FLOOD LEVEL MONITORING AND ALERTING SYSTEM

A Social Relevant Project report-II submitted to

JAWAHARLAL NEHRU TECHONOLOGICAL UNIVERSITY ANANTAPUR ANANTHAPURAMU

in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

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SREE VIDYANIKETHAN ENGINEERING COLLEGE

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Sree Sainath Nagar, A. Rangampet, Tirupathi - 517102.

(2019-2023)

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PEO2. Successful entrepreneurial or technical career in the core or allied areas of electronics and communication engineering.

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Program Outcomes

On successful completion of the Program, the graduates of B.Tech. (ECE) Program will be able to:

PO1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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PO7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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PO10 **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear

PO11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Lifelong learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

On successful completion of the Program, the graduates of B. Tech. (ECE) will be able to

PSO1. Design and develop customized electronic circuits for domestic and industrial applications.

PSO2. Use specific tools and techniques to design, analyze and synthesize wired and wireless communication systems for desired specifications and applications.

PSO3. Apply suitable methods and algorithms to process and extract information from signals and images in Radar, Satellite, Fiber optic and Mobile communication systems.

Department of Electronics and Communication Engineering

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Certificate

This is to certify that the Social Relevant Project Report entitled

FLOODLEVEL MONITORING AND ALERTING SYSTEM

is the bona fide work done & submitted by

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Head of the Department

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Date of Exam:

Examiner-1

Examiner-2

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ABSTRACT

Flood is one of the most dangerous natural disasters which cannot be ignored. It creates huge economic damage and also results in massive loss of life. Every year many people die due to lack of early warning. One of the research focus has been the use of Arduino Uno microcontroller, Ultrasonic sensor, passive infrared sensor and many others to sense and measure distances. By the usage of this system it alerts the people before the water level reaches the safety level via buzzer, lcd display. The incoming water level is measured by ultrasonic sensor. The program to run the circuit was developed using Arduino ide and stored at the memory of the Arduino microcontroller. The study demonstrated that the designed sensor could be used to accurately determine the position of an approaching object and display the distance readings on the lcd. Simultaneously the sensor display visual led signals set. Here, in this system we make prediction of flood on the basis of output of Arduino Uno and alert respective authorities about possible floods using IoT.

KEYWORDS: Arduino Uno, Internet of Things, Android based application, Flood alert system.

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CHAPTER-1

INTRODUCTION

1.1 GENERAL:

In most countries in the world, flood had caused damages to properties and it involved a large amount of loss to individuals and governments. During flood, it is important to have efficient flood response operation system to manage all activities among different related agencies.

These last decades, lots of flooding order to get an update or latest information In addition to that, individuals risk technologies has been developed to minimize the danger of flood in inhabited areas. Currently, the Philippine government funded the Project NOAH of the Department of Science and Technology (DOST). They installed Automated Rain Gauges (ARG) and Water Level Monitoring Stations (WLMS) along the country's major river basins (RBs).

However, these systems are usually for one-way communication only. In order to get an update or latest information, local communities need to access the website. And in accessing this website, it requires computer or smart phone that has an Internet feature, and most individual could hardly afford to purchase one. In addition to that, individuals are busy for their daily routine, and monitoring activity cannot be their priority. These are the reasons why communities are blinded with the current status of the nearby river watershed. The unawareness led to the overflow of the watercourses of the river waterway and the subsequent inundation of various localities causing extensive damages to properties and human life.

1.2 MOTIVATION OF THE PROJECT:

Flooding is usually brought on by an increased quantity of water in a water system, like a lake, river overflowing. On occasion a dam fractures, abruptly releasing a massive quantity of water. In today's scenario there is no immediate indication about the flooding for the people. Many people die because of heavy flooding and gets affected. By providing flood levels in three stages. First level means the message will sent to all the mobile in offline communication(gsm), Second level means the Buzzer will give alert, Third level means the motor will stop which gives a red alert. LCD is used to display the levels of flood. This will be uploaded in webpage with date and time by using IoT.

1.3 WORKING PRINCIPLE:

In this project, an ultrasonic sensor which is HC-SR04 as shown in figure 1 is used to detect the water level during flood strikes. This sensor is often used for distance measurement applications such as level control and also capable of detecting most objects that are metal or non-metal, clear or opaque, liquid. The ultrasonic sensor emits a 40 000 Hz ultrasound through the air and it will bounce back to the module if there an object in front of it. To generate the ultrasound, the Trig must be set on a High State for 10 μs which will be sent the 8-cycle sonic burst which then will travel at the speed of sound and it will be received in the Echo pin. The Echo pin will output the time in microseconds, and the sound wave travelled.

Fig 1.1 Ultrasonic Sensor

CHAPTER-2

HARDWARE COMPONENTS

COMPONENTS REQUIRED:

1) Arduino uno
2) Ultrasonic sensor
3) Potentiometer
4) Buzzer
5) LCD display
6) LED

2.1 Arduino UNO:

The Arduino is a small computer that you can program to read information from the world around you and send commands to the outside world. All of this is possible because you can connect several devices and components to the Arduino to do what you want.

What is an Arduino?

