DISTANCE MEASUREMENT USING ULTRASONIC SENSOR & ARDUINO

Department of Information & Communication Technology

Microprocessor & Microcontroller Project Report

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Date of Submission: May,2022

CERTIFICATE OF APPROVAL

This is to certify that the project titled "**Distance Measurement using Ultrasonic Sensor and Arduino**" carried out by Jasmine Akter,Maria Nusrat,Md Rasel Hossain,Mehedi Hasan Sakib, for the partial fulfillment of the requirements of Microprocessor & Microcontroller based project.the dissertation has been carried out under my guidance and is record of the authentic work carried out successfully.

.....

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DECLARATION

"We Do hereby declare that this submission is our own work conformed to the norms and guidelines is given by our supervisor and that, to the best of our knowledge and belief, it contains no material previously written by another neither person nor material (data, theoretical analysis, figures, and text) which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text."

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ABSTRACT

Nowadays, we have some difficulties in obtaining the distance that we want to measure. Even though, measuring tape is an easy option, but this kind of tool will have a limitation of manual error.

The project is designed to measuring distance using ultrasonic waves and interfaced with arduino. We know that human audible range is 20hz to 20khz. We can utilize these frequency range waves through ultrasonic sensor HC-SR04.The advantages of this sensor when interfaced with arduino which is a control and sensing system, a pro per distance measurement can be made with new techniques. Ultrasonic sensors are first rate gear to degree distance without real touch and used at several places like water degree measurement, distance dimension etc. this is an efficient manner to measure small distances exactly. on this assignment we've got used an Ultrasonic Sensor to determine the space of an obstacle from the sensor.

In many applications like vehicle control, medical applications, robotic movement control, etc.; distance measurement of an object is used. This can be done using a variety of sensors- Ultrasonic, IR, radar, laser, etc. Measurement using ultrasonic sensors is the cheapest and its reliability among several others is very high.

In this project distance measurement and location of an object by using ultrasonic sensor and microcontroller is present.

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ACKNOWLEDGEMENT

We take this opportunity to think certain people without whom this endeavor would not have been possible. We would also express our thanks to the head of the Department. We would like to express our sincere gratitude to our guide Alimul rajee sir for constant encouragement , help and guidance without which this project would not have been completed.

We would like to express our sincere gratitude towards our supervisor for their constant support and valuable advice throughout the progress of the project . Last but not the least , We express our heartiest acknowledgment to our parents, friends and colleagues who directly or indirectly

helps us in completing this project.

LIST OF ABBREVIATIONS

LED: Light Emitting Diode

IDE: Intrigated development environment

LDR: Light Dependent Repeater

ISP: In- System programming

RX : Reciever

TX: Transmitter

ToF:Time of flight

IJCACS: International Journal of Control, Automation, Communication and Systems

ATS:Arduino Ethernet shield

AWS: Arduino Wireless shield

AMDS:Arduino Motor Driver Shield

USB: Universal serial bus

EPROM : Electrically Erasable Programmable Read Only Memory

SRAM: Static random acces memory

GPS: Ground

UAV: Unmanned aerial vehicle

HVAC:Heating, Ventilation, and Air Conditioning

MOSFET: Metal-oxide-semiconductor field-effect transistor

TRIAC: Triode for Alternating Current

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CHAPTER 1

INTRODUCTION

Distance measurement of an object in front or by the side of the moving entity is required in large number of devices. These devices may be small or large and can be quite simple or complicated. Distance measurement has important applications in automotive and industrial applications. The distance measurement through sensors is useful in detecting obstacles.

It uses ultrasonic waves to search an object same as Bats uses sonar technique to communicate with other bats. Bats are wonderful creatures. Blind from the eyes but the vision is sharper than humans, Ultrasonic ranging is the technique used by bats. Ultrasonic sensor provides an easy way in distance measurement. The sensor is perfect for distance measurements between moving or stationary objects. Ultrasonic Sensor measure the distance of the objects in air through non-contact technique. They measure distance without damage and are easy to use and reliable. [5]

In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emissions of the sound by the transmitter to its contact with the receiver. The formula for this calculation is D = ½ T x C (where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second). For example, if a scientist set up an ultrasonic sensor aimed at a box and it took 0.025 seconds for the sound to bounce back, the distance between the ultrasonic sensor and the box would be,

D = 0.5 x 0.025 x 343 or about 4.2875 meters.

An ultrasonic sensor emits sound waves toward an object and determines its distance by detecting reflected waves Ultrasonic sensor diagram.(Robo Galaxy)Ultrasonic sensors are used primarily as proximity sensors.[6]

1.1 Problem statement

A low cost distance measurement system using ultrasonic sensor which works good in different light condition and has the capability to detect the distance of the object. The hardware utilized included the Arduino Uno on a bread board interfaced with LCD, LEDs, Buzzer and 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 display.[8]

1.2 Necessity of the project

The main objective of the project is to provide useful and low cost measurement system that is easy to configure and handle. In this method of distance sensing and measurement is efficient and assures measurements of small distances precisely. This distance sensing and measurement system can get wide applications where proximity detection is required e.g. in industries and traffic departments.[7]

CHAPTER 2

LITERATURE SURVEY

Latha, N. Anju, B. Rama Murthy, and K. Bharat Kumar try to develop an application which is based upon the reflection of sound waves.They offer low cost and a precision of less than 1 cm in distance measurements of up to 6m [9]. However, the most popular method used in these measurements is based on the time of flight (ToF) measurement. This ToF is the time elapsed between the emission and subsequent arrival after reflection of an Ultrasonic pulse train travelling at the speed of sound. This causes large response times for a single measurement.[9]

Bereziuk, Oleh, et al. proposed a device that allows to measure the distances to obstacles for the development of highly efficient dustcarts as the main link in the structure of machines for the collection and primary processing of municipal solid wastes. A structural scheme of the device and a block diagram of the program algorithm is also proposed that allows to control the operation of the microcontroller of the device for distance measuring with consideration of environmental parameters.[10]

Carullo, Alessio, and Marco Parvis develop an automotive application which is able to self-adapt to the environmental conditions. The sensor contains a noise measurement system and an auto-change facility of the signal that is used to drive the transmitter, thus producing the best accuracy under different condition. Tests have been performed in real driving conditions and have shown a regular behavior of the sensor under all typical driving maneuvers for speeds of up to 33 m/s (120 km/h). The sensor features a simple and costless analog processing of the signal without employing microprocessors.[11]

CHAPTER 3

SYSTEM DESCRIPTION

3.1 Components Used

1. Arduino uno
2. Ultrasonic Sensor
3. LCD Display
4. Laser Module
5. Jumper Wire
6. Switch
7. Battery

3.2 Arduino(uno)

3.2.1 Introduction

Arduino is an open source microcontroller which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, students and professionals to create devices that interact with their environment using sensors and actuators. Based on simple microcontroller boards, it is an open source computing platform that is used for constructing and programming electronic devices. It is also capable of acting as a mini computer just like other microcontrollers by taking inputs and controlling the outputs for a variety of electronics devices. It is also capable of receiving and sending information over the internet with the help of various Arduino shields, which are discussed in this paper. Arduino uses a hardware known as the Arduino development board and software for developing the code known as the Arduino IDE (Integrated Development Environment). Built up with the 8-bit Atmel AVR microcontroller's that are manufactured by Atmel or a 32-bit Atmel ARM, these microcontrollers can be programmed easily using the C or C++ language in the Arduino IDE. Unlike the other microcontroller boards in India, the Arduino boards entered the electronic market only a couple of years ago, and were restricted to small scale projects only. People associated with electronics are now gradually coming up and accepting the role of Arduino for their own projects. This development board can also be used to burn (upload) a new code to the board by simply using a USB cable to upload. The Arduino IDE provides a simplified integrated platform which can run on regular personal computers and allows users to write programs for Arduino using C or C++. International Journal of Control, Automation, Communication and Systems (IJCACS), Vol.1, No.2, April 2016 22 With so many Arduino boards available in the market, selecting a particular development board needs a variety of survey done with respect to their specifications and capabilities, which can be used for the project execution according to its specified applications.[13]

3.2.2. NEED FOR ARDUINO

Why is there a need to use Arduino in specific? or What makes it different from others? Massimo Banzi, a Co-founder of Arduino mentions some very important reasons for this question.

1) Active User Community: A group of people using a similar product can hold posted message conversations and share their experiences or solve the problems of the other users in the communities with their own experiences [13].

“If you start charging for everything, everything dies very quickly.” says Banzi, Arduino Cofounder.

2) Growth of Arduino: Arduino was developed with intent to provide an economical and trouble-free way for hobbyists, students and professionals to build devices that interact with their situation using sensors and actuators. This makes it perfect for newcomers to get started quickly[13].

3) Inexpensive Hardware: Since Arduino is an open source platform the software is not purchased and only the cost of buying the board or its parts is incurred, thus making it very cheap. The hardware designs are also available online for free from its official website [13].

4) Arduino Board as a Programmer: To make Arduino board function easy and also making it available everywhere these boards come with a USB cable for power requirements as well as functioning as a programmer [13].

5) Multi-platform Environment: The Arduino IDE is capable of running on a number of platforms including Microsoft, Linux and Mac OS X making the user community even larger[13].

3.2.3. TYPE OF ARDUINO BOARDS

Arduino boards are available with many different types of built-in modules in it. Boards such as Arduino BT come with a built-in Bluetooth module, for wireless communication. These built-in modules can also be available separately which can then be interfaced (mounted) to it. These modules are known as Shield.

Some of the most commonly used Shields are:

• **Arduino Ethernet shield:** It that allows an Arduino board to connect to the internet using the Ethernet library and to read and write an SD card using the SD library [14].

• **Arduino Wireless shield:** It allows your Arduino board to communicate wirelessly using Zigbee [14].

• **Arduino Motor Driver Shield**: It allows your Arduino boards to interface with driver of a motor etc. [14]

International Journal of Control, Automation, Communication and Systems (IJCACS), Vol.1, No.2, April 2016

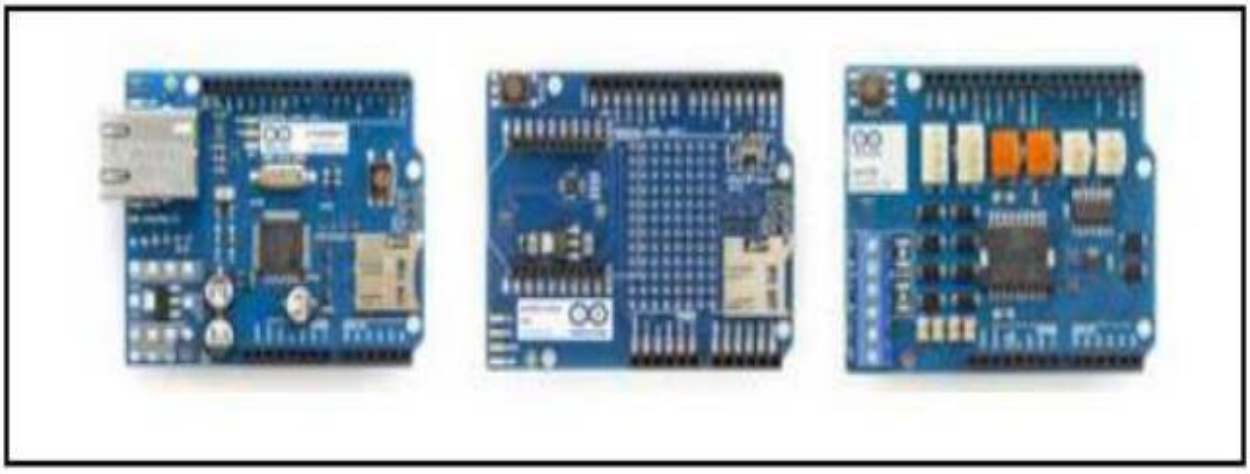


Fig. 3.2.3.1.Arduino Shields – Ethernet, Wireless and Motor Driver

Here is a list of the different types of Arduino Boards available along with its microcontroller type,crystal frequency and availabilities of auto reset facility:

Table :3.2.3.1. Heading and text fonts

Arduino Type	Microcontroller	Clock Speed
Arduino Uno	ATmega328	16 MHz with auto-reset
Arduino Duemilanove / ATmega328	ATmega328	16 MHz with auto-reset
Arduino Nano	ATmega328	16 MHz with auto-reset
Arduino Nano	ATmega2560	16 MHz with auto-reset
Arduino Leonardo	ATmega32u4	16 MHz with auto-reset
Arduino Mini w/ ATmega328	ATmega328	16 MHz with auto-reset
Arduino Etherne	Equivalent to Arduino	UNO with an Ethernet shield
Arduino Fio	ATmega328	8 MHz with auto-reset
Arduino BT w/ ATmega328	ATmega328	16 MHz with auto-reset
LilyPad Arduino w/ ATmega328	ATmega328	8 MHz (3.3V) with auto-reset
Arduino Pro or Pro Mini	ATmega328	16 MHz with auto-reset
Arduino NG	ATmega8	16 MHz with auto-reset

3.2.4. ELEMENTS OF ARDUINO BOARDS

Elements of an Arduino Board can be done into two categories:

- Hardware
- Software

3.2.4.1. Hardware

The Arduino Development Board consists of many components that together makes it work. Here are some of those main component blocks that help in its functioning:

• **Microcontroller**: This is the heart of the development board, which works as a mini computer

and can receive as well as send information or command to the peripheral devices connected to it. The microcontroller used differs from board to board; it also has its own various specifications.

