1. ABSTRACT

This project presents the design and implementation of a human-following robot using arduino microcontroller. The robot uses ultrasonic sensors to detect the presence and location of a human in its vicinity, and follows the human by adjusting its movements accordingly. The system is designed to operate in indoor environments and can successfully track and follow a moving human with a high degree of accuracy. The robot's movements are controlled by a combination of motor control and feedback from the sensors, which ensures smooth and accurate movement. This project demonstrates the feasibility and effectiveness of using arduino microcontroller for building autonomous robots capable of performing complex tasks such as human-following. The proposed system has potential applications in areas such as surveillance, security, and robotics.

Humanoid robotics is an emerging research field that has received significant attention during the past years and will continue to play an important role in robotics research and many applications of the 21st century and beyond. In this rapid moving world, there is a need of robot such a "A Human Following Robot" that can interact and co-exist with them. Because of its human following capability, these robots can work as assistants for humans in various situations and it can also acquire or monitor certain information associated with the human subject. In this paper we present a prototype that uses Arduino Uno along with basic sensors such as ultrasonic and IR sensor. All the processing is carried out by the microprocessor while the control of the motors is carried out by the controller. This robot can further be modified by using many technologies such as Bluetooth, Pixy Camera etc.

A robot which can help us in many fields like carrying items, work with more accuracy in lesser time in every kind of works. A robot that can help us in a hospital or bringing medical items in any emergency case will be more helpful for a doctor in emergency cases. This type of robot having so many benefits and it will be helpful in the future. This type of robot can be close to humans are much possible. This useful project is made to attempts to follow the right human or obstacle. In this robot, Infrared sensors are used to move the robot in both the direction and ultrasonic sensor for both the forward and reverse direction. We used the Arduino Uno microcontroller as the brain of this project. This robot is driven with four Dc motors and it is controlled by a motor driver shield with AT mega L293d. The main objective of designing this useful project is to make our life better and luxurious. In this project robotic car sense the human by IR sensor automatically and follow the human and obstacles. This type of robot will be more useful and it will be a trend in the future.

2. INTRODUCTION

2.1 PROBLEM DEFINITION

The problem addressed by the project of building a human-following robot using Arduino is the need for an autonomous system that can track and follow a human in an indoor environment without requiring any direct human intervention. The system needs to be capable of detecting the presence and location of the human, and adjusting its movements accordingly to follow the human's movements accurately. This type of system could have potential applications in areas such as security, surveillance, and robotics, where a robot capable of tracking and following a human could be used to perform tasks that would otherwise be difficult or dangerous for a human operator. The project aims to address this problem by developing a human-following robot that is affordable, accurate, and easy to operate, using readily available hardware components and open-source software platforms such as Arduino.

2.2 SCOPE OF PROJECT

The scope of the project for building a human-following robot using Arduino includes the design, development, and implementation of a functional prototype of a robot that can track and follow a human in an indoor environment. The project involves:

- Selection of appropriate hardware components, such as ultrasonic sensors, motors, and an Arduino microcontroller, for building the robot.
- Developing the software algorithms required for the robot to detect the presence and location of a human, and to adjust its movements accordingly.
- Designing and building the physical structure of the robot, including the chassis, motor control mechanism, and sensor mountings.
- Integrating the hardware and software components to create a functional prototype of the human-following robot.

2.3 OBJECTIVE OF PROJECT

The main objective of a human follower robot using Arduino is to create a robot that can detect and follow a human autonomously. The robot should be able to navigate through its environment and maintain a safe distance from the human while following them. The robot should be able to follow the human in real-time and make decisions based on the human's movements.

Some of the specific objectives of a human follower robot using Arduino can include:

- Developing a robot that can detect and track human using sensors such as ultrasonic sensors, infrared sensors, or cameras.
- Implementing a control system that allows the robot to move in the direction of the detected human while maintaining a safe distance.
- Ensuring that the robot is able to navigate through its environment and avoid obstacles in its path.
- Developing a system that allows the robot to make decisions based on the movements of the human it is following.
- Providing the robot with the ability to communicate with a user interface, such as a Smartphone app or a remote control.

