PURBANCHAL UNIVERSITY

Biratnagar, Nepal

A Project report on

"Obstacle Avoiding, Bluetooth Control and Human Following Robot"

In the partial fulfillment for the requirement of the 3rd Semester Project-III (subject code-BIT206CO) in the completion of **Bachelor of Information Technology (BIT)** degree at **KIST college of Information Technology**, under **Purbanchal University.**

Submitted by:

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Submitted to:

Purbanchal University

Under The Guidance of Mr. Kiran Adhikari (Project Teacher), BIT

KIST COLLEGE OF INFORMATION AND TECHNOLOGY

KAMALPOKHARI, KATHMANDU NEPAL

KIST COLLEGE OF INFORMATION AND TECHNOLOGY

KAMALPOKHARI, KATHMANDU, NEPAL

CERTIFICATE

This is to certify that the project work entitled **"Obstacle Avoiding, Bluetooth Control and Human Following Robot" is** carried out by **ADISON GIRI (5417)**, **HAWANA TAMANG (5413), KUSHAL PATHAK (5398)** Bonafide students of **KIST COLLEGE OF INFORMATION AND TECHNOLOGY** in partial fulfillment for the award of **BACHELOR IN INFORMATION AND TECHNOLOGY** of the **PURBANCHAL UNIVERSITY**, **BIRATNAGAR NEPAL**, during the year **2022-2023**. It is certified that all corrections indicated for internal assessment have been incorporated in the report submitted in the department library. The project report has been approved, as it satisfied the academic requirements in respect of the project work prescribed for the said degree.

The details of the students are as follows: -

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Course: - BIT (Bachelor's in INFORMATION TECHNOLOGY)

Semester: - 3rd Semester

Subject: - Project-III

Subject Code : - BIT (206CO)

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Examiners Certificate

Project report

On

"Obstacle Avoiding, Bluetooth Control and Human Following Robot"

Developed by Adison Giri, Hawana Tamang, Kushal Pathak

Is approved and is acceptable in qualify form.

Internal Examiner:	External Examiner:
Name:	Name:
Designation:	Designation:

ACKNOWLEDGEMENT

It is with greatest satisfaction and euphoria that we are submitting our project report entitled **"Obstacle Avoiding, Bluetooth Control and Human Following Robot".** We have completed it as a part of the curriculum of **PURBANCHAL UNIVERSITY.**

We also take this opportunity to express a deep sense of gratefulness to our **Project Teacher Kiran Adhikari** for their amiable support, valuable information and guidance which helped us in completing this task throughout its various stages. We are indebted to all members of **KIST College,** for the valuable support and suggestion provided by them using their specific fields knowledge. We are grateful for their cooperation during the period of our project.

Finally, we would also like to express our gratefulness towards **Purbanchal University** for designing such a wonderful course structure. It will help us to get more knowledge in the field of Information Technology & help us to have a bright future in the field of technology.

We hope our university will accept this attempt as a successful project.

Last but not the least, our sincere thanks to our parents, teaching and non-teaching staffs of our college and also my friends.

ADISON GIRI (333688)

HAWANA TAMANG (333695)

KUSHAL PATHAK (333697)

STUDENT'S DECLARATION

We hereby declare that the project report entitled "**Obstacle Avoiding, Bluetooth Control and Human Following Robot**" is a result of our own work. If we are found guilty of copying any other report or published information and showing as our original work, we understand that we shall be liable and punishable by **Purbanchal University**.

We further certify that this Project submitted in partial fulfillment of the requirement for the award of Bachelor in Information Technology (**BIT**) of the **Purbanchal University** is our original work and has not been submitted for award of any other degree or other similar title or prize.

S.N.	Name	Registration No.	Symbol No.
1	Adison Giri	058-3-2-04712-2020	333688
2	Hawana Tamang	058-3-2-04719-2020	333695
3	Kushal Pathak	058-3-2-04722-2020	333697

TO WHOM IT MAY CONCERN

This is to certify that **Mr. Adison Giri, Miss. Hawana Tamang, Mr. Kushal Pathak, of Bachelor in Information Technology (BIT)** has studied as per the curriculum of **BIT 3rd Semester** and completed the project entitled "**Obstacle Avoiding, Bluetooth Control and Human Following Robot"**. This project is the original work of **Mr. Adison Giri, Miss. Hawana Tamang, Mr. Kushal Pathak** and was carried out under the supervision of **Mr. Kiran Adhikari** as per the guidelines provided by **Purbanchal University** and certified as per the student's declaration that project "**Obstacle Avoiding, Bluetooth Control and Human Following Robot**" has not been presented anywhere as a part of any other academic work.

The detail of the student is as follows:

Name of Students: Adison Giri
Hawana Tamang
Kushal Pathak

Semester : 3rd
Subject Code : BIT 206 CO
Project Title : **Obstacle Avoiding, Bluetooth Control and Human Following Robot**

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ABSTRACT

The purpose of **"Obstacle Avoiding, Bluetooth Control and Human Following Robot"** is to automate the existing manual system by the help of computerized equipment's and full-fledged computer software, fulfilling their requirements, so that the manual work can be easily done with less time and ease to the people. The required software and hardware are easily available and easy to work with.