• **External Power Supply**: This power supply is used to power the Arduino development board

with a regulated voltage ranging from 9 – 12 volts.

• **USB plug**: This plug is a very important port in this board. It is used to upload (burn) a program to the microcontroller using a USB cable. It also has a regulated power of 5V which also powers the Arduino board in cases when the External Power Supply is absent.

• **Internal Programmer**: The developed software code can be uploaded to the microcontroller via USB port, without an external programmer.

• **Reset button**: This button is present on the board and can be used to resets the Arduino microcontroller.

• **Analog Pins**: There are some analog input pins ranging from A0 – A7 (typical). These pins are used for the analog input / output. The no. of analog pins also varies from board to board.

• **Digital I/O Pins**: There are some digital input pins also ranging from 2 to 16 (typical). These pins are used for the digital input / output. The no. of these digital pins also varies from board to board.

•**Power and GND Pins**: There are pins on the development board that provide 3.3, 5 volts and ground through them.

Fig. 3.2.4.1.A labled diagram of an Arduino Board and an IDE.

3.2.4.2. Software

The program code written for Arduino is known as a sketch. The software used for developing such sketches for an Arduino is commonly known as the Arduino IDE. This IDE contains the following parts in it:

• **Text editor**: This is where the simplified code can be written using a simplified version of C++ programming language.

• **Message area**: It displays error and also gives a feedback on saving and exporting the code.

• **Text**: The console displays text output by the Arduino environment including complete error messages and other information

• **Console Toolbar**: This toolbar contains various buttons like Verify, Upload, New, Open, Save and Serial Monitor. On the bottom right hand corner of the window there displays the Development Board and the Serial Port in use.

3.2.4.3. Features of Arduino IDE

- 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 of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

3.2.5. PROGRAMMING BASICS

Now we'll discuss about the programming techniques of Arduino sketch in the Arduino IDE. There are two main parts every sketch will always have, they are:

- void setup ()
- void loop ()

1) void setup():

This is the first routine that begins when the Arduino starts functioning. This function is executed only once throughout the entire program functioning.

The setup function contains the initialization of every pin we intend use in our project for input or output. Here is an example of how it should be written:

Here the pin is the no. of the pin that is to be defined. INPUT / OUPUT correspond to the mode in which the pin is to be used.

```
void setup()
  {
    pinMode(pin, INPUT);
    pinMode(pin, OUTPUT);
  }
```

```
void setup()
  {
     Serial.begin(9600);
  }
```

FIGURE:3.2.5.1

It also contains the initialization of the Serial Monitor. A serial monitor is used to know the data that are being sent serially to any peripheral device.

Before using any variables for programming it is necessary to define them above the function "void setup()"

2) void loop():

This function is the next important function in the Sketch. It consists of that part of the code that

needs to be continuously executed unlike the part of the code written in the setup function. An example of a void loop is as follows:

```
void loop()
  {
     digitalWrite(pin, HIGH);
  }
```

FIGURE:3.2.5.2

Here digital Write is a function that writes a high or a low value to a digital pin. If the pin has been

configured as an OUTPUT with pin Mode(), its voltage will be set to the corresponding value: 5V

(or 3.3V on 3.3V boards) for HIGH, 0V (ground) for LOW.

Similarly if there is a need for delay in the sketch then there is another function that creates a delay in the execution of the code

```
delay(1000);   //delay for a second
```

FIGURE:3.2.5.3

This creates a delay in the execution of the program for the time period specified (in milliseconds).

Using the above two function lets create a sketch for blinking a led.

```
// this loop function executes only once
void setup()
  {
    pinMode(13, OUTPUT);  // initialize digital pin 13 as an output.
  }

// this loop function executes forever
void loop()
  {
    digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
    delay(1000);              // wait for a second
    digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
    delay(1000);              // wait for a second
  }
```

Fig. 3.2.5.4. Arduino Shields – Ethernet, Wireless and Motor Driver

3.2.6. APPLICATIONS

Arduino has endless applications as it has been used extensively for creating projects by hobbyist, amateurs and professional in various fields of engineering. Here are some of those amazing projects that have been developed on an Arduino platform:

1. Arduino Satellite (ArduSat)

ArduSat is an open source satellite completely based on Arduino to create a stage for space discoveries. Built by Spire previously known as NanoSatisfi, ArduSat collects various types of information's from the space environment, with the help of numerous sensors that includes temperature sensors, pressure sensors, cameras, GPS, spectrometer, and magnetometer etc with its programmable Arduino processors [16].

This platform also allows common public to experiment their projects in space. ArduSat can be used for photography from space, making a spectrograph of the sun, detecting high energy radiation, compiling temperature readings and observing meteors etc. [15]

2. ArduPilot (ArduPilotMega - APM)

ArduPilot is an unmanned aerial vehicle (UAV) based on the open source platform and built using Aruino Mega which is able to control independent multicopters, fixed-wing aircraft, traditional helicopters and ground rovers. [17]It was created by the DIY Drones community in 2007 and was also an award winning platform of 2012 [17].[12]

3.2.7 Pin diagram

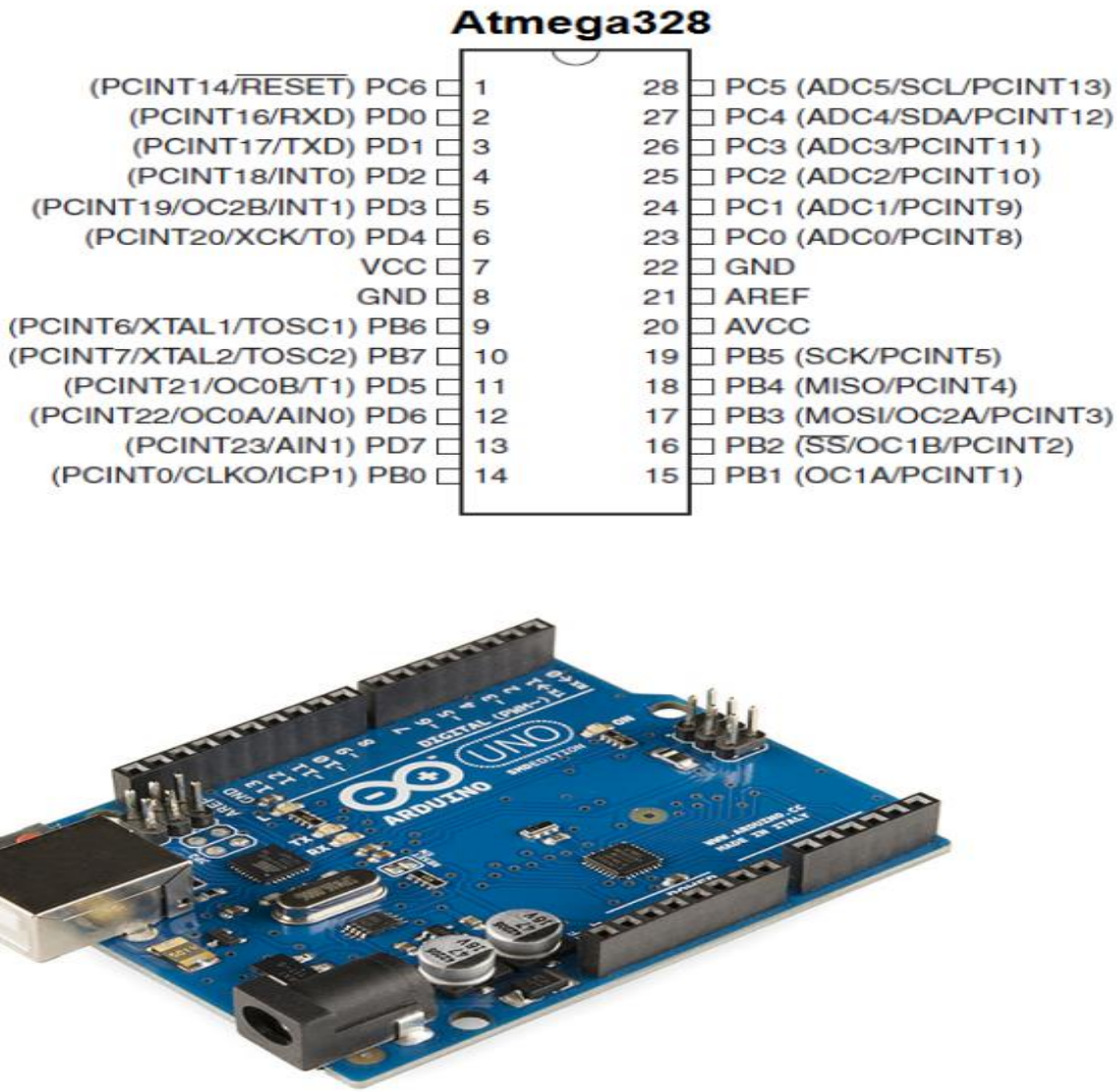


FIGURE:3.2.7.1

3. 2.8 Key Parameters

Parameter	Value
CPU type	8-bit AVR
Performance	20 MIPS at 20 MHz[2]
Flash memory	32 Kb
SRAM	2 kB
EEPROM	1 kB
Pin count	28-pin PDIP, MLF, 32-pin TQPF, MLF
Maximum operating frequency	20 MHz

Number of touch channels	16
Hardware QTouch Acquisition	No
Maximum I/O pins	23
External interrupts	2
USB Interface	No
USB Speed	–

TABLE:3.2.8.1

3.3 Ultrasonic Sensor

3.3.1. Introduction

The HC-SR04 Ultrasonic Distance Sensor is an inexpensive device that is very useful for robotics and test equipment projects. This tiny sensor is capable of measuring the distance between itself and the nearest solid object. The HC-SR04 can be hooked directly to an Arduino or other microcontroller and it operates on 5 volts.

This ultrasonic distance sensor is capable of measuring distances between 2 cm to 400 cm. It's a low current device so it's suitable for battery powered devices.

3.3.2 Electrical Parameter

3.3.3 Working

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 perate at a frequency above human hearing.

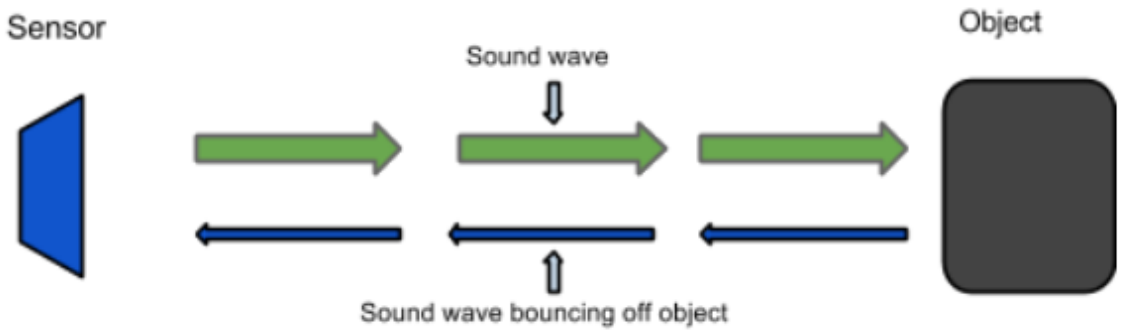


FIGURE:3.3.3.1

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 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.[18]

Figure 2

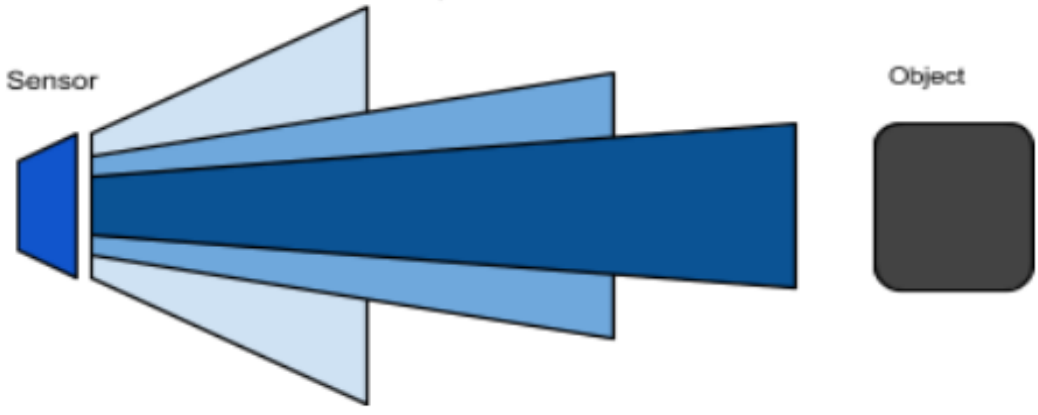


FIGURE:3.3.3.2

3.3.4. 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).

