COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

COCHIN UNIVERSITY COLLEGE OF ENGINEERING KUTTANAD, PULINCUNNU

PROJECT REPORT

DETECTION AND NOTIFICATION OF POTHOLES AND HUMPS USING IOT

SUBMITTED BY

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in partial fulfilment of the award of degree of **Bachelor of Technology** in

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DIVISION OF ELECTRONICS AND COMMUNICATION ENGINEERING

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COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

COCHIN UNIVERSITY COLLEGE OF ENGINEERING KUTTANAD, PULINCUNNU

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CERTIFICATE

Certified that this is a bonafide project report of the project titled **DETECTION AND NOTIFICATION OF POTHOLES AND HUMPS USING IOT** submitted by **ANOOP ASHOK** (Register No:**20318506**), **G S GOPIKA** (Register No:**20318517**), **PRAFUL RAJ** (Register No:**20318525**), **RUGMINI K S** (Register No:**20318530**) under the Division of **Electronics and Communication Engineering**, Cochin University College of Engineering Kuttanad, Pulincunnu, Alappuzha in partial fulfilment of the award of the degree of Bachelor of Technology in Electronics and Communication Engineering.

Nishanth R	**Anilkumar K K**	**Dr. Manoj V.J**
Guide	Project Coordinator	Head of Division

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ABSTRACT

Transportation is globally grown in urban and rural areas, carried out through several modes and tracks; air, land, and sea. Road transportation has progressively increased over the years with improvement in connectivity between cities, towns and villages. With the increasing mobility and transfer both human and all of the commodity, these cause an increasing number of problems in transportation.

Over the last two decades, there has been a tremendous increase in the vehicle population. This proliferation of vehicles has led to problems such as traffic congestion and an increase in the number of road accidents. Pathetic condition of roads is a boosting factor for traffic congestion and accidents. Researchers are working in the area of traffic congestion control, an integral part of vehicular area networks, which is the need of the hour today.

Roads normally have speed breakers so that the vehicle’s speed can be controlled to avoid accidents. However, these speed breakers are unevenly distributed with uneven and unscientific heights. Identification of pavement distress such as potholes and humps not only help drivers to avoid accidents or vehicle damages but also helps authorities to maintain roads.

In this paper, an Automatic Pothole Detection and Alert System is developed. The system identifies a pothole, alerts the rider and generates location database of existing potholes. This in turn can create cautiousness in the riders, decrease number of accidents.

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CHAPTER 1

INTRODUCTION

India, the second-most populous country in the world and a fast-growing economy, is known to have a gigantic network of roads. Roads are the dominant means of transportation in India today. They carry almost 90 percent of the country's passenger traffic and 65 percent of its freight. Road transportation has expanded the most over the last 50 years, both for passengers and freight markets. This represents a dramatic change in the built environment with the massive addition of road infrastructures supporting urban mobility and connecting cities. Road transport remains the most favoured mode of transport for both freight and passenger movement in India. The fast-growing population, exceptional rate of motorization coupled with the ever growing urbanization has made people vulnerable to frequent road accidents resulting in fatalities, injuries/disabilities.

Even though roads are the most convenient mode of transportation, there are several factors which makes roads dangerous including potholes, humps and traffic violation. Transportation is globally grown in urban and rural areas, but one of the major problems addressed is the maintenance of roads. Well maintained roads contribute a major portion to the country's economy. Most of the roads in India are narrow and congested with poor surface quality, and road maintenance needs are not satisfactorily met. No matter where you are in India, driving is a breath-holding, multi-mirror involving, potentially life-threatening affair.

Road safety continues to be a major developmental issue, a public health concern and a leading cause of death and injury across the world, killing more than 1.35 million globally as reported in the Global Status report on Road Safety 2018 with 90% of these casualties taking place in the developing countries and 11% alone being accounted for by India. As per the Report on Road accidents in India 2019 by the ministry of road transport and highways, the accident-related deaths in India in 2019 were 1, 51,113 in number. According to WHO, the accidents caused by roads because significant public health related problems killing more than 1.25 million people and 50 million injured. 90% of accidents due to potholes causing road accidents are occurring in developed countries.

Several factors can cause the accidents that includes human, vehicles, roads, and environmental factors. Bad roads are a big problem for vehicles and drivers, this is because the deterioration of roads leads to more expensive maintenance, not only for the road itself but also for vehicles. One of factor that becomes the main concern in this research is pothole. Every year several road accidents take place solely credited to the potholes. Accordingly, road surface condition monitoring systems are very important solutions to improve traffic safety, reduce accidents and protect vehicles from damage due to bad roads.

Many metro areas are implementing the use of smart technology to withstand congestion. Technology in transportation becomes important nowadays and must be developed overtime. In the era of development, there are so many roads extensions to balance the significant additions of motorized vehicles.

Having a transportation system that adapts to the needs of commuters is one thing, but having a roadway that can provide real-time feedback and guidance to drivers is even more valuable for drivers. Identification of pavement distress such as potholes and humps not only helps drivers to avoid accidents or vehicle damages but also helps authorities to maintain roads.

To prevent accident to happen, the pothole detection system can be used. The proposed work designed an IoT prototype to collect data which can be used to detect potholes and humps. In this paper, an Automatic Pothole and Hump Detection using IoT and Alert System is developed using ultrasonic sensor, accelerometer, and Global Positioning System (GPS) integrated with ATMEGA328P. The system identifies a pothole, alerts the rider and generates location database of existing potholes. A warning system has been implemented so that it can warn the onboard driver about the upcoming pothole or speed bump. This research is expected to become an appropriate technology that can benefit the community and can reduce the accident and the mortality rate due to damaged road.

Traffic will continue to plague cities as more drivers hit the roads each year, and city engineers will need to look to cutting-edge technology to help the public have a healthier and happier life.

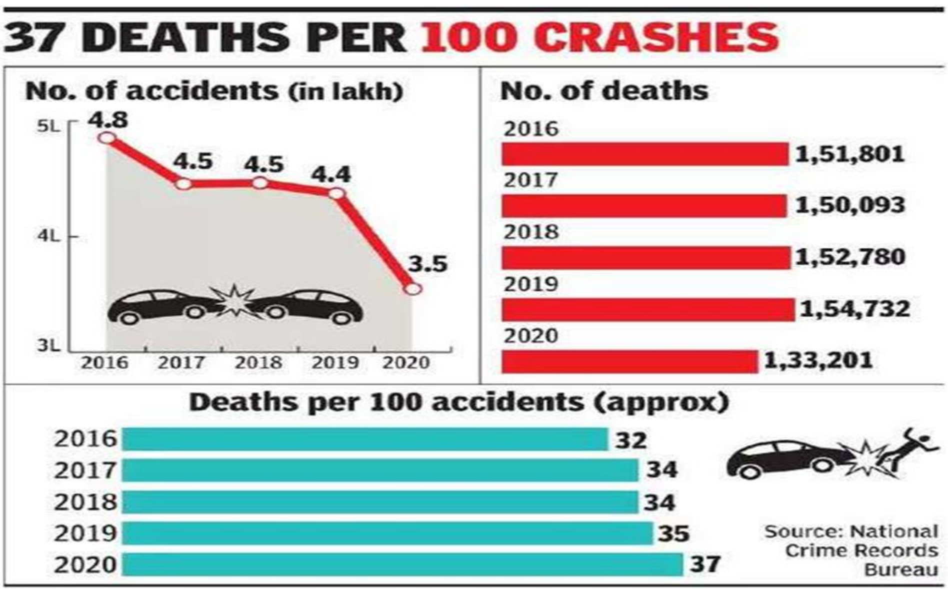
CHAPTER 2

LITERATURE SURVEY

2.1 ROAD ACCIDENTS IN INDIA

According to the latest edition of the World Road Statistics (WRS) 2018, curated by the International Road Federation, Geneva, India witnesses the third highest number of accidents in the world. According to the report, people in the age bracket of 18 to 45 years comprise the majority of the ones dying in such car accidents in the country. India ranks number 1 per number of persons killed and ranks number 3 per number of persons injured in road accidents.

India recorded 1.2 lakh cases of "deaths due to negligence relating to road accidents" in 2020, with 328 persons losing their lives every day on an average, despite the COVID-19 lockdown, according to government data. In terms of percentage, as high as 69.8% of people died in car accidents in India in 2020. Ministry of road transport and highways disclosed that as many as 4,775 accidents occurred in 2019 due to potholes and 3,564 such accidents were reported in 2020.



2.2 EXISTING TECHNOLOGIES

2.2.1 Models to Detect the Three-Dimensional Cross Section of Pavement Pothole Using Digital Image Processing Technologies

This model proposes a vehicle-based computer vision approach to identify potholes using a window-mounted camera. Existing literature on pothole detection uses either theoretically constructed pothole models or footage taken from advantageous vantage points at low speed, rather than footage taken from within a vehicle at speed. A distinguishing feature of the work presented in this paper is that a thorough exercise was performed to create an image library of actual and representative potholes under different conditions, and results are obtained using a part of this library. A model of potholes is constructed using the image library, which is used in an algorithmic approach that combines a road colour model with simple image processing techniques such as a Canny filter and contour detection. Using this approach, it was possible to detect potholes with a precision of 81.8% and recall of 74.4%.