Obstacle Avoiding, Bluetooth Control and Human Following Robot, as declared above, can lead to ease in the manual system. It can assist the user to avoid the obstacles, follow human and reduce the manual work of hand car and it can also be controlled through the user's own device. Thus, it will help organization in better utilization of resources.

The aim is to automate its existing manual system by the help of computerized equipment and full-fledged computer software, fulfilling their requirements, so that the users can easily perform their daily task with ease and no pressure. Basically, the project describes how to manage for good performance and better services for the clients.

According's: OBH refers to Obstacle Avoiding, Bluetooth Control and Human Following

Table of Contents

Contents

Chapter 1

1.1. Introduction

An Obstacle avoiding, Bluetooth- controlled, human- following Arduino Robot is a type of robotic car that can move around autonomously while avoiding obstacles in its path. It can also e controlled remotely through a Bluetooth connection using a mobile device or computer. Additionally, it can be programmed to follow a human by using sensors and algorithms to detect and track a human's movement. This type of Arduino car is a popular project among robotics enthusiasts and is often used as a learning tool to develop skills in coding, electronics, and mechanical engineering.

Obstacle Avoiding:

The obstacle avoiding feature of the Arduino car allows it to detect objects in its path. Using sensors such as ultrasonic sensors or infrared sensors. The car can then automatically steer or stop to avoid the obstacle.

Bluetooth Control:

Bluetooth control allows the Arduino car to be controlled remotely using a Bluetooth connection. This feature enables the user to control the car's movement using a mobile device or computer or Bluetooth control application with a Bluetooth module. The user can send commands such as "forward", "backward", "left", "right", etc. to control the car's movements.

Human Following:

Human following is a more advanced feature of the Arduino car that uses sensors and algorithms to detect and track a human's movement. This feature involves using image processing techniques to identify and track a human in the car's field of view. The car can then follow the human by moving towards them while maintaining a safe distance.

Overall, an obstacle avoiding, Bluetooth- controlled, human following Arduino car is a versatile and exciting project for anyone interested in robotics and electronics. It combines multiple features into one project, allowing the user to learn and experiment with various technologies and techniques.

1.2. OBJECTIVES

1.2.1. Objectives of Obstacle Avoiding Robot

- Detecting Obstacles: The robot must be able to detect obstacles in its path using sensors such as ultrasonic or infrared sensors.
- Reacting to obstacles: The robot must be able to react to obstacles in its path by stopping, changing direction, or taking other actions to avoid a collision.
- Navigating around obstacles: The robot must be able to navigate around obstacles by finding an alternative path to its destination.
- Operating autonomously: The robot should be able to operate autonomously without human intervention, allowing it to navigate through an environment without constant monitoring.
- Providing real-time feedback: The robot should be able to provide real-time feedback to the user about its location, status, and any obstacle detected.

1.2.2. Objectives of Bluetooth Control Robot

- Enable wireless connectivity between the car's audio system and mobile devices.
- Provide hands – free communication for drivers, reducing the risk of distracted driving.
- Allow drivers to stream music wirelessly from their mobile devices.
- Enable voice commands to control the car's audio system.
- Enhance the overall driving experience by providing entertainment and communication capabilities.
- Enable features such as remote keyless entry, vehicle diagnostics, and location – based services.

1.2.3. Objectives of Human Following Robot

- To enhance safety by using advanced sensors and algorithms to detect and avoid collisions with pedestrians and other objects.
- To increase convenience by allowing the car to navigate crowded areas such as pedestrian zones, shopping malls, and airports.
- To provide a more autonomous and flexible transportation solution that can adapt to a range of environments, making it ideal for urban transportation.
- To reduce congestion and improve mobility by providing a sustainable and efficient transportation solution.
- To enhance the overall user experience by providing a more comfortable and convenient mode of transportation that eliminates the need for human intervention.

1.3. FEATURES

1.3.1. Features of Obstacle Avoiding Robot

- Obstacle detection: The robot is equipped with sensors such as ultrasonic or infrared sensors to detect obstacles in its path.
- Obstacle avoidance: The robot is capable of avoiding obstacles in its path by stopping, changing direction, or taking other actions to navigate around the obstacle.
- Autonomous operation: The robot can operate autonomously without human intervention, allowing it to navigate through an environment without constant monitoring.
- Mobility: The robot is typically equipped with wheels or tracks to move around in an environment, allowing it to navigate through a variety of terrains.
- Power efficiency: The robot is designed to operate efficiently, with power-saving features such as sleep modes or energy – efficient motors.
- Compact and lightweight: The robot is often designed to be compact and lightweight, making it easy to transport and maneuver in tight spaces.

