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**INTRODUCTION**

Obstacle avoidance robots have gained significant traction in recent years due to their ability to navigate autonomously in dynamic environments (Cho & Hong, 2007). Ultrasonic sensors, with their non-contact and accurate distance measurement capabilities, play a crucial role in enabling these robots to detect and avoid obstacles effectively (Song et al., 2017).

In this report, we will review the existing obstacle avoiding robots that use ultrasonic sensors, evaluate the science of ultrasonic sensing, explain the implementation algorithm for the SRF05 ultrasonic rangefinder sensor, and develop a detailed block diagram for the system. We will also give a detailed explanation of the components required to develop an obstacle avoiding robot.

**LITERATURE REVIEW**

There are many examples of obstacle avoiding robots that use ultrasonic sensors in different ways. Some of them are:

- Arduino Uno and HY-SRF05 ultrasonic sensor: This is a basic obstacle avoiding robot that uses an Arduino Uno, a HY-SRF05 ultrasonic sensor, and a L298N motor driver module. The robot detects the obstacle in front of it and turns left or right depending on the distance. The code is simple and easy to understand.

- Build an Obstacle-Avoiding Robot (BlueBot Project #4): This is a more advanced obstacle avoiding robot that uses two ultrasonic sensors mounted on servo motors to scan the environment. The robot uses a state machine to implement different behaviors, such as exploring, avoiding, escaping, and following. The robot also has a buzzer and LEDs to indicate its status. The code is more complex and uses libraries and functions.

- Obstacle Avoiding Robot: This is a creative obstacle avoiding robot that uses an Arduino Nano, a HC-SR04 ultrasonic sensor, and a L293D motor driver module. The robot has a cute design and uses cardboard and popsicle sticks to make the chassis and the whiskers. The robot detects the obstacle using the ultrasonic sensor and the whiskers, and turns away from it. The code is similar to the first example, but with some modifications.

- Obstacle Avoider Robot Using Arduino and IR Sensor: This is a different obstacle avoiding robot that uses an Arduino Uno, three range adjustable IR sensors, and a L298N motor driver module. The robot uses the IR sensors to detect the obstacle and the line, and turns left, right, or stops accordingly. The code is also simple and easy to understand.

**EVALUATION OF THE SCIENCE OF ULTRASONIC SENSING**

Ultrasonic sensors have emerged as a preferred choice for obstacle avoidance in robots due to their non-contact nature, affordability, and accuracy (Braitenberg & Schütz, 1998).Ultrasonic sensing is a technique that uses ultrasonic waves to measure the distance to an object. Ultrasonic waves are sound waves with frequencies above the human hearing range, typically above 20 kHz. Ultrasonic sensors consist of a transmitter and a receiver, which can be separate or combined in one device. The transmitter emits an ultrasonic pulse, which travels through the air and reflects off the object. The receiver detects the reflected pulse and measures the time it takes for the pulse to travel back.

**REVIEW OF THE SRF04 AND SRF05 ULTRASONIC RANGEFINDER SENSORS**

The SRF04 and SRF05 ultrasonic rangefinder sensors share several similarities, including their operating principle and basic functionality (Parvez, 2007).

The similarities and differences of SRF04 and SRF05, are shown in the table below:

|  |  |  |
| --- | --- | --- |
| Feature | SRF04 | SRF05 |
| Pins | 4 | 5 |
| Mode | Single | Dual |
| Trigger Pin | Input | Input/Output |
| Echo Pin | Output | Input/Output |
| Mode Pin | N/A | Input |
| Voltage | 5V | 5V |
| Current | 15mA | 30mA |
| Range | 3cm-3m | 3cm-4m |

The main difference between the SRF04 and SRF05 is the mode of operation. The SRF04 has a single mode, which uses separate trigger and echo pins. The SRF05 has a dual mode, which can use separate trigger and echo pins, or a single pin for both trigger and echo. The mode pin determines which mode to use. If the mode pin is left unconnected, the SRF05 works in the same way as the SRF04. If the mode pin is connected to ground, the SRF05 works in the single pin mode, which saves a valuable pin on the microcontroller.

**IMPLEMENTATION ALGORITHM FOR THE SRF05 SENSOR**

The implementation algorithm for the SRF05 sensor depends on the mode of operation. In this section, we will explain the algorithm for the single pin mode, which is more efficient and flexible. The flowchart for the algorithm is shown in Figure 1.

Figure 1. Flowchart for the implementation algorithm for the SRF05 sensor in single pin mode.

The algorithm consists of the following steps:

1. Set the pin as output and send a 10 us high pulse to trigger the sensor.

2. Set the pin as input and wait for the pin to go high, indicating the start of the echo pulse.

3. Start a timer and wait for the pin to go low, indicating the end of the echo pulse.

4. Stop the timer and read the elapsed time.

5. Calculate the distance using the formula: Distance = (Time x 343) / 2 / 100, where Time is in microseconds and Distance is in centimeters.

6. Display the distance on the serial monitor or LCD screen.

7. Repeat the steps from 1 to 6 with a delay of at least 50 ms between each cycle.

**EVALUATION OF THE MOBILITY SYSTEM OF AN OBSTACLE AVOIDING ROBOT**

The mobility system of an obstacle avoiding robot is the part that enables the robot to move and steer in different directions. The mobility system consists of two main components: the motors and the wheels. The motors are the devices that convert electrical energy into mechanical energy, and provide the power and torque for the robot's movement. The wheels are the devices that transfer the motion of the motors to the ground, and provide the traction and stability for the robot's movement.