Basically, it is a small development board with a brain (also known as a microcontroller) that you can connect to electrical circuits. This makes it easy to read inputs – read data from the outside – and control outputs - send a command to the outside. The brain of this board (Arduino Uno) is an ATmega328p chip where you can store your programs that will tell your Arduino what to do.

Exploring the Arduino Uno Board:

In the figure below you can see an Arduino board labeled. Let's see what each part does.

- **Microcontroller:** The ATmega328p is the Arduino brain. Everything on the Arduino board is meant to support this microcontroller. This is where you store your programs to tell the Arduino what to do.
- **Digital pins:** Arduino has 14 digital pins, labeled from 0 to 13 that can act as inputs or outputs.

❼ When set as inputs, these pins can read voltage. They can only read two states: HIGH or LOW.

❼ When set as outputs, these pins can apply voltage. They can only apply 5V (HIGH) or 0V (LOW).

- **PWM pins:** These are digital pins marked with a ~ (pins 11, 10, 9, 6, 5 and 3). PWM stands for "pulse width modulation" and allows the digital pins output "fake" varying amounts of voltage. You'll learn more about PWM later.

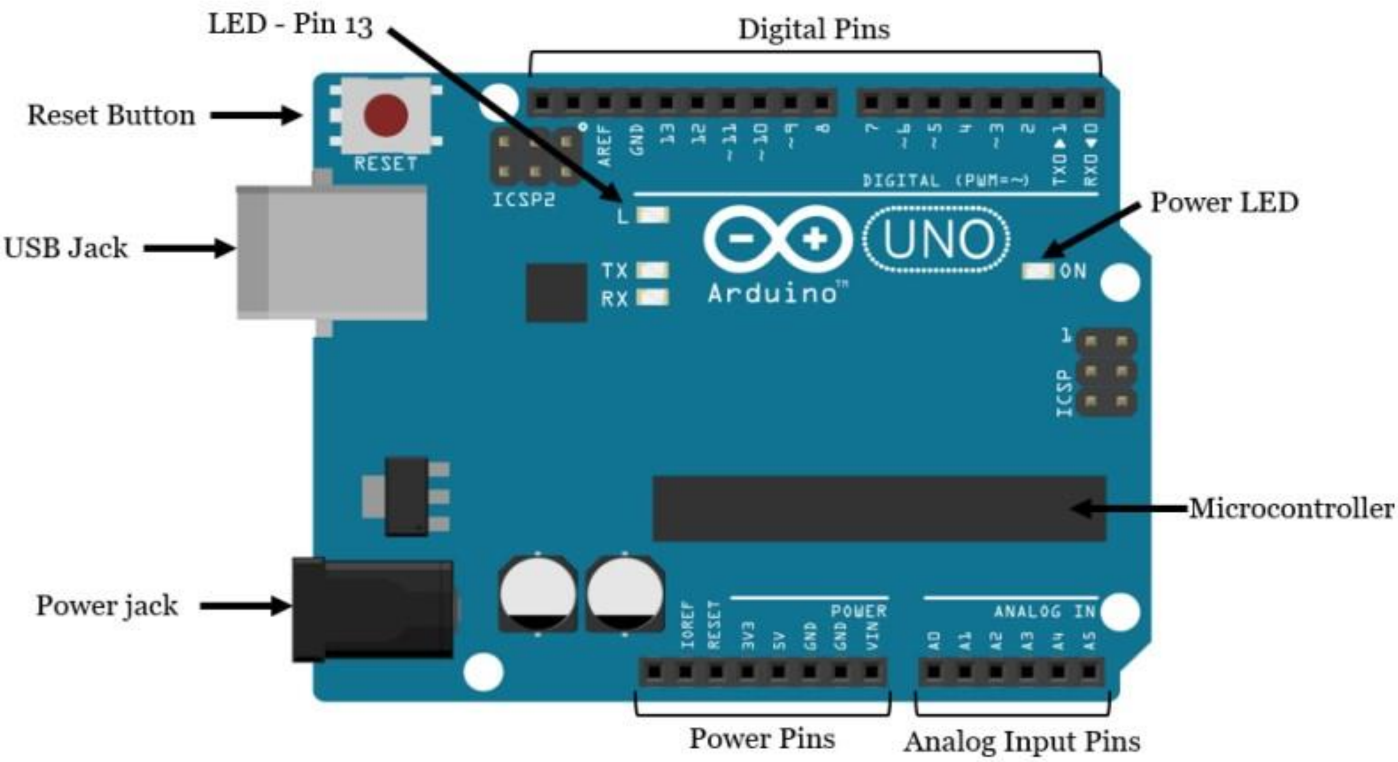


Fig. 2.1 Arduino Uno

- **TX and RX pins**: Digital pins 0 and 1. The T stands for "transmit" and the R for "receive". The Arduino uses these pins to communicate with other electronics via Serial. Arduino also uses these pins to communicate with your computer when uploading new code. Avoid using these pins for other tasks other than serial communication, unless you're running out of pins.
- **LED attached to digital pin 13:** This is useful for an easy debugging of the Arduino sketches.
- **TX and RX LEDs:** these leds blink when there are information being sent between the computer and the Arduino.
- **Analog pins:** the analog pins are labeled from A0 to A5 and are often used to read analog sensors. They can read different amounts of voltage between 0 and 5V. Additionally, they can also be used as digital output/input pins like the digital pins.

- **Power pins:** the Arduino provides 3.3V or 5V through these pins. This is really useful since most components require 3.3V or 5V to operate. The pins labelled as "GND" are the ground pins
- **Reset button:** when you press that button, the program that is currently being run in your Arduino restarts. You also have a Reset pin next to the power pins that acts as reset button. When you apply a small voltage to that pin, it will reset the Arduino.
- **Power ON LED**: will be on since power is applied to the Arduino.
- **USB jack:** you need a male USB A to male USB B cable (shown in figure below) to upload programs from your computer to your Arduino board. This cable also powers your Arduino.

2.2 Ultrasonic sensor:

For water level measurement, we have used ultrasonic sensors. This sensor will work on sound navigation and ranging. It will work by transmitting the wave of short and high frequencies and echo will get reverted back, depending on these the level will be measured. The distance between sensor and water level will be calculated as –

Distance $L = \frac{1}{2} \times T \times C$
Where L=Distance
C=Sonic speed
T=Time between transmission and reception

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-touse package. From 2cm to 400 cm or 1" to 13 feet. Its operation is not affected by sunlight or black material like sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.

Features of HC-SR04

- Power Supply :+5V DC
- Quiescent Current : <2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance : 2cm – 400 cm/1″ – 13ft
- Resolution : 0.3 cm

- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10uS

How Does it Work? The ultrasonic sensor uses sonar to determine the distance to an object. Here's what happens:

1. The transmitter (trig pin) sends a signal: a high-frequency sound;

2. When the signal finds an object, it is reflected and…

3. The transmitter (echo pin) receives it.

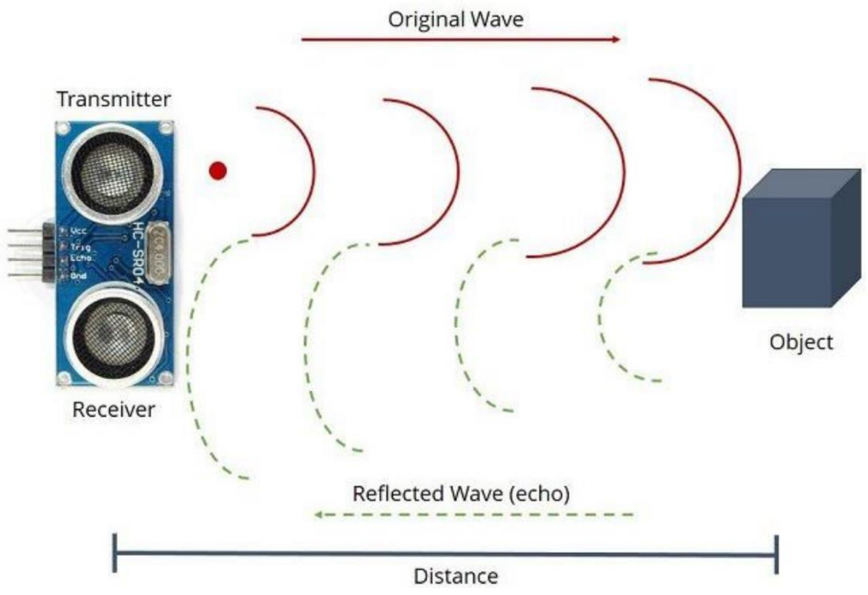


Fig. 2.2 Ultrasonic Sensor

The time between the transmission and reception of the signal allows us to calculate the distance to an object. This is possible because we know the sound's velocity in the air.

Sensor Pins:

- VCC: +5VDC
- Trig : Trigger (INPUT)
- Echo: Echo (OUTPUT)
- GND: GND

Fig.2.3 Ultrasonic Sensor Pins

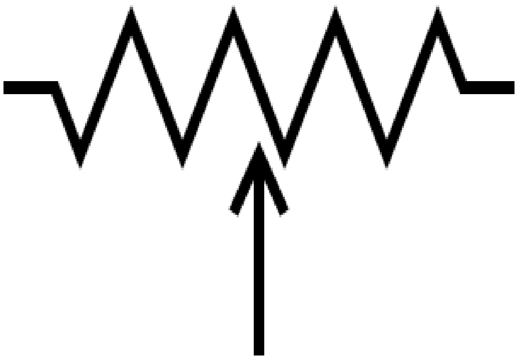
2.3 Potentiometer:

A potentiometer is a manually adjustable variable resistor with 3 terminals. Two of the terminals are connected to the opposite ends of a resistive element, and the third terminal connects to a sliding contact, called a wiper, moving over the resistive element. The potentiometer essentially functions as a variable resistance divider. The resistive element can be seen as two resistors in series (the total potentiometer resistance), where the wiper position determines the resistance ratio of the first resistor to the second resistor. If a reference voltage is applied across the end terminals, the position of the wiper determines the output voltage of the potentiometer.

A potentiometer is also commonly known as a potmeter or pot. The most common form of potmeter is the single turn rotary potmeter. This type of pot is often used in audio volume control (logarithmic taper) as well as many other applications. Different materials are used to construct potentiometers, including carbon composition, cermet, wirewound, conductive plastic or metal film.

A potentiometer is a manually adjustable, variable resistor with three terminals. Two terminals are connected to the ends of a resistive element, the third terminal is connected to an adjustable wiper. The position of the wiper sets the resistive divider ratio.

When you move the wiper to the left side, the resistance between the middle pin and the left pin decreases. And the resistance between the middle pin and the right pin increases. Move the wiper to the right, and the opposite happens.



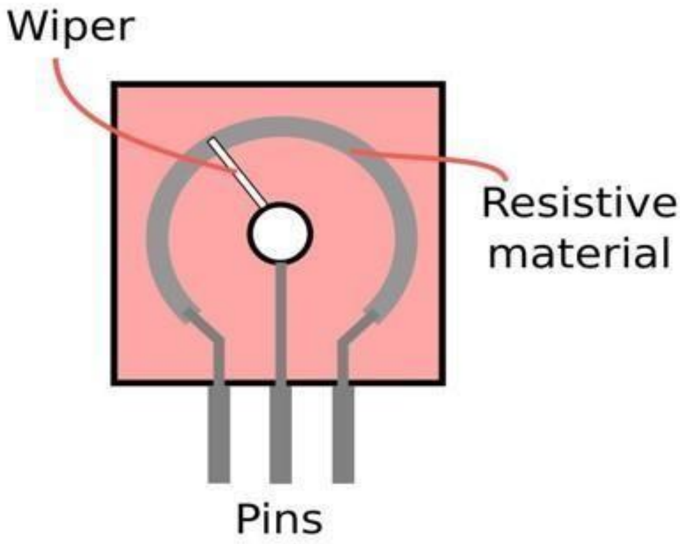


Fig. 2.4 Schematic symbol

Fig. 2.5 Potentiometer

2.4 Buzzer:

Buzzer or Beeper is an audio signing tool, which can be mechanical, electromechanical, or piezoelectric. Buzzer and beepers is widely used in include alarm devices, timers, and user input verification such as mouse clicks or keys.

- Rated Voltage: 6V DC.
- Operating Voltage: 4-8V DC.
- Rated current: <30mA.
- Sound Type: Continuous Beep.
- Resonant Frequency: ~2300 Hz.
- Small and neat sealed package.

Fig. 2.6 Buzzer

2.5 LCD Display:

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizes. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. LCDs are used in a wide range of applications, including LCD televisions, computer monitors, instrument panels, aircraft cockpit displays, and indoor and outdoor signage. Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smart phones.

LCD 16×2 Pin Diagram

The 16×2 LCD pinout is shown below.

- **Pin1 (Ground):** This pin connects the ground terminal.
- **Pin2 (+5 Volt):** This pin provides a +5V supply to the LCD
- **Pin3 (VE):** This pin selects the contrast of the LCD.
- **Pin4 (Register Select):** This pin is used to connect a data pin of an MCU & gets either 1 or

0. Here, data mode = 0 and command mode =1.

- **Pin5 (Read & Write):** This pin is used to read/write data.
- **Pin6 (Enable):** This enables the pin must be high to perform the Read/Write procedure. This pin is connected to the data pin of the microcontroller to be held high constantly.
- **Pin7 (Data Pin):** The data pins are from 0-7 which are connected through the microcontroller

  For data transmission. The LCD module can also work on the 4-bit mode through working on pins 1, 2, 3 & other pins are free.
- **Pin8** – Data Pin 1
- Pin9 – Data Pin 2
- **Pin10** – Data Pin 3 • **Pin11** – Data Pin 4 • **Pin12** – Data Pin 5 • **Pin13** – Data Pin 6
- **Pin14** – Data Pin 7
- **Pin15 (LED Positive**): This is a +Ve terminal of the backlight LED of the display & it is connected to +5V to activate the LED backlight.
- **Pin16 (LED Negative):** This is a -Ve terminal of a backlight LED of the display & it is connected to the GND terminal to activate the LED backlight.

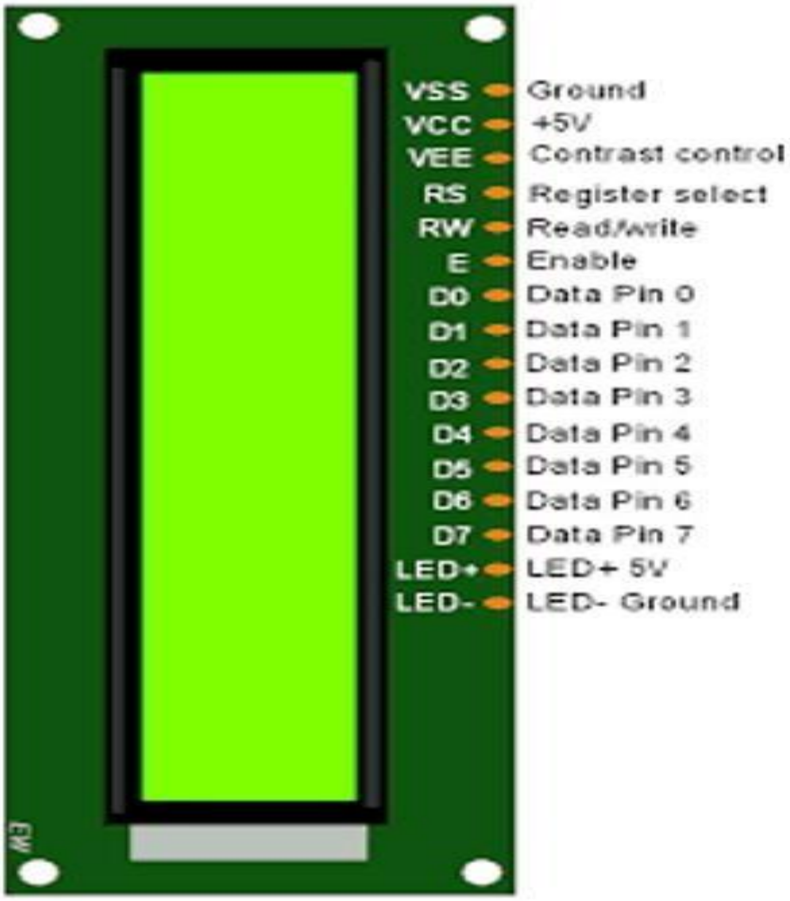


Fig.2.7 LCD Display

2.6 LED:

A light-emitting diode (LED) is a semiconductor device that emits light when an electric current is passed through it. Light is produced when the particles that carry the current (known as electrons and holes) combine together within the semiconductor material. Since light is generated within the solid semiconductor material, LEDs are described as solid-state devices.

Since light is generated within the solid semiconductor material, LEDs are described as solidstate devices. The term solid-state lighting, which also encompasses organic LEDs (OLEDs), distinguishes this lighting technology from other sources that use heated filaments (incandescent and tungsten halogen lamps) or gas discharge (fluorescent lamps).

Fig. 2.8 LED

CHAPTER-3

SOFTWARE CONFIGURATION

3.1 SOFTWARE CONFIGURATION:

This is a simple Flood Level Monitoring system made with help of buzzer, LED , LCD Display and an Ultrasonic sensor also known as Proximity/Distance Sensor (HC-SR04). One can stop the buzzer by pressing the button.

This study sought to first design of a motion detector to detect approaching objects and raise a light (from an LED) and a sound alarm (from a sound buzzer). To achieve this, the components that include the Arduino Uno, Potentiometer, LEDs, Buzzer, LCD and ultrasonic sensor were fixed to the breadboard and connected as described in chapter three Vcc port in the microcontroller chip to the positive channel of the breadboard. Another cable was grounded to the negative terminal of the breadboard from the GD port of the chip.

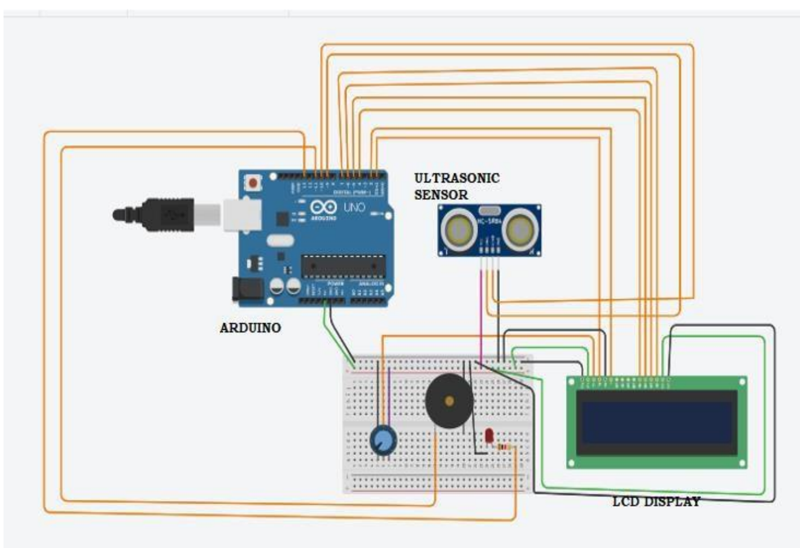


Fig. 3.1 Software Configuration

CHAPTER-4

HARDWARE DISPLAY

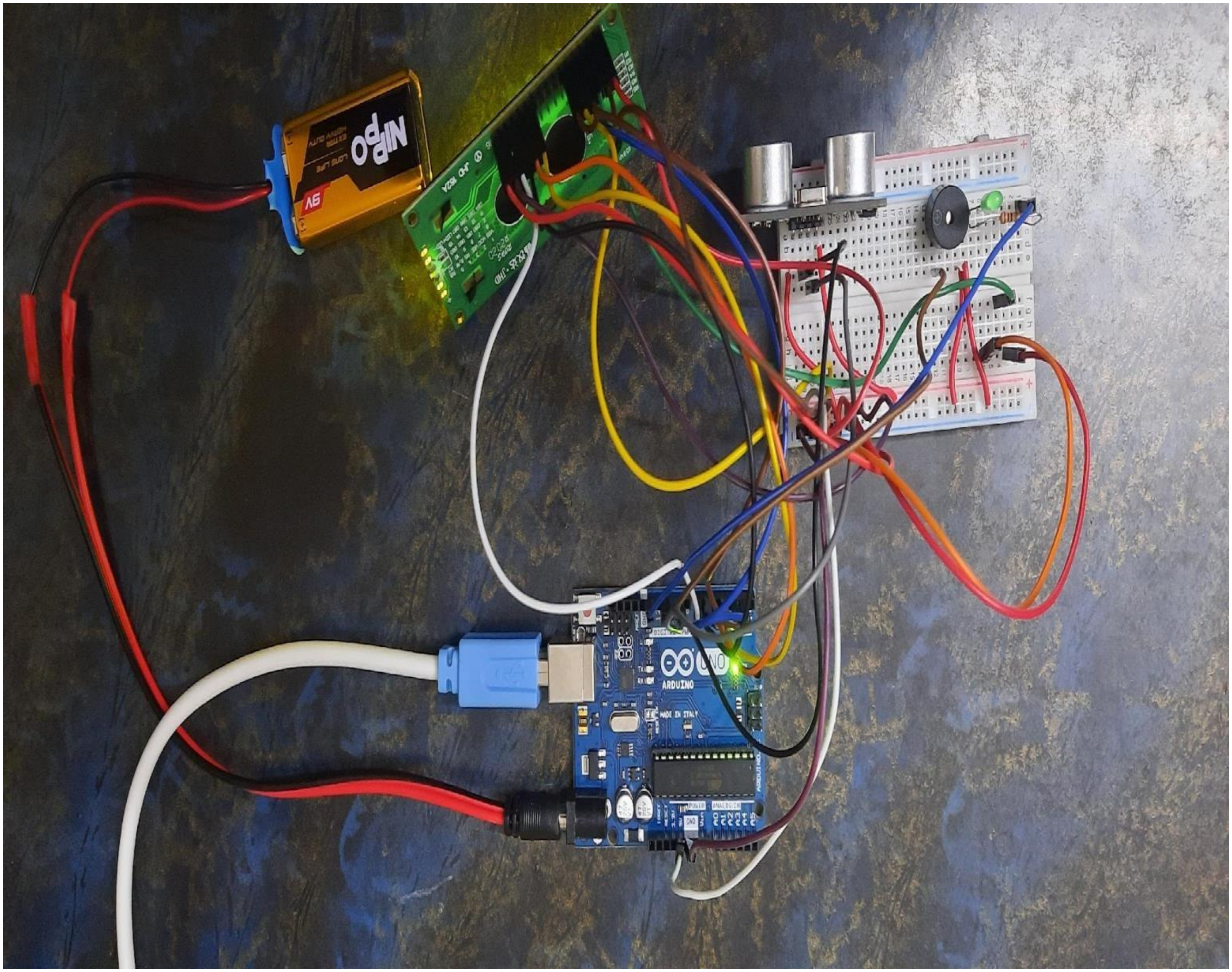


Fig.4.1 Hardware Display

The transmitter of the HC-SR04 sensor transmits an ultrasonic wave in the air. If this wave is reflected by some object in the range of sensor then the reflected wave in the air is received by the receiver of the sensor.

The power the HC-SR04 module with 5 volts and GND to the Arduino UNO. The trigger pin and Echo pin are the input and output pins so they have to be connected to the input and output pins of the Arduino UNO. This module has HD44780 driver from Hitachi on it which helps to interface and communicate with the microcontrollers. This LCD can work in 4 bit mode and 8 bit mode. In 4 bit mode only 4 data pins are required to establish connection between LCD and microcontroller whereas in 8 bit mode 8 data pins are required.

An ultrasonic sensor will be placed at some base level such that the transmitter and receiver will face the water level. Arduino UNO will measure the distance between sensor and water level. The LCD will print the distance between them. We will set some benchmark for flood level and as water will reach the benchmark we will set the buzzer to ‘high’ and the LCD will print the text alerting about the flood.

The function LiquidCrystal lcd() takes the pin number of data connected to Arduino UNO. Lcd.begin() initiates the 16×2 LCD. Pins 18 and 20 are set output pins for trigger and buzzer respectively and pin 19 is set as input for echo pin.

Set the condition of flood condition as the distance between water level and ultrasonic sensor becomes 40cm. So as water level reaches 40 cm or less than the buzzer will set HIGH to give alert and LCD will print and show flood alert message.

4.1 CODE:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(1, 2, 4, 5, 6,
7);  const int trigPin = 9;
const int echoPin = 10; const
int buzzer = 11; const int
ledPin = 13; long duration; int
distanceCm; int
safetyDistance;
void setup() {

lcd.begin(16,1);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
pinMode(buzzer, OUTPUT);
pinMode(ledPin, OUTPUT);
Serial.begin(9600);
} void loop() {
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin,
HIGH); distanceCm=
duration*0.034/2;
safetyDistance = distanceCm; if
(safetyDistance <= 05){
digitalWrite(buzzer, HIGH);
digitalWrite(ledPin, HIGH);
```

```
} else{
digitalWrite(buzzer,
LOW);
digitalWrite(ledPin,
LOW);
}
lcd.setCursor(0,0);
lcd.print("Distance
:                    ");
lcd.print(distanceC
m);        lcd.print("
cm"); delay(100);
}
```

CHAPTER-5

CONCLUSION

This project highlights the possibility to provide an alert system that will overcome the risk of flood. As the project is enabled with IOT technology and hence the sensor data can be monitored from anywhere in the world.

More sensors can be integrated into the system in order to create more accurate and efficient flood detection system.

It can also contribute to multiple government agencies or authority that ultimately help the society and mankind about the flood like hazardous natural disaster. It will monitor each and every aspect that can lead to flood. If the water level rises, it will send an alert immediately. It also ensures increased accessibility in dealing and reverting to this catastrophic incident. In summary, it will help the community in taking quick decisions and planning against this disaster mankind about the flood like hazardous natural disaster.

CHAPTER-6

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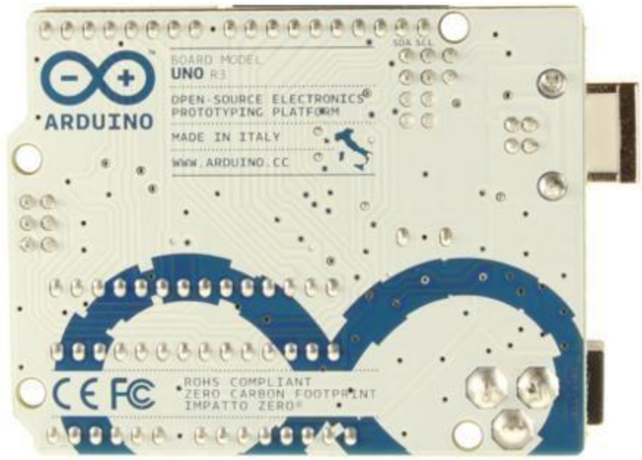
CHAPTER-7

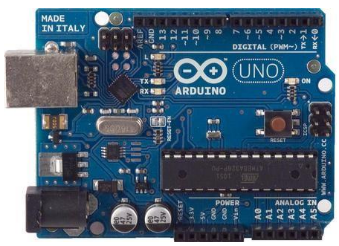
ANNEXURE

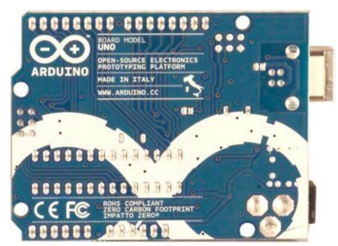
Arduino Uno

Arduino Uno R3 Front



Arduino Uno R3 Back





Arduino Uno R2 Front Arduino Uno SMD Arduino Uno Front Arduino Uno Back

Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.
Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.
Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Schematic & Reference Design

EAGLE files: arduino-uno-Rev3-reference-design.zip (NOTE: works with Eagle 6.0 and newer)
Schematic: arduino-uno-Rev3-schematic.pdf

Note: The Arduino reference design can use an Atmega8, 168, or 328, Current models use an ATmega328, but an Atmega8 is shown in the schematic for reference. The pin configuration is identical on all three processors.

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.**This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication using the SPI library.
- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **TWI: A4 or SDA pin and A5 or SCL pin.** Support TWI communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and ATmega328 ports. The mapping for the Atmega8, 168, and 328 is identical.

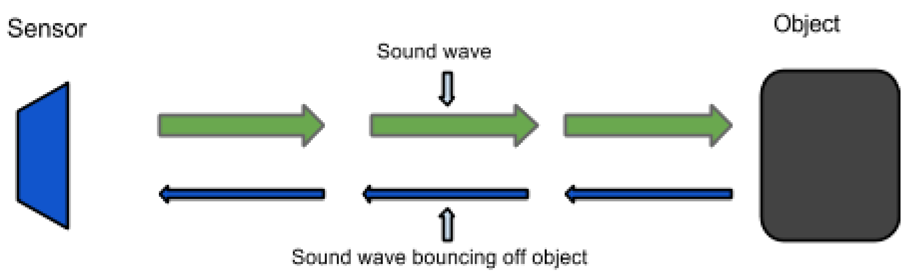
HC-SR04 ULTRASONIC SENSOR

The purpose of this file is to explain how the HC-SR04 works. It will give a brief explanation of how ultrasonic sensors work in general. It will also explain how to wire the sensor up to a microcontroller and how to take/interpret readings. It will also discuss some sources of errors and bad readings.

1. **How Ultrasonic Sensors Work**
2. **HC-SR04 Specifications**
3. **Timing chart, Pin explanations and Taking Distance Measurements**

1. How Ultrasonic Sensors Work

Ultrasonic sensors use sound to determine the distance between the sensor and the closest object in its path. How do ultrasonic sensors do this? Ultrasonic sensors are essentially sound sensors, but they operate at a frequency above human hearing.



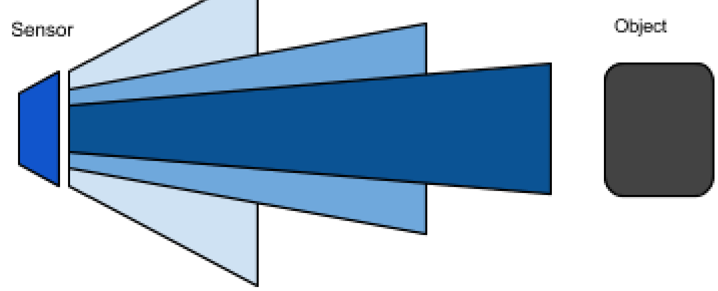
The sensor sends out a sound wave at a specific frequency. It then listens for that specific sound wave to bounce off of an object and come back (Figure 1). The sensor keeps track of the time between sending the sound wave and the sound wave returning. If you know how fast something is going and how long it is traveling you can find the distance traveled with equation 1.

Equation 1. $d = v \times t$

The speed of sound can be calculated based on the a variety of atmospheric conditions, including temperature, humidity and pressure. Actually calculating the distance will be shown later on in this document.

It should be noted that ultrasonic sensors have a cone of detection, the angle of this cone varies with distance, Figure 2 show this relation. The ability of a sensor to detect an object also depends on the objects orientation to the sensor. If an object doesn't present a flat surface to the sensor then it is possible the sound wave will bounce off the object in a way that it does not return to the sensor.

Figure 2



2. HC-SR04 Specifications

The sensor chosen for the Firefighting Drone Project was the HC-SR04. This section contains the specifications and why they are important to the sensor module. The sensor modules requirements are as follows.

- Cost
- Weight
- Community of hobbyists and support
- Accuracy of object detection
- Probability of working in a smoky environment
- Ease of use

The HC-SR04 Specifications are listed below. These specifications are from the Cytron Technologies HC-SR04 User's Manual (source 1).

- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working current: 15mA
- Effectual Angle: <15º
- Ranging Distance: 2-400 cm

- Resolution: 0.3 cm
- Measuring Angle: 30º
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm
- Weight: approx. 10 g

The HC-SR04's best selling point is its price; it can be purchased at around $2 per unit.

3. Timing Chart and Pin Explanations

The HC-SR04 has four pins, VCC, GND, TRIG and ECHO; these pins all have different functions. The VCC and GND pins are the simplest -- they power the HC-SR04. These pins need to be attached to a +5 volt source and ground respectively. There is a single control pin: the TRIG pin. The TRIG pin is responsible for sending the ultrasonic burst. This pin should be set to HIGH for 10 μs, at which point the HC-SR04 will send out an eight cycle sonic burst at 40 kHZ. After a sonic burst has been sent the ECHO pin will go HIGH. The ECHO pin is the data pin -- it is used in taking distance measurements. After an ultrasonic burst is sent the pin will go HIGH, it will stay high

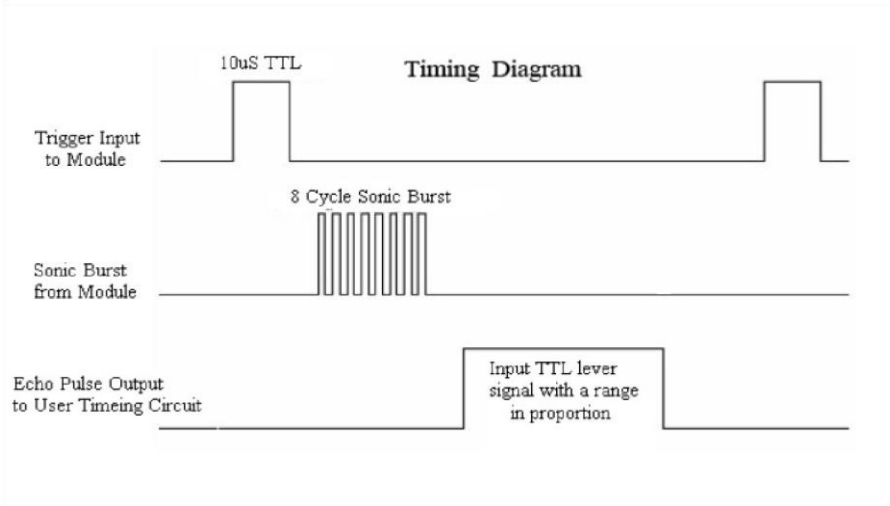
until an ultrasonic burst is detected back, at which point it will go LOW.

Taking Distance Measurements

The HC-SR04 can be triggered to send out an ultrasonic burst by setting the TRIG pin to HIGH. Once the burst is sent the ECHO pin will automatically go HIGH. This pin will remain HIGH until the the burst hits the sensor again. You can calculate the distance to the object by keeping track of how long the ECHO pin stays HIGH. The time ECHO stays HIGH is the time the burst spent traveling. Using this measurement in equation 1 along with the speed of sound will yield the distance travelled. A summary of this is listed below, along with a visual representation in Figure 2.

1. Set TRIG to HIGH
2. Set a timer when ECHO goes to HIGH
3. Keep the timer running until ECHO goes to LOW
4. Save that time
5. Use equation 1 to determine the distance travelled

Figure 3
Source 2



Source 2

To interpret the time reading into a distance you need to change equation 1. The clock on the device you are using will probably count in microseconds or smaller. To use equation 1 the speed of sound needs to determined,which is 343 meters per second at standard temperature and pressure. To convert this into more useful form use equation 2 to change from meters per second to microseconds per centimeter. Then equation 3 can be used to easily compute the distance in centimeters.

Equation 2. *Distance* = 17S0p.e1e5d m × M10e0t ecrms × 117e06.1 µ5S m × 58.7c7m2 µS

Equation 3. *Distance* = ti5m8e = µsµ/csm = cm