OBSTACLE DETECTION AND COLLISION AVOIDANCE ROBOT

A MINI PROJECT REPORT

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ABSTRACT

Significant improvements in robotics have been made recently, especially in the areas of obstacle recognition and collision avoidance. The design of an autonomous robot that can recognise barriers in its environment and successfully avoid collisions is discussed in this study. The suggested system has reliable collision avoidance and obstacle detection capabilities thanks to the use of an ultrasonic sensor and an Arduino microcontroller. The robot's main sensing device, the ultrasonic sensor, emits ultrasonic waves and measures how long it takes for the waves to return after striking an object. The robot's location in relation to the obstacle is determined using this information. Based on the measured distances, the Arduino microcontroller analyses the sensor data and takes the necessary steps. The robot uses a collection of established algorithms and control techniques to achieve collision avoidance. The robot analyses the information it receives from the ultrasonic sensor when it detects an obstruction within a predetermined range and decides the safest path to take to get past it. The robot's motors are then instructed by the Arduino microcontroller to steer clear of the obstruction, preventing collisions. Several controlled experiments were used to gauge the effectiveness of the suggested system. The robot successfully avoided collisions and spotted obstructions, proving its dependability and effectiveness. The system is an economical and practical option for obstacle identification and collision avoidance in robotics applications thanks to its low-cost implementation utilizing Arduino and the easily accessible ultrasonic sensor. The findings of this study aid in the creation of intelligent robots that can independently navigate challenging terrain. To enhance overall performance, the proposed strategy lays a basis for future improvements and integration with other sensing technologies. Obstacle detection and collision avoidance are essential for safe and effective operations in a variety of sectors, including autonomous vehicles, healthcare robotics, and industrial automation.

CHAPTER NO: 1

INTRODUCTION

INTRODUCTION

For autonomous robotic systems operating in complex and dynamic environments, obstacle identification and collision avoidance are essential skills. Robotic devices are safe and effective in a variety of applications, from industrial automation to healthcare robotics and autonomous transportation, thanks to their capacity to detect and react to obstacles in real-time. This work offers a novel method for creating an obstacle detection and collision avoidance robot using an ultrasonic sensor and an Arduino platform in order to meet this pressing demand.

The Arduino platform, which has seen significant developments in microcontroller technology, has created new opportunities for developing affordable and widely available robotic systems. Arduino microcontrollers are a great option for prototyping and implementing intelligent robot functionalities because they provide a user-friendly programming environment and a variety of suitable sensors and actuators.

The widely accessible and reasonably priced ultrasonic sensor is essential to the suggested technology. The sensor gives precise distance measurements to identify obstacles in the robot's environment by generating ultrasonic waves and observing the amount of time it takes for the waves to return after colliding with an object. The robot can create a thorough picture of its surroundings thanks to these distance measures, enabling well-informed decision-making and effective navigation.

The major goal of this project is to create a robot that is capable of autonomous obstacle detection and real-time collision avoidance. The suggested system offers a practical and economical solution for obstacle identification and collision avoidance in robotics by fusing the capabilities of an Arduino microcontroller and an ultrasonic sensor. The robot can analyse sensor data, design safe paths, and carry out precise movements to avoid obstacles thanks to the system's architecture, which combines cognitive algorithms and control mechanisms.

The results of this study have broad ramifications for the robotics industry. The implementation of intelligent robots in numerous industries is made possible by the creation of a reliable and reasonably priced obstacle detection and collision avoidance system. Healthcare robotics can improve patient care and assistance, while industrial automation operations can gain from increased safety and efficiency. Additionally, autonomous transportation systems can increase reliability and lower the chance of mishaps.

In conclusion, this study proposes a novel strategy for creating an ultrasonic sensor-based obstacle detection and collision avoidance robot utilising Arduino. The suggested approach provides a practical and economical means of establishing accurate collision avoidance and obstacle detection capabilities. The implementation of the system's technical components, such as sensor integration, algorithm design, and experimental evaluation, will be covered in more detail in the sections that follow. These sections will also emphasise how this research may have the potential to revolutionise the area of robotics.

CHAPTER NO: 2

LITERATURE REVIEW

LITERATURE REVIEW

Critical areas of robotics that have received a lot of attention in research and development are obstacle detection and collision avoidance. An overview of pertinent research and technological developments in the area of obstacle detection and collision avoidance utilising Arduino and ultrasonic sensors is provided in the literature review.

Numerous academics have looked into using ultrasonic sensors in robotic systems to detect obstacles. In their research, Ata et al. (2016) used Arduino and ultrasonic sensors to create an autonomous navigation system for a mobile robot. Using a mix of ultrasonic sensors and clever algorithms, the system effectively identified impediments and avoided them.

Additionally, Naeem et al. (2018) proposed a similar method for developing a drone collision avoidance system by integrating Arduino and ultrasonic sensors. The system's capacity to identify obstacles on the way and adjust the drone's course ensures safe and obstacle-free navigation.

Numerous sensors working together has been the subject of certain experiments to enhance obstacle detection. Tang et al. (2019) developed an obstacle detecting system using an Arduino, ultrasonic sensors, and infrared sensors. The improved accuracy of obstacle recognition made possible by the fusion of the data from these sensors allows the robot to avoid collisions with objects more successfully.

The potential for obstacle detection and collision avoidance has increased recently with the development of alternative sensing technologies like LiDAR and computer vision. These innovations provide more accurate and thorough environmental data. A collision avoidance system for an autonomous car was created by Chen et al. (2021) using an Arduino microcontroller, ultrasonic sensors, and a LiDAR sensor. LiDAR and ultrasonic sensors worked together to create a comprehensive perception system for precise obstacle identification and avoidance.

The literature research as a whole emphasises how Arduino and ultrasonic sensors are frequently used to create obstacle detection and collision avoidance systems. These studies show how ultrasonic sensors and Arduino microcontrollers can be used to create dependable and affordable robotic solutions. These systems' performance is further improved by the incorporation of intelligent algorithms, the fusion of sensor data, and the investigation of machine learning methods.