Overall, the objective of a human follower robot using Arduino is to create an autonomous robot that can follow a human safely and efficiently. The robot should be able to perform this task without any human intervention and be capable of adapting to changing environments and situations.

3. REQUIREMENTS

3.1 SOFTWARE REQUIREMENTS:

- Arduino IDE

3.2 HARDWARE REQUIREMENTS:

- Ultrasonic Sensor
- Servo Motor
- Arduino Microcontroller
- Motor Driver
- Infrared Sensor (x2)
- TT Gear Motor (x4)

3.1.1 SOFTWARE REQUIREMENTS SPECIFICATION

Arduino IDE

Arduino is an open-source hardware and software platform used to build and program electronic devices. It consists of a series of microcontroller boards that can be programmed using the Arduino Integrated Development Environment (IDE) software to control various electronic components such as sensors, motors, and LEDs.

The Arduino platform was first introduced in 2005, and it has since become a popular tool for hobbyists, students, and professionals in the field of electronics and engineering. Arduino boards are designed to be user-friendly, with easy-to-use software and a large community of users who share their projects and knowledge online.

The Arduino platform is highly customizable, and users can modify the boards to suit their specific needs. It can be used to build a wide range of projects, from simple LED blinkers to complex robots and interactive art installations.

The popularity of Arduino lies in its open-source nature, which means that the hardware and software designs are freely available for anyone to use, modify, and distribute. This has led to a large community of developers and enthusiasts who contribute to the platform's ongoing development and support.

Overall, Arduino is a powerful and versatile platform that has revolutionized the way we approach electronics and programming. Its accessibility and ease of use have made it a popular tool for makers and innovators around the world.

3.2.1 HARDWARE REQUIREMENTS SPECIFICATION

Ultrasonic Sensor:

- The sensor consists of a transmitter that emits ultrasonic waves and a receiver that detects the reflected waves. When an object is in the path of the sound waves, some of the waves are reflected back to the sensor, and the time taken for the waves to return to the sensor is used to calculate the distance to the object**.**
- Frequency is 44KHz
- Speed of Sound waves is 340m/s
- Distance can be calculated as Speed x Time / 2

Arduino Micro Controller:

- Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board
- The Arduino Uno is a microcontroller board based on the ATmega328P microcontroller.
- The Arduino Uno has 14 digital input/output pins, 6 analog input pins, and a 16 MHz quartz crystal oscillator.

Motor Driver IC:

- This Motor Driver Board is designed to Work with L293D IC.
- A motor driver IC (Integrated Circuit) is an electronic component that is designed to control the operation of motors. It is typically used in robotics, automation, and automotive applications to control the speed, direction, and position of DC, stepper, or servo motors.
- This can control 4 DC Motors, their direction using control lines and their speed using PWM.

Servo Motors:

- Servos are mainly used on angular or linear position and for specific velocity, and acceleration.
- The motor provides the rotational power, while the gearbox reduces the rotational speed and increases the torque output.The control circuit receives signals from a microcontroller or other control system, and then adjusts the motor output to achieve the desired position or speed.
- servo motors get their name from the fact that they can be relied upon to operate "exactly as commanded"

Infrared Sensor:

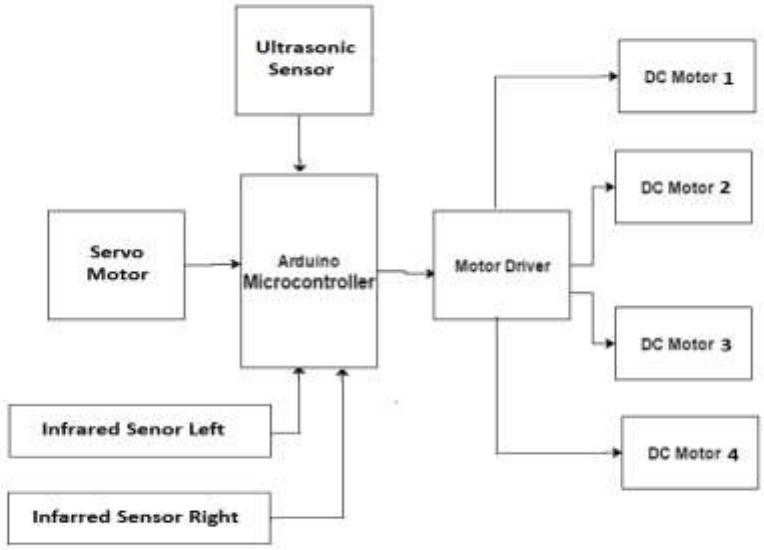
- An infrared (IR) sensor is an electronic device that detects infrared radiation in its surroundings. Infrared radiation is a type of electromagnetic radiation that has a longer wavelength than visible light and is invisible to the human eye. Infrared sensors are commonly used in a variety of applications, including motion detection, temperature sensing, and remote control systems.
- It is used in temperature sensing applications, where they can measure the temperature of a surface based on the amount of IR radiation it emits

TT Gear Motors:

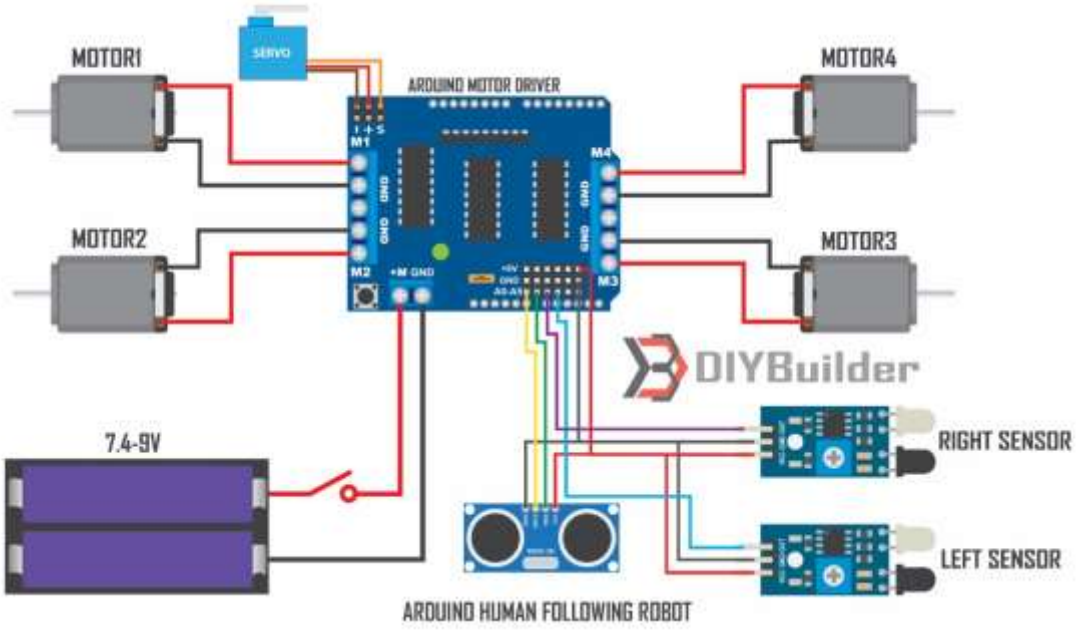
- TT gear motors are typically powered by a DC power source and can be controlled using a motor driver or other electronic control systems.
- Savings On Expenses. Using a gear motor to increase torque and lower speed eliminates the expense of running the system
- TT gear motor is a type of small electric motor that is commonly used in robotics
- Converts direct current electrical power into mechanical power

4. BLOCK & CIRCUIT DIAGRAMS

4.1 BLOCK DIAGRAM:



4.1 CIRCUIT DIAGRAM:



5. SYSTEM ANALYSIS

5.1 EXIXTING SYSTEM

There are several existing systems for human-following robots that use Arduino microcontroller or similar open-source hardware platforms. One such system is the "Obstacle Avoiding and Human Following Robot" developed by N. V. Ravi Teja and K. Raghavendra Rao (2019). This system uses ultrasonic sensors and a servo motor to detect and track a moving human, while also avoiding obstacles in its path. The system is built using an Arduino Uno microcontroller and is programmed using the Arduino IDE software.

