR Sensor senses some objects, that are sensible to IR rays, in the surroundings using infrared rays. Active IR Sensor is used in this project. In this sensor it has LM358 IC (op-amp) that uses IR LED (transmitter) to emit infrared rays, and when an object that is sensible to IR radiation comes in the range of IR LED the IR ray is reflected and the reflected ray is sensed by IR Photodiode (receiver) and sends signal to LM358 IC. An IR LED and an IR Photodiode, together called as Photocoupler. LM358 IC sends a high signal to output pin when no object is detected and low signal when an object is detected. It also has a potentiometer that controls the range of IR Sensor.

It $3\times$ pins, Out pin for object detection, V_{cc} and Gnd pins for power supply. Its operating voltage is $3.3-5v$ DC (range depends on input voltage), current is $20mA$. Its range is up to $20cm$.

Ultrasonic Sensor:

Figure 2.4: Ultrasonic

Ultrasonic Sensor senses objects, that are sensible to Ultrasonic sound waves, and finds the distance of the object from the sensor. HC-SR04 Ultrasonic sensor is used in this project. EM78P153 8-bit microprocessor is used as microcontroller for this Ultrasonic sensor, LM324 IC (op-amp) is used as comparator at transmitter section, also as bandpass filter and 2 more are used.

It has $4\times$ pins, Trig pin to Trigger Ultrasonic wave, Echo pin to listen for the triggered Ultrasonic wave, V_{cc} and Gnd pins for power supply. Its operating voltage is $5v$ DC. It has a range of $2-400cm$.

Servo Motor:

Figure 2.5: Servo Motor

Servo Motor rotates 180^o with a controlled rotation angle. It works on PPM principle, electric pulses with different width from $1-2ms$ maps to $0-180^o$. Servo Motor SG-90 is used in this project. It uses CMOS IC 7555 as microcontroller and IC 555 for precision timing or to generate pulses. It uses brushed DC motor.

It has $3\times$ pins, Position pin for controlling the angle, V_{cc} and Gnd pins for power supply. It has operating voltage $4.8-6v$ DC mapping a torque of $1.8-2.5kgcm$ and speed of $400-500\ degrees/sec$, $50Hz$ working frequency.

Motor:

Figure 2.6: Gear Motor

Motor is used to move the car. TT Gear Motor is used in this project. TT Gear Motor has improved torque compared to normal DC motor to carry heavy weight when used in projects.

It has $2\times$ pins, either V_{cc} or Gnd pins for power supply (rotation direction depends on connection). It has operating voltage $3-6v$ DC mapping a torque of $0.15-0.60Nm$ and speed of $90-200\,RPM$, no-load current less than $150mA$.

Motor Driver:

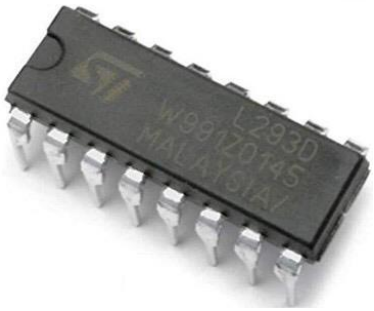

Figure 2.7: Motor Driver

Motor Driver is used to drive motor according to the inputs given. As Arduino operates at $5v$ and Motors operate at $6v$ a motor driver is used that gives $6v$ instead of $5v$ when given high signal. L293D is used as Motor Driver in this project. It uses PWM principle for controlling motor speed and H-Bridge principle for direction of rotation of motor.

It has $16\times$ pins, $2\times$ Enable pins, $2\times V_{in}$, $4\times Gnd$, $4\times$ input signal, $4\times$ output signal. It has supply voltage $4.5-36v$.

Bluetooth Module:

Figure 2.8: Bluetooth Module

Bluetooth Module helps in wireless data communication between Bluetooth connected devices. HC-06 Bluetooth Module is used in this project.

It has $6\times$ pins, Key pin determines whether the module works in AT command mode or normal mode, State pin represents the state of the module, TX and RX pins are for transmitting and receiving data, V_{cc} and Gnd pins for power supply. It has operating voltage $3.6-6v$ DC, current $40mA$. Its range is $<100m$. TX and RX pins are operated in $3.3v$, TX transmits signals in range of $0-3.3v$ and RX receives signal in range of $0-5v$ as Arduino Uno operates at $5v$ and so a voltage divider is constructed with $1k\Omega$ and $2k\Omega$ resistors in series and there will be $3.3v$ across $2k\Omega$ resistor, here $0-5v$ is mapped to $0-3.3v$.