It is crucial to remember that the subject of obstacle identification and collision avoidance is dynamic, with continuous research and developments in other sensor technologies as well, even though the studies presented here predominantly use Arduino and ultrasonic sensors. In order to increase the precision and dependability of obstacle identification and collision avoidance in robotics, researchers continue to investigate fresh technologies. These include computer vision, LiDAR, and radar. These developments create fresh opportunities for ongoing research and development in this field.

CHAPTER NO: 3

SYSTEM ARCHITECTURE

SYSTEM ARCHITECTURE

3.1 BLOCK DIAGRAM

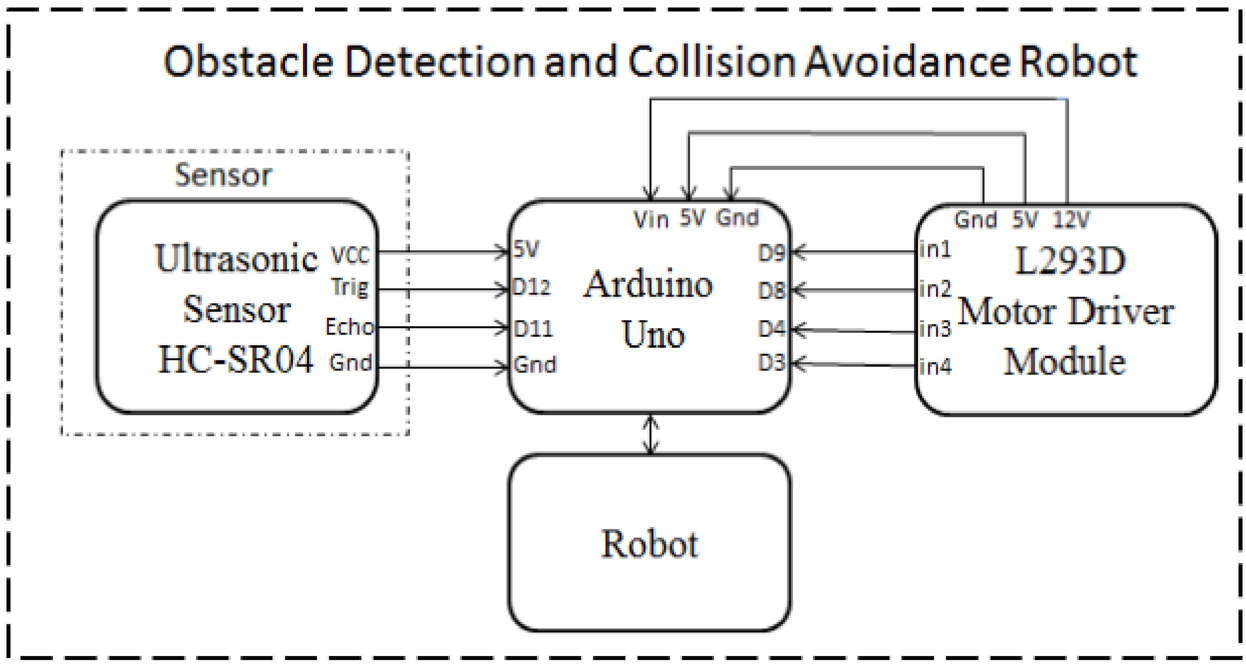


Fig. 3.1.1 Block diagram

The sonar system is used in HC-SR04 ultrasonic sensor to determine distance to an object like bats do. It offers excellent non-contact range detection from about 2 cm to 400 cm or 1feet to 13 feet. Its operation is not affected by sunlight or black material. The ultrasonic sensor emits the short and high frequency signal. If they detect any object, then they reflect back echo signal which is taken as input to the sensor through Echo pin .Firstly user initialize Trigger and Echo pin as low and push the robot in forward direction. When obstacle is detected Echo pin will give input as high to microcontroller. Pulse In function is used for calculating the time of distance from the obstacle. Every time the function waits for pin to go high and starts timing, then timing will be stopped when pin go to low. It returns the pulse length in microseconds or when complete pulse was not received within the timeout it returns. The timing has been determined means it gives length of the pulse and will show errors in shorter pulses.

Pulses from 10microseconds to 3 minutes in length are taken into consideration.

After determining the time, it converts into a distance. If the distance of object is moderate then speed of robot get reduced and will take left turn, If obstacle is present in left side then it will take right turn.

If the distance of object is short then speed of robot get reduced and will turn in backward direction and then can go in left or right direction. This robot was built with an Arduino development board on which microcontroller is placed.