1.3.2. Features of Bluetooth Control Robot

- Wireless Connectivity: A Bluetooth module allows wireless connectivity between the car's audio system and mobile devices such as smartphones, tablets, or laptops.
- User – friendly interface: The robot can be controlled using a mobile device or computer with a Bluetooth module, making it easy to operate with a user – friendly interface.
- Customizable controls: The robot can be programmed to respond to different commands, such as forward, backward, left, right etc.
- Compatibility with Arduino Boards: The robot is typically built using Arduino Boards, which are popular among hobbyists and professionals alike for their flexibility and ease of use.
- Expandability: The robot can be expanded with additional sensors, actuators, or other components to enhance its functionality or adapt it to different applications.
- Low cost: The components needed to build a Bluetooth control robot Arduino are relatively inexpensive, making it an affordable project for hobbyists or students.

1.3.3. Features of Human Following Robot

- Human detection: The robot is equipped with sensors, such as cameras or infrared sensors, to detect the presence of a human in its field of view.
- Human tracking: The robot is capable of tracking the movement of a human and following them as they move around in its environment.
- Autonomous operation: The robot can operate autonomously without human intervention, allowing it to follow human without constant monitoring.
- Mobility: The robot is typically equipped with wheels or tracks to move around in an environment, allowing it to follow a human through a variety of terrains.
- Customizable behavior: The robot can be programmed to respond to different human behaviors or adjust its behavior based on environmental factors such as obstacles or terrain.
- Low cost: The components needed to build a human following robot. Arduino are relatively inexpensive, making it an affordable for students.

1.4. Team Structure and Roles

The member assigned with these particular responsibilities.

Members	Study &Analysis	Designing	Coding &Hardware	Debugging	Documentation
Adison Giri	Adison Giri	Adison Giri	Adison Giri	Adison Giri	Adison Giri
Hawana Tamang	Hawana Tamang	Hawana Tamang	Hawana Tamang	Hawana Tamang	Hawana Tamang
Kushal Pathak	Kushal Pathak	Kushal Pathak	Kushal Pathak	Kushal Pathak	Kushal Pathak

Chapter 2: System Analysis

2.1. Literature Review

Robot have been a subject of interest in literature for many years, with various depictions ranging from mechanical servants to sentient beings. Robots have been used to explore themes such as artificial intelligence, morality, and the relationship between humans and machines.

A robot is a machine that is designed to perform tasks autonomously or with minimal human intervention. Robots can be programmed to perform a wide range of tasks, from simple repetitive actions to complex operations that require advanced sensing, decision – making, and mobility capability.

Robots typically consists of several key components, including sensors, actuators, and a control system. The sensors allow the robot to perceive its environment and gather data, while the actuators allow the robot to manipulate objects and interact with its surroundings. The control system coordinates the robot's actions based on inputs from the sensors and commands from the operator or the robot's programming.

The development of robotics technology continues to advance rapidly, with new breakthroughs in sensing, mobility, and artificial intelligence allowing robots to perform increasingly complex tasks. As robots become more advanced and accessible, they are expected to play an even greater role in shaping the future of society and the economy.

The details of research behind this project are explained here:

- At first, research was done on a website "https://www.srituhobby.com" whose URL is given in **References**. Within this website, numerous projects written for microcontroller 8051 were available for study out of which, we studied:

  Project Name: **Obstacle Avoiding, Bluetooth Control and Human Following Robot**

Chapter 3: System Design

3.1. Working Principle

3.1.1. Obstacle Avoiding

The (7800 mah) battery provides the power supply to Arduino uno, motor shield, dc motors, sensors at the beginning. Then the ultrasonic sensors sense its surrounding, if the view field is clear then the car moves front, if the robot finds obstacle, then it comes backwards, stops and then checks its surrounding through the motor driver, if the view is clear then it moves right or left or front according to the detection of the sensor.