This module uses UART (Universal Asynchronous Receiver Transmitter) protocol. It is serial communication protocol. It transmits data at a speed up to $2.1Mbps$. To avoid interference, it uses FHSS (Frequency Hopping Spread Spectrum) technique. Its frequency range is $2.40-2.48GHz$ ISM Band (Industrial Scientific and Medical Band (It is a part of radio spectrum that can be used for any purpose without any license in most countries)). Its power level is Class 2

$(+6dBm)$. It uses Gauss Frequency Shift Keying modulation mode. It has a security feature of Authentication and Encryption.

Radio Frequency Transmitter and Receiver:

Figure 2.9: RF TX & RX

Radio Frequency Transmitter and Receiver helps in transmitting data wirelessly. RF $433MHz$ Transmitter and Receiver modules are used in this project. $433.92MHz$ and $4.33MHz$ frequencies are used at Transmitter and Receiver section. Its range is up to 100m. This uses Amplitude Shift Keying technique for transmission.

Transmitter has Power Amplifier that amplifies power of data signal that is to be transmitted. The data signal and a carrier wave signal are passed through Multiplexer that outputs a third wave signal that is to be transmitted through antenna. Receiver has Low-Noise Amplifier that is designed to provide high voltage gain while contributing minimal noise.

Transmitter has $4\times$ pins, Antenna, Data pin, V_{cc} and Gnd pins for power supply. Receiver has $8\times$ pins, Antenna, $2\times$ Data pins, $2\times V_{cc}$ and $3\times Gnd$ pins for power supply.

Encoder & Decoder:

Figure 2.10: Encoder & Decoder

Encoder & Decoder are used to encode and decode data. HT 12E Encoder & HT 12D Decoder are used in this project. RF modules have no security that data can be transmitted to anyone or received from anyone and there will be data overlapping. Here encoder & decoder helps in maintaining security and make sure of no data overlapping. HT 12 module uses 12-bit data in which 8-bits are address and 4-bits are data, this 12-bit data is transmitted at a time in serial mode. If 8-bit address of encoder is not equal to 8-bit address of decoder then the signal will be discarded. They have operating voltage $2.4-12v$.