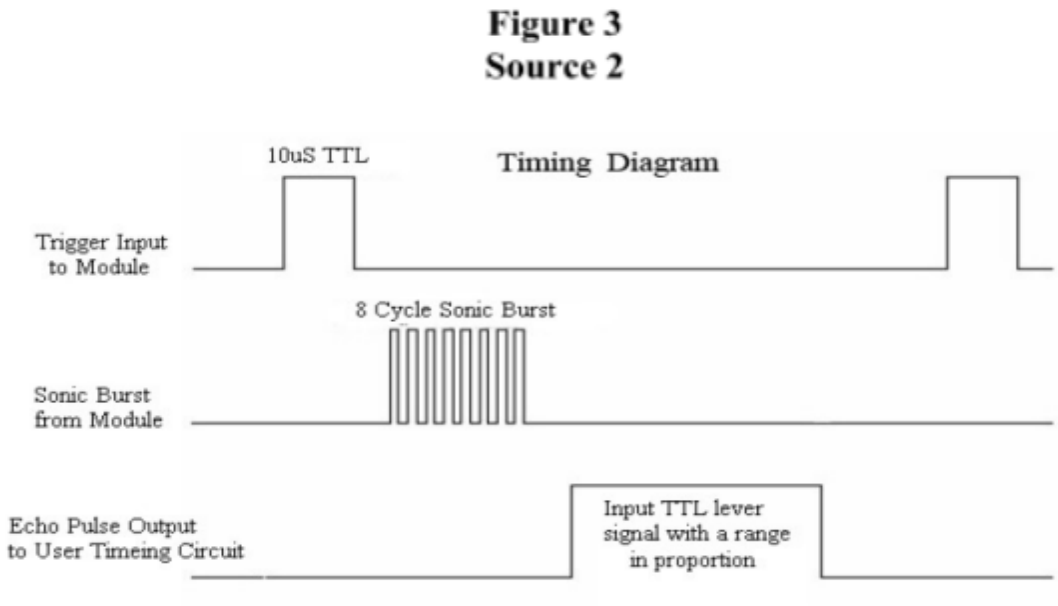
- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working current: 15mA
- Effectual Angle: <15º
- Ranging Distance: 2-400 cm
- Resolution: 0.3 cm
- Measuring Angle: 30º
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm

- Weight: approx. 10 g [18]

3.3.5. 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.[18]

FIGURE:3.3.5.1



Source 2

3.3.6. OPERATION

Ultrasonic distance sensors use pulses of ultrasonic sound (sound above the range of human hearing) to detect the distance between them and nearby solid objects.The device operates as follows:

1. A 5 volt pulse of at least 10 uS (10 microseconds) in duration is applied to the Trigger pin.

2. The HC-SR04 responds by transmitting a burst of eight pulses at 40 KHz. This 8-pulse pattern makes the "ultrasonic signature" from the device unique, allowing the receiver to discriminate between the transmitted pattern and the ultrasonic background noise.

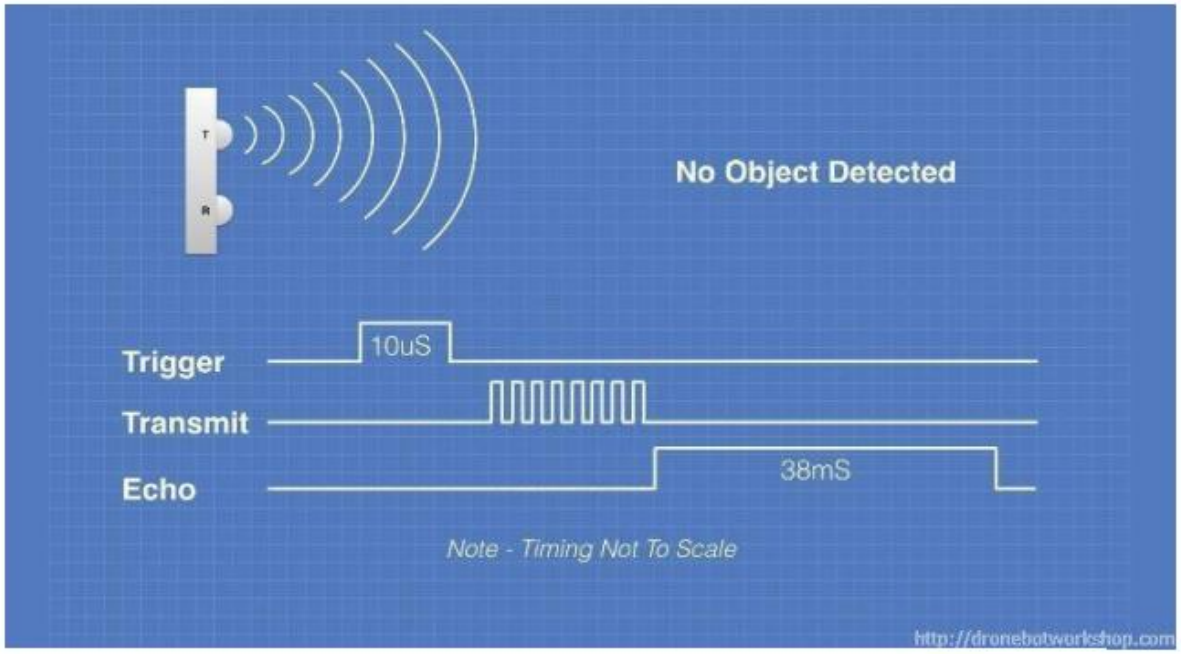
3. The eight ultrasonic pulses travel through the air away from the transmitter. Meanwhile the Echo pin goes high to start forming the beginning of the echo-back signal.

4. If the pulse in NOT reflected back then the Echo signal will timeout after 38 mS (38 milliseconds) and return low. This produces a 38 mS pulse that indicates no obstruction within the range of the sensor.

5. If the pulse IS reflected back the Echo pin goes low when the signal is received. This produces a pulse whose width varies between 150 uS to 25 mS, depending upon the time it took for the signal to be received.

6. The width of the received pulse is used to calculate the distance to the reflected object. Remember that the pulse indicates the time it took for the signal to be sent out and reflected back so to get the distance you'll need to divide your result in half.

Fig 3.3.1


No Object Detected
Trigger
10uS
Transmit
Echo
38mS
Note - Timing Not To Scale
http://dronebotworkshop.com

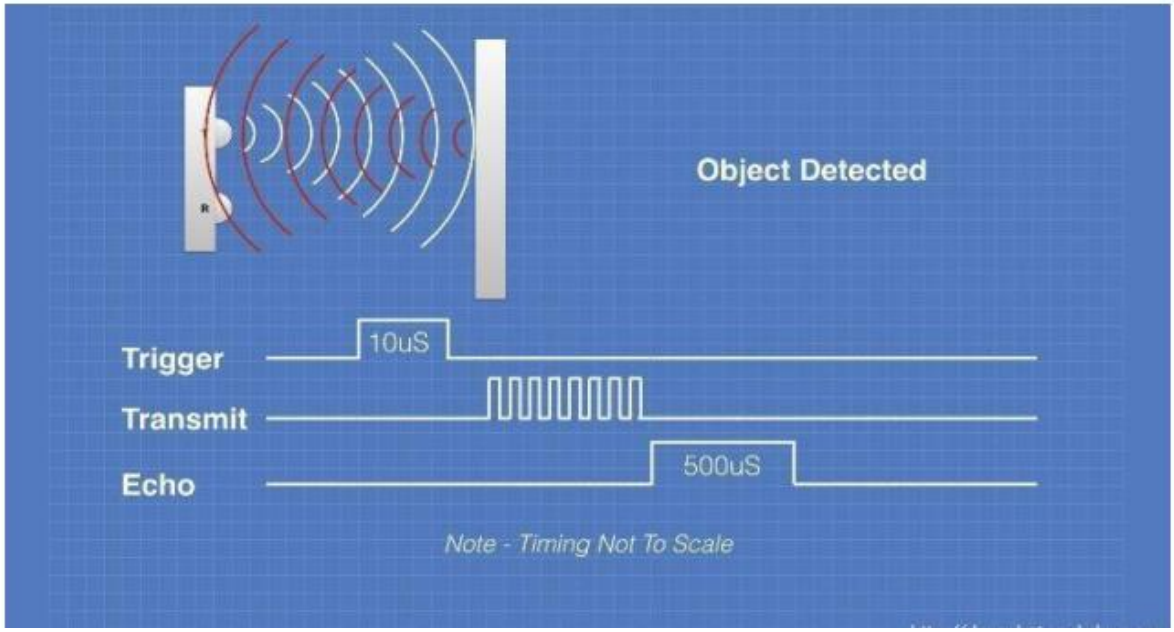

Object Detected
Trigger
10uS
Transmit
Echo
500uS
Note - Timing Not To Scale

Fig:3.3.2

The illustration below shows the dimensions of the HC-SR04 Ultrasonic Distance Sensor as well as the effective angle of operation. As you can see the sensor is most accurate when the object to be detected is directly in front of it but you do get a response from objects within a 45 degree "window". The documentation recommends confining that window to 30 degrees (15)degrees on either side) for accurate readings.

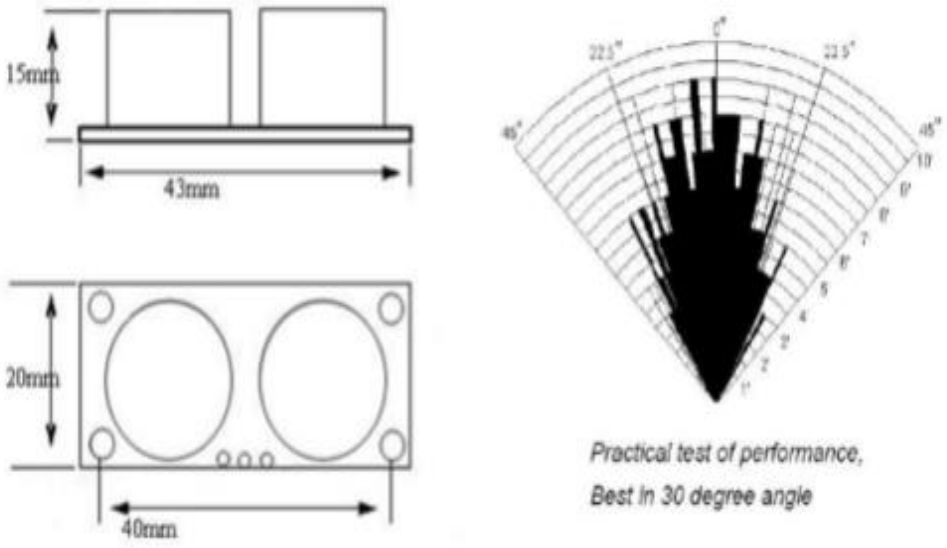


Fig : 3.3.3

3.4. LASER DIODE MODULE

3.4.1 Definition

LASER is an acronym of Light amplification by stimulated emission of radiation. A laser diode emits radiation of a single wavelength or sometimes a narrow band of closely spaced wavelength.It emits light due to stimulated emission, in this when an incident photon strike semiconductor atom, the electrons at higher energy level recombine with lower energy level hole. Due to this two photons are emitted one incident photon and other is emitted due to recombination of electrons and hole.

LEDs also work on the same principle but the major difference is the internal architecture. A laser diode is formed from narrow channels and it acts as a waveguide for light. But LEDs is made up of wide channels.

Due to its structure Laser diode emits coherent & monochromatic light (Single colour). The light emitted by Laser diode consists of single wavelength while LEDs emit light consisting of a wide band of wavelengths. Thus, the light emitted by LED is incoherent.

3.4.2. Construction of Laser diode

The Laser diode is made up of two layers of Semiconductors i.e. P-type and N-type. The layers of semiconductors are made up of GaAs doped with materials like selenium, aluminium or silicon. The construction is same as that of LED except the channels used in Laser are narrow to produce a single beam of light.

And one more difference in a Laser diode is that an intrinsic layer of GaAs (undoped) is also present. This layer is called active layer. The active layer is enclosed by layers of lower refractive index. This act as optical reflectors.