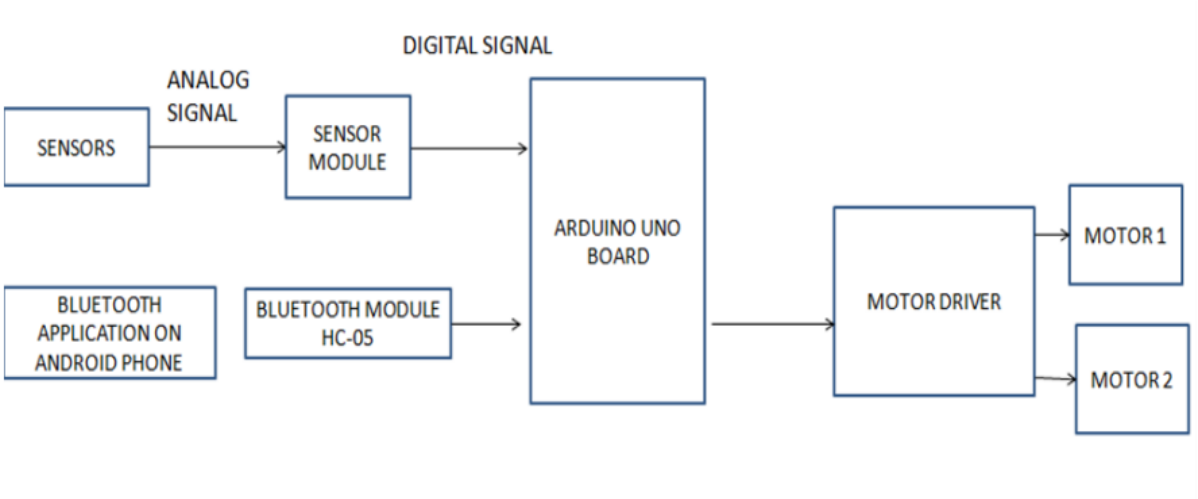
3.1.2. Bluetooth Control

After the supply of power from the battery, the Bluetooth module in the robot is opened automatically, then we have to connect our remote control or mobile device to the robot through the Bluetooth connection (Here, HC-05 is used while paring the mobile device). Then according to the buttons pressed in the Bluetooth remote controller the robot follows the actions such as front, back, left, right, front – left, front – right, back – left, back – right.

3.1.3. Human Following

The power supply goes through the Arduino, motor shield to the ultrasonic sensor, IR sensors and servo motor. The ultrasonic sensor is the primary sensor for sensing the people, the IR sensor is the secondary sensor for the motion detection, it detects the movement of the people and moves by following the people. It moves front, back, right, left, etc., where ever the human goes.

3.2. Block Diagram



3.3. Equipment Required

- **Arduino Uno:** The Arduino uno is a popular microcontroller board that is used widely by students, professionals for various projects. It is based on the ATmega328P microcontroller and has a range of features, including digital and analog I/O pins, PWM output, and serial communication capabilities.
    - Specification of Arduino Uno:
    - Microcontroller: ATmega328P
    - Operating Voltage: 5V
    - Digital I/O Pins: 14
    - Analog Input Pins: 6
- **Motor Shield:** A motor shield is an expansion board that is designed to be used with an Arduino board. It provides an easy way to control motors, such as DC motors or stepper motors, using the Arduino. The motor shield included four motor drivers, which are electronic circuits that control the speed and the direction of the motor.
- **Servo Motors:** A servo motor is a type of motor that is designed to provide precise control over its position and speed. It is commonly used in robotics and other applications where precise control is required. Here two servo motors were used in the robot, (i.e., one for obstacle avoiding and another for human following feature).
- **Ultrasonic Sensor:** Ultrasonic sensor is primary sensor in the project. It uses high – frequency sound waves to detect the distance of an object. Here, two ultrasonic sensors were used in the robot (i.e., one for obstacle avoiding and another for human following mechanism)
- **IR Sensor:** IR sensor typically also the secondary sensor used in the project. It uses infrared light to detect the presence of an object or measure its distance. IR sensors can provide fast and accurate detection of objects and are less affected by environmental factors such as light and color than other optical sensors. Here, one IR sensor was used for the human following mechanism.
- **Bluetooth Module:** Bluetooth module (HC-05) was used for the Bluetooth module and voice control mechanism. It receives the commands and follows the actions according to the command.

3.4. Gantt Chart

S.N.	Tasks	Week 1	Week 2	Week 3	Week 4
1	Requirement gathering and planning				
2	Analysis				
3	Designing				
4	Coding & Hardware Implementation				
5	Testing and debugging				
6	Documentation				

Total Time: 4 weeks (1 Month)

Chapter 4: System Development and Implementation

4.1. Software Specifications

Computer software specification we have used for development:

- Operating System: Windows 10 Operating System
- Proteus 8 Professional
- Arduino IDE

4.2. Hardware Specifications

Computer hardware specification we have used for development:

- Processor: AMD A9 Processor
- RAM: 8 GB
- SSD: 128 GB
- HDD: 1TB

4.3. Source Code

```
/*obstacle avoiding, Bluetooth control, voice control robot car.*/

#include <Servo.h>
#include <AFMotor.h>
#define Echo A0
#define Trig A1
#define motor 10
#define Speed 170
#define spoint 103
char value;
int distance;
int Left;
int Right;
int L = 0;
int R = 0;
int L1 = 0;
int R1 = 0;
Servo servo;
AF_DCMotor M1(1);
AF_DCMotor M2(2);
AF_DCMotor M3(3);
AF_DCMotor M4(4);
void setup() {
  Serial.begin(9600);
  pinMode(Trig, OUTPUT);
  pinMode(Echo, INPUT);
```

```
  servo.attach(motor);
  M1.setSpeed(Speed);
  M2.setSpeed(Speed);
  M3.setSpeed(Speed);
  M4.setSpeed(Speed);
}
void loop() {
  Obstacle();
  //Bluetoothcontrol();
  //voicecontrol();
}
/*void Bluetoothcontrol() {
  if (Serial.available() > 0) {
    value = Serial.read();
    Serial.println(value);
  }
 if (value == 'F') {
    forward();
  } else if (value == 'B') {
    backward();
  } else if (value == 'R') {
    left();
  } else if (value == 'I'){
    forward_left();
  } else if (value == 'H'){
    backward_left();
  } else if (value == 'L') {
    right();
  } else if (value == 'G'){
    forward_right();
  } else if (value == 'J'){
    backward_right();
  }else if (value == 'S') {
    Stop();
  }
}*/

void Obstacle() {
  distance = ultrasonic();
  if (distance <= 12) {
    Stop();
    backward();
    delay(100);
```

```
    Stop();
    L = leftsee();
    servo.write(spoint);
    delay(800);
    R = rightsee();
    servo.write(spoint);
    if (L < R) {
      right();
      delay(500);
      Stop();
      delay(200);
    } else if (L > R) {
      left();
      delay(500);
      Stop();
      delay(200);
    }
  } else {
    forward();
  }
}
/*void voicecontrol() {
  if (Serial.available() > 0) {
    value = Serial.read();
    Serial.println(value);
    if (value == '^') {
      forward();
    } else if (value == '-') {
      backward();
    } else if (value == '<') {
      L = leftsee();
      servo.write(spoint);
      if (L >= 10 ) {
        left();
        delay(500);
        Stop();
      } else if (L < 50) {
        Stop();
      }
    } else if (value == '>') {
      R = rightsee();
      servo.write(spoint);
      if (R >= 10 ) {
```

```
    right();
    delay(500);
    Stop();
  } else if (R < 50) {
    Stop();
  }
  }else if(value == '>>'){
  R = rightsee();
  servo.write(spoint);
  if (R >= 10 ) {
    right();
    delay(500);
    forward();
  } else if (R < 50) {
    forward();
}
  }
else if (value == '<<') {
  L = leftsee();
  servo.write(spoint);
  if (L >= 10 ) {
    left();
    delay(500);
    forward();
  } else if (L < 50) {
    forward();
  }
}else if(value == '->'){
 L = leftsee();
  servo.write(spoint);
  if (L >= 10 ) {
    left();
    delay(500);
    backward();
  } else if (L < 50) {
    backward();
}
}else if(value == '-<'){
   R = rightsee();
  servo.write(spoint);
  if (R >= 10 ) {
    right();
    delay(500);
```

```
      backward();
    } else if (R < 50) {
      backward();
   }
   }else if (value == '*') {
    Stop();
   }
  }
}*/
// Ultrasonic sensor distance reading function
int ultrasonic() {
  digitalWrite(Trig, LOW);
  delayMicroseconds(4);
  digitalWrite(Trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(Trig, LOW);
  long t = pulseIn(Echo, HIGH);
  long cm = t / 29 / 2; //time convert distance
  return cm;
}
void forward() {
  M1.setSpeed(255);
  M1.run(FORWARD);
  M2.setSpeed(255);
  M2.run(FORWARD);
  M3.setSpeed(255);
  M3.run(FORWARD);
  M4.setSpeed(255);
  M4.run(FORWARD);
}
void forward_left() {
  M1.setSpeed(255);
  M1.run(FORWARD);
  M2.setSpeed(255);
  M2.run(FORWARD);
  M3.setSpeed(255);
  M3.run(FORWARD);
  M4.setSpeed(255);
  M4.run(FORWARD);
  M1.setSpeed(255);
  M1.run(FORWARD);
  M2.setSpeed(255);
  M2.run(FORWARD);
```