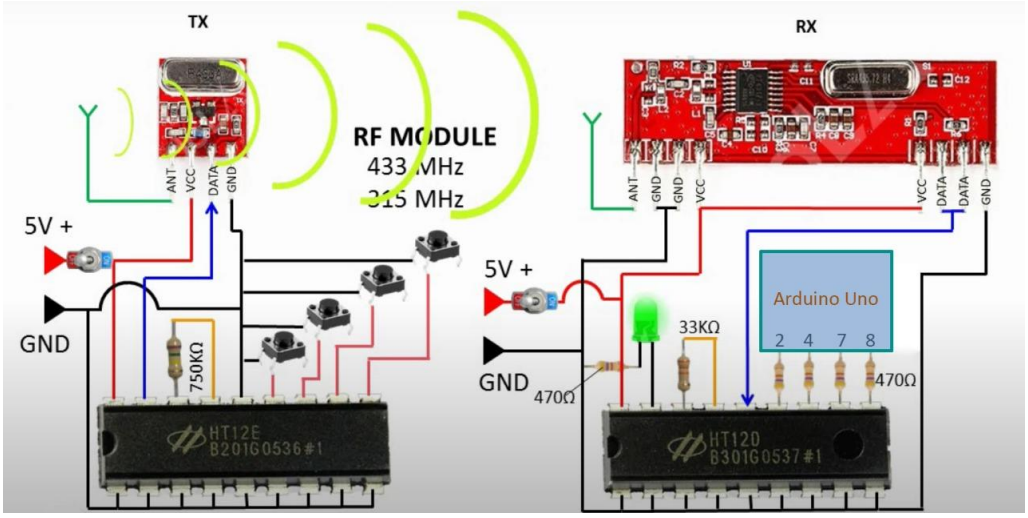

Figure 2.11: RF TX & RX Circuit Diagram

Chapter 4

Implementation and Coding

Arduino Programming Code:

```
//Bluetooth HC 06
#include <SoftwareSerial.h>
SoftwareSerial hcSerial(A5, 11); // RX, TX
char btValue;
char btCtrlValue = 'T'; // SELECT (Automatic)
String fromPC = "";

//UltraSonic Sensor
#define US_T 3
#define US_E A0
int distance;

//Servo Motor
#include <Servo.h>
Servo servo;
int ServoPosition;

//Right IR Sensor
#define IR_R 7

//Left IR Sensor
#define IR_L 8

//RF Remote
#define L_RF_R A2
#define R_RF_R A1
#define B_RF_R A4
#define F_RF_R A3

//Wheels
#define RP 6
#define RN 5
#define LP 9
#define LN 10
```

```
void setup() {
  // put your setup code here, to run once:

  //Bluetooth
  Serial.begin(9600); // hardware serial for the USB-PC
  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }
  hcSerial.begin(9600);  // software serial Arduino to HC-06 (9600 is default)

  //Ultrasonic Sensor
  pinMode(US_T, OUTPUT);
  pinMode(US_E, INPUT);

  //Servo Motor
  servo.attach(2);
  setServoPosition(90, 10); // (int Position, int Delay);
  rotateHead(15);

  //Right IR Sensor
  pinMode(IR_R, INPUT);

  //Left IR Sensor
  pinMode(IR_L, INPUT);

  //RF Remote
  pinMode(L_RF_R, INPUT);
  pinMode(R_RF_R, INPUT);
  pinMode(B_RF_R, INPUT);
  pinMode(F_RF_R, INPUT);

  // Wheels
  pinMode(RP, OUTPUT);
  pinMode(RN, OUTPUT);
  pinMode(LP, OUTPUT);
  pinMode(LN, OUTPUT);
}
void loop() {
  // put your main code here, to run repeatedly:

  // Read from HC-06
  if (hcSerial.available()) {
    while (hcSerial.available()) { // While there is more to be read, keep reading.
      btValue = (char)hcSerial.read();
      if (btValue == 'E') btCtrlValue = 'E';
      if (btValue == 'A') btCtrlValue = 'A';
      if (btValue == 'T') btCtrlValue = 'T';
    }
  }
  // Remote Controll
  if (btCtrlValue == 'T') { // START
    //Serial.println("Remote CTRL");
    rfRemote();
  }
  // Automatic Controll
  if (btCtrlValue == 'E') { // SELECT
    //Serial.println("Automatic");
    automatic();
  }
  // Bluetooth Controll
  if (btCtrlValue == 'A') { // START
    //Serial.println("BLUETOOTH CTRL");
    btCtrl();
  }
}
```

```
void rfRemote()
{
  if(digitalRead(F_RF_R)==0){
    forward();
  }if(digitalRead(B_RF_R)==0){
    backward();
  }if(digitalRead(R_RF_R)==0){
    right();
  }if(digitalRead(L_RF_R)==0){
    left();
  }
  if((digitalRead(F_RF_R)==1)&&(digitalRead(B_RF_R)==1)&&(digitalRead(R_RF_R)==1)&&(digitalRead(L_RF_R)==1)){
    stop_();
  }
}
void automatic()
{
  if (digitalRead(IR_L) == LOW && digitalRead(IR_R) == LOW) {
    int dis = getDistance();
    if (dis > 5 && dis <= 50) {
      forward();
    } else if (dis <= 2) {
      backward();
    }
    else {
      stop_();
    }
  } else if (digitalRead(IR_L) == LOW && digitalRead(IR_R) == HIGH) {
    left();
  } else if (digitalRead(IR_L) == HIGH && digitalRead(IR_R) == LOW) {
    right();
  } else if (digitalRead(IR_L) == HIGH && digitalRead(IR_R) == HIGH) {
    int dis = getDistance();
    if (dis > 5 && dis <= 50) {
      forward();
    } else if (dis <= 2) {
      backward();
    }
    else {
      stop_();
    }
  }
}
```

```
void btCtrl()
{
  if (btValue == 'F') {
    forward();
  } if (btValue == 'L') {
    left();
  } if (btValue == 'R') {
    right();
  } if (btValue == 'B') {
    backward();
  }
  if (btValue == 'S') {
    backward();
  } if (btValue == 'X') {
    forward();
  } if (btValue == 'O') {
    stop_();
  }
  if (btValue == 'T') {
  } if (btValue == 'E') {
  } if (btValue == 'A') {
  }
}

// Ultrasonic Sensor
int getDistance()
{
  // Clears the trigPin condition
  digitalWrite(US_T, LOW);
  delayMicroseconds(2);
  // Sets the trigPin HIGH (ACTIVE) for 10 microseconds
  digitalWrite(US_T, HIGH);
  delayMicroseconds(10);
  digitalWrite(US_T, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  long duration = pulseIn(US_E, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2; // Speed of sound wave divided by 2 (go and back)

  return distance;
}
```

```
// Servo Motor
void rotateHead(int Delay)
{
  for (int i = 91; i <= 180; i++) {
    servo.write(i);
    delay(Delay);
  }
  for (int i = 179; i >= 0; i--) {
    servo.write(i);
    delay(Delay);
  }
  for (int i = 1; i <= 90; i++) {
    servo.write(i);
    delay(Delay);
  }
}

void setServoPosition(int Position, int Delay) {
  ServoPosition = servo.read();
  if (ServoPosition > Position) {
    for (int i = ServoPosition - 1; i >= Position; i--) {
      servo.write(i);
      delay(Delay);
    }
  } else if (ServoPosition < Position) {
    for (int i = ServoPosition + 1; i <= Position; i++) {
      servo.write(i);
      delay(Delay);
    }
  } else if (ServoPosition == Position) {}
}
void stop_()
{
  //Serial.println("STOP");

  analogWrite(RP, 0);
  analogWrite(RN, 0);
  analogWrite(LP, 0);
  analogWrite(LN, 0);
}

void forward()
{
  //Serial.println("FORWARD");

  analogWrite(RP, 255);
  analogWrite(RN, 0);
  analogWrite(LP, 255);
  analogWrite(LN, 0);
}

void backward()
{
  //Serial.println("BACKWARD");

  analogWrite(RP, 0);
  analogWrite(RN, 255);
  analogWrite(LP, 0);
  analogWrite(LN, 255);
}

void right()
{
  //Serial.println("RIGHT");

  analogWrite(RP, 0);
  analogWrite(RN, 255);
  analogWrite(LP, 255);
  analogWrite(LN, 0);
}

void left()
{
  //Serial.println("LEFT");

  analogWrite(RP, 255);
  analogWrite(RN, 0);
  analogWrite(LP, 0);
  analogWrite(LN, 255);
}
```