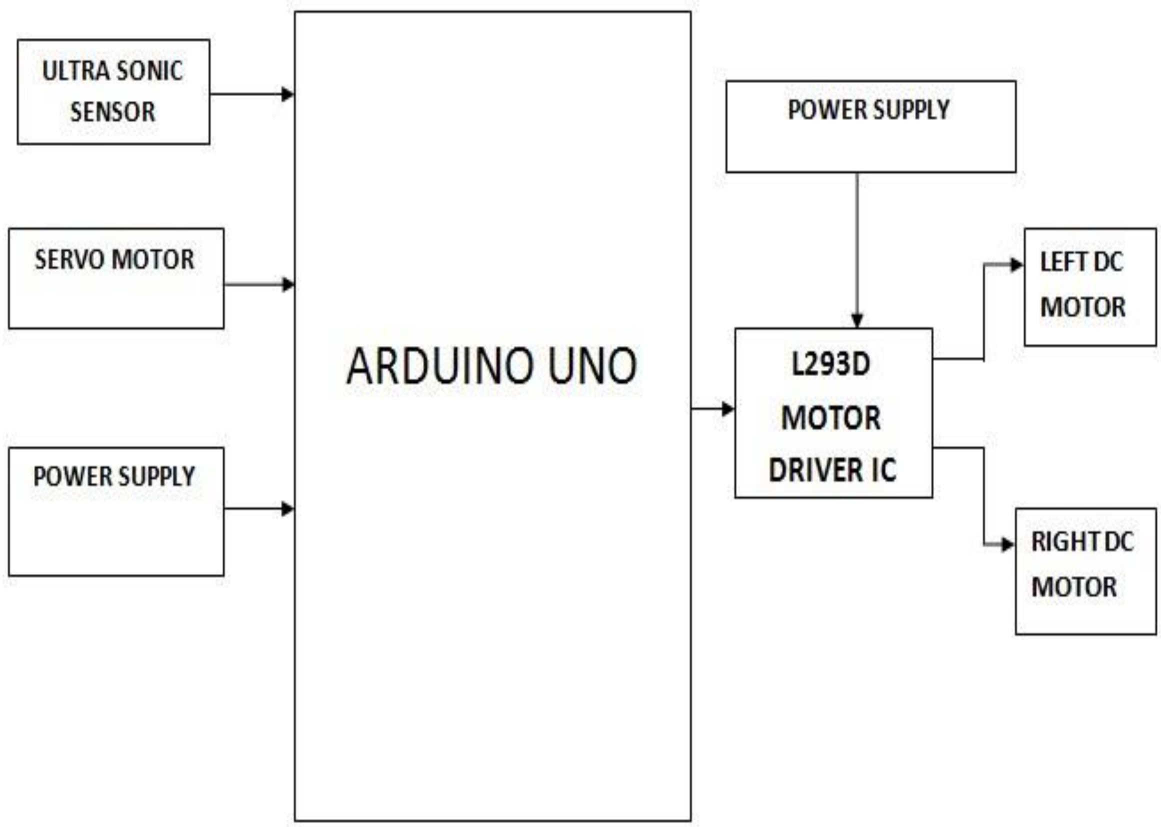


Fig. 3.1.2 Block diagram

Arduino board is connected with DC Motor through Motor driver board (pin10, pin11, pin12, pin13) which provides power to the actuators. Actuators are used to move robot in Forward, Backward, Left and Right directions. The brief description of inputs pins for movement of robot is given in below in table. The movement of robot will be stop whenever there is an obstacle is present on its path which can be detected by ultrasonic sensors. Ultrasonic sensors give time in length to the microcontroller as an input for further actions.

TABLE I. INPUT PINS FOR MOVEMENT

Movement	**Pin10**	**Pin11**	**Pin 12**	**Pin 13**
Forward	1	0	0	1
Backward	0	1	1	0
Left	1	0	1	0
Right	0	1	0	1

3.2 DESIGN & HARDWARE

A design and hardware configuration for creating an obstacle detection and collision avoidance robot are as follows:

1. Hardware Components
2. Hardware Connections
3. Software Implementation
4. Robot Operation

3.2.1 Hardware Components:

a) Arduino Uno: The Arduino Uno serves as the brain of the robot, controlling its movements and processing sensor data.

b)Ultrasonic Sensor: Use an ultrasonic sensor to detect obstacles and measure distances.

c)Motor Driver (L293N): The motor driver controls the two motors of the robot and provides the necessary power and control signals.

d)Two DC Motors: These motors are responsible for the robot's movement and steering.

e)Power Supply: Provide a suitable power source, such as a battery pack or power bank, to power the Arduino, motors, and motor driver.

f)Jumper Wires: Use jumper wires to establish connections between the components.

3.2.2 Hardware Connections:

- Connect the ultrasonic sensor to the Arduino Uno using jumper wires. Connect the sensor's VCC pin to the 5V pin on the Arduino, GND to GND, Trig to a digital pin (e.g., D7), and Echo to another digital pin (e.g., D6).
- Connect the motor driver (L293N) to the Arduino. Connect the motor driver's VCC1 pin to the 5V pin on the Arduino, GND to GND, and IN1, IN2, IN3, and IN4 pins to digital pins on the Arduino (e.g., D2, D3, D4, and D5).
- Connect the two DC motors to the motor driver. Connect the motor driver's OUT1 and OUT2 pins to one motor and OUT3 and OUT4 pins to the other motor. Ensure the motors are connected correctly, with their polarity matching.
- Connect the power supply to the Arduino Uno and the motor driver, ensuring appropriate voltage and current ratings.

3.2.3 Software Implementation:

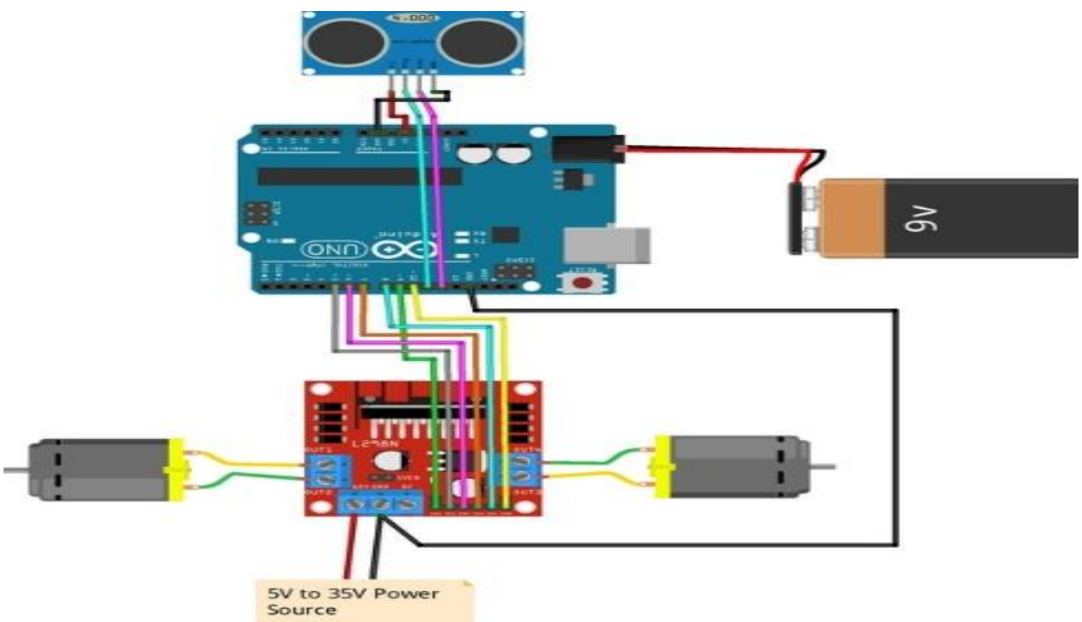
- Install the Arduino IDE on your computer and open it.
- Write the necessary code to control the motors, read data from the ultrasonic sensor, and implement the obstacle detection and collision avoidance algorithms.
- Use the Arduino IDE to upload the code to the Arduino Uno.
- Test the robot by powering it on and observing its behavior. Ensure the motors respond correctly to the code and the ultrasonic sensor detects obstacles accurately.