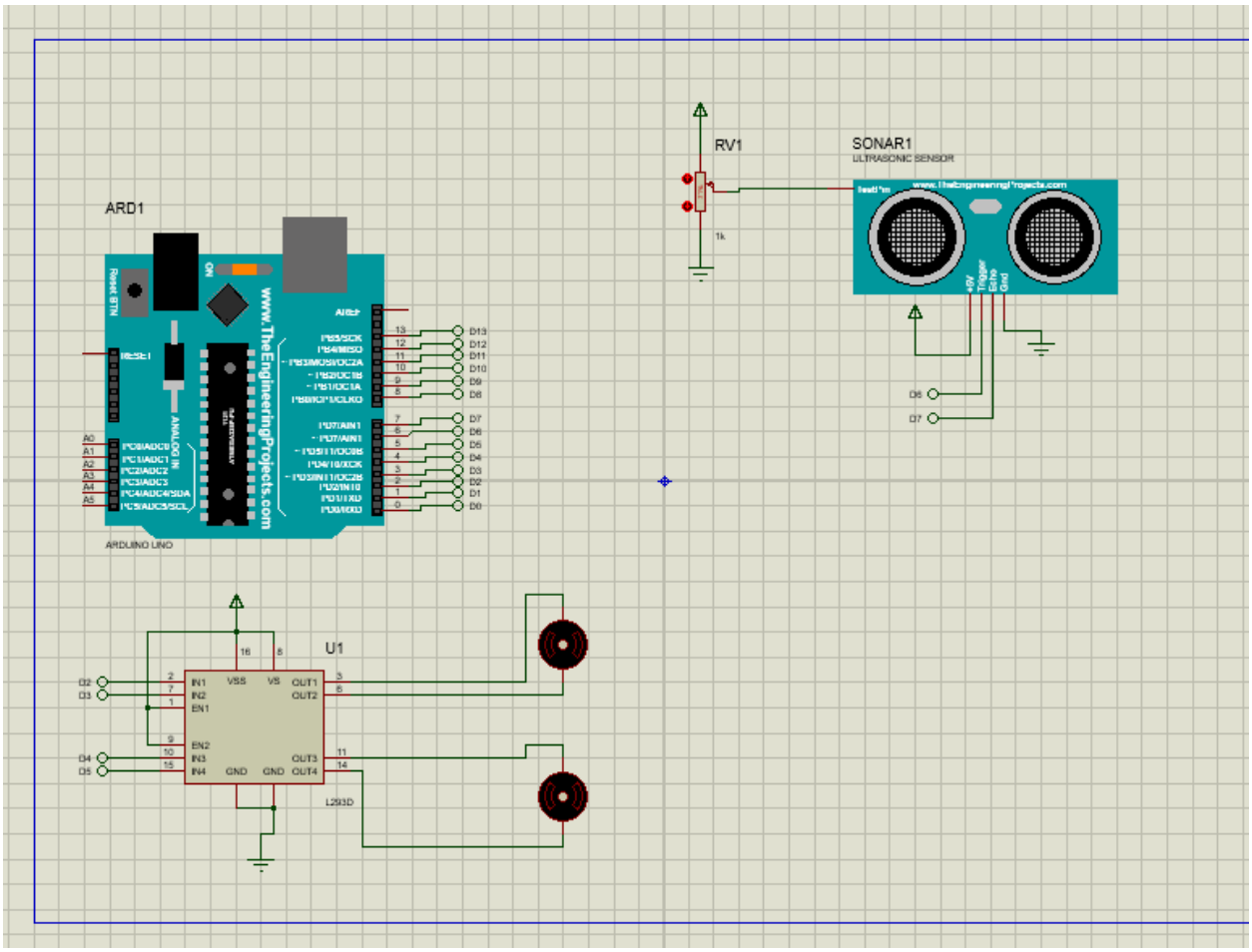
```
  M3.setSpeed(255);
  M3.run(BACKWARD);
  M4.setSpeed(255);
  M4.run(BACKWARD);
}
 void forward_right() {
   M1.setSpeed(255);
  M1.run(FORWARD);
  M2.setSpeed(255);
  M2.run(FORWARD);
  M3.setSpeed(255);
  M3.run(FORWARD);
  M4.setSpeed(255);
  M4.run(FORWARD);
  M1.setSpeed(255);
  M1.run(BACKWARD);
  M2.setSpeed(255);
  M2.run(BACKWARD);
  M3.setSpeed(255);
  M3.run(FORWARD);
  M4.setSpeed(255);
  M4.run(FORWARD);
 }
void backward() {
  M1.setSpeed(255);
  M1.run(BACKWARD);
  M2.setSpeed(255);
  M2.run(BACKWARD);
  M3.setSpeed(255);
  M3.run(BACKWARD);
  M4.setSpeed(255);
  M4.run(BACKWARD);
}
void backward_right() {
  M1.setSpeed(255);
  M1.run(BACKWARD);
  M2.setSpeed(255);
  M2.run(BACKWARD);
  M3.setSpeed(255);
  M3.run(BACKWARD);
  M4.setSpeed(255);
  M4.run(BACKWARD);
  M1.setSpeed(255);
```

```
  M1.run(BACKWARD);
  M2.setSpeed(255);
  M2.run(BACKWARD);
  M3.setSpeed(255);
  M3.run(FORWARD);
  M4.setSpeed(255);
  M4.run(FORWARD);
}
void backward_left() {
  M1.setSpeed(255);
  M1.run(BACKWARD);
  M2.setSpeed(255);
  M2.run(BACKWARD);
  M3.setSpeed(255);
  M3.run(BACKWARD);
  M4.setSpeed(255);
  M4.run(BACKWARD);
  M1.setSpeed(255);
  M1.run(FORWARD);
  M2.setSpeed(255);
  M2.run(FORWARD);
  M3.setSpeed(255);
  M3.run(BACKWARD);
  M4.setSpeed(255);
  M4.run(BACKWARD);
}
void right() {
  M1.setSpeed(255);
  M1.run(BACKWARD);
  M2.setSpeed(255);
  M2.run(BACKWARD);
  M3.setSpeed(255);
  M3.run(FORWARD);
  M4.setSpeed(255);
  M4.run(FORWARD);
}
void left() {
  M1.setSpeed(255);
  M1.run(FORWARD);
  M2.setSpeed(255);
  M2.run(FORWARD);
  M3.setSpeed(255);
  M3.run(BACKWARD);
```