Chapter 5

Conclusion and Future Scope

5.1 Conclusion

A successful implementation of a person follower robot is illustrated in this research. This robot does not only have the detection capability but following ability as well. The tracking is basically performed on the tag and the human is followed based on that detection. It was also kept in mind that the following capability of the robot should be as efficient as possible. The tests were performed on the different conditions to pinpoint the mistake in the algorithm and correct them. The different sensors that were integrated with the robot added an additional advantage.

5.2 Future Scope

There are many interesting applications of this research in different fields whether military or medical. GSM module can be added to it so that a sim in inserted and it can be operated with other mobile using phone call or message and it can be connected to the cellular network and through internet it can be controlled from a large distance. This capability of a robot could also be used for military purposes. By mounting a real time video recorder and camera on top of the sensor, we can monitor the surroundings by just sitting in our rooms. We can also add some modifications in the algorithm and the structure as well to fit it for any other purpose. Example a vehicle follower. Similarly, it can assist the public in shopping malls, hospitals, airports. So, there it can act as a luggage carrier, hence no need to carry up the weights or to pull that. Using this algorithm, the robot will automatically follow that person.

References

1. Arduino Uno
"Introduction to Arduino – A piece of cake!" by Alan G. Smith
http://www.introtoarduino.com/downloads/IntroArduinoBook.pdf

2. Servo Motor
https://circuitdigest.com/article/servo-motor-working-and-basics#:~:text=A%20servo%20motor%20is%20a,to%20rotate%20with%20great%20precision.

3. IR Sensor
https://www.elprocus.com/infrared-ir-sensor-circuit-and-working/

4. Ultrasonic Sensor
https://components101.com/sensors/ultrasonic-sensor-working-pinout-datasheet

5. L293D Motor Driver
https://components101.com/ics/l293d-pinout-features-datasheet

6. HC-06 Bluetooth Module
https://components101.com/wireless/hc-06-bluetooth-module-pinout-datasheet

7. UART
https://www.circuitbasics.com/basics-uart-communication/
https://www.electronicshub.org/basics-uart-communication/

8. HT-12e Encoder
https://components101.com/ics/ht12e-encoder-pin-diagram-datasheet

9. HT-12d Decoder
https://components101.com/ics/ht12d-rf-decoder-ic

10. RF Transmitter & Receiver
https://robu.in/what-is-rf-transmitter-and-receiver/