2.2.2 System where Wi-Fi Equipped Vehicles Collect Information about the Road Surface and Pass it to the Wi-Fi Access Point

Many on-going projects in the field of vehicular networks are working in the direction of providing drivers with relevant information about roads and traffic movements. In this model, a novel Wi-Fi based architecture for Pothole Detection and Warning System assists the driver in avoiding potholes on the roads by giving prior warnings. The system consists of access points placed on the roadsides for broadcasting data, which can be received by Wi-Fi enabled vehicles as they enter the area covered by the influence of the access points. The mobile nodes can also broadcast their response as feedback which when received by access point can be utilized for backend server processing. The pothole detection application proposed in this paper enables the driver to receive information of the potholes on the roads in the vicinity of the moving vehicle. The application can be integrated in the vehicle so as to alarm the driver in the form of a visual signal, audio signal or even trigger the braking system.

2.2.3 Real-time Pothole Detection Models using Android Smartphone with Accelerometer

This model proposes a mobile sensing system for road irregularity detection using Android OS based smart-phones. Preliminary data from the accelerometer sensors were collected using a modified LynxNet collar device on an urban road with various potholes. The device is based on the Tmote Mini sensor node with Texas Instruments microcontroller MSP430F1611 and Analog Devices 3-axis accelerometer ADXL335. For raw acceleration data acquisition and transmission through USB interface to a laptop computer, MansOS based software was used. Previously developed RoadMic pothole detection methodology was used to collect reference data, and the test drives were located on the same test track, where RoadMic tests were performed. After acquisition of the first test data set, research of potential event related features was performed. The emphasis was put on features that do not require resource intensive signal processing techniques and therefore are suitable for implementation of real time detection using devices with limited hardware and software resources

2.2.4 Methods to Distinguish Potholes from Other Defect such as Crack

The method uses the semantic texton forests (STFs) algorithm as a supervised classifier on a calibrated region of interest, which is the area of the video frame depicting only the usable part of the pavement lane. The overall accuracy of the method is above 82%, with a precision of more than 91% for longitudinal cracks, more than 81% for transverse cracks, more than 88% for patches, and more than 76% for potholes. The duration for training and classifying spans from 25 to 150 min, depending on the number of video frames used for each experiment.

CHAPTER 3

THEORY

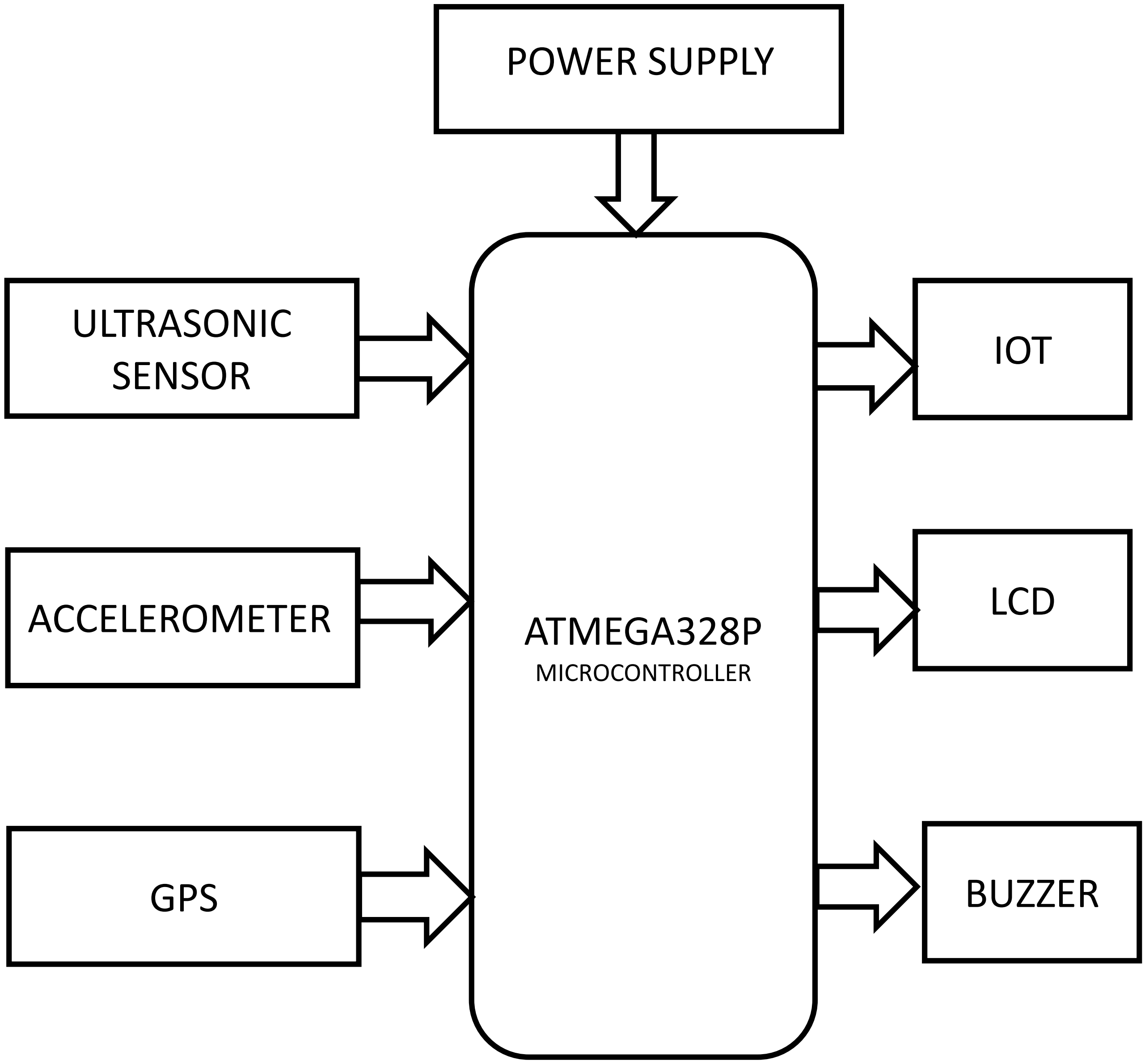
3.1 OBJECTIVE

The proposed system involves the detection of potholes and humps-their geographical locations, real time value and accelerometer value. The inclusion of Internet of Things enhances application of this model, since the sensed data produced over the cloud can provide alerts to drivers and data can be analyzed by the authorized persons in large scale.

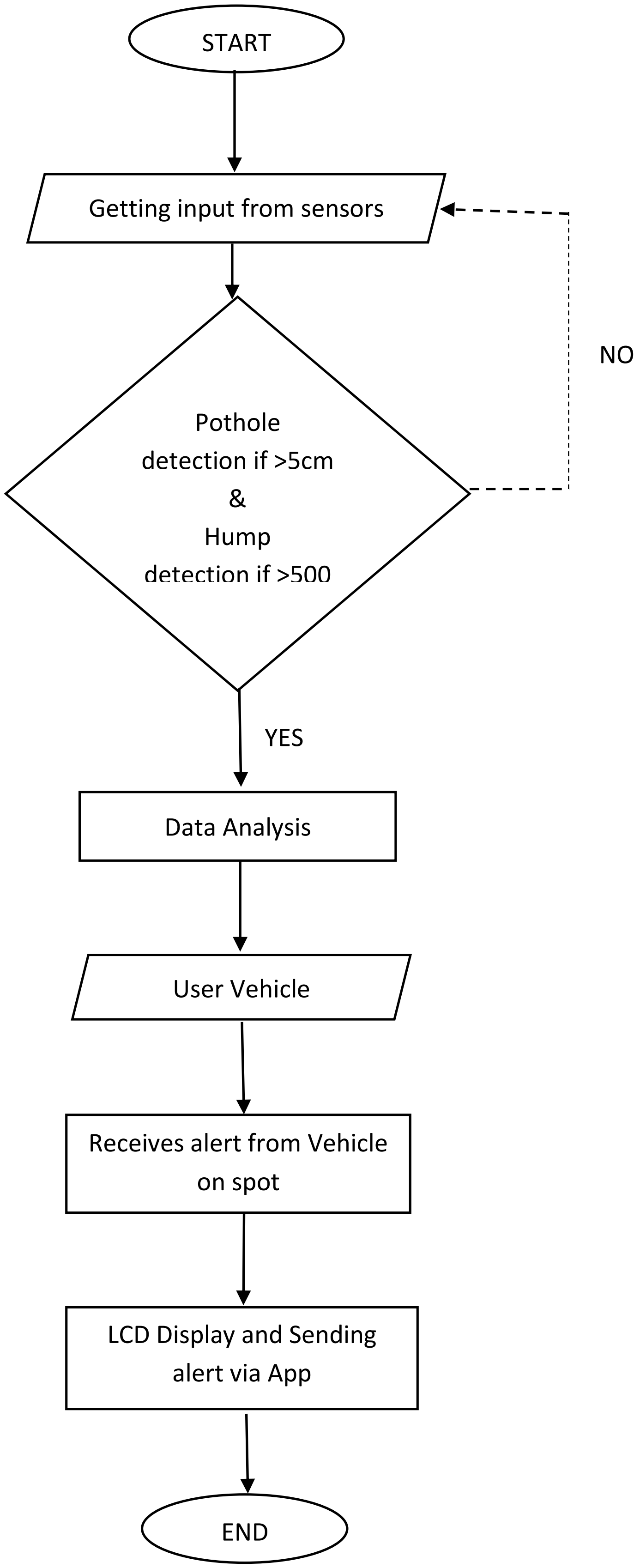
3.2 METHODOLOGY

Proposed a system where sensors are mounted on public vehicles. These sensors record vertical and horizontal accelerations experienced by vehicles on their route. The installed GPS device takes note of its corresponding coordinates to locate the potholes and the collected data is processed to locate potholes along the path traversed earlier by the vehicle. The detection of pothole is done using the ultrasonic sensor. This system uses ultrasonic sensor to sensing the potholes and warnings given by buzzer, if the driving vehicle is coming near a pothole. The gyro sensor has a function to determine the acceleration of the vehicle and provides the data to the microcontroller. The entire data processing was done on a microcontroller Arduino-based so the system can be easily created or modified with the Arduino program language. This kind of microcontroller is commonly used due to several benefits which are size, convenience, and features. The information is displayed on the LCD display. The data from by these sensors is collected by the controller and transmitted by IOT to store in the cloud.