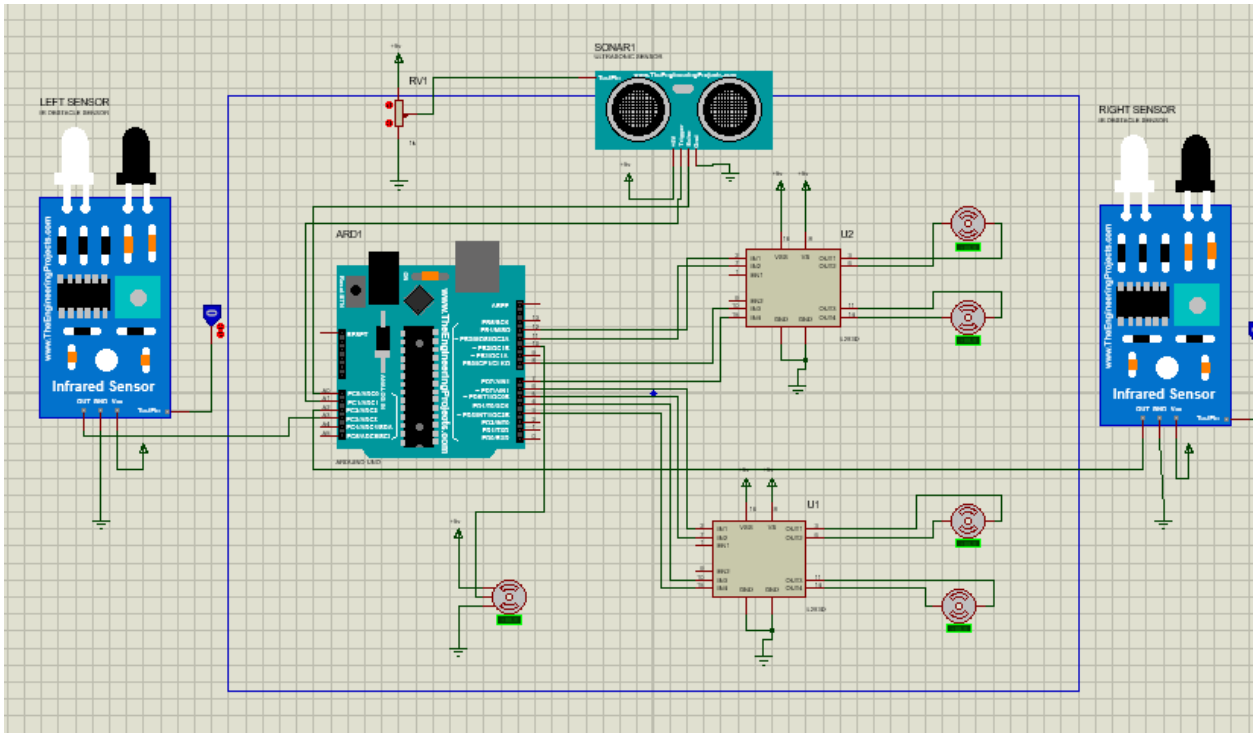
```
  M4.setSpeed(255);
  M4.run(BACKWARD);
}
void Stop() {
  M1.setSpeed(0);
  M1.run(RELEASE);
  M2.setSpeed(0);
  M2.run(RELEASE);
  M3.setSpeed(0);
  M3.run(RELEASE);
  M4.setSpeed(0);
  M4.run(RELEASE);
}
int rightsee() {
  servo.write(20);
  delay(800);
  Left = ultrasonic();
  return Left;
}
int leftsee() {
  servo.write(180);
  delay(800);
  Right = ultrasonic();
  return Right;
}
```