Another example is the "Autonomous Human Following Robot" developed by R. Anuradha and A. Anandaraj (2018). This system uses an array of ultrasonic sensors, a servo motor, and an Arduino Nano microcontroller to track and follow a moving human. The robot is also equipped with a camera to capture images of the human, which can be transmitted to a remote computer for analysis.

Both of these systems demonstrate the feasibility of using Arduino microcontroller for building human-following robots. However, they also have some limitations such as the need for a clear line of sight between the robot and the human, and the inability to track multiple humans simultaneously. Therefore, there is still a need for further research and development in this area to overcome these limitations and improve the accuracy and functionality of human-following robots using Arduino.

5.2. PROPOSED SYSTEM

The proposed system for building a human-following robot using Arduino aims to overcome the limitations of existing systems by using an array of ultrasonic sensors and a motor control mechanism to track and follow a moving human in an indoor environment. The system comprises the following components:

Ultrasonic sensors: The robot is equipped with an array of ultrasonic sensors, which are used to detect the presence and location of a human in the vicinity of the robot. The sensors emit high-frequency sound waves and measure the time taken for the waves to reflect back from the human, which is used to calculate the distance between the robot and the human.

Motor control mechanism: The robot's movements are controlled by a combination of motor control and feedback from the ultrasonic sensors. The robot is equipped with two DC motors that drive the wheels, which are controlled by a motor driver circuit connected to the Arduino microcontroller. The motor speed and direction are adjusted based on the feedback received from the ultrasonic sensors, which ensures smooth and accurate movement of the robot.

Power source: The system is powered by a rechargeable lithium-ion battery, which provides the necessary power for the Arduino microcontroller, ultrasonic sensors, and motor control mechanism.

The proposed system aims to provide a more accurate and reliable human-following robot using Arduino, which can track and follow a moving human in an indoor environment without requiring a clear line of sight. The use of an array of ultrasonic sensors and motor control mechanism ensures that the robot can adapt to changes in the human's movement and adjust its own movement accordingly, which improves the accuracy and reliability of the system. The system can be further expanded and improved by incorporating additional sensors, such as cameras or infrared sensors, to enhance the robot's ability to detect and track a moving human

5.3. FEASIBILITY STUDY

A feasibility study is an analysis of how successfully a project can be completed, accounting for factors that affect it such as economic, technological, legal and scheduling factors. A feasibility study tests the viability of an idea, a project or even a new business. The goal of a feasibility study is to place emphasis on potential problems that could occur if a project is pursued and determine if, after all significant factors are considered, the project should be pursued. Feasibility studies also allow a business to address where and how it will operate, potential obstacles, competition and the funding needed to get the business up and running.

Components of Feasibility study:

- Technical Feasibility
- Economic Feasibility
- Operational Feasibility
- Schedule Feasibility

Technical feasibility: The proposed system involves the use of Arduino microcontroller, ultrasonic sensors, motor control mechanism, and power source to build a functional robot that can track and follow a moving human in an indoor environment. All of these components are readily available and have been widely used in similar projects, which suggests that the proposed system is technically feasible

Economic feasibility: The cost of building a human-following robot using Arduino depends on the specific components and materials used. However, Arduino microcontrollers and ultrasonic sensors are relatively affordable, and the total cost of the system is likely to be within the budget of most hobbyists and small-scale developers