3.2.4 Robot Operation:

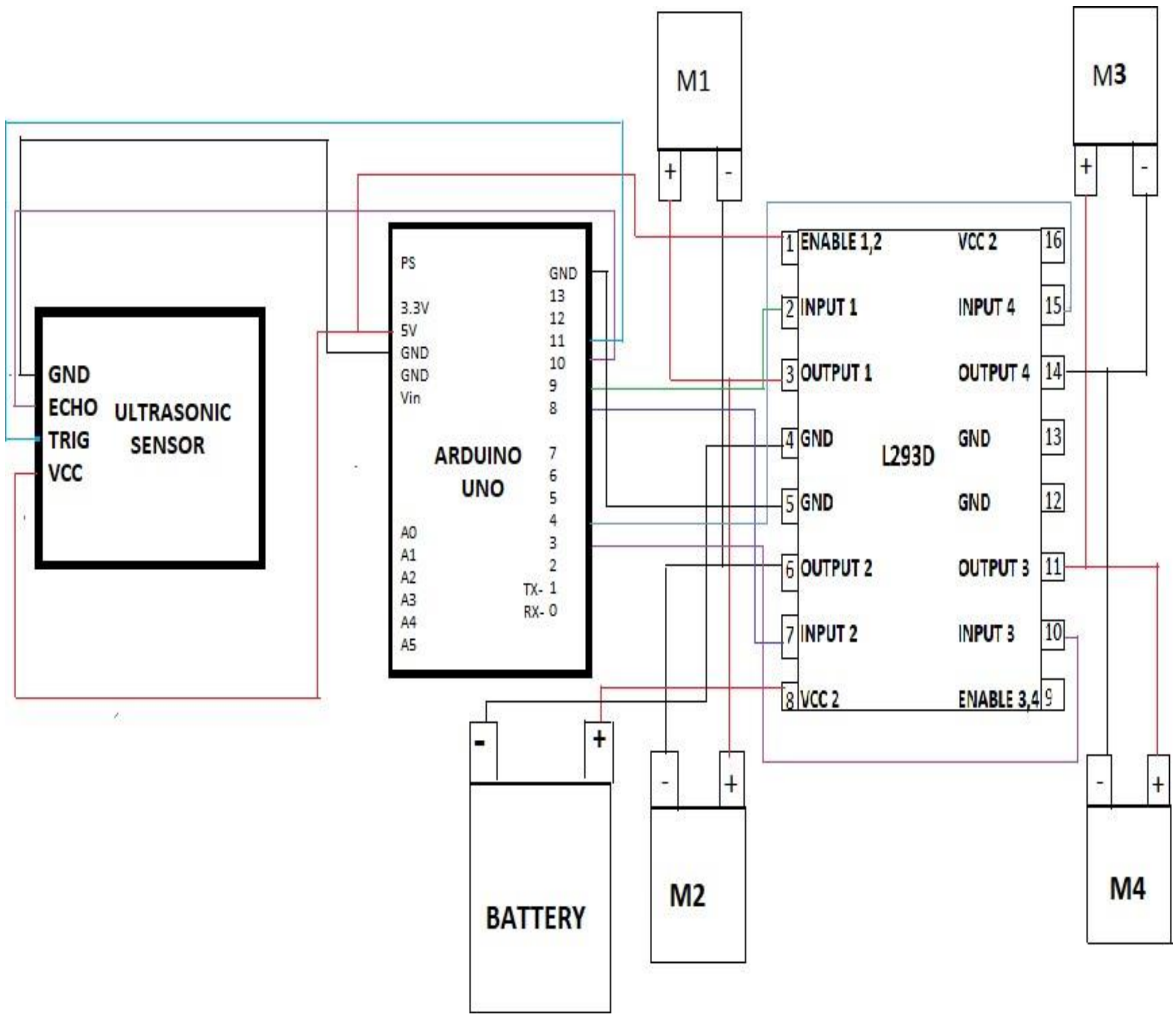
- Once the robot is powered on, it will start scanning the environment using the ultrasonic sensor.
- The Arduino will read the distance measurements from the ultrasonic sensor.
- Based on the detected distances, the Arduino will calculate the safest path to avoid obstacles.
- The Arduino will send appropriate control signals to the motor driver, which will drive the motors accordingly to navigate the robot around the obstacles.
- The robot will continue to scan the environment, detect obstacles, and adjust its trajectory to avoid collisions in real-time.

3.3 CIRCUIT DIAGRAM

3.3.1 FOUR MOTOR DRIVE



3.3.2 TWO MOTOR DRIVE



3.4 COMPONENT DESCRIPTION AND FUNCTION

3.4.1 ARDUINO UNO:

A microcontroller board called Arduino/Genuino Uno is based on the ATmega328P. It has a 16 MHz quartz crystal, 6 analogue inputs, 14 digital input/output pins (of which 6 can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; to get started, just use a USB cable to connect it to a computer, or an AC-to-DC adapter or battery to power it. With your UNO, you can experiment without worrying too much about making a mistake; in the worst case, you can replace the chip for a few dollars and start over.