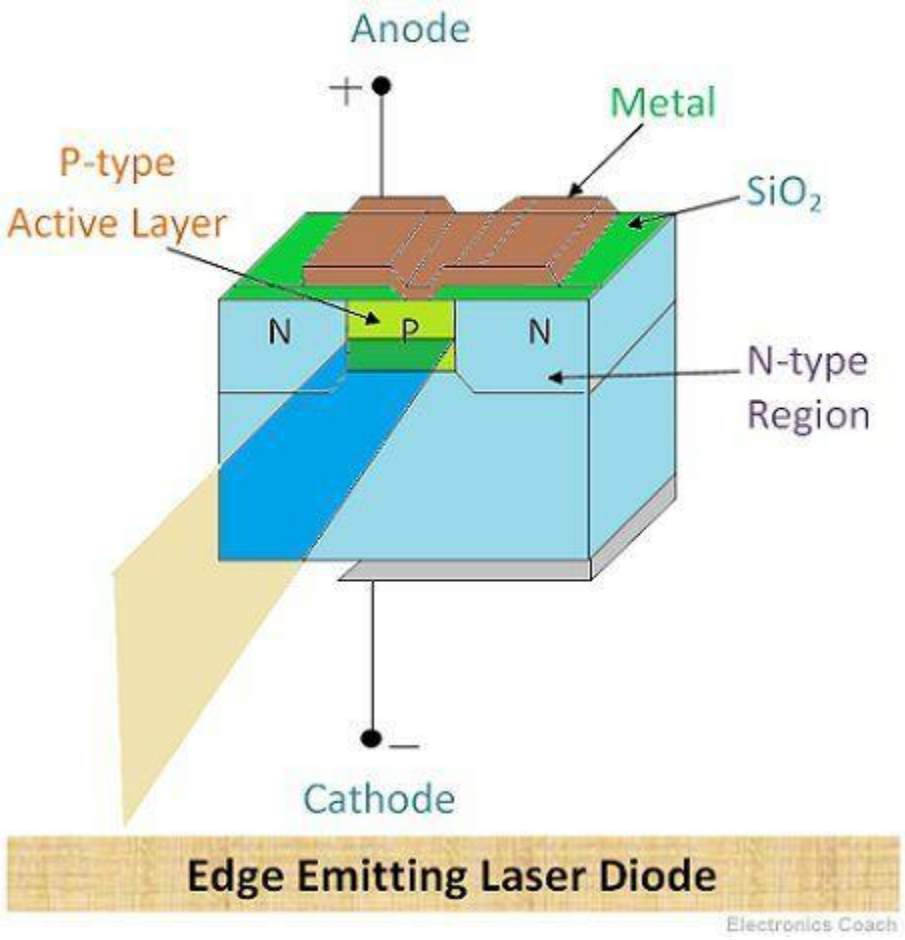


FIGURE:3.4.2.1

These layers along with active layer form a waveguide so that light can travel only in a single path in a single and fixed direction. The beam of light is produced in this section. The metal contacts are provided to facilitate biasing.

3.4.3. Working of Laser diode

The laser diode works on the principle that every atom in its excited state can emit photons if electrons at higher energy level are provided with an external source of energy.

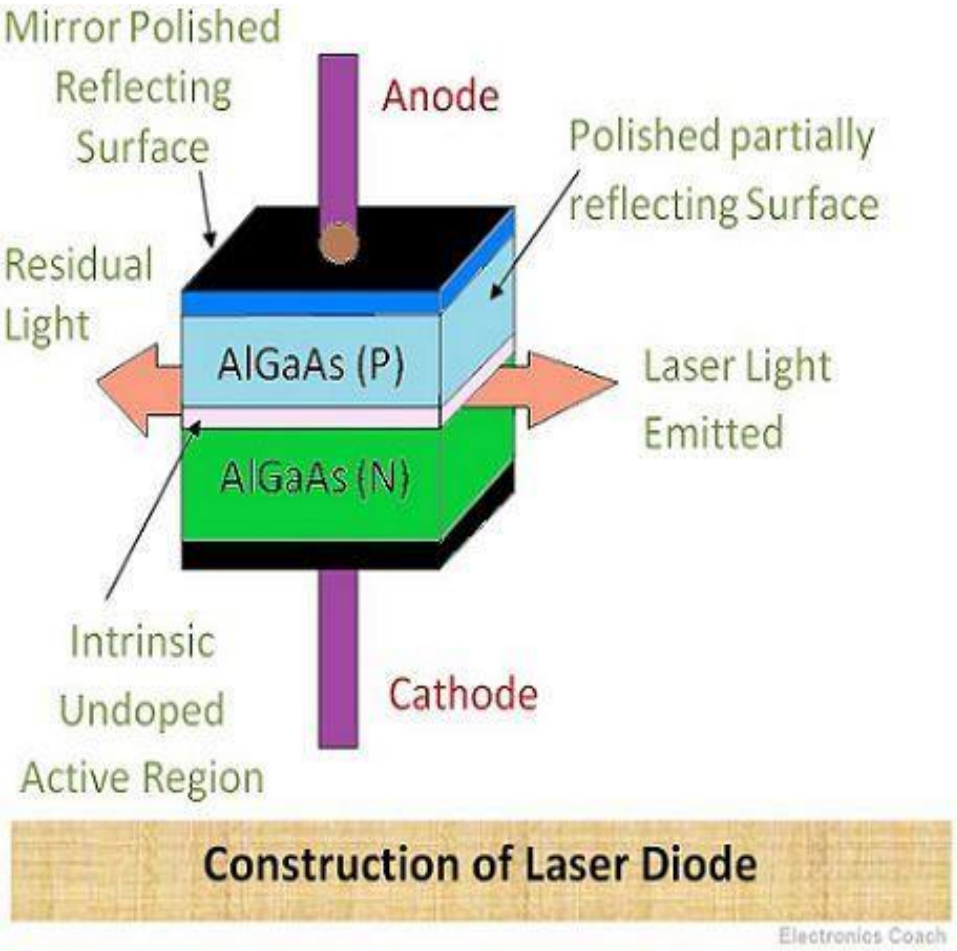


FIGURE:3.4.3.1

There are basically three phenomena by which an atom can emit light energy and that are **Absorption, Spontaneous Emission** & **Stimulated emission.**

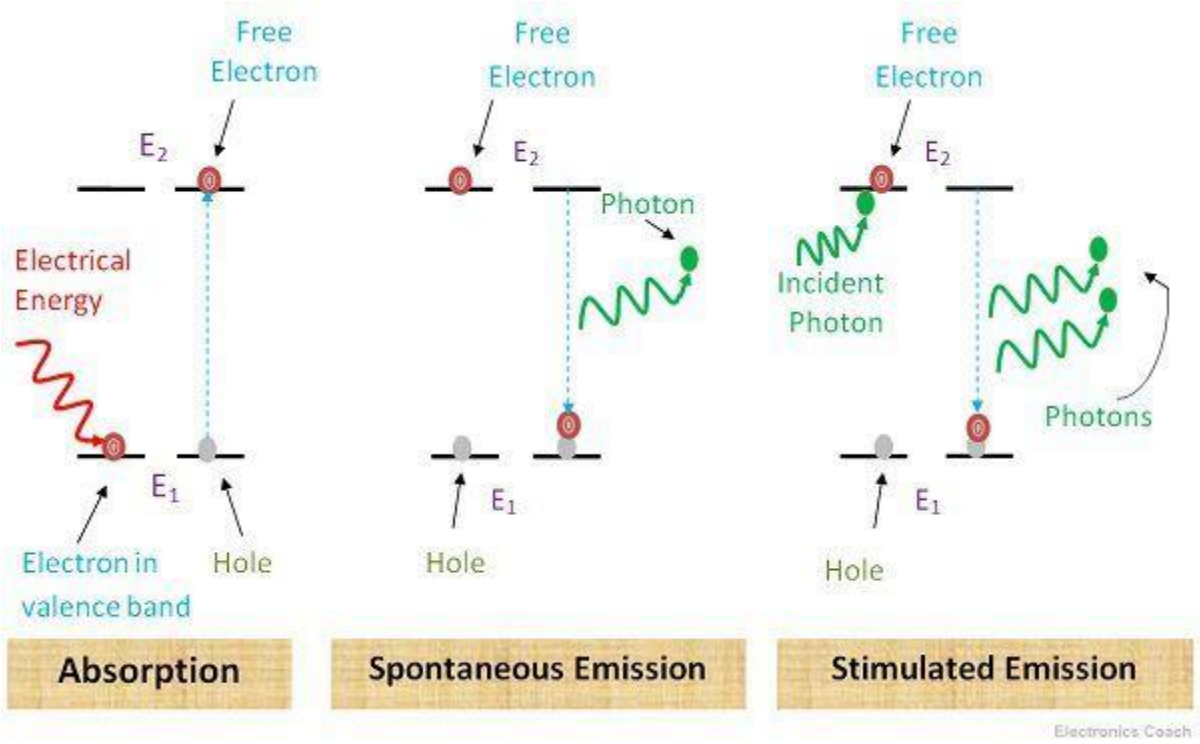


FIGURE:3.4.3.2

Absorption

In absorption, the electrons at lower energy levels jump to higher energy level i.e. from valence band to conduction band when the electrons are provided with an external source of energy. Now, there are holes at lower energy level i.e. valence band and electrons at higher energy level i.e. conduction band.

Spontaneous Emission

Now, if the electrons in higher energy level are unstable then they will tend to move to the lower energy level in order to achieve stability. But if they will move from higher energy level to lower energy levels they will definitely release the energy which will be the energy difference between these two levels. The energy released will be in the form of light and thus photons will be emitted. This process is called **spontaneous emission.**

Stimulated Emission

In stimulated emission, the photons strike electrons at higher energy level and these photons are supplied from an external light energy source. When these photons strike the electrons, electrons gain energy and they recombine with holes and release an extra photon. Thus, one incident photon stimulates another photon to release. Thus, this process is called stimulated emission.

Population inversion

The density of electrons at energy levels is the population of electrons and it is more in valence band or lower energy band and less in the conduction band or higher energy level. If the population of electrons increases at higher energy level or the lifetime of higher energy states is long then stimulated emission will increase. This increase of population at higher energy level is termed as **population inversion.**And this is the requisite state for Laser diode. More the population inversion more will be the electrons at higher and meta stable state and more will be the stimulated emission. The photons emitted are in the same phase with the incident photons. And these photons travel as a single beam of light and thus produce coherence.[19]

3.4.4. Major Categories of Laser Diode

There are two major categories of Laser Diode i.e. **Injection Laser Diode** & **Optically Pumped semiconductor laser diode.**

1. **Injection laser diode:** The operation is similar to LED except that LEDs are formed by wide channels of Semiconductor while Laser diodes are formed from narrow channels. We have already discussed this in the construction of Laser Diode. In this, the light beam travels in the waveguide and the diode itself acts as a waveguide. The light beam is amplified by repeated stimulated emission.
2. **Optically Pumped Semiconductor Laser:** In optically pumped laser the injection laser diode acts as an external pump. The III & V group semiconductor materials act as a basis. And the amplification is achieved by stimulated emission.

It offers several advantages such as prevention from interference caused due to the electrode structure. Besides, it also provides an advantage of wavelength selection.

3.4.5. Laser Diode L-I Characteristics

The light energy increases with increase in laser current but it is dependent on temperature. It is evident from the curve that the light energy increases after a particular threshold laser current. This threshold value of laser current increases exponentially with the temperature.

Thus, at a higher temperature, the threshold value of laser current up to which light energy is generated, also increases. Thus, it is necessary to operate the laser diode up to threshold value of laser current because above this value there is no light energy. In order to have a reliable operation, it is necessary to determine the threshold value of laser current.[19]

V-I Characteristics of Laser diode

The forward voltage of laser diode is generally around 1.5 V. Although the forward voltage depends on operating temperature. The variance of current in the diode with the voltage can be understood with the help of below diagram.

