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# Obstacle detection using ultrasonic sensor for a mobile robot

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# Obstacle detection using ultrasonic sensor for a mobile robot

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**Abstract.** There have been a number of successful attempts in designing obstacle avoiding robots. These works differ by selection of sensors, path mapping process and the algorithms applied to set the operational parameters. In this paper we present a los cost ultrasonic distance sensor for obstacle avoidance for mobile robot navigation. The system is implemented using microcontroller Arduino Uno, a Wi-Fi module, an Arduino motor shield driver which controls the robot through the geared dc motors. The system showed good performance under various lighting conditions. Experimental results with varied positions of obstacle show the flexibility of the robot to avoid it and have shown a decent performance in our laboratory. The robot is additionally ready to acknowledge victims before it, the sensing element system is extremely low-cost as a result of it solely uses one distance sensing element.

## 1. Introduction

There have been a number of successful attempts in designing obstacle avoiding robots [1, 2, 3]. These works differ by selection of sensors, path mapping process and the algorithms applied to set the operational parameters. There have been numerous projects in this area using laser scanner, an infrared sensor, GPS and multiple sensors to accomplish obstacle detection and avoidance [4]. Researchers are persistently trying to find more precise ways to develop autonomous robot or vehicle movement technology. In obstacle detection, the selection of sensor is vital for the required application of the robot, otherwise, it might fail to operate even though all hardware and software are working properly. For example, a robot with optical sensors in a room with glass walls might create more collisions than avoidance. Hence sensors should be selected in accordance with the characteristics of the obstacles. 240 °laser scanner was used as a sensor to build a robot based on Small Mobile Robot (SMR) platform. The robot generates a collision-free path from a grid map using wavefront algorithm. Other researchers applied low cost sensor network for avoiding obstacle using RGB and Infrared camera and ultrasonic sensors which can detect different obstacles [5] also obstacle warning and avoidance system is an important technology in several applications including manned and unmanned aircraft [6]. [7] Present tree trunk detection and mobile robot localization using camera and ultrasonic sensor to get the location data of the trunk. Proposed road detection and tracking system for mobile robots which achieved a good recognition rate [8].

## 2. Related Works

[9] Presented a single-beam mechanically-scanning profiling sonar to detect obstacles under water. The profiling sonar has the ability to produce a cone-shaped beam which is ideal for detecting near-surface obstacles. One of the objectives of their work was to investigate the suitability of using sonar near the water-air boundary for which the study found promising results. There were other works using multiple sensors to make the robot more accustomed to its surroundings by employing both range and appearance-based obstacle detection [10, 11]. Their obstacle detection also includes a combination of global and local avoidance. They fused the strengths of an image and an ultrasonic sensor to detect objects and measure its size. Detection of the object was carried out by the ultrasonic

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sensor and its measurement required the help of a camera. The code was designed to receive the distance to object, its height and width. Surveillance robots are specially designed for mining accidents, earthquake disasters, and hostage situations etc. Many groups of researchers have developed surveillance robots with the ability to conduct emergency search and rescue work. [12] presented 'Robot-Assisted Emergency Search and Rescue System with a Wireless Sensor Network. [13] presented 'Mobile Rescue Robot for Human Body Detection in Rescue Operation of Disaster'. [14] presented 'Rescue Robotics Using Artificial Intelligence', [15] presented 'Design and Implementation of e-Surveillance Robot for Video Monitoring and Living Body Detection' and [16] presented 'Surveillance Robot Using Arduino Microcontroller, Android APIs and the Internet'. All of those researchers are based on gas sensor, LDR & metal detector to detect a bomb, PIR to sense human movement and to detect human alive or dead, LM35 to detect temperature, Distance sensors, Compass & communicating over Zig-Bee, RF & internet. By detecting human body temperature wirelessly, the system can identify whether the human is alive or dead. The robot also has a long-range First-person view (FPV) video monitoring system.

## 3. Implementations

The system is implemented using microcontroller Arduino Uno, a Wi-Fi module, an Arduino motor shield driver which controls the robot through the geared dc motors. The Arduino is powered by a 7.4V, 2400mAh lithium polymer battery, which sends sizeable current to the dc motor for its movement and also powers the Wi-Fi module for visual transmission and recording of data which also send current to the servo motors for tilting the robot camera module for optimum visual.

### *3.1. Arduino UNO R3 Microcontrolller*

The Arduino projects provide an integrated development environment (IDE) supported process, and programming is completely employing a language supported wiring that is extremely almost like C++. The Arduino Uno is the motherboard for which this robot depends on utilizing the ATmega328. It has fourteen advanced pins for info and yield. It is fueled by a DC supply or an AC to DC gadget. Inside the Arduino, there is a microcontroller that is a PC circuit having a memory, processor, and programmable info yield pins as shown in figure 1.

**Figure 1.** Arduino UNO R3

### *3.2. Engine Control Module (Motor Shield)*

The Arduino Motor shield relies on the L298 (datasheet), that could be a dual full-bridge driver designed to drive inductive loads like relays, solenoids, DC and stepping motors. It allows you to drive two DC motors along with your Arduino board, controlling the speed and direction of every one independently. This shield has separate channels and uses four of the Arduino pins to settle on the rotation direction and varying the speed, quick break or sense the current flowing through the motor. In total there are eight pins in use on this shield. You will be able to use every channel on an individual basis to drive 2DC motors or more or mix them to drive one bipolar stepper motor as shown in figure 2.

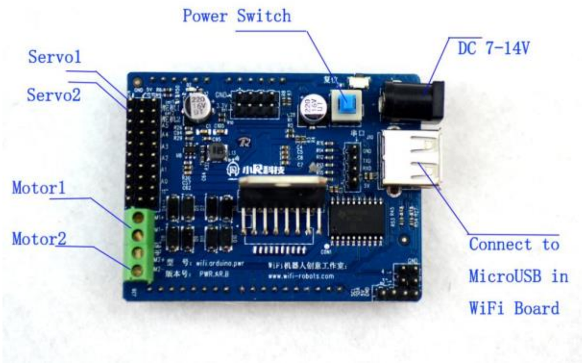


**Figure 2.** PWR Power and Motor Shield

### *3.3. HC-SR04 Ultrasonic sensor*

The HC-SR04 ultrasonic sensing element uses echo sounder to work out the gap to an object like dolphins do. It offers wonderful non-contact detection with high accuracy associated stable readings in an easy-to-use package from two cm to four hundred cm. Its operation isn't restricted by daylight or black material. It comes with a transmitter and recipient module shown in figure 3.

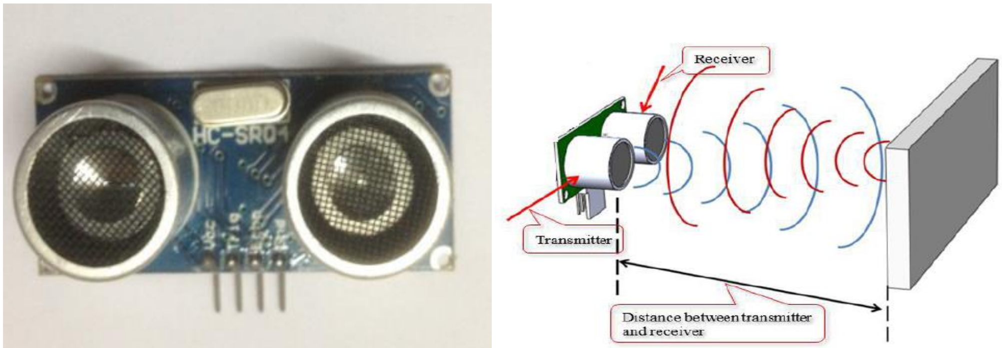


**Figure 3.** Ultrasonic Sensor

### *3.4. Working Principle*

As shown in figure 3, the ultrasonic sensor radiates the short and high-recurrence flag. These spread inside the air at the rate of sound. The ultrasonic sensor comprises a multivibrator, attached to the base. The multivibrator is a mix of a resonator and vibrator. The resonator conveys imperceptible wave created by the vibration. The ultrasonic sensor truly comprises of two sections; the anode that creates a 40 kHz wave and consequently the indicator recognizes 40 KHz wave and sends an electrical flag back to the microcontroller. The ultrasonic sensor enables the robot to pretty much observe and recognize a protest, maintain a strategic distance from impediments.

### *3.5. Self-Protection*

The collision avoidance is authorized utilizing an ultrasonic sensor; that transmits an unintelligible heartbeat each 0.3s to discover any obstruction inside the change of 100cm. considering the broadness of the system is 30cm; the indicator is guided by a servo at skillet points of - 30 °, - 15 °, 0 °, +15 °, + 30 ° to discover any hindrance close the trail of the robot; wherever 0 ° speaks to the bearing of straight movement ahead. It's accepted that there aren't any overhanging deterrents or sharp obstructions like metal bars. The ultrasonic sensor beneath the base of the system sporadically screens the space to the

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base. The rough separation to the base is 4cm; though the component is on the base. Any positive deviation from this value is dealt with as a hoist up from the base and produces an alarm.

*3.6. Power Supply*

Powered supply via a 7.4V 2400mAh lithium polymer battery. Lipo is a reversible battery of lithium-ion technology employing a compound solution rather than a liquid one. High physical phenomenon solid polymers form this kind of solution. These lipo batteries give the next specific energy than alternative lithium-battery sorts.

## 4. Result

**Table 1.** Avoidance Accuracy of Static Obstacle

| Environment | Type of obstacle | Detected | Avoided | Accuracy |
|---|---|---|---|---|
| Well-lit | Single solid obstacle | Yes | Yes | 100% |
| Dimly-lit | Single solid obstacle | Yes | Yes | 100% |
| Well-lit | Uniform shaped surface | Yes | Yes | 100% |
| Dimly-lit | Uniform shaped surface | Yes | No | 40% |
| Well-lit | Double solid obstacles | Yes | Yes | 75% |
| Dimly-lit | Double solid obstacles | Yes | Yes | 70% |
| | | | Average | 80.83% |

Accuracy = (number of successful avoidances)/(number of test cases)

| Accuracy Range | |
|---|---|
| Extremely Sharp | 80-100% |
| Slightly sharp | 60-79% |
| Sharp | 50-59% |
| Not sharp | 0-49% |

Table 1 shows the precision of the system when tested against the fluctuated environment, variety of obstacle, and in this way the things once the object is recognized it stayed away from it.

Experimental results with varied positions of obstacle show the flexibility of the robot to avoid it and have shown a decent performance in our laboratory. The robot is additionally ready to acknowledge victims before it, the sensing element system is extremely low-cost, as a result, it solely uses one distance sensing element.

## 5. Conclusion

Obstacle avoidance capability needs to be considered when designing mobile robots for different applications. The low cost ultrasonic sensor for mobile robot is aim to design and implement a helpful tool that improves the ability of mobile robot to avoid obstacle successfully. A series of test were done to check the reliability of the system. In our experiment the ultrasonic distance sensing element was accustomed to offer a large field of detection. Which can be implemented on mobile robots both remotely controlled and also on autonomous mode, once in the autonomous mode, the initial loading of the code needs no user intervention throughout its operation. When it is placed in an unknown setting with obstacles, it runs while avoiding all obstacles with significant accuracy. Result demonstrated high accuracy of the ultrasonic sensor to avoid obstacle

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