3.3 BLOCK DIAGRAM



3.4 FLOW CHART



CHAPTER 4

COMPONENTS USED

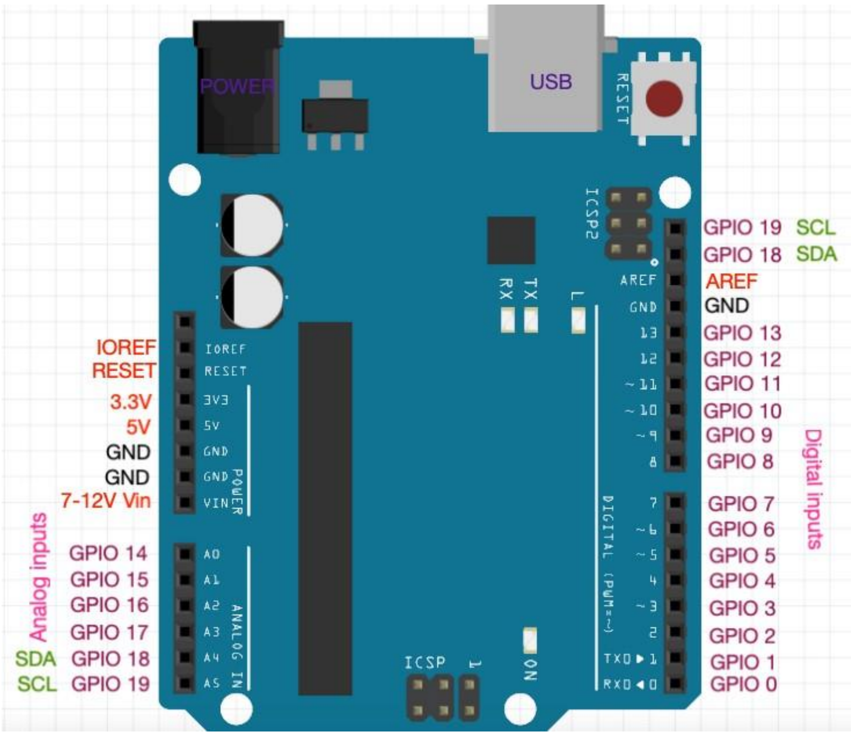
4.1 ARDUINO UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts."Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes pre-programmed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol.

4.1.1 Specification

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volt
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by boot loader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz

4.1.2 Pin out Configuration



The Arduino UNO board contains the following components and specifications:

ATmega328: This is the brain of the board in which the program is stored.

Ground Pin: there are several ground pins incorporated on the board.

PWM: the board contains 6 PWM pins. PWM stands for Pulse Width Modulation, using this process we can control the speed of the servo motor, DC motor, and brightness of the LED.

Digital I/O Pins: there are 14 digital (0-13) I/O pins available on the board that can be connected with external electronic components.

Analogue Pins: there are 6 analogue pins integrated on the board. These pins can read the analogue sensor and can convert it into a digital signal.

AREF: It is an Analog Reference Pin used to set an external reference voltage.

Reset Button: This button will reset the code loaded into the board. This button is useful when the board hangs up, pressing this button will take the entire board into an initial state.

USB Interface: This interface is used to connect the board with the computer and to upload the Arduino sketches (Arduino Program is called a Sketch)

DC Power Jack: This is used to power up the board with a power supply.

Power LED: This is a power LED that lights up when the board is connected with the power source.

Micro SD Card: The UNO board supports a micro SD card that allows the board to store more information.

3.3V: This pin is used to supply 3.3V power to your projects.

5V: This pin is used to supply 5V power to your projects.

VIN: It is the input voltage applied to the UNO board.

Voltage Regulator: The voltage regulator controls the voltage that goes into the board.

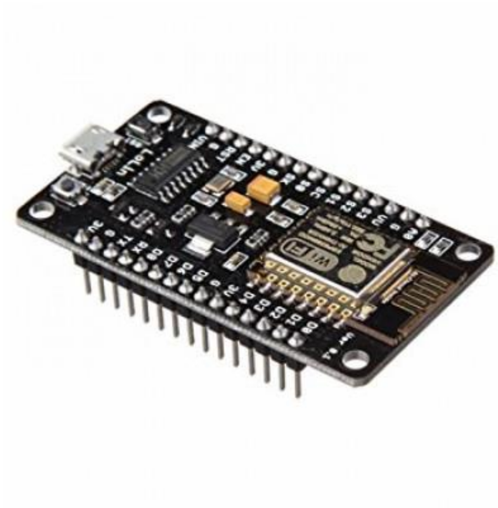
SPI: The SPI stands for Serial Peripheral Interface. Four Pins 10(SS), 11(MOSI), 12(MISO), 13(SCK) are used for this communication.

TX/RX: Pins TX and RX are used for serial communication. The TX is a transmit pin used to transmit the serial data while RX is a receive pin used to receive serial data.

4.2 NODE MCU

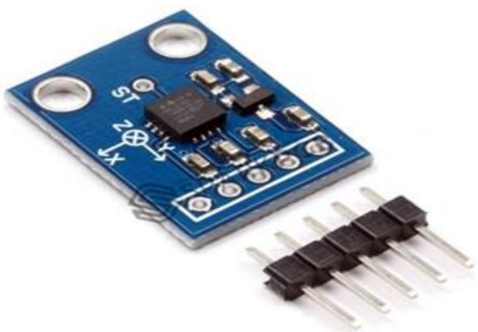
NodeMCU is an open-source Lua based firmware for the ESP8266 Wi-Fi SOC from Espressif and uses an on-module flash based SPIFFS file system. NodeMCU is implemented in C and is layered on the Espressif NON-OS SDK. The firmware was initially developed as is a companion project to the popular ESP8266-based NodeMCU development modules, but the project is now community-supported, and the firmware can now be run on any ESP module. Features of NodeMCU are

- Open-source
- Interactive
- Programmable
- Low cost
- Simple & Smart
- WI-FI enabled

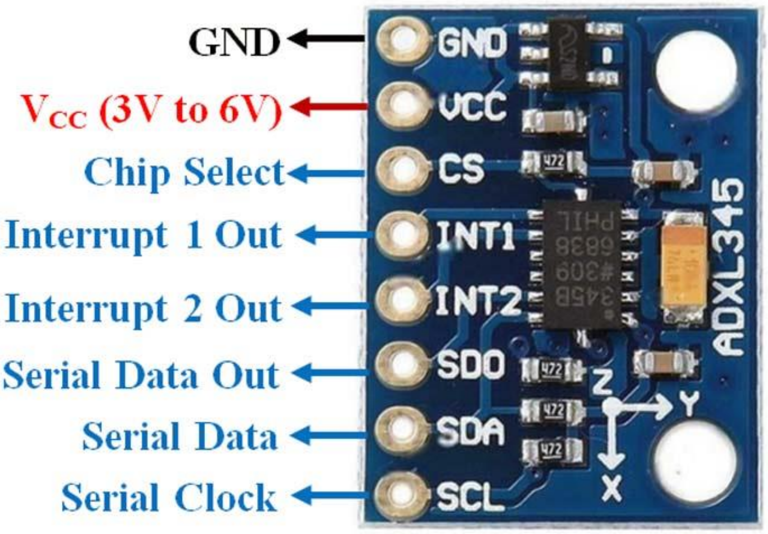


4.3 ADXL345 ACCELEROMETER

The ADXL345 is a small, low power, complete 3-axis MEMS accelerometer modules with both I2C and SPI interfaces. The ADXL345 board feature on-board 3.3V voltage regulator and level shifter. This ADXL345 Accelerometer module consists of an ADXL345 Accelerometer IC, Voltage Regulator IC, Level Shifter IC, resistors, and capacitors in an integrated circuit. Different manufacturers use a different voltage regulator IC. The product measures acceleration with a minimum full-scale range of ±16g. The ADXL345 is well suited for mobile device applications. It measures the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (4 mg/LSB) enables measurement of inclination changes less than 1.0°.



4.3.1 Pin Configuration



Pin Name	Pin Configuration
GND	Ground Pin
VCC	Power Supply Pin(3V to 6V)
CS	Chip Select Pin
INT1	Interrupt 1 Output
INT2	Interrupt 2 Output
SDO	Serial Data Output
SDA	Serial Data Input & Output
SDL	Serial Communication Clock

4.4 NEO-6M GPS MODULE

The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations. The GPS receiver gets a signal from each GPS satellite. The NEO-6M GPS module is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. The module simply checks its location on earth and provides output data which is longitude and latitude of its position. It is from a family of stand-alone GPS receivers featuring the high-performance u-blox 6 positioning engines. These flexible and cost-effective receivers offer numerous connectivity options in a miniature package. The compact architecture, power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints.