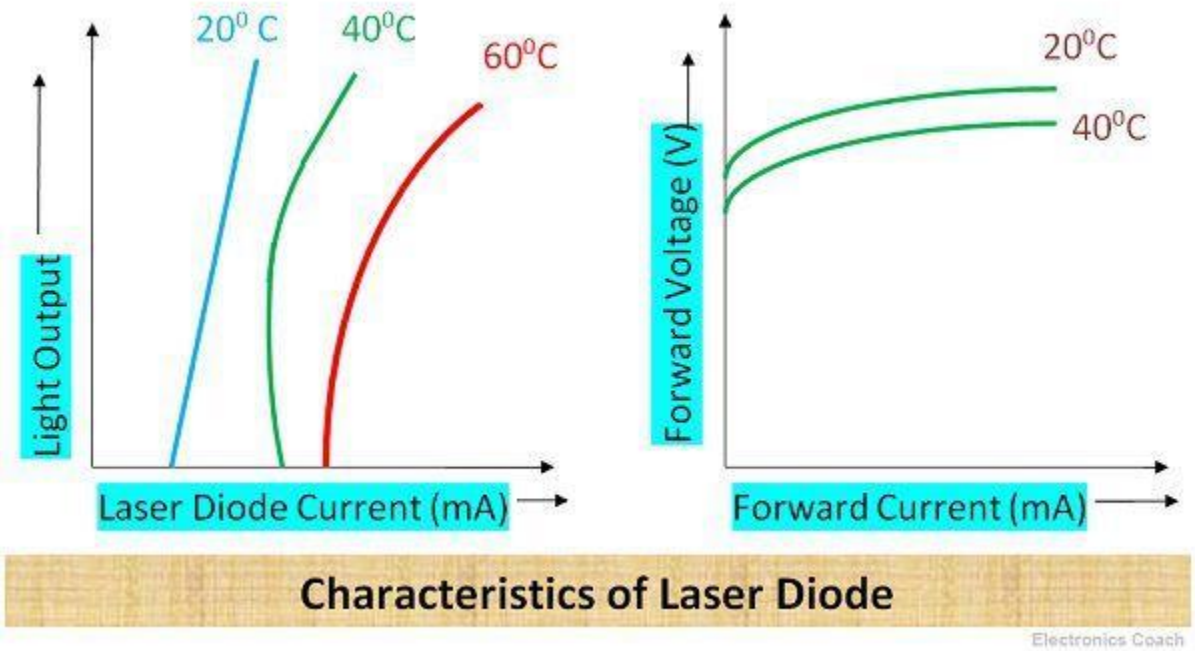


FIGURE: 3.4.5.1

3.4.6. Advantages & Disadvantage of Laser Diode

Advantages

1. Low power Consumption device.
2. Economical as its cost of manufacturing and operation is low.
3. It can be operated for a long time.
4. Portable due to its small size and internal architecture.
5. Highly reliable and highly efficient.

Disadvantages

1. These are temperature dependent and thus its operation is affected by the change in operating temperature.
2. It is not suitable for high power application.

3.4.7. Applications of Laser diode

1. Fibre optical communication system.
2. Barcode readers.
3. Laser Printing and laser scanning.
4. Rangefinders.
5. In medical fields in surgical instruments.
6. In CD players and DVD recorder.

These are some of the significant applications of the LASER diode. Amongst all of these applications the most crucial realm in which laser diode finds its application is optical fibre communication system.[19]

3.5. LCD Display

3.5.1. INTRODUCTION

An electronic device that is used to display data and the message is known as LCD 16×2. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters (16×2=32) in total & every character will be made with 5×8 (40) Pixel Dots. So the total pixels within this LCD can be calculated as 32 x 40 otherwise 1280 pixels.

FIGURE:3.5.1.1: LCD 16 X2

16 X2 displays mostly depend on multi-segment LEDs. There are different types of displays available in the market with different combinations such as 8×2, 8×1, 16×1, and 10×2, however, the LCD 16×2 is broadly used in devices, DIY circuits, electronic projects due to less cost, programmable friendly & simple to access.[16]

3.5.2. Specifications of LCD 16X2

The **specifications of LCD 16X2** are discussed below.

- The operating voltage of this display ranges from 4.7V to 5.3V
- The display bezel is 72 x 25mm
- The operating current is 1mA without a backlight
- PCB size of the module is 80L x 36W x 10H mm
- HD47780 controller
- LED color for backlight is green or blue

- Number of columns – 16
- Number of rows – 2
- Number of LCD pins – 16
- Characters – 32
- It works in 4-bit and 8-bit modes
- Pixel box of each character is 5×8 pixel
- Font size of character is 0.125Width x 0.200height

3.5.3. LCD 16X2 Pin Configuration

The **pin configuration of LCD 16 X 2** is discussed below so that LCD 16×2 connection can be done easily with external devices.

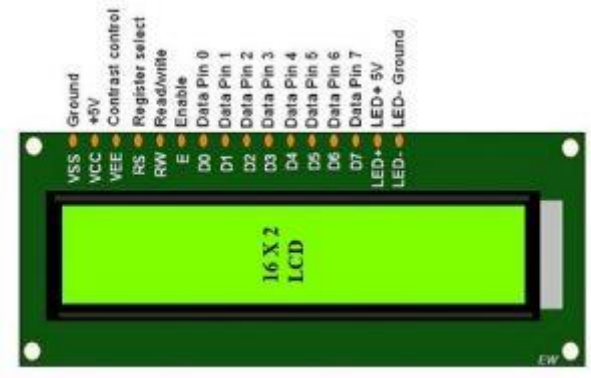


FIGURE:3.5.3.1: 16X2 LCD Pin Diagram

- 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.[16]

3.5.4. LCD 16X2 Commands

The **LCD 16×2 commands** are discussed below.

HexCode 1	This command will remove data displaying on the screen ofLCD.
HexCode 2	It used to move return home.
HexCode 4	It is used to modify a cursor location to the left side.
HexCode 6	It is used to change the cursor location to the right side.
HexCode 5	It is used to shift the display to right.
HexCode 7	It used to shift the display to left.
HexCode 8	It is used to turn ON the cursor &turn off the display
HexCode 0A	It is used to turn OFF the cursor & turn oON the display
HexCode 0C	It is used to turn ON the display & blink the cursor.
HexCode 0E	It is used to turn ON display & blink the cursor

HexCode 0F	It changes the cursor location to left.
HexCode 10	It changes the cursor location to right.
HexCode 14	It changes the display location to the left side.
HexCode 18	It changes the display location to the right side.
HexCode 1C	It is used to shift the cursor to the primary line.
HexCode 80	It moves the cursor to the beginning of the next line
HexCode 38	2- lines & 5×7 matrix

Table:3.5.4.1

3.5.5.Working Principle

The basic **working principle of LCD** is passing the light from layer to layer through modules. These modules will vibrate & line up their position on 90^{o} that permits the polarized sheet to allow the light to pass through it.

These molecules are accountable for viewing the data on every pixel. Every pixel utilizes the method of absorbing light to illustrate the digit. To display the value, the position of molecules must be changed to the angle of light.

So this light deflection will make the human eye notice the data that will be the ingredient wherever the light gets absorbed. Here, this data will supply to the molecules & will be there till they get changed.At present, LCDs are used frequently in CD/DVD players, digital watches, computers, etc. In screen industries, LCDs have replaced the CRTs (Cathode Ray Tubes) because these displays use more power as compared to LCD, heavier & larger.

The displays of LCDs are thinner as compared to CRTs. As compared to LED screens, LCD has less power consumption because it functions on the fundamental principle of blocking light instead of dissipating.

3.5.6. Registers of LCD

The registers used in LCD are two types like data register & command register. The register can be changed by using the RS pinout. If we set ‘0’ then it is command register and if it is ‘1’ then it is data register.

Command Register

The main function of the command register is to save instructions illustrated on LCD. That assists in data clearing & changes the cursor location & controls the display.

Data Register

The data register is used to save the date to exhibit on the LCD. Once we transmit data to LCD, then it shifts to the data register to process the data. If we fix the register value at one that the data register will start working.[16]

3.6. SWITCH

3.6.1. INTRODUCTION

A Switch is a device which is designed to interrupt the current flow in a circuit. In simple words, a Switch can make or break an electrical circuit. Every electrical and electronics application uses at least one switch to perform ON and OFF operation of the device.

So, switches are a part of the control system and without it, control operation cannot be achieved. A switch can perform two functions, namely fully ON (by closing its contacts) or fully OFF (by opening its contacts).

When the contacts of a switch are closed, the switch creates a closed path for the current to flow and hence load consumes the power from source.

3.6.2.Characteristics of a Switch

Before proceeding further and looking at different types of switches, let us see some important points on the Characteristics of a Switch.

- The two important characteristics of a switch are its Poles and Throws. A pole represents a contact and a throw represents a contact-to-contact connection. Number of poles and throws are used to describe a switch.
- Some standard numbers of poles and throws are Single (1 pole or 1 throw) and Double (2 poles or 2 switches).
- If the number of poles or throws are greater than 2, then the number is often directly used. For example, a three pole six throw switch is often represented as 3P6T.
- Another important characteristic of a switch is its action i.e., whether it is a Momentary or Latched action. Momentary Switches (like push buttons, for example) are used to make momentary contact (for a brief time or as long the button is pressed).
- Latched Switches on the hand, maintain the contact until it is forced to the other position.

3.6.3.Types of Switches

Basically, Switches can be of two types. They are:

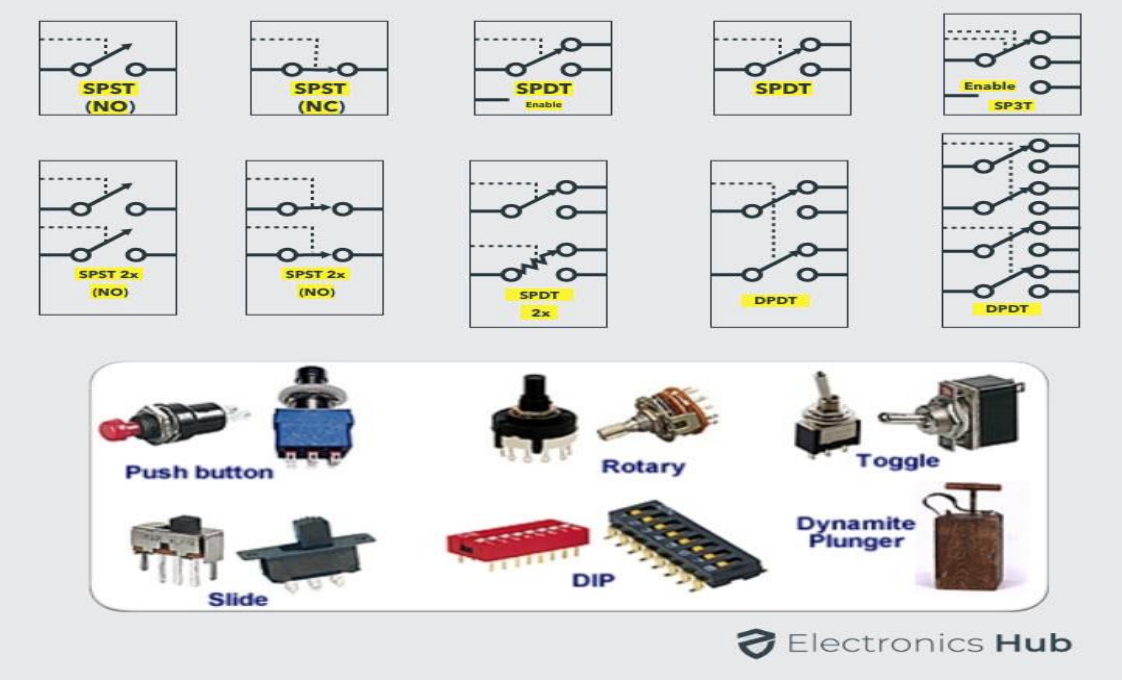
- Mechanical
- Electronic

Mechanical Switches are physical switches, which must be activated physically, by moving, pressing, releasing, or touching its contacts.Electronic Switches, on the other hand, do not require any physical contact in order to control a circuit. These are activated by semiconductor action.

3.6.4.Mechanical Switches

Mechanical switches can be classified into different types based on several factors such as method of actuation (manual, limit and process switches), number of contacts (single contact and multi contact switches), number of poles and throws (SPST, DPDT, SPDT, etc.), operation and construction (push button, toggle, rotary, joystick, etc.), based on state (momentary and locked switches)etc.

FIGURE:3.6.4.1



Based on the number of poles and throws, switches are classified into following types. The pole represents the number of individual power circuits that can be switched. Most of the switches are designed have one, two or three poles and are designated as single pole, double pole and triple pole.

The number of throws represents the number of states to which current can pass through the switch. Most of the switches are designed to have either one or two throws, which are designated as single throw and double throw switches.[21]

3.6.5. Electronic Switches

The electronic switches are generally called as Solid State switches because there are no physical moving parts and hence no physical contacts. Most of the appliances are controlled by semiconductor switches such as motor drives and HVAC equipment.

There are different types of solid state switches are available in todays consumer, industrial and automotive market with different sizes and ratings. Some of these solid state switches include transistors, SCRs, MOSFETs, TRIACs and IGBTs.

3.6.6.Bipolar Transistors

A transistor either allows the current to pass or it blocks the current as similar to working of normal switch.

In switching circuits, transistor operates in cut-off mode for OFF or current blocking condition and in saturation mode for ON condition. The active region of the transistor is not used for switching applications.