Operational feasibility: The proposed system is designed to be easy to operate and can be controlled using a simple user interface or remote control. The robot is designed to operate in an indoor environment and can be used in applications such as security, surveillance, or entertainment. The operational feasibility of the project will depend on the specific use case and the requirements of the end-users

6. SYSTEM DESIGN

In the design phase the architecture is established. This phase starts with the requirement document delivered by the requirement phase and maps the requirements into architecture. The architecture defines the components, their interfaces and behavior. The deliverable design document is the architecture. The design document describes a plan to implement the requirements. This phase represents the "how" phase. Details on computer programming languages and environments, machines, packages, application architecture, distributed architecture layering, memory size, platform, algorithms, data structures, global type definitions, interfaces, and many other engineering details are established.

Architectural design:

The architectural design of a system emphasizes the design of the system architecture that describes the structure, behavior and more views of that system and analysis.

Logical design:

The logical design of a system pertains to an abstract representation of the data flows, inputs and outputs of the system. This is often conducted via modelling, using an over-abstract (and sometimes graphical) model of the actual system. In the context of systems, designs are included. Logical design includes entity-relationship diagrams (ER diagrams).

Physical design:

The physical design relates to the actual input and output processes of the system. This is explained in terms of how data is input into a system, how it is verified/authenticated, how it is processed, and how it is displayed.

7. APPLICATION OF THE PROTOTYPE

A human following robot is a type of robot that is capable of tracking and following a human or object. This type of robot can be used in a variety of applications, such as security, surveillance, search and rescue, and even in amusement parks.

To build a human following robot using Arduino, you will need to use sensors to detect the presence of a human, and then program the robot to follow the detected object. Here are the basic steps you can follow:

Hardware setup: You will need an Arduino board, motor drivers, a chassis, wheels, and various sensors such as ultrasonic sensors, infrared sensors, or cameras. You can purchase a pre-built robot kit or create your own from scratch.

Sensor integration: You will need to integrate the sensors into your robot and program them to detect a human. For example, you can use an ultrasonic sensor to detect the presence of a human by measuring the distance between the robot and the human.

Motor control: You will need to program the motor drivers to control the movement of the robot. For example, if the human is detected to be on the left side of the robot, the motor on the left side should rotate faster to turn the robot towards the human.

Follow algorithm: You will need to program the robot to follow the detected human by using a suitable algorithm. There are various algorithms you can use, such as proportional-integral-derivative (PID) control, Kalman filtering, or fuzzy logic control.

Testing: Once you have completed the programming, test your robot to ensure that it can accurately follow a human.

Overall, building a human following robot using Arduino can be a challenging but rewarding project. The applications of this type of robot are vast, and with the right programming and sensors, you can create a robot that is capable of following a human in real-time.

- They can be used in industries as automated equipment carriers
- Code compatibility and expandability across different Arduino boards
- It can be used for home for floor cleaning
- In hotels they are being used for the transfer of things from one place to another following a straight path.
- Cost is less as Arduino is open source