4.5 HC-SR04 ULTRASONIC SENSOR

HC-SR04 Ultrasonic sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. At its core, the HC-SR04 Ultrasonic distance sensor consists of two ultrasonic transducers. The one acts as a transmitter which converts electrical signal into 40 KHz ultrasonic sound pulses. The receiver listens for the transmitted pulses. If it receives them, it produces an output pulse whose width can be used to determine the distance the pulse travelled. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm.

4.6 LIQUID CRYSTAL DISPLAY

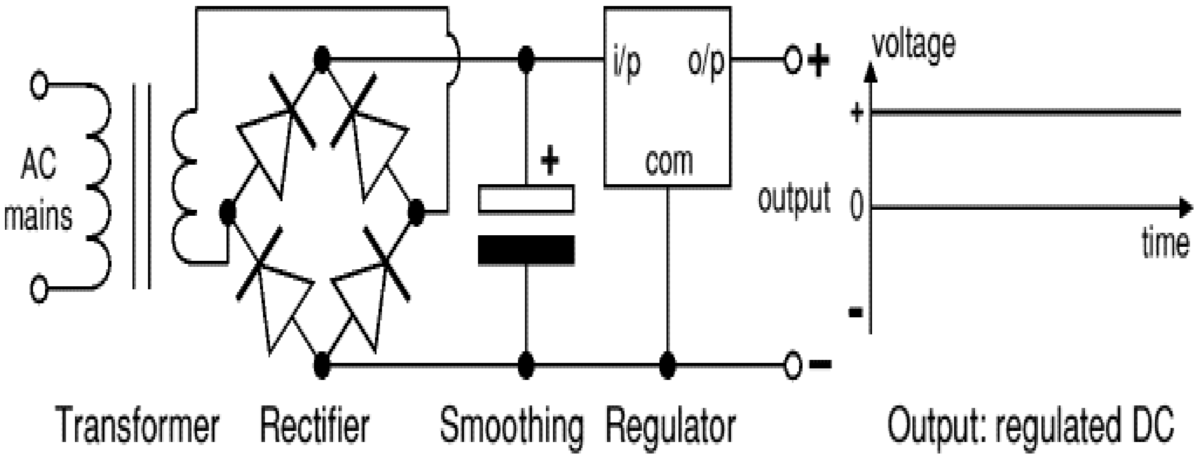
A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary image are made up of a large number of small pixels, while other displays have larger elements. An LCD is a small low-cost display. It is easy to interface with a microcontroller because of an embedded controller

4.7 BUZZER

A buzzer or beeper is a signalling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board.

4.8 POWER SUPPLY CIRCUIT

A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. Power supplies for electronic devices can be broadly divided into linear and switching power supplies. The linear supply is a relatively simple design that becomes increasingly bulky and heavy for high current devices; voltage regulation in a linear supply can result in low efficiency. A switched-mode supply of the same rating as a linear supply will be smaller, is usually more efficient, but will be more complex.



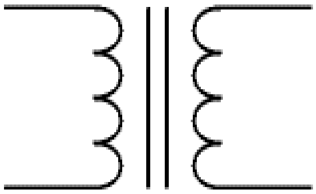
4.8.1 Linear Power supply

An AC powered linear power supply usually uses a transformer to convert the voltage from the wall outlet (mains) to a different, usually a lower voltage. If it is used to produce DC, a rectifier is used. A capacitor is used to smooth the pulsating current from the rectifier. Some small periodic deviations from smooth direct current will remain, which is known as ripple. These pulsations occur at a frequency related to the AC power frequency.

4.8.2 Transformer

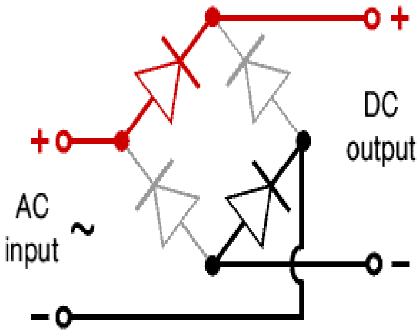
Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage to a safer low voltage.

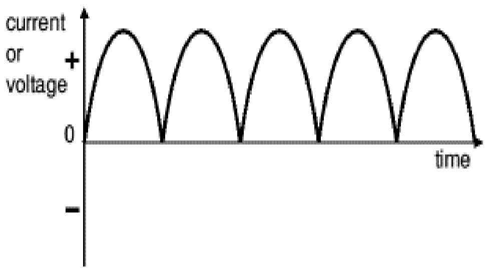
The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft iron core of the transformer.



4.8.3 Bridge rectifier

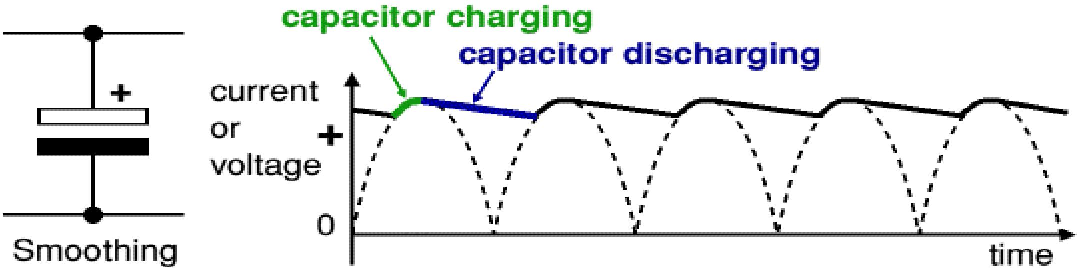
A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave. 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand.





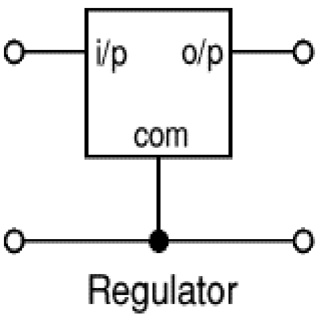
4.8 Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output. Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small ripple voltage.



4.8.5 Regulator

Voltage regulator ICs are available with fixed or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current and overheating. The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and current.

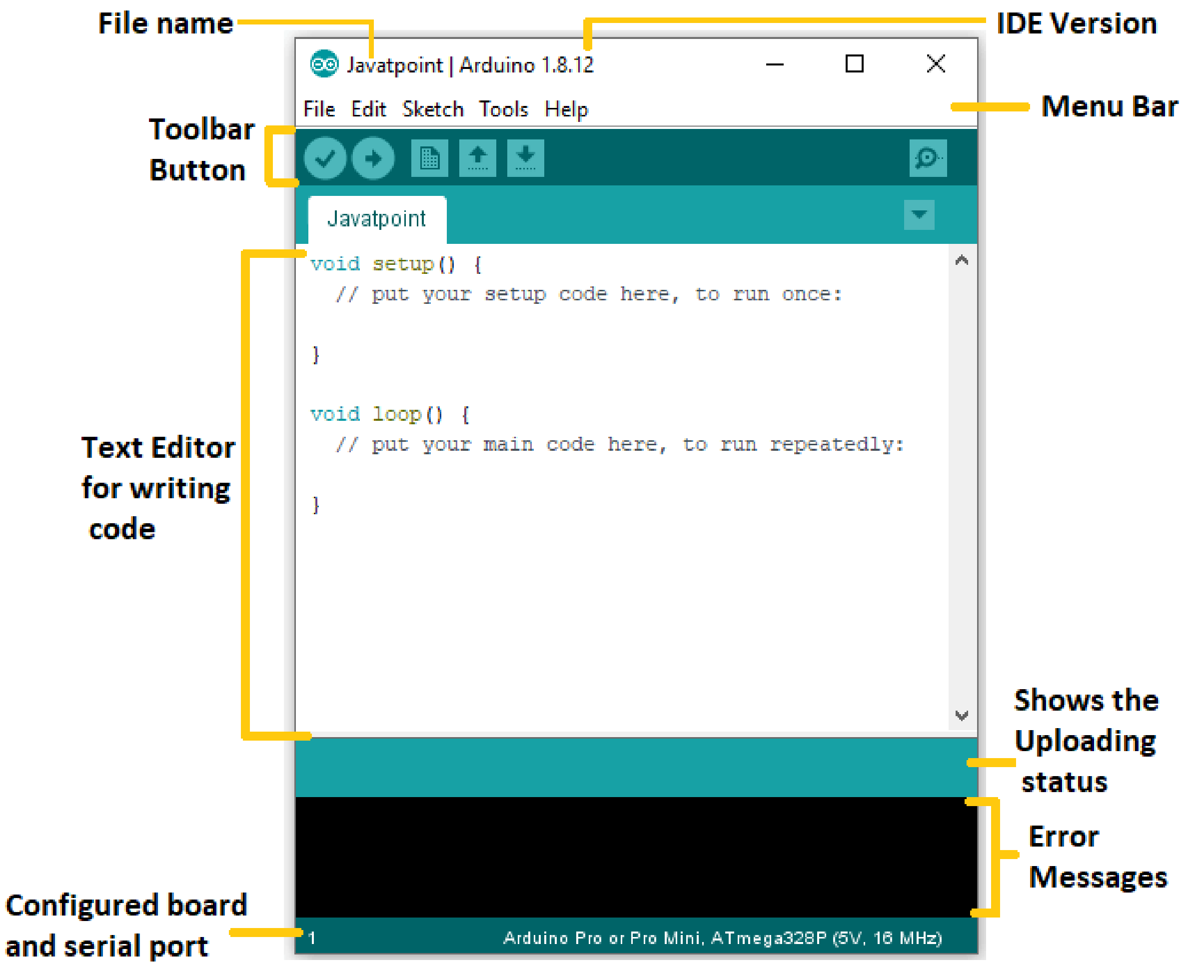


CHAPTER 5

SOFTWARES USED

5.1 ARDUINO IDE

The Arduino integrated development environment (IDE) is a cross platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring.