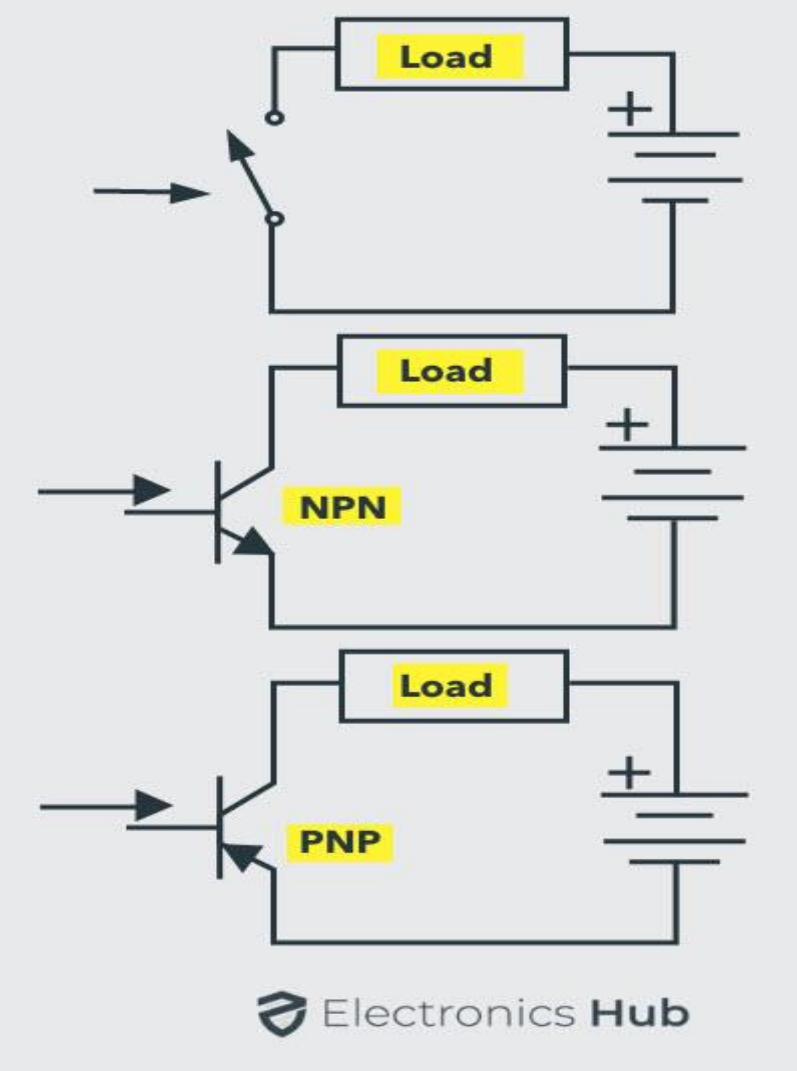


FIGURE:3.6.6.1

Both NPN and PNP transistors are operated or switched ON when a sufficient base current is supplied to it. When a small current flows though the base terminal supplied by a driving circuit (connected between the base and emitter), it causes the transistor to turn ON the collector-emitter path.

And it is turned OFF when the base current is removed and base voltage is reduced to a slight negative value. Even though it utilizes small base current, it is capable of carrying much higher currents through the collector- emitter path.[21]

3.7. JUMPER WIRE

3.7.1. INTRODUCTION

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires.

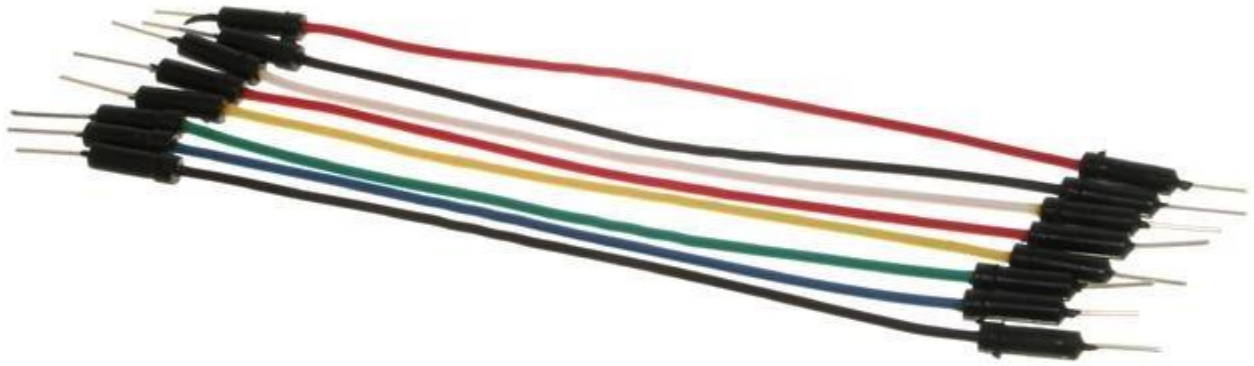


FIGURE:3.7.1.1

Though jumper wires come in a variety of colors, the colors don't actually mean anything. This means that a red jumper wire is technically the same as a black one. But the colors can be used to your advantage in order to differentiate between types of connections, such as ground or power.

While jumper wires are easy and inexpensive to purchase, it can also be a fun task to challenge students to make their own. Doing so requires insulated wire and wire strippers. However, beware that it is important not to nick the wire when stripping off the insulation.

3.7.2. Types of Jumper Wires

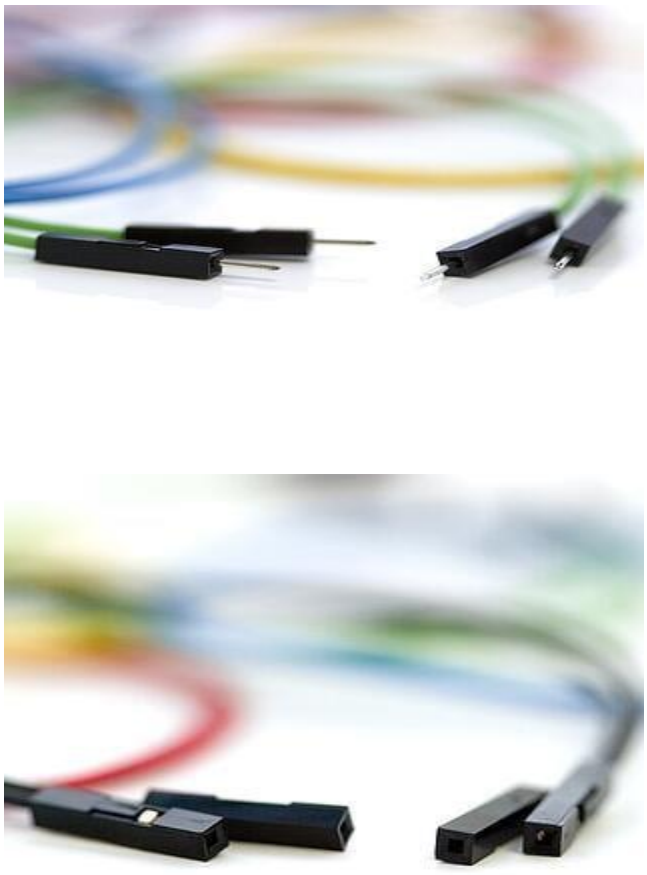


FIGURE:3.7.2

Jumper wires typically come in three versions: male-to-male, male-to-female and female-to-female. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use most often. When connecting two ports on a breadboard, a male-to-male wire is what you'll need.

3.8. BATTERY

3.8.1.INTRODUCTION

A battery is a device that converts chemical energy into electrical energy and vice versa. This summary provides an introduction to the terminology used to describe, classify, and compare batteries for hybrid, plug-in hybrid, and electric vehicles. It provides a basic background, defines the variables used to characterize battery operating conditions, and describes the manufacturer specifications used to characterize battery nominal and maximum characteristics.[23]

3.8.2. Battery Basics

• **Cell, modules, and packs** – Hybrid and electric vehicles have a high voltage battery pack that consists of individual modules and cells organized in series and parallel. A cell is the smallest, packaged form a battery can take and is generally on the order of one to six volts. A module consists of several cells generally connected in either series or parallel. A battery pack is then assembled by connecting modules together, again either in series or parallel.

• **Battery Classifications** – Not all batteries are created equal, even batteries of the same chemistry. The main trade-off in battery development is between power and energy: batteries can be either high-power or high-energy, but not both. Often manufacturers will classify batteries using these categories. Other common classifications are High Durability, meaning that the chemistry has been modified to provide higher battery life at the expense of power and energy.

• **C- and E- rates** – In describing batteries, discharge current is often expressed as a C-rate in order to normalize against battery capacity, which is often very different between batteries. A C-rate is a measure of the rate at which a battery is discharged relative to its maximum capacity. A 1C rate means that the discharge current will discharge the entire battery in 1 hour. For a battery with a capacity of 100 Amp-hrs, this equates to a discharge current of 100 Amps. A 5C rate for this battery would be 500 Amps, and a C/2 rate would be 50 Amps. Similarly, an E-rate the discharge power. A 1E rate is the discharge describes power to discharge the entire battery in 1 hour.

• **Secondary and Primary Cells** – Although it may not sound like it, batteries for hybrid, plug-in, and electric vehicles are all secondary batteries. A primary battery is one that can not be recharged. A secondary battery is one that is rechargeable.

• **(Maximum) Internal Resistance** – The resistance within the battery, generally different for charging and discharging[23]

FIGURE:3.8.2.1

CHAPTER-4

SOFTWARE DESCRIPTION

4.1. Arduino IDE

4.1.1 Introduction

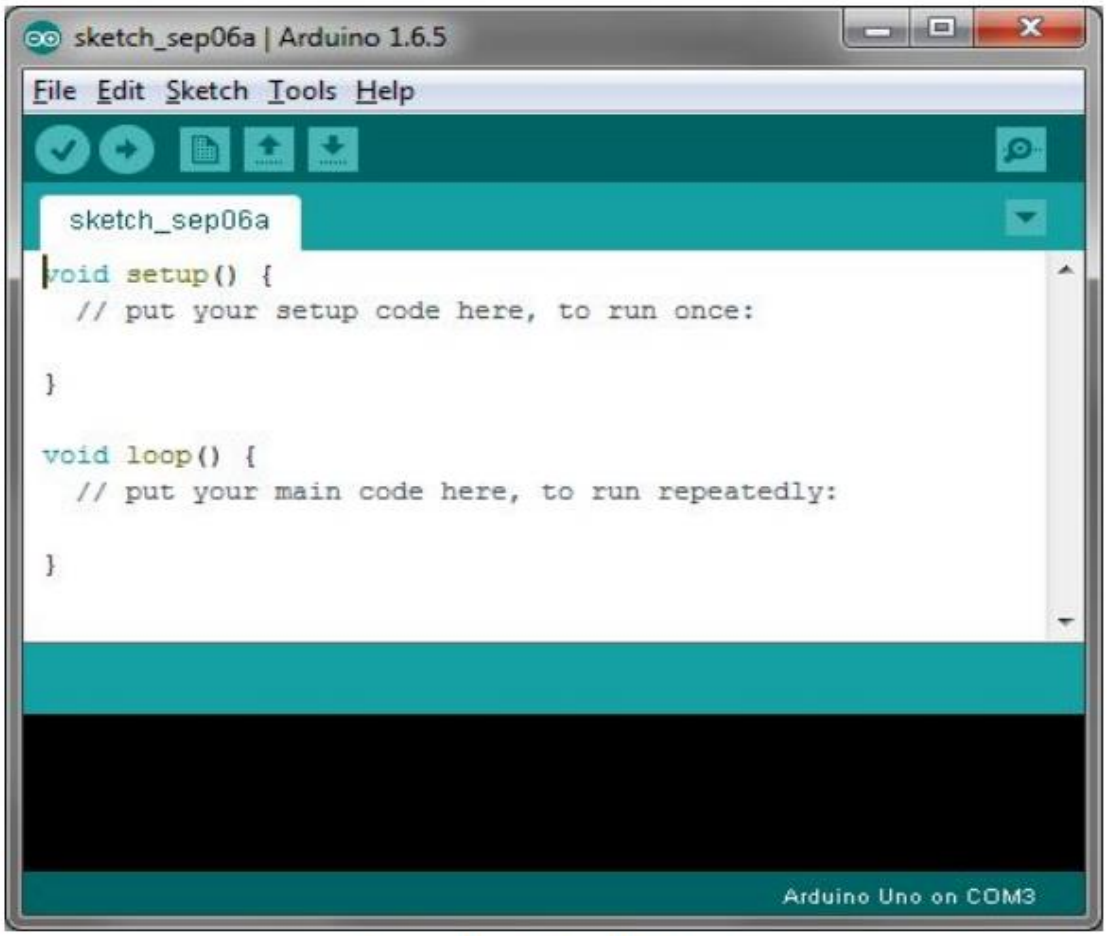
Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

4.1.2 Programming Language used

First, the Arduino compiler/IDE accepts C and C++ as-is. In fact many of the libraries are written in C++. Much of the underlying system is not object oriented, but it could be. Thus, "The arduino language" is C++ or C.

4.1.3 Getting started with arduino ide

This is the Arduino IDE once it's been opened. It opens into a blank sketch where you can start programming immediately. First, we should configure the board and port settings to allow us to upload code. Connect your Arduino board to the PC via the USB cable.