Fig. 3.4.1.1 Arduino UNO

The Italian word "uno" (which translates to "one") was chosen to signify the 1.0 release of the Arduino Software (IDE). The Uno board with the Arduino Software (IDE) version served as the foundation for later generations of Arduino. The Uno board is the first in a line of USB Arduino boards and serves as the platform's benchmark. For a comprehensive list of all previous, current, and out-of-date models, see the Arduino index of boards.

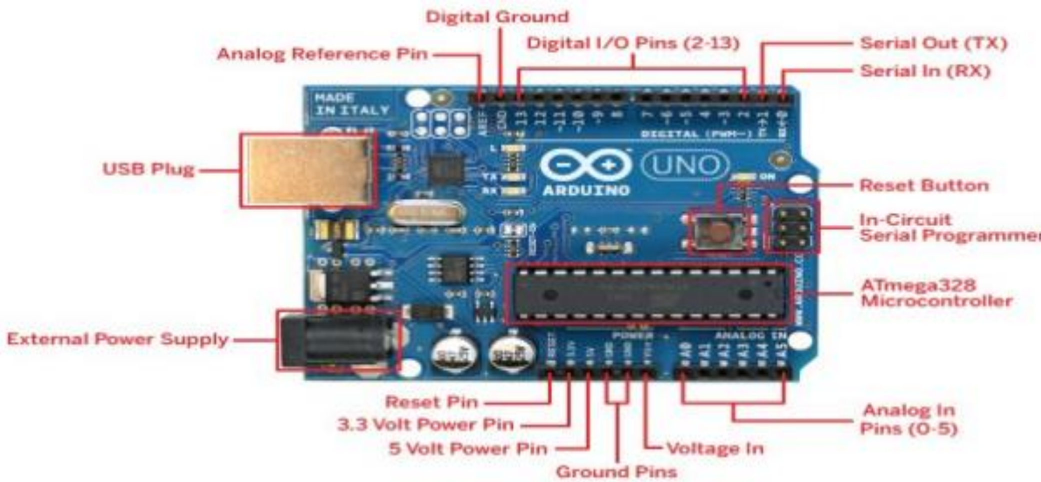


Fig. 3.4.1.2 Description image of pin specifications in Arduino UNO

3.4.2 Motor Drivers (L293D IC):

Motor drivers serve as current amplifiers by taking a low current control signal and producing a greater current signal. The motors are driven by the greater current signal. A motor driver called L293D enables direct current (DC) motors to run in either direction. Two H-bridge driving circuits are incorporated into it. Voltage must be switched to rotate the motor in either a clockwise or anticlockwise direction. A circuit known as an H-bridge enables voltage to flow in either direction. H-bridge IC are hence perfect for driving a DC motor.

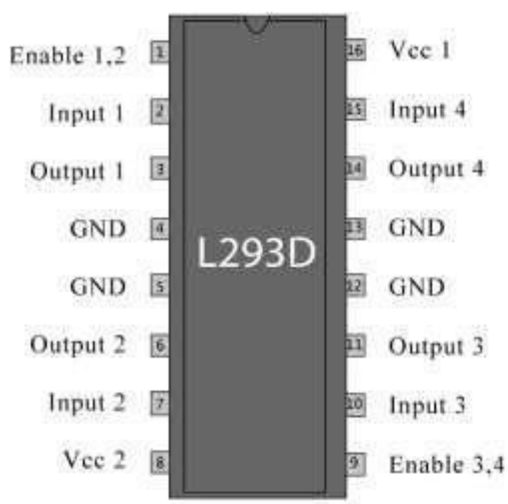


Fig. 3.4.2.1 Pin diagram of motor drive (L293D)

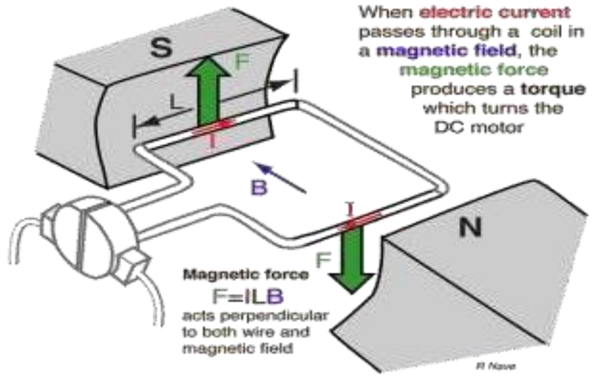
The pins 2, 7, 15, and 10 are the four input pins for the L293D, as seen on the pin diagram. Right input for the motor on the right side and left input for the motor connected across the left will control rotation, respectively. The inputs sent across the input pins as LOGIC 0 or LOGIC 1 are used to rotate the motors. Logic 1 and Logic 0 must be connected to the input pins in order for the motor to rotate in a clockwise orientation. For the two motors to begin spinning, the enable pins 1 and 9 need to be high. The linked driver is enabled when an enable input is set to high. The outputs thus become active and operate in synchrony with their inputs. Like that driver, whose outputs are off and in the high-impedance condition when the enable input is low.

3.4.3 Motor (60rpm/ 12V DC Motor)

Fig. 3.4.3.1 Servo motor image (60/12v DC)

The robot that detects obstacles and avoids them makes use of two 200 rpm, 12V DC geared motors. The used motor has internal holes and a 6mm shaft diameter. The inside holes make it simple to mount the wheels with screws. It is a simple, affordable motor that can be used in robotics applications.

An Electrical Using a DC motor, you can turn electrical energy into mechanical energy. The foundation of a DC motor's operation is the idea that a current-carrying conductor experiences a mechanical force when it is exposed to a magnetic field.Fleming's Left-Hand Rule provides the direction of mechanical force, and F = BIL Newton provides the magnitude of that force. Because alternating current is provided by all electric supply companies, DC motors are rarely employed in typical applications.