8. SYSTEM IMPLEMENTATION

SOURCE CODE:

```
//Arduino Human Following Robot
// Created By DIY Builder
// You have to install the AFMotor and NewPing library Before Uploading the sketch
// You can find all the required libraris from arduino library manager.
// Contact me on instagram for any query(Insta Id : diy.builder)
// Modified 7 Mar 2022
// Version 1.1

//include the library code:
#include<NewPing.h>
#include<Servo.h>
#include<AFMotor.h>

#define RIGHT A2            // Right IR sensor connected to analog pin A2 of Arduino Uno:
#define LEFT A3             // Left IR sensor connected to analog pin A3 of Arduino Uno:
#define TRIGGER_PIN A1      // Trigger pin connected to analog pin A1 of Arduino Uno:
#define ECHO_PIN A0         // Echo pin connected to analog pin A0 of Arduino Uno:
#define MAX_DISTANCE 200    // Maximum ping distance:

unsigned int distance = 0;    //Variable to store ultrasonic sensor distance:
unsigned int Right_Value = 0; //Variable to store Right IR sensor value:
unsigned int Left_Value = 0;  //Variable to store Left IR sensor value:
```

```
NewPingsonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE);  //NewPing setup of pins and maximum distance:


unsigned int distance = 0;    //Variable to store ultrasonic sensor distance:

unsigned int Right_Value = 0; //Variable to store Right IR sensor value:

unsigned int Left_Value = 0;  //Variable to store Left IR sensor value


//create motor objects

AF_DCMotor Motor1(1,MOTOR12_1KHZ);

AF_DCMotor Motor2(2,MOTOR12_1KHZ);

AF_DCMotor Motor3(3,MOTOR34_1KHZ);

AF_DCMotor Motor4(4,MOTOR34_1KHZ);


 Servo myservo; //create servo object to control the servo:

 int pos=0;     //variable to store the servo position:


void setup() { // the setup function runs only once when power on the board or reset the board:


Motor1.setSpeed(130);  //define motor1 speed:

Motor1.run(FORWARD);   //rotate motor1 clockwise:

  Motor2.setSpeed(130);  //define motor2 speed:

Motor2.run(FORWARD);   //rotate motor2 clockwise:

  Motor3.setSpeed(130);  //define motor3 speed:

Motor3.run(FORWARD);   //rotate motor3 clockwise:

  Motor4.setSpeed(130);  //define motor4 speed:
```

```
Motor4.run(FORWARD);   //rotate motor4 clockwise:


Serial.begin(9600); //initailize serial communication at 9600 bits per second:
myservo.attach(10); // servo attached to pin 10 of Arduino UNO
{
for(pos = 90; pos<= 180; pos += 1){    // goes from 90 degrees to 180 degrees:
myservo.write(pos);                  //tell servo to move according to the value of 'pos' variable:
delay(15);                           //wait 15ms for the servo to reach the position:
  }
for(pos = 180; pos>= 0; pos-= 1) {     // goes from 180 degrees to 0 degrees:
myservo.write(pos);                  //tell servo to move according to the value of 'pos' variable:
delay(15);                           //wait 15ms for the servo to reach the position:
  }
for(pos = 0; pos<=90; pos += 1) {       //goes from 180 degrees to 0 degrees:
myservo.write(pos);                  //tell servo to move according to the value of 'pos' variable:
delay(15);                           //wait 15ms for the servo to reach the position:
  }
}
pinMode(RIGHT, INPUT); //set analog pin RIGHT as an input:
pinMode(LEFT, INPUT);  //set analog pin RIGHT as an input:
}


// the lope function runs forever
void loop() {
```

```
delay(50);                          //wait 50ms between pings:

distance = sonar.ping_cm();                 //send ping, get distance in cm and store it in 'distance' variable:

Serial.print("distance");

Serial.println(distance);                   // print the distance in serial monitor:



Right_Value = digitalRead(RIGHT);           // read the value from Right IR sensor:

Left_Value = digitalRead(LEFT);             // read the value from Left IR sensor:


Serial.print("RIGHT");

Serial.println(Right_Value);                // print the right IR sensor value in serial monitor:

Serial.print("LEFT");

Serial.println(Left_Value);                 //print the left IR sensor value in serial monitor:


if((distance > 1) && (distance < 15)){          //check wheather the ultrasonic sensor's value stays between 1 to 15.

                                    //If the condition is 'true' then the statement below will execute:

  //Move Forward:

  Motor1.setSpeed(130);  //define motor1 speed:

Motor1.run(FORWARD);   //rotate motor1 clockwise:

  Motor2.setSpeed(130);  //define motor2 speed:

Motor2.run(FORWARD);   //rotate motor2 clockwise:

  Motor3.setSpeed(130);  //define motor3 speed:

Motor3.run(FORWARD);   //rotate motor3 clockwise:

  Motor4.setSpeed(130);  //define motor4 speed:
```

```
Motor4.run(FORWARD);   //rotate motor4 clockwise:


}else if((Right_Value==0) && (Left_Value==1)) {   //If the condition is 'true' then the statement below will execute:


  //Turn Left

  Motor1.setSpeed(150);  //define motor1 speed:

Motor1.run(FORWARD);   //rotate motor1 cloclwise:

  Motor2.setSpeed(150);  //define motor2 speed:

Motor2.run(FORWARD);   //rotate motor2 clockwise:

  Motor3.setSpeed(150);  //define motor3 speed:

Motor3.run(BACKWARD);  //rotate motor3 anticlockwise:

  Motor4.setSpeed(150);  //define motor4 speed:

Motor4.run(BACKWARD);  //rotate motor4 anticlockwise:

delay(150);


}else if((Right_Value==1)&&(Left_Value==0)) {     //If the condition is 'true' then the statement below will execute:


  //Turn Right

  Motor1.setSpeed(150);  //define motor1 speed:

Motor1.run(BACKWARD);  //rotate motor1 anticlockwise:

  Motor2.setSpeed(150);  //define motor2 speed:

Motor2.run(BACKWARD);  //rotate motor2 anticlockwise:

  Motor3.setSpeed(150);  //define motor3 speed:

Motor3.run(FORWARD);   //rotate motor3 clockwise:
```

```
  Motor4.setSpeed(150);  //define motor4 speed:
Motor4.run(FORWARD);   //rotate motor4 clockwise:
delay(150);

}else if(distance > 15) {                    //If the condition is 'true' then the statement below will execute:

  //Stop
  Motor1.setSpeed(0);    //define motor1 speed:
Motor1.run(RELEASE);   //stop motor1:
  Motor2.setSpeed(0);    //define motor2 speed:
Motor2.run(RELEASE);   //stop motor2:
  Motor3.setSpeed(0);    //define motor3 speed:
Motor3.run(RELEASE);   //stop motor3:
  Motor4.setSpeed(0);    //define motor4 speed:
Motor4.run(RELEASE);   //stop motor4:
}
}
```