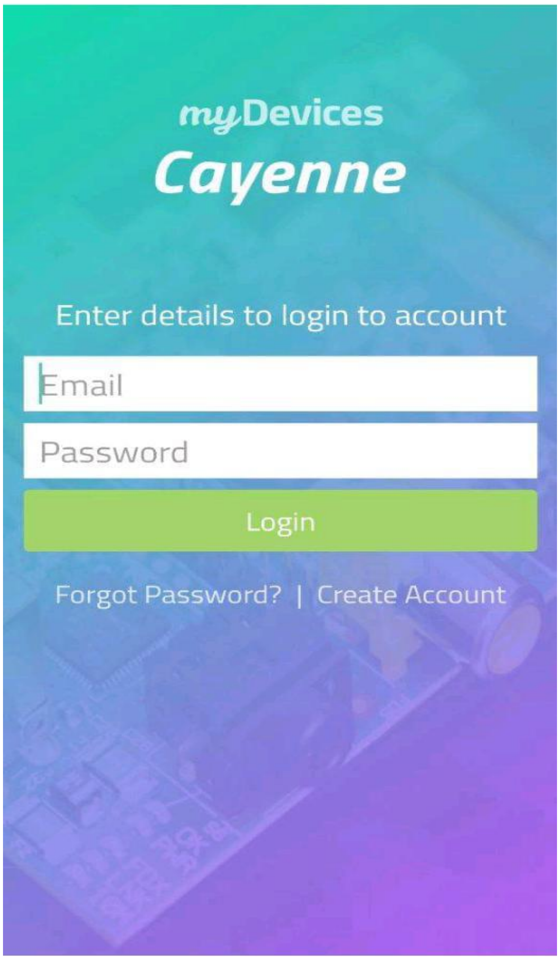


The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE is incredibly minimalistic, yet it provides a near complete environment for most Arduino-based projects. The top menu bar has the standard options, including “File” (new, load save, etc.), “Edit” (font, copy, paste, etc.), “Sketch” (for compiling and programming), “Tools” (useful options for testing projects), and “Help”. The middle section of the IDE is a simple text editor that where you can enter the program code. The bottom section of the IDE is dedicated to an output window that is used to see the status of the compilation, how much memory has been used, any errors that were found in the program, and various other useful messages.

5.2 CAYENNE

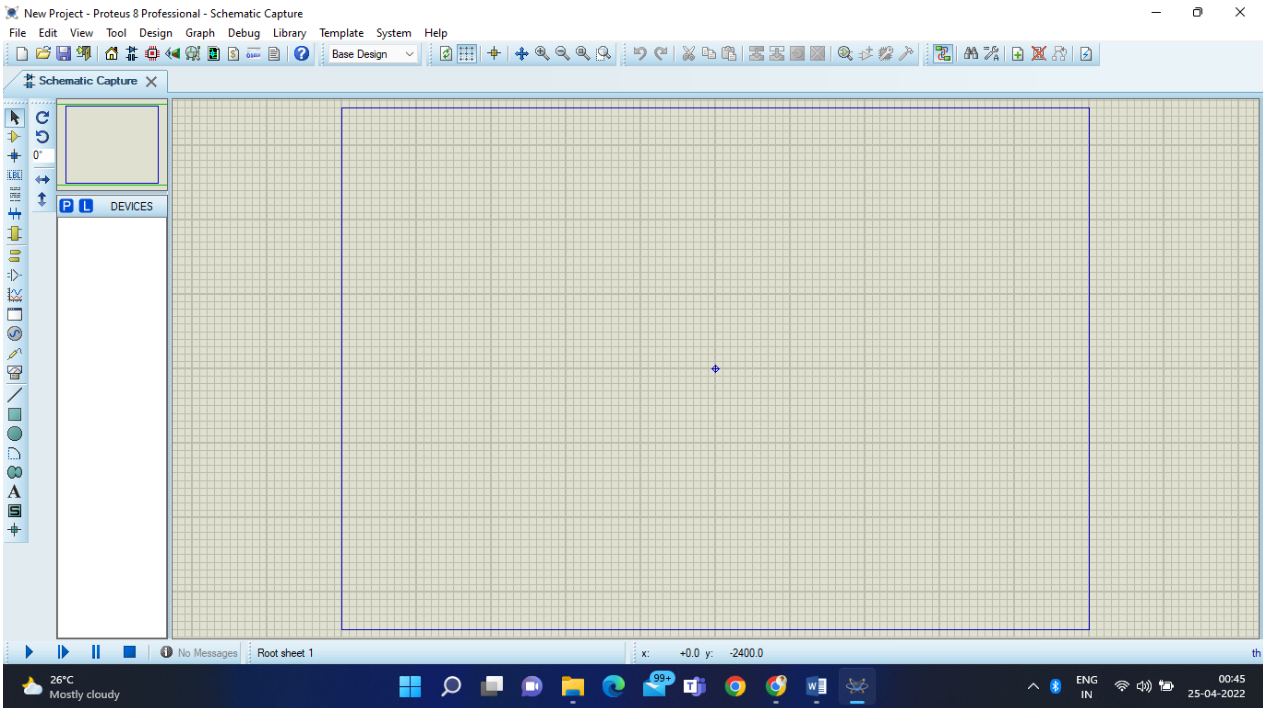
Cayenne is an app for smartphones and computers that allows you to control the Raspberry Pi and soon also the Arduino through the use of an elegant graphical interface and a solid nice communication protocol.
The features are:

- Add and remotely control sensors, motors, actuators, GPIO boards, and more
- Customizable dashboards with drag-and-drop widgets for connection devices
- Create triggers and threshold alerts for devices, events, and actions
- Schedule one-time or multi-device events for easy automation
- Quick and easy setup



5.3 PROTEUS

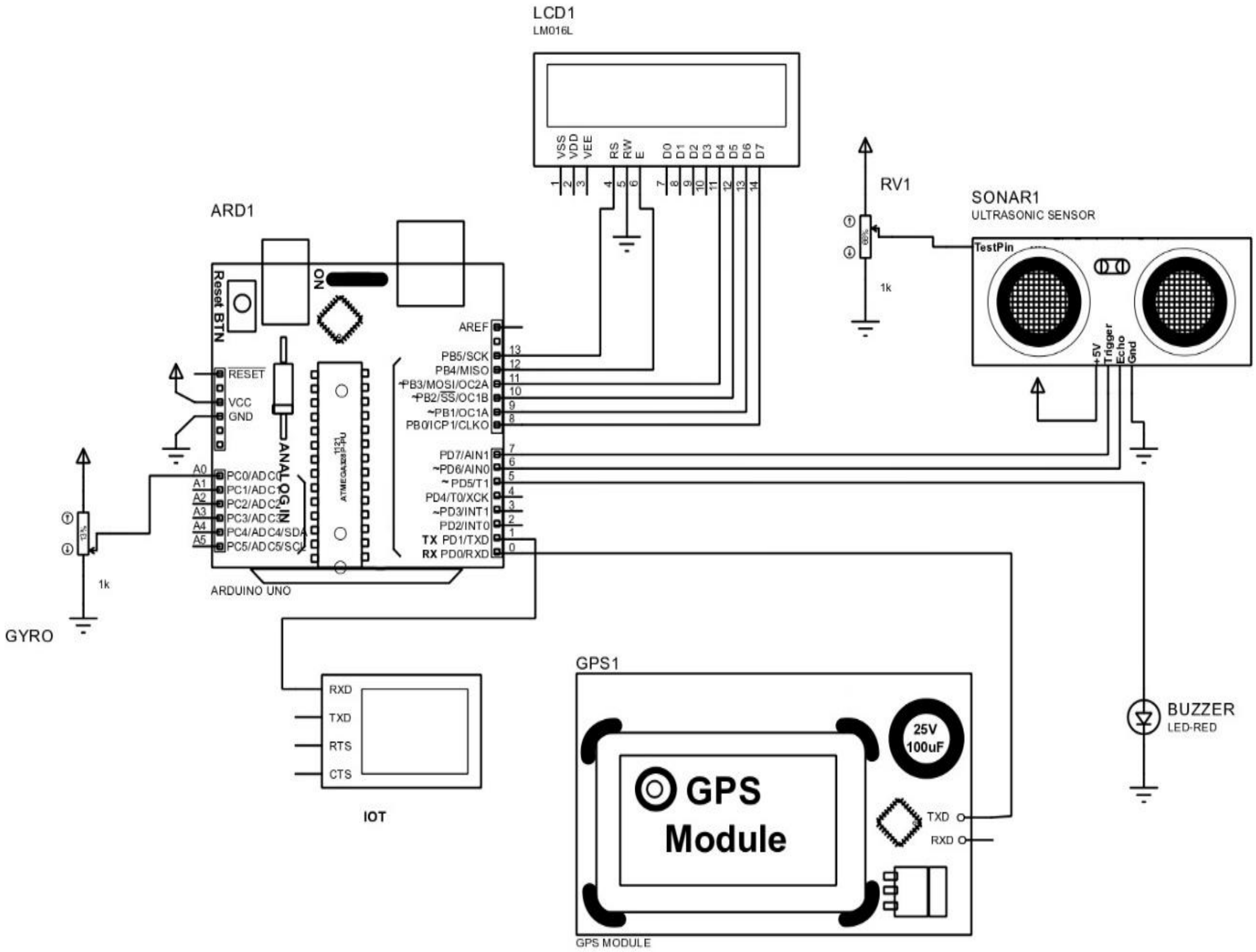
The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations. Many of the components in Proteus can be simulated. There are two options for simulating: Run simulator and advance frame by frame. The "Run simulator" option simulates the circuit in a normal speed (If the circuit is not heavy). "Advance frame by frame" option advances to next frame and waits till you click this button for the next time. This can be useful for debugging digital circuits. You can also simulate microcontrollers. The microcontrollers which can be simulated include PIC24, dsPIC33, 8051, Arduino, ARM7 based microcontrollers.