3.4.3.2 Working of servo motor

3.4.4 ULTRASONIC SENSOR

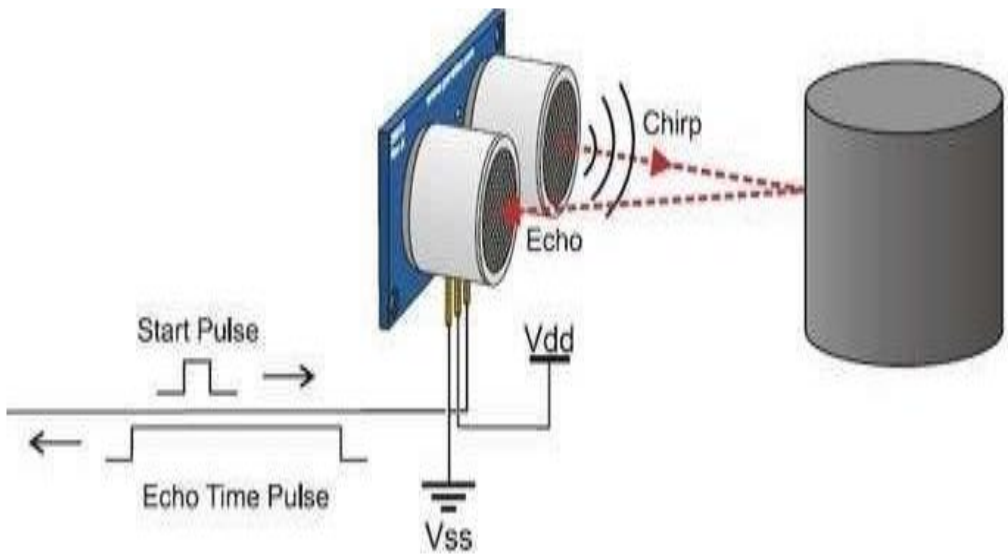
Fig. 3.4.4.1 Image of ultrasonic sensor

An ultrasonic sensor is a tool that uses sound waves to gauge a distance to an item. By emitting a sound wave at a particular frequency and listening for the return of that sound wave, it calculates distance. The distance between the sonar sensor and the item can be determined by keeping track of how long passes between the sound wave's generation and its return.

When an object or obstruction gets in its way, the ultrasonic it generates at a frequency of 40 000 Hz will bounce back to the module. You can determine the distance by taking into account the sound's speed and travel time.

There are four pins on the HC-SR04 ultrasonic module: Ground, VCC, Trig, and Echo. The module's Ground and VCC pins must be linked to the Ground and 5 volts pins on the Arduino Board, respectively, and the trig and echo pins must be attached to any of the board's Digital I/O pins.

You must set the Trig on a High State for 10 s in order to generate the ultrasonography. In response, the Echo pin will receive an 8 cycle sonic burst that was sent out at the speed of sound. The echo pin will output the sound wave's travel time in microseconds.



3.4.4.2 working of ultrasonic sensor

Features of Ultrasonic Sensor:

- Compact and light weight
- High sensitivity and high pressure
- High reliability
- Power consumption of 20mA
- Pulse in/out communication
- Narrow acceptance angle
- Provides exact, non-contact separation estimations within 2cm to 3m
- The explosion point LED shows estimations in advancement
- 3-pin header makes it simple to connect utilizing a servo development link .

CHAPTER NO: 4

WORKING PRINCIPLE

WORKING PRINCIPLE

4.1 FLOW CHART

Figure 1 shows the Flow Chart of the working of the obstacle avoidance robot. Initially it checks obstacle within 30cm.If there is an obstacle it stops moving and turns towards left and checks if there is an object closer than 30 cm . The check has two possible outcomes, yes or no. Yes, meaning that there is indeed some object closer than 30 cm. No, meaning that there is no objects detected within 30cm. If there is nothing within 30 cm the robot can simply move forward as the path is clear. If there is something closer than 30 cm the robot must perform obstacle avoidance .

The first stage of obstacle avoidance is to stop the robot! If you don't stop the robot immediately it will crash! After the robot has stopped it needs to see what way it should go. It does this by looking both directions, much like you should when you cross the road. First the robot turns left, takes a reading, turns right, and takes a reading.

Another check occurs to see what direction is the best way to go. If left is the way to go it has to turn back to the left and then go forward. If right is the way to go the robot simply moves forward as it is already facing in the right direction.