The mobility system of an obstacle avoiding robot can be evaluated based on several criteria, such as:

- Speed: The speed of the robot is the rate of change of its position, and it depends on the voltage and current supplied to the motors, and the diameter and friction of the wheels. The speed of the robot can affect its performance and efficiency, as it determines how fast it can reach its destination and avoid obstacles. The speed of the robot can be measured by dividing the distance traveled by the time taken, and it can be expressed in units such as meters per second or kilometers per hour.

- Direction: The direction of the robot is the angle of its orientation, and it depends on the rotation and direction of the motors, and the alignment and configuration of the wheels. The direction of the robot can affect its performance and accuracy, as it determines how well it can follow its path and avoid obstacles. The direction of the robot can be measured by using a compass or a gyroscope, and it can be expressed in units such as degrees or radians.

- Maneuverability: The maneuverability of the robot is the ability to change its speed and direction, and it depends on the control and feedback of the motors, and the design and flexibility of the wheels. The maneuverability of the robot can affect its performance and adaptability, as it determines how easily it can adjust its movement and avoid obstacles. The maneuverability of the robot can be measured by using a test course or a simulation, and it can be expressed in terms such as turning radius, angular velocity, or acceleration.

**BLOCK DIAGRAM OF THE SYSTEM**

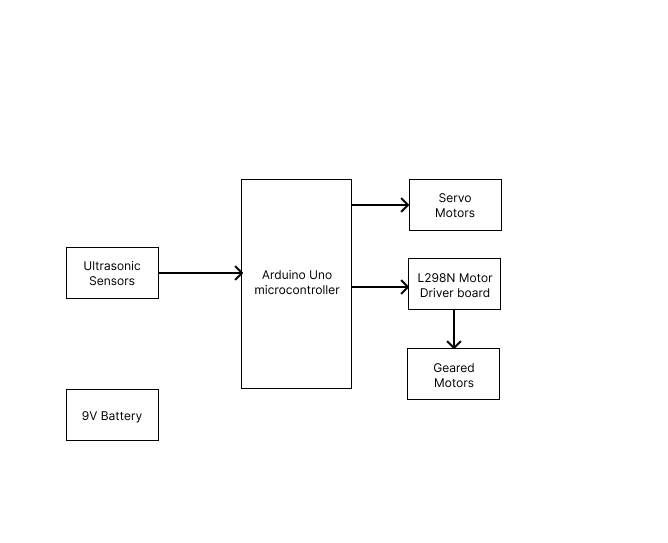


Figure 2. Block diagram of the system.

The block diagram of the system consists of the following components:

- Arduino Uno

- Ultrasonic Sensor

- Servo Motor

- L298N Motor Driver Module

- DC/Geared Motors

- Wheels

- Battery

**DETAILED EXPLANATION OF THE COMPONENTS**

The detailed explanation of the components required to develop an obstacle avoiding robot using Arduino Uno and ultrasonic sensor is as follows:

- Arduino Uno: This is the microcontroller board that acts as the brain of the robot. A microcontroller is a small computer that can execute a program and perform various tasks. Arduino Uno is one of the most popular and widely used microcontroller boards, as it is easy to use, program, and interface with other components.

- Ultrasonic Sensor: This is the sensor that measures the distance to the obstacle using ultrasonic waves. A sensor is a device that can detect and measure a physical quantity, such as light, temperature, or sound, and convert it into an electrical signal. Ultrasonic sensor is one of the common and simple sensors for distance measurement, as it is widely available, low-cost, and easy to use.

- Servo Motor: This is the motor that rotates the ultrasonic sensor to scan the environment. A motor is a device that can convert electrical energy into mechanical energy, and provide the power and torque for the movement. Servo motor is one of the common and precise motors for rotation, as it can control the angle, speed, and direction of rotation.

- Wheels: These are the devices that transfer the motion of the DC motors to the ground. They consist of a rim, a tire, and a hub. They provide the traction and stability for the robot's movement. They are attached to the DC motors using screws or bolts, and are aligned and configured to enable the robot to move and steer in different directions.

- Battery: This is the device that provides the electrical energy for the robot. A battery is a device that stores chemical energy and converts it into electrical energy. It can be a rechargeable or a non-rechargeable battery, and it can have different voltages and capacities.

**CONCLUSION**

Obstacle avoidance robots have demonstrated immense potential in various applications, ranging from autonomous exploration to industrial automation (Cho & Hong, 2007), In this report, we have reviewed the existing obstacle avoiding robots that use ultrasonic sensors, evaluated the science of ultrasonic sensing, explained the implementation algorithm for the SRF05 ultrasonic rangefinder sensor, and developed a detailed block diagram for the system. We have also given a detailed explanation of the components required to develop an obstacle avoiding robot using Arduino Uno and ultrasonic sensor.

We have learned that obstacle avoiding robot is a useful and interesting project that can demonstrate the skills and knowledge of electronics, robotics, sensors, microcontrollers, and programming. We have also learned that obstacle avoiding robot is a low-cost and accessible project that can be built using simple and common components, such as Arduino Uno and ultrasonic sensor.

We have also identified some of the challenges and limitations of our project, such as the accuracy and range of the ultrasonic sensor, the speed and direction of the motors, the logic and algorithm of the Arduino code, and the power and weight of the battery. We have also suggested some of the possible improvements and extensions of our project, such as using a servo motor to rotate the ultrasonic sensor, using a PID controller to adjust the speed and direction of the motors, using a state machine to implement the logic and algorithm of the Arduino code, and using a rechargeable battery or a solar panel to power the robot.

We hope that this report has provided a comprehensive and systematic overview of the obstacle avoiding robot using Arduino Uno and ultrasonic sensor, and has inspired and motivated the readers to explore and experiment with this project. We also hope that this report has contributed to the existing knowledge and practice of electronics, robotics, sensors, microcontrollers, and programming. Thank you for your attention and interest.

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