CHAPTER 6

EXPERIMENTAL SETUP

6.1 CIRCUIT DIAGRAM



The circuit diagram shows the hardware setup of the model. In the hardware setup, the transformer of 12V is used to convert the ac supply. The output from transformer is connected to the power supply circuit consisting of the rectifier, regulator etc. This power supply circuit provides the ample amount of power for the Arduino uno. The sensors are then connected to the arduino uno. The trigger and echo pin of the ultrasonic sensor is connected to the digital pins of the arduino uno. Apart from the ground and Vcc pins the gyro sensor's x, y, z ports are connected to the analog pins of the arduino uno. The GPS module will give the humps location, the transmitter of this module is connected to the receiver pin of the Arduino uno. Similarly, the NodeMCU module is also connected, the receiver pin of this module is connected to the transmitter pin of the arduino. A buzzer for the alert mechanism is also connected to one of the digital pins of the module. In the same manner lcd is also linked to the digital pins of the arduino uno.

The ultrasonic sensor is settled up facing the road. It is the sensing unit of our device. The data which is collected by the ultrasonic sensor is transmitted to the Arduino Uno, the microcontroller unit which process the codes and gives alerts according to the depth/ height dimensions which we given. If pothole is detected, then the buzzer will alerts and "Pothole detected" notification as well as depth distance will be shown in the LCD screen. If the distance is below the threshold then the LCD screen will display "Not detected". The GPS module will give the humps location & it can be seen in the LCD screen as well. The Node MCU part in the device is connected to Cayenne App which will display the outputs in mobile phone too.

6.2 INTERFACING WITH ARDUINO

```
#include <TinyGPS.h>
#include<LiquidCrystal.h>
LiquidCrystal lcd(13,12,11,10,9,8);
TinyGPS gps;
const int trigPin = 7;
const int echoPin = 6;
long duration;
int distanceCm, distanceInch;
void setup()
{
 lcd.begin(16,2);
 Serial.begin(9600);
 Serial.print("Simple TinyGPS library");
 pinMode(trigPin, OUTPUT);
 pinMode(echoPin, INPUT);
 pinMode(5,OUTPUT);
 pinMode(A0,INPUT);
 pinMode(A1,INPUT);
 pinMode(A2,INPUT);
       lcd.setCursor(0,0);
       lcd.print("Path hole");
       lcd.setCursor(0,1);
       lcd.print("system");
       delay(2000);
       lcd.clear()
}
void loop()
{
       ultrasonic();
            acc();
}
void acc()
{
        int x = analogRead(A0);
```

```
        int y = analogRead(A1);
        int z = analogRead(A2);
//Serial.print(x);
//Serial.print(y);
//Serial.print(z);
//delay(2000);
     if(x<500)
     {
          lcd.setCursor(0,1);
          lcd.print("G-Nor");
          Serial.print('b');
           digitalWrite(5,LOW);  ////buzzzer
     }
     else if(x>500)
     {
      lcd.setCursor(0,1);
      lcd.print("G-Det");
      Serial.print('B');
  bool newData = false;
  unsigned long chars;
  unsigned short sentences, failed;
  // For one second we parse GPS data and report some key values
  for (unsigned long start = millis(); millis() - start < 1000;)
  {
    while (Serial.available())
    {
      char c = Serial.read();
      //Serial.print(c);
      if (gps.encode(c))
        newData = true;
    }
  }
  if (newData)      //If newData is true
  {
    float flat, flon;
    unsigned long age;
```

```
   gps.f_get_position(&flat, &flon, &age);
  //Serial.print("Latitude = ");
 //Serial.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat,
6);
   lcd.setCursor(0,0);
   lcd.print("Lat: ");
   lcd.print(flat);
   delay(1000);
//Serial.print(" Longitude = ");
//Serial.print(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon,
6);
   //gsm(flat , flon);
//    delay(100);
//       gsm(flon);
  lcd.setCursor(0,1);
  lcd.print("Lon: ");
  lcd.print(flon);
  delay(1000);
  }
  Serial.println(failed);
      digitalWrite(5,HIGH);  ////buzzzer
      delay(1000);
      digitalWrite(5,LOW);  ////buzzzer
     }
     delay(1000);
}
void ultrasonic()
{
      digitalWrite(trigPin, LOW);
      delayMicroseconds(2);
      digitalWrite(trigPin, HIGH);
      delayMicroseconds(10);
      digitalWrite(trigPin, LOW);
      duration = pulseIn(echoPin, HIGH);
      distanceCm= duration*0.034/2;
      lcd.setCursor(11,0);
```

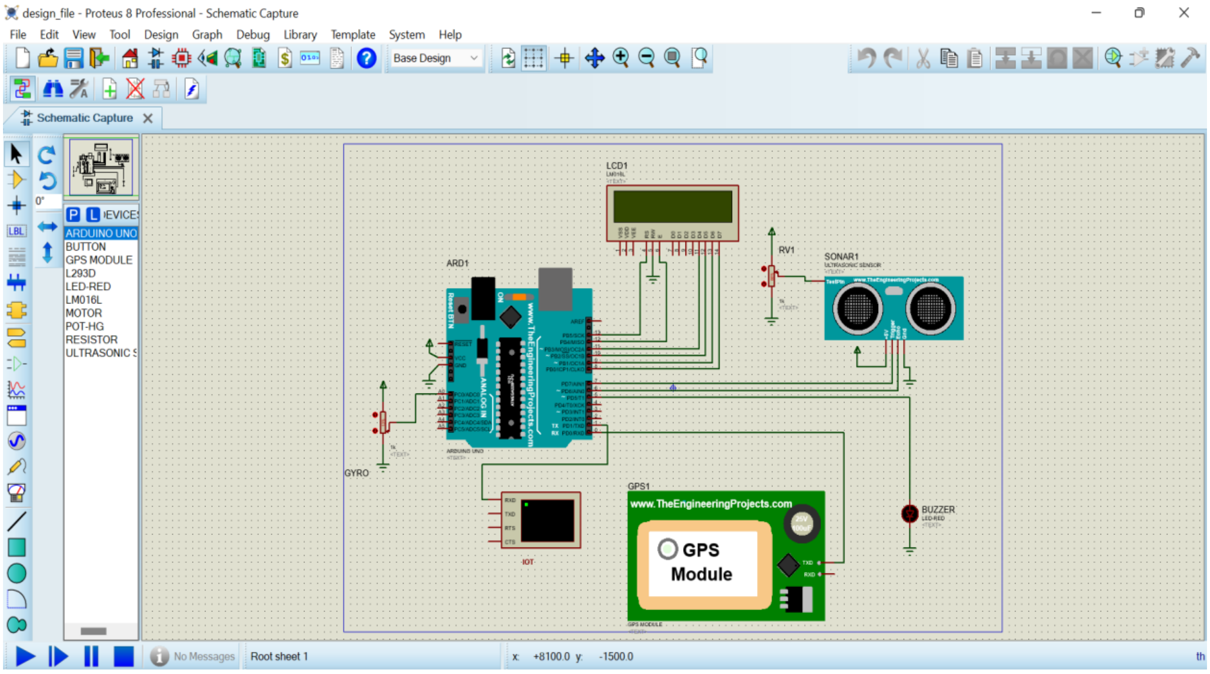
```
 lcd.print("D:");
       lcd.print(distanceCm);
   lcd.print("    ");
       if(distanceCm < 5)
       {
    lcd.setCursor(0,0);
     lcd.print("Path-H-Nor");
Serial.print('a');

delay(1000);
   digitalWrite(5,LOW);  ////buzzzer
       }
else
    {
     lcd.setCursor(0,0);
     lcd.print("Path-H-Det");
    Serial.print('A');
    delay(1000);
    digitalWrite(5,HIGH);  ////buzzzer
    delay(1000);
    digitalWrite(5,LOW);  ////buzzzer
    }

}
```