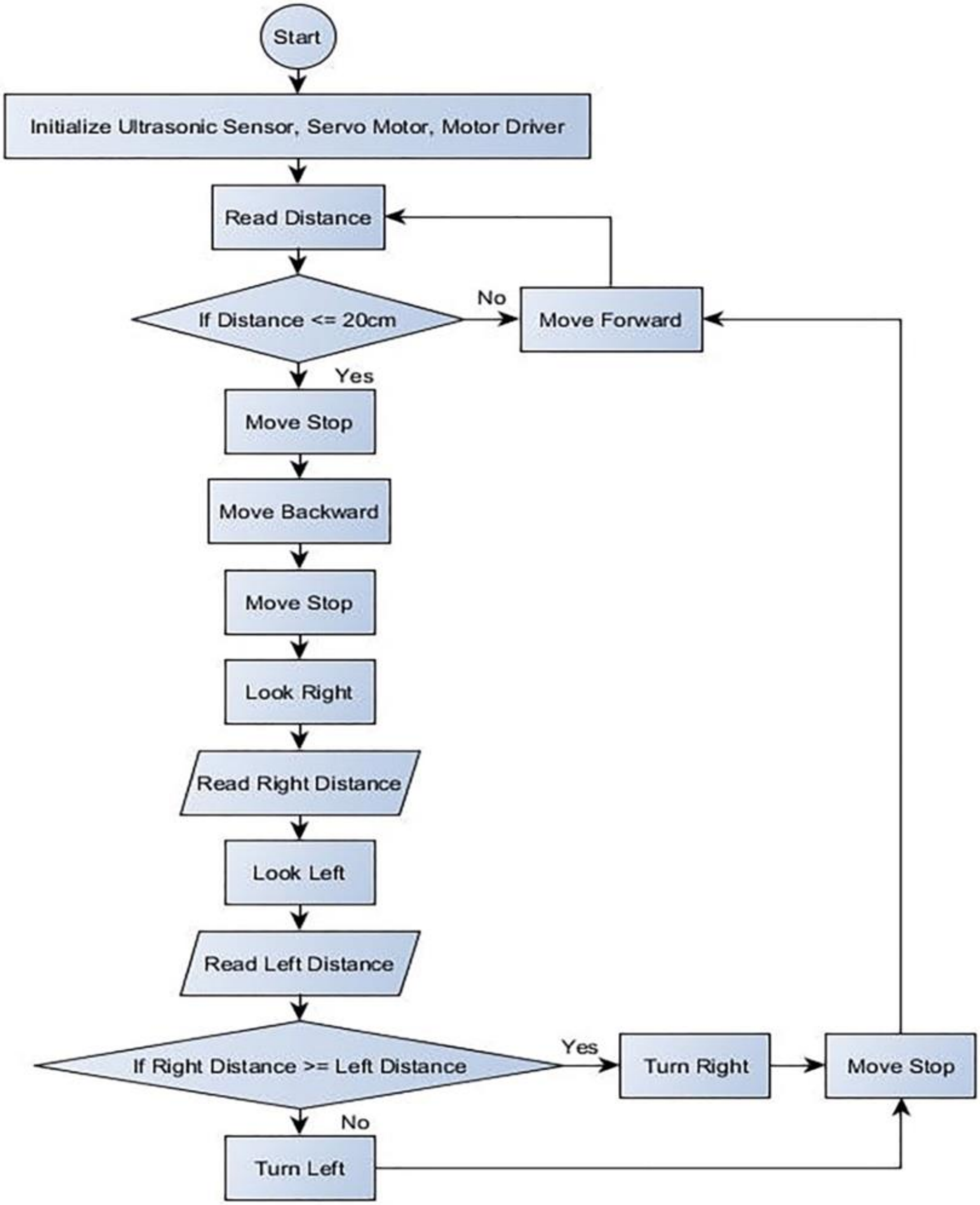


Fig. 4.1.1 Flow chart of obstacle avoidance robot

4.2 WORKING PRINCIPLE

Ultrasonic sensors are used by the robotic vehicle to avoid obstacles in its path. The requested operation is accomplished using an Arduino. Through a motor driver IC, Arduino is connected to the motors. The robot's front is where the ultrasonic sensor is mounted.

The ultrasonic sensor constantly transmits ultrasonic waves from its sensor head while the robot travels along the targeted path. The ultrasonic waves are reflected back by obstacles whenever they are in its path, and the arduino receives the information each time. Based on ultrasonic signals, the Arduino manages the motors to the left, right, back, and front. Pulse width modulation (PWM) is used to regulate each motor's speed.

When an object is detected by an ultrasonic sensor that is kept in the path, the sensor sends a signal to the Arduino Uno, which then instructs it to rotate the motors M3 and M4 in the forward direction and M1 and M2 in the reverse direction to move the car in the left direction.

Similar to this, every time a car encounters an object in its path, the automobile detects it and rotates to the left to get around the obstruction.

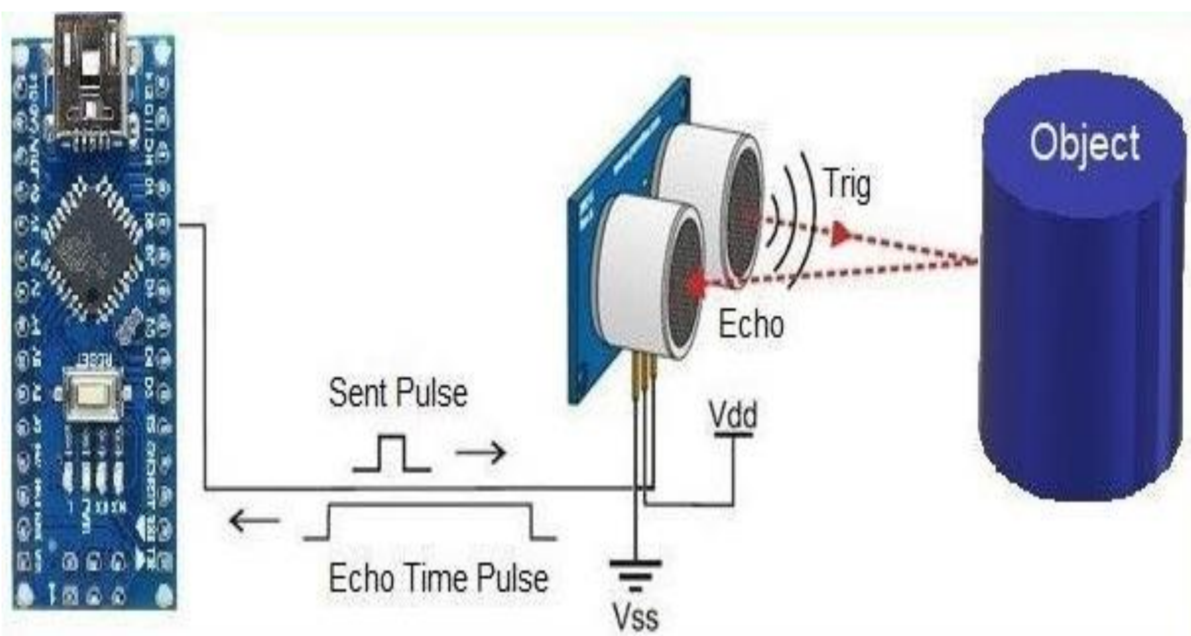


Fig.4.2.1 Working of robot

4.3 PROGRAM FOR ARDUINO

```
const int TrigPin = 12;
const int EchoPin = 11;
const int mot1 = 9;
const int mot2 = 8;
const int mot3 = 4;
const int mot4 = 3;
long period, interval;

void setup()
{
pinMode(TrigPin,OUTPUT);
pinMode(EchoPin,INPUT);
pinMode (mot1,OUTPUT);
pinMode (mot2,OUTPUT);
pinMode (mot3,OUTPUT);
pinMode (mot4,OUTPUT);
}
```

```
void loop()
{
digitalWrite(TrigPin,LOW);
delayMicroseconds(2);
digitalWrite(TrigPin,HIGH);
delayMicroseconds(10);
digitalWrite(TrigPin,LOW);
period = pulseIn(EchoPin,HIGH);
interval = period/58.2;
if(interval<20)
{
digitalWrite(mot1,LOW);
digitalWrite(mot2,HIGH);
digitalWrite(mot3,HIGH);
digitalWrite(mot4,LOW);
}
else
{
digitalWrite(mot1,HIGH);
digitalWrite(mot2,LOW);
```

```
digitalWrite(mot3,HIGH);
digitalWrite(mot4,LOW);
}
delay(100);
}
```