4.4. Simulation

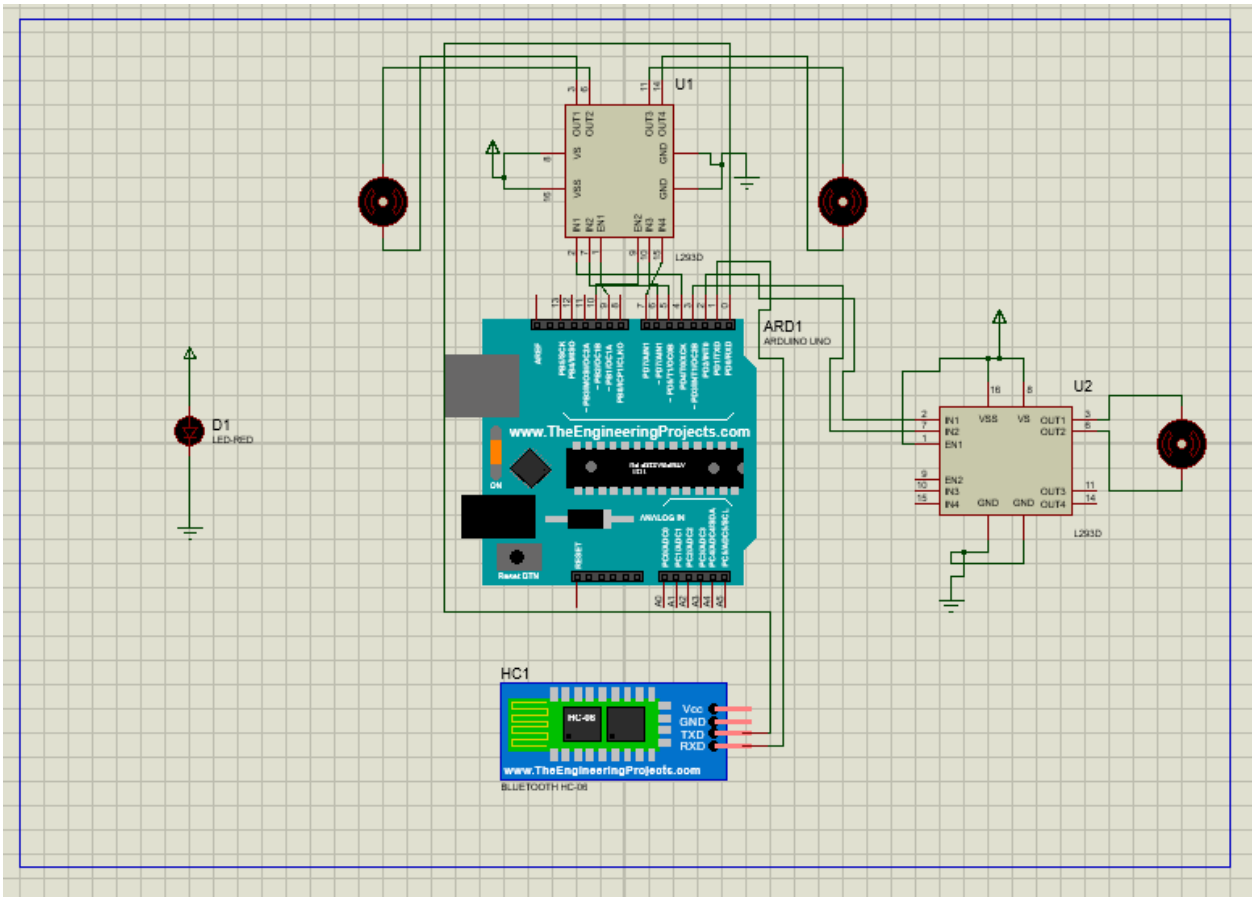
4.4.1. Obstacle Avoiding



4.4.2. Human Following



4.4.3. Bluetooth Control



Chapter 5: Conclusion

5.1. Conclusion

In conclusion, the obstacle avoiding, human following, and Bluetooth control robots using Arduino are three impressive examples of how modern technology can be used to create intelligent and interactive robots. These robots are capable of performing a variety of tasks, from navigating through complex environments to following a person or a remote-control command.

The obstacle avoiding robot is designed to avoid collisions with obstacles using sensors such as ultrasonic or IR sensors, it is ideal for use in situations where safety and collision avoidance are critical, such as in autonomous vehicles or in industrial automation.

The human following robot is capable of tracking and following a person or object using sensors such as a camera or an IR sensor, it is ideal for use in situations where tracking or surveillance is required, such as in security or monitoring application.

The Bluetooth control robot is designed to be controlled wirelessly using a Bluetooth – enabled device such as smartphone or tablet. It is ideal for use in situations where remote control or teleoperation is required, such as in entertainment or gaming applications.

Overall, these robots demonstrate the versality and adaptability of Arduino Technology, which can be used to create robots for a wide range of applications. As technology continues to advance, we can expect to see even more sophisticated and capable robots developed using Arduino and other similar platforms.

5.2. Limitations of the project

- **Limited Range of control:** With wired control systems, the robot can only be controlled within a certain distance from the control device, which limits its range of operation.

- **Inconvenient control:** Wired control systems can be inconvenient to use, as the user must be physically connected to the robot at all the times.

- **Limited Mobility:** Without human following capabilities, the robot may be limited in its ability to move around in the environment and interact with people.

- **Lack of Autonomy:** Without human following capabilities, the robot may require manual control, which can be time – consuming and limit its usefulness in certain application.

- **Limited Interaction:** Without human following capabilities, the robot may be limited in its ability to interact with people, which can limit its usefulness in applications such as personal assistants or entertainment.

5.3. Future Enhancements

- **Integration with other technologies:** Bluetooth control can be integrated with other technologies such as artificial intelligence and machine learning to enhance the functionality and versatility of robotic systems.
- **Enhanced Security:** Bluetooth technology is constantly evolving, with newer versions offering enhanced security features to protect against cyberattacks and hacking.
- **Increased automation:** With the integration of Bluetooth technology, robots can be programmed to perform tasks more autonomously, reducing the need for manual control.
- **Improved navigation:** Advanced human following robots can be equipped with more advanced navigation systems, allowing them to navigate through more complex environments and interact with people more naturally.
- **Enhanced sensory capabilities:** Future human following robots may be equipped with more advanced sensors, allowing them to detect more subtle human movements and gestures.
- **Integration with other technologies:** Human following robots can be integrated with other technologies such as voice recognition and natural language processing to enhance their ability to communicate with people.

5.4. References

[How to make a multi-function Arduino robot - SriTu Hobby]
https://www.youtube.com/watch?v=yAV5aZ0unag&t=192s
https://www.youtube.com/watch?v=aE_J7B-O4VQ&t=58s