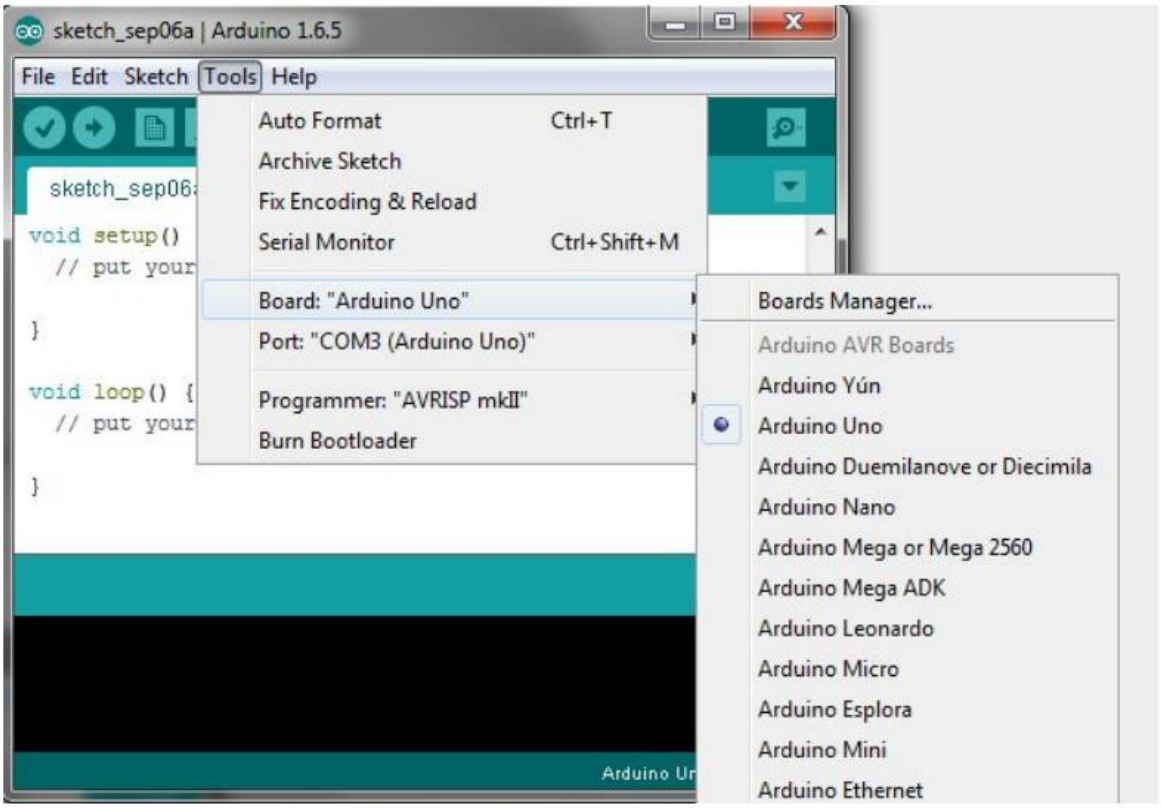


Arduino IDE Default Window

FIGURE:4.1.3.1

IDE: Board Setup

You have to tell the Arduino IDE what board you are uploading to. Select the Toolspulldown menu and go to Board.This list is populated by default with the currently available Arduino Boards that are developed by Arduino. If you are using an Uno or an Uno-Compatible Clone (ex. Funduino, SainSmart, IEIK, etc.), select Arduino Uno. If you are using another board/clone, select that board.[24]

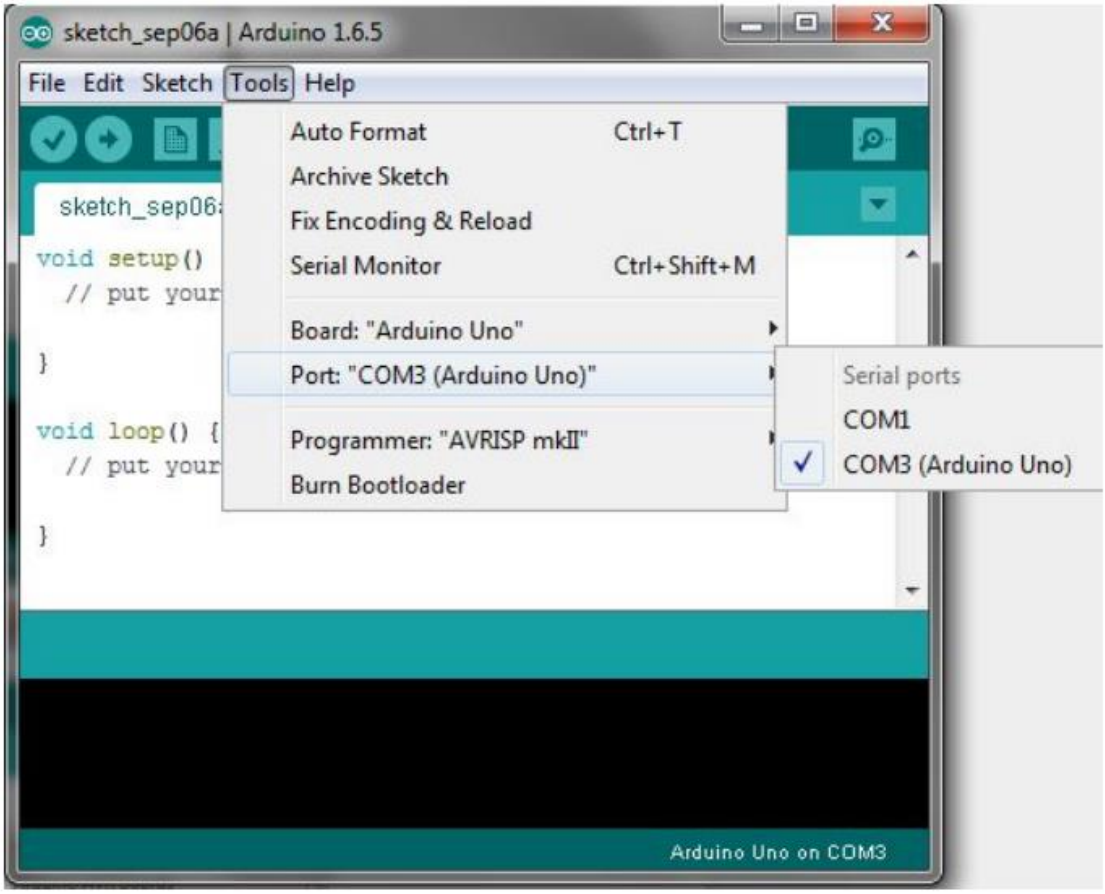


Arduino IDE: Board Setup Procedure

FIGURE:4.1.3.2

IDE: COM Port Setup

If you downloaded the Arduino IDE before plugging in your Arduino board, when you plugged in the board, the USB drivers should have installed automatically. The most recent Arduino IDE should recognize connected boards and label them with which COM port they are using. Select the Tools pulldown menu and then Port.Here it should list all open COM ports, and if there is a recognized Arduino Board, it will also give it's name. Select the Arduino board that you have connected to the PC. If the setup was successful, in the bottom right of the Arduino IDE, you should see the board type and COM number of the board you plan to program. Note: the Arduino Uno occupies the next available COM port; it will not always be COM3.[24]



Arduino IDE: COM Port Setup

FIGURE:4.1.3.3

At this point, your board should be set up for programming, and you can begin writing and uploading code.[24]

4.1.4. Features of Arduino IDE

• The project file or the sketches for a project are saved with the file extension .ino

• Features such as cut / copy / paste are supported in this IDE.

• There also is a facility for finding a particular word and replacing it with another by pressing the Ctrl + F buttons on the keyboard.

• The most basic part or the skeleton of all Arduino code will have two functions.

4.2 Processing IDE

4.2.1 Introduction

Processing (programming language) Processing is an open-source computer programming language and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context.

4.2.2 Processing Software

Word processing software is used to manipulate a text document, such as a resume or a report. You typically enter text by typing, and the software provides tools for copying, deleting and various types of formatting.

4.2.3 Getting Started

1. Open processing IDE 3.3.7.

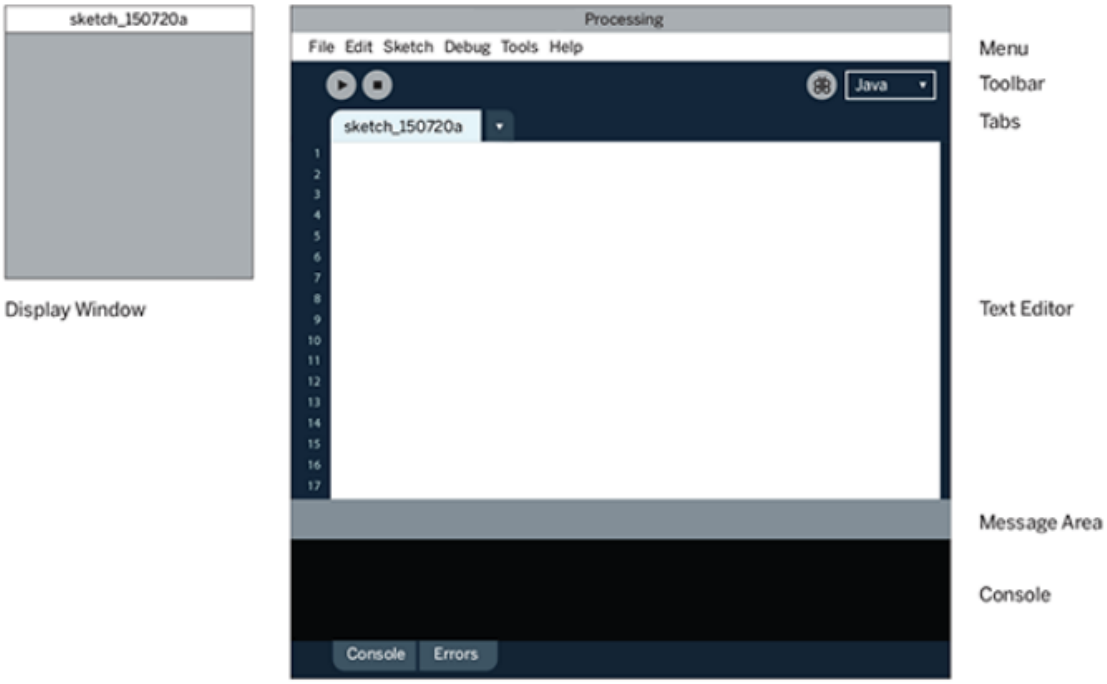


Fig : 4.3.2.1

2.Go to file menu and create new page.

3. Write the code.

4. Run.

4.3 How processing IDE communicate with Arduino IDE?

The Arduino IDE and the Processing IDE will communicate with each other through serial communication. The Processing IDE has a serial library which makes it easy to communicate with the Arduino.