6.3 INTERFACING WITH ESP826

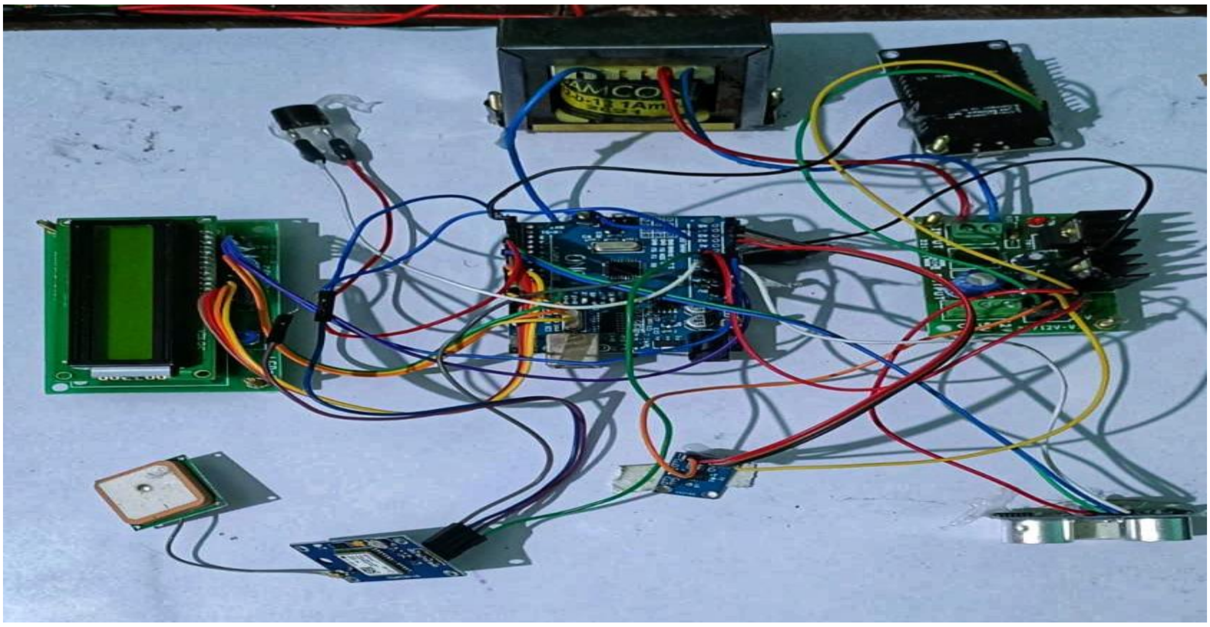
```
#include <CayenneMQTTESP8266.h>
#define CAYENNE_PRINT Serial
#define CAYENNE_DEBUG
#include<stdio.h>
char z;
char ssid[] ="WifiName";
char wifiPassword[] ="WifiPassword";
char username[] = "befc7ca0-b6fa-11ec-8c44-371df593ba58";
char password[] =
"0d9d1d9be24b770109814de36cb5f4862165a155";
char clientID[] = "c8669cd0-b6fa-11ec-8c44-371df593ba58";
int number;
WiFiClient client;
void setup()
    {
       Serial.begin(9600);
       Serial.print("hai");
      Cayenne.begin(username, password, clientID, ssid,
wifiPassword);
    }
void loop()
```

```
{
      Cayenne.loop();
      if(Serial.available() > 0)
        {
          char z = Serial.read();
            if(z=='A')
          {
        Cayenne.celsiusWrite(1,1);
           }
          else if(z=='a')
          {
        Cayenne.celsiusWrite(1,0);
          }
if(z=='B')
          {
        Cayenne.celsiusWrite(2,1);
         }
          else if(z=='b')
          {
        Cayenne.celsiusWrite(2,0);
          }
       }
  }
```

6.4 SOFTWARE SETUP



6.5 HARDWARE SETUP

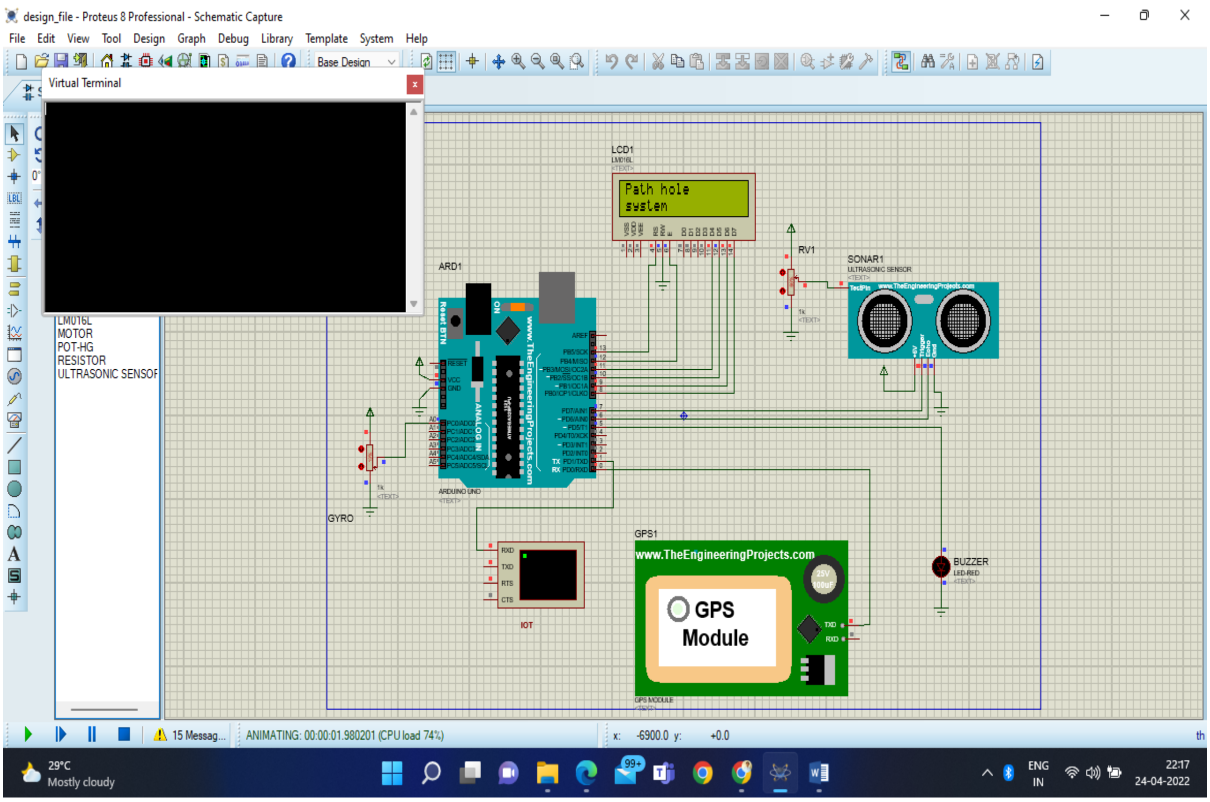


CHAPTER 7
RESULT AND DISCUSSION

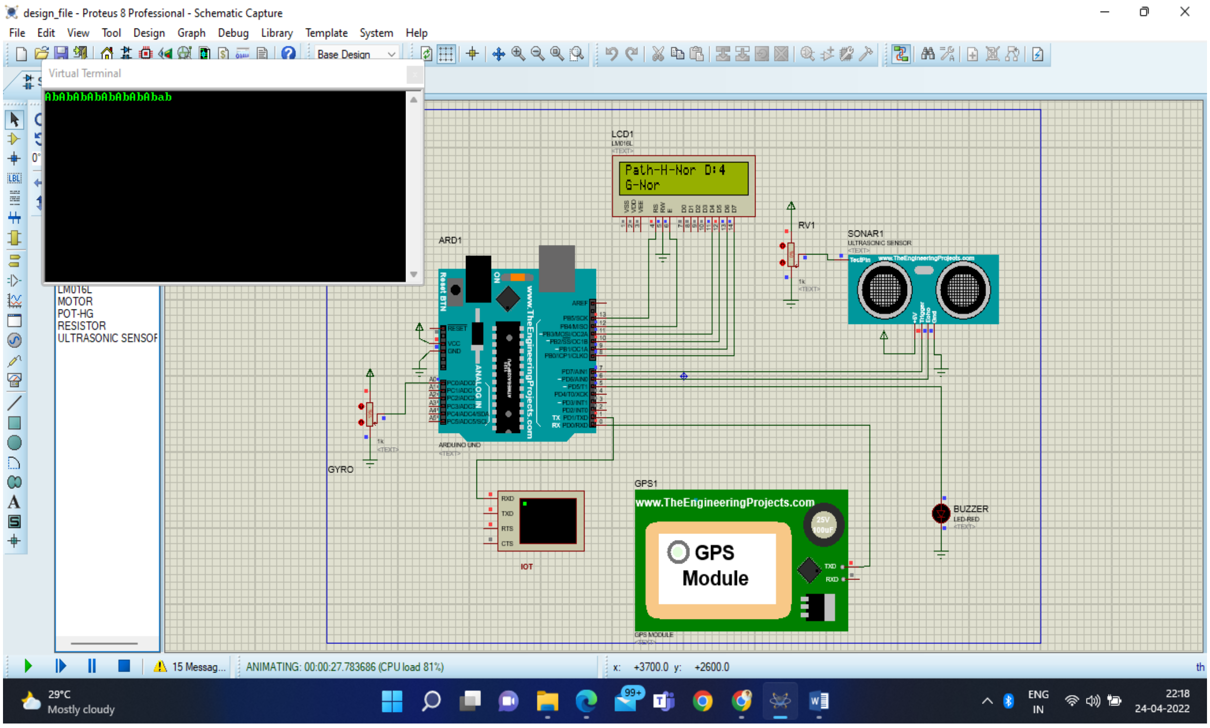
The working of the proposed system was tested in a simulated environment. Software as well as hardware simulation was carried out. Software simulation was successfully carried out on Proteus software. The hardware test was divided into two parts:

1. Detection of humps and potholes and receiving message on LCD
2. Receiving alert in the Cayenne app.

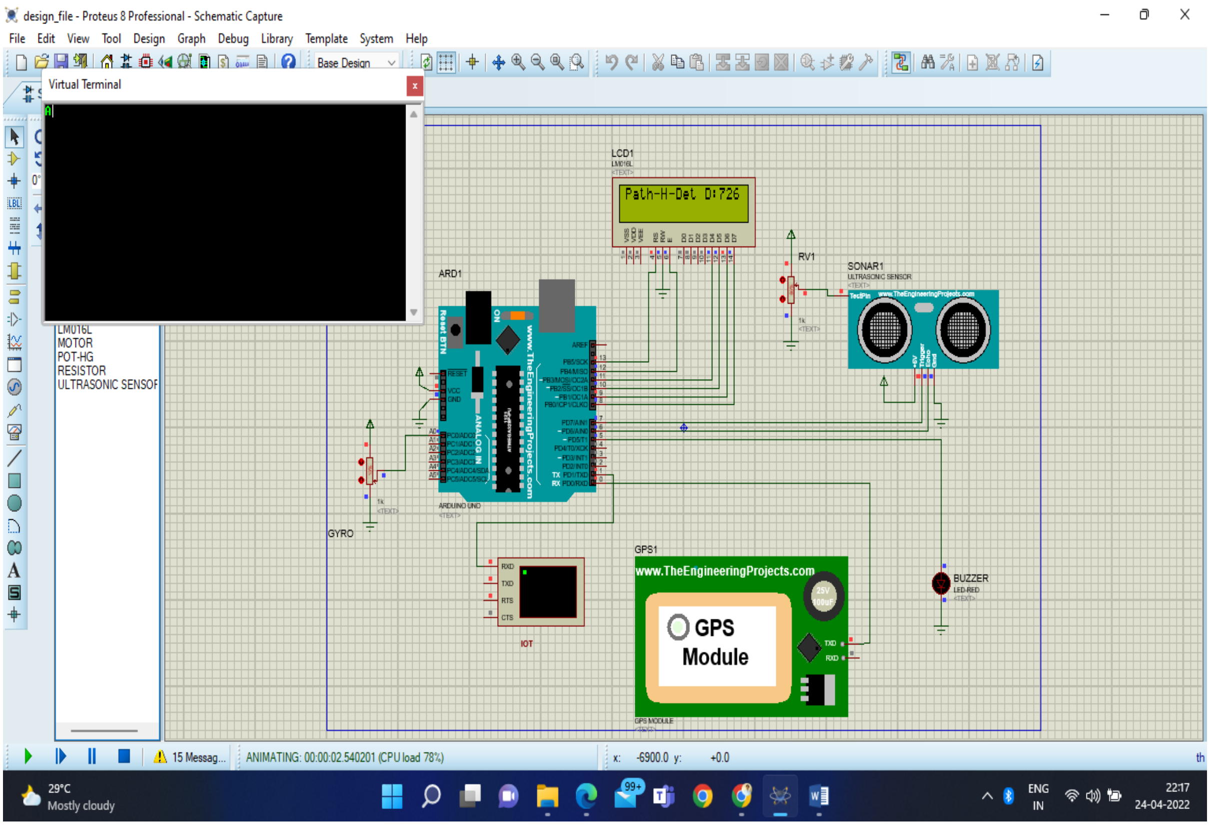
7.1 SOFTWARE SIMULATION



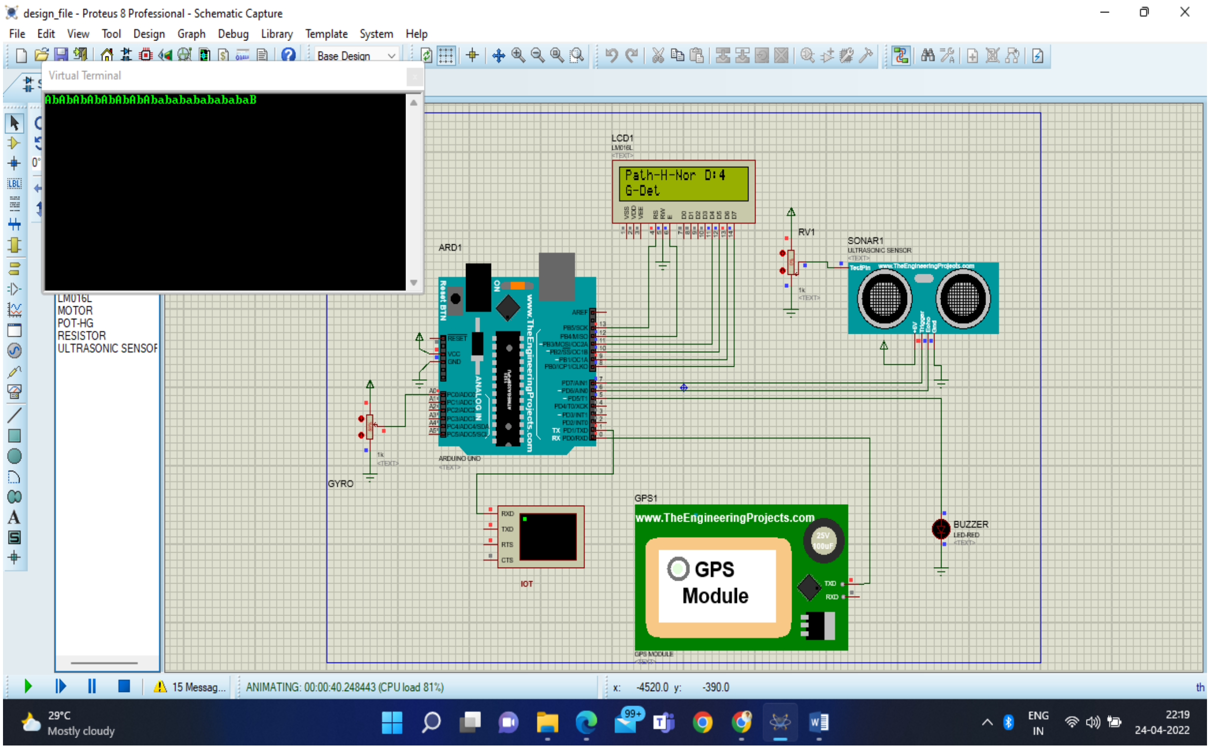
Starting of simulation



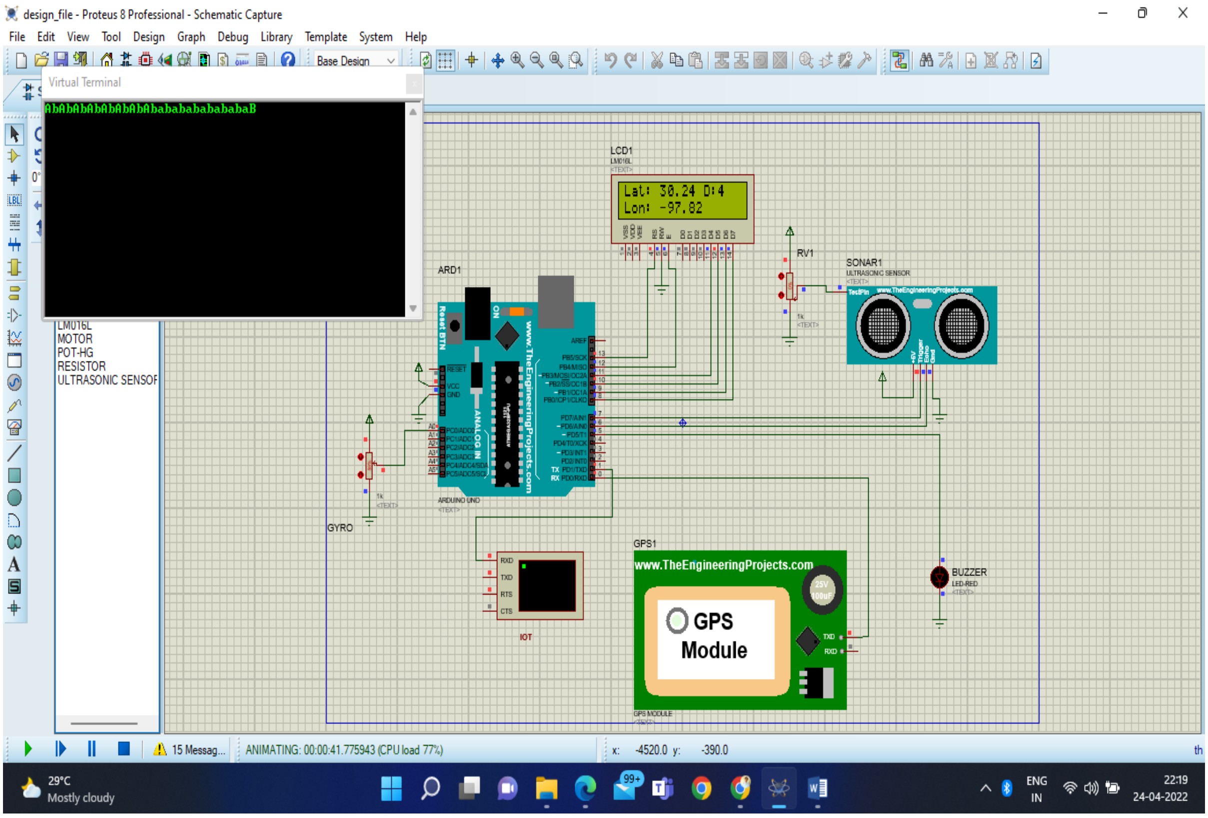
Pothole not detected (D<4) & Gyro not detected



Pothole detected (D>4) & Gyro not detected