4.4 APPLICATIONS

This device has application in surveying different landscapes and mapping them. It can also be used in commercial devices like

- Automated lawn mover.
- Smart room cleaner etc.
- Obstacle avoiding robots can be used in almost all mobile robot navigation systems.
- They can also be used in dangerous environments, where human penetration could be fatal.
- Unmanned vehicle driving.
- Mining Vehicle that uses Obstacle Detection
- Automatic change over's of traffic signals
- Intruder alarm system
- Counting instruments access switches parking meters
- Back sonar of automobiles

CHAPTER NO: 5

EXPERIMENTAL RESULTS

EXPERIMENTAL RESULTS

The result is obtained for obstacle avoidance robot using Arduino, if the robot moves forward if any obstacle detect it check for other directions and moves where there is no obstacles it moves in forward direction, to sense the obstacle ultrasonic sensor is used. We used servo motor to rotate the ultrasonic sensor.

The working principle of the robot is transmitting sensed signal to the microcontroller to control the DC motors for obstacle avoidance. The direction of the motors to move either clockwise or anti- clockwise directions as provided by the microcontroller. Ultrasonic sensor detect a moving object while IR sensor does not detect any object, the robot will move backward (motor 1 and motor 2 counter clockwise).

The sensor also detects object, the robot will stop (motor 1 and motor 2 OFF). After 50 ms, motor 1 will move clockwise and the robot will turn left. After 500 ms, the robot will move forward (motor 1 and motor 2 clockwise) and after 1000ms, both motors will stop. From the flow chart in Figure 10, it shows that the IR sensors are very effective in sensing signals in their path for the obstacle avoiding robots to evade obstacles in its path.

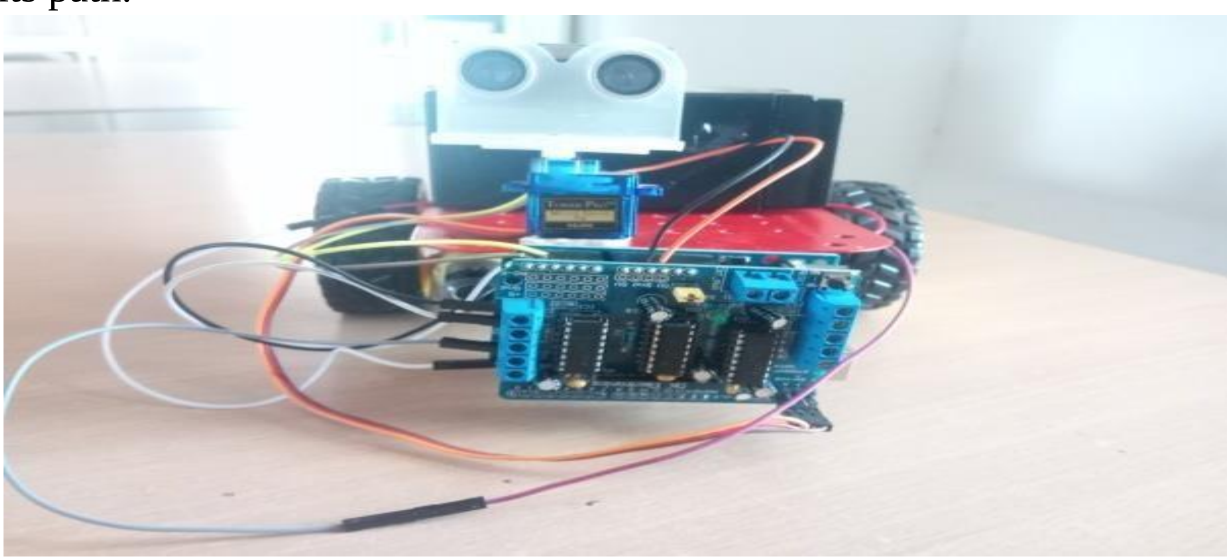


Fig. 5.1 OBSTACLE DETECTION AND COLLISION AVOIDANCE ROBOT

CHAPTER NO: 6

CONCLUSION

CONCLUSION

The goal of our project is to create a autonomous robot which intelligently detects the obstacle in his path and navigate according to the actions we set for it. The above Arduino controller and ultrasonic sensor were studied and the HcSR-04 ultrasonic sensor was selected, as the controlling result are satisfying for its use in the automobile prototype system bring developed. It was used to sense the obstacle and avoidance them. On successful implementation of obstacle avoidance algorithm was successfully carried out too with minimal errors, by coding the algorithm in python. Obstacle avoidance is a very good application to be used in vehicle preventing many accidents and loss of life .This project developed an obstacle avoiding robot to detect and avoid obstacles in its path. The robot is built on the Arduino platform for data processing and its software counterpart helped to communicate with the robot to send parameters for guiding movement. For obstacle detection, three ultrasonic distance sensors were used that provided a wider field of detection. The robot is fully autonomous and after the initial loading of the code, it requires no user intervention during its operation. When placed in unknown environment with obstacles, it moved while avoiding all obstacles with considerable accuracy. In order to optimize the movement of the robot, we have many considerations for improvement. However, most of these ideas will cost more money and time as well. In future cameras can be used to detect the obstacle however, it is better to get CCD or industrial use ones to get clear and fast pictures. Even the ones we mentioned in the camera holder part will be better because of the special software.

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