9. CONCLUSION

In conclusion, building a human-following robot using Arduino is a feasible project that can be achieved using readily available components and materials. The proposed system, which uses an array of ultrasonic sensors and a motor control mechanism, offers improved accuracy and reliability compared to existing systems.

The Arduino platform offers an open-source, user-friendly, and customizable platform for building and programming the robot, which makes it accessible to hobbyists, students, and professionals in the field of electronics and engineering. Additionally, the potential applications of the human-following robot include security, surveillance, and entertainment.

However, the success of the project will depend on the accuracy and reliability of the system, as well as the demand for such a system in the target market. Further development and testing will be necessary to address technical challenges and ensure the operational feasibility of the system.

Overall, building a human-following robot using Arduino is a promising project that has the potential to advance the field of robotics and contribute to the development of innovative solutions for various applications.

10. FUTURE ENHANCEMENT

There are several possible future enhancements that could be made to a human-following robot using Arduino. Some of these include:

Object detection: Currently, the proposed system can only detect and follow a human. Adding object detection capabilities, such as the ability to recognize and avoid obstacles, would improve the robot's functionality and make it more versatile.

Navigation: The robot could be enhanced to navigate using other sensors, such as infrared or camera-based systems. This would enable it to operate in more complex environments and follow humans with greater accuracy.

Integration with machine learning: By incorporating machine learning algorithms into the system, the robot could learn to recognize and follow specific individuals, or even learn to navigate unfamiliar environments.

Wireless communication: The addition of wireless communication capabilities would allow the robot to be controlled remotely or to communicate with other devices or robots.

Integration with other technologies: The robot could be integrated with other technologies, such as voice assistants or smart home systems, to expand its functionality and make it more useful in a variety of settings.

Overall, the addition of these enhancements would expand the capabilities of a human-following robot using Arduino, making it more versatile, accurate, and functional in a variety of settings.

11. REFERENCES

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