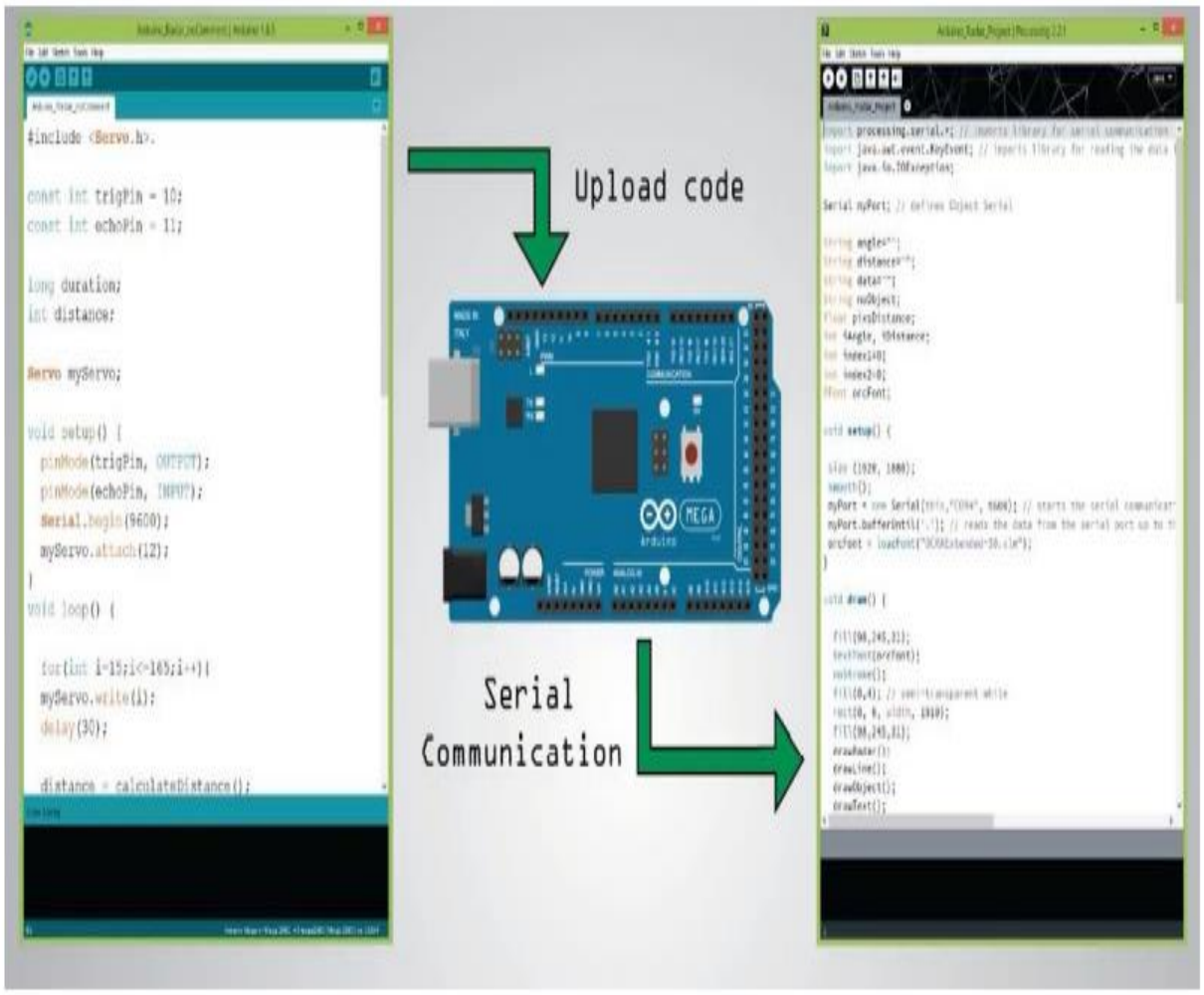


Fig : 4.3.1

CHAPTER 5

METHODOLOGY

5.1 Schematic Diagram

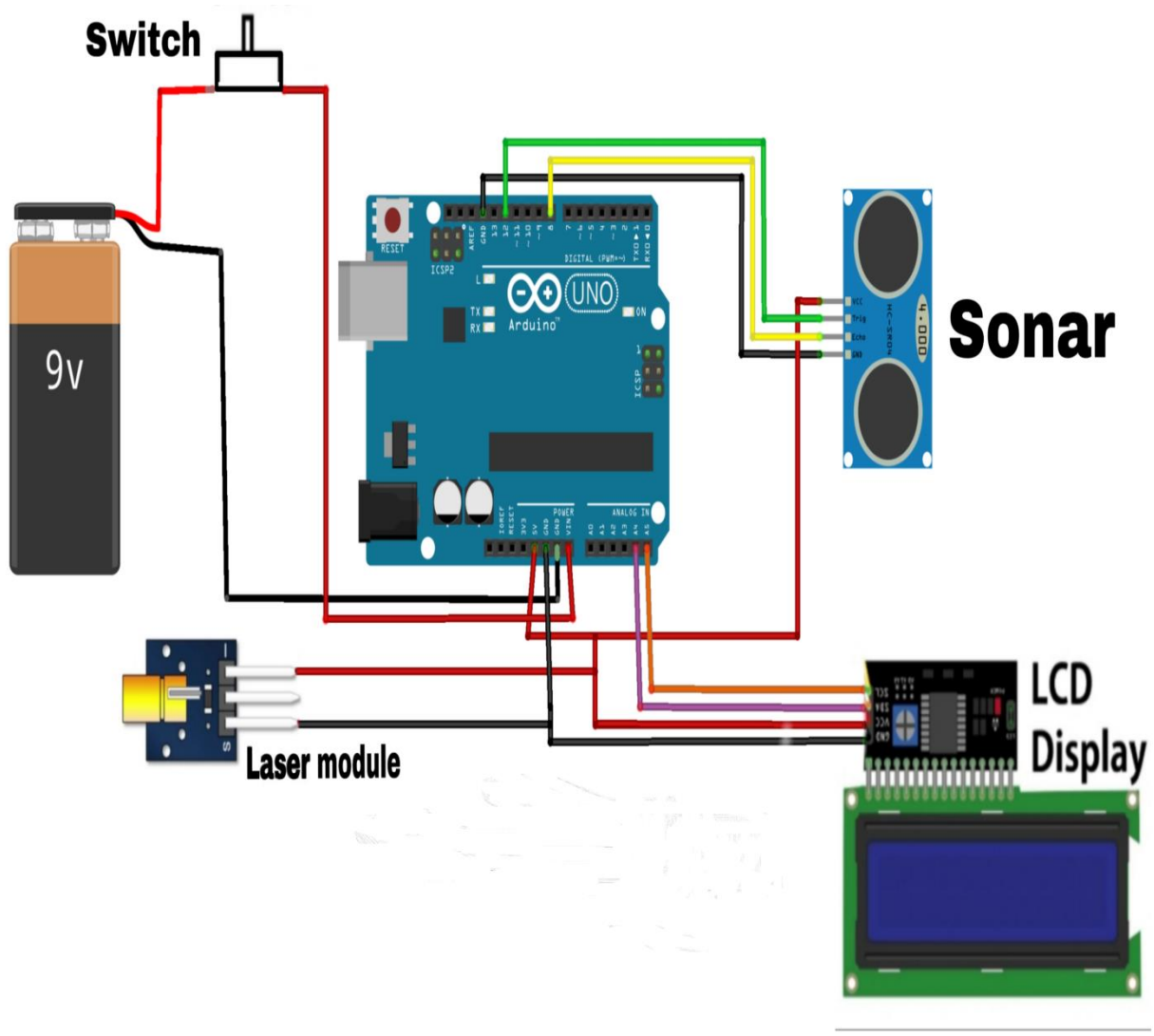


FIGURE:5.1.1

5.2 Implementation

1.Wireless distance measurement system is used to measure the distance between two object precisely.

In this particular project we are using an ultrasonic sensor to measure the distance and we placed the ultrasonic sensor on the top of a servo motor to rotate it at a range of 15 degree to 165 degree.

So by this angle range upto 400cm distance the ultrasonic senses can locate and measure the distance of any object .

2. Now for the hardware port first we take a male to male jumper wire and connect it with 5V pin and connect the other end to the positive rail of breadboard.

Next we take another male to male jumper wire and connect it to the ‘GND’ pin of Arduino and we connect the other port to negative rail of the breadboard.

After that we connect ‘Vcc’ and ‘GND’ pin of both ultrasonic sensor and servo motor to the positive and negative rail of the breadboard respectively. Next we connect the trigger pin of ultrasonic sensor to ‘pin 9’ of Arduino board and we connect pin of ultrasonic sensor to ‘pin 11’ of Arduino board and we connect the data pin of servo motor to ’pin 12’ of Arduino board. And hence the connection of Arduino is completed.

Next we write the code on Arduino IDE and burn it to the Arduino board.

3. We use ‘processing 3.3.7’ software. It is mainly programming language and environment built for the electronics art and graphics used design.

We use this software to locate the object on the computer screen. And print the distance of the object measured by the ultrasonic sensor.

4. We use ‘processing IDE’ to write the code processing IDE similar to the ‘Arduino IDE’. And the ‘processing IDE’ communicate through serial communication with the ’Arduino IDE’.

5.For the communication process we send the data received from ultrasonic sensor to the serial monitor with the same additional characters. These data in the serial monitor will be later received by the ‘processing IDE’ and hence the communication between Arduino IDE and processing IDE is completed.

6.Now we can see the distance of the object at which angle it is located as well as the location of the object in the monitor.

CHAPTER 6

RESULT

6.1. RESULT

The working model of the proposed distance measurement system using ultrasonic sensor was successfully designed and implemented. The circuit was able to measure distance upto 400cm.The circuit was also able to locate the object. Circuit was tested to measure various distance .It has a fast response. The ultrasonic module works good.

By using ultrasonic sensor we were able to reduce cost and increase efficiency. This implementation has been the readily used in the fast growing electronic industry.

CHAPTER 7

APPLICATION

1. Driverless car**.**

2. Robotics

3. To measure the level of fuel in the aircraft fuel tank**.**

4. In radar

5.Maintaining distance in pandemic time

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

8.1 Conclusion

The objective of this project was to design and implement an wireless distance measurement device using ultrasonic sensor. By using the system we can not only calculate the distance of the object but we can also locate the object.

The following can be concluded from the above project-:

1. The system can calculate the distance of the object without errors.

2. The system can locate the object.

3. The system provide low cost and efficient solution.

8.2 Future scope

1. We can use humidity sensors in future to measure distance in different environment.

2. Using ultrasonic sensor with better specification we can increase the distance

measurement range.

3. This system is used in driverless car to detect obstacle.

CHAPTER 9

REFERENCES

1. Shrivastava, Prakhar, Praveen Kumar, and Ankit Tiwari. "Project review on ultrasonic distance measurement." *Int J Eng Tech Res. ISSN* (2014): 2321-0869.
2. Ramesh, P., Sai Sudheera, and D. Vinay Reddy. "Distance measurement using ultrasonic sensor and Arduino." *Journal of Advanced Research in Technology and Management Sciences (JARTMS)* 3.2 (2021).
3. Sunitha, S. "Distance measurement using ultrasonic sensor and NodeMCU." *International Research Journal of Engineering and Technology* 4.6 (2017): 1794-1797.
4. Vidhya, D. S., et al. "Obstacle detection using ultrasonic sensors." *IJIRST–International Journal for Innovative Research in Science & Technology* 2.11 (2016).
5. Soni, Ayush, and Ankish Aman. "Distance Measurement of an Object by using Ultrasonic Sensors with Arduino and GSM Module." *International Journal of Science Technology & Engineering* 4.11 (2018): 23-28.
6. Ramesh, P., Sai Sudheera, and D. Vinay Reddy. "Distance measurement using ultrasonic sensor and Arduino." *Journal of Advanced Research in Technology and Management Sciences (JARTMS)* 3.2 (2021).
7. Gabriel, Mutinda Mutava, and Kamweru Paul Kuria. "Arduino uno, ultrasonic sensor HC-SR04 motion detector with display of distance in the LCD." *International Journal of Engineering Research and Technical Research* 9 (2020).
8. Gabriel, M.M. and Kuria, K.P., 2020. Arduino uno, ultrasonic sensor HC-SR04 motion detector with display of distance in the LCD. *International Journal of Engineering Research and Technical Research, 9.*
9. Latha, N. Anju, B. Rama Murthy, and K. Bharat Kumar. "Distance sensing with ultrasonic sensor and Arduino." *International Journal of Advance Research, Ideas and Innovations in Technology* 2.5 (2016): 1-5.

10. Bereziuk, Oleh, et al. "Ultrasonic microcontroller device for distance measuring between dustcart and container of municipal solid wastes/O." *Bereziuk, M. Lemeshev, V. Bogachuk, W. Wójcik, K. Nurseitova, A. Bugubayeva//Przeglad Elektrotechniczny.–Warszawa, Poland* 4 (2019): 146-150.

11. Carullo, Alessio, and Marco Parvis. "An ultrasonic sensor for distance measurement in automotive applications." *IEEE Sensors journal* 1.2 (2001): 143.

12. Louis, Leo. "working principle of Arduino and u sing it." *International Journal of Control, Automation, Communication and Systems (IJCACS)* 1.2 (2016): 21-29.

13. ARDUINO.CC, "Arduino – Introduction", 2015 [Online] Available: http://arduino.cc/en/Guide/Introduction. [Accessed: 25- Feb - 2015].

14. Arduino.cc, 'Arduino - Products', 2015. [Online]. Available: http://arduino.cc/en/Main/Products. [Accessed: 25- Feb- 2015].

15. Kickstarter, 'ArduSat - Your Arduino Experiment in Space', 2015. [Online]. Available: https://www.kickstarter.com/projects/575960623/ardusat-your-arduino-experiment-in-space. [Accessed: 23- Feb- 2015]

16. Wikipedia, 'ArduSat', 2015. [Online]. Available: http://en.wikipedia.org/wiki/ArduSat. [Accessed: 23- FEB- 2015].

17. ArduPilot Mega, 'ArduPilot Mega', 2015. [Online]. Available: http://www.ardupilot.co.uk/. [Accessed: 23- Nov- 2015].

18. Morgan, Elijah J. "HC-SR04 ultrasonic sensor." (2014): 1-5.

19. Website link: https://electronicscoach.com/laser-diode.html
Retrival Date: 26,may,2022

20. Website link: https://www.watelectronics.com/lcd-16x2/
Retrival Date: 26,may,2022.

21. Website link: **https://www.electronicshub.org/switches/**

Retrival Date:26,may,2022.

22. Website link**:** **https://nickelinstitute.org/en/about-nickel-and-its-applications/nickel-in-batteries/a-guide-to-understanding-battery-specifications/** Retrival Date:26,may,2022

23. Website link: **http://web.mit.edu/evt/summary_battery_specifications.pdf**

Retrival Date:may,2022.

24. Arduino, S.A., 2015. Arduino. *Arduino LLC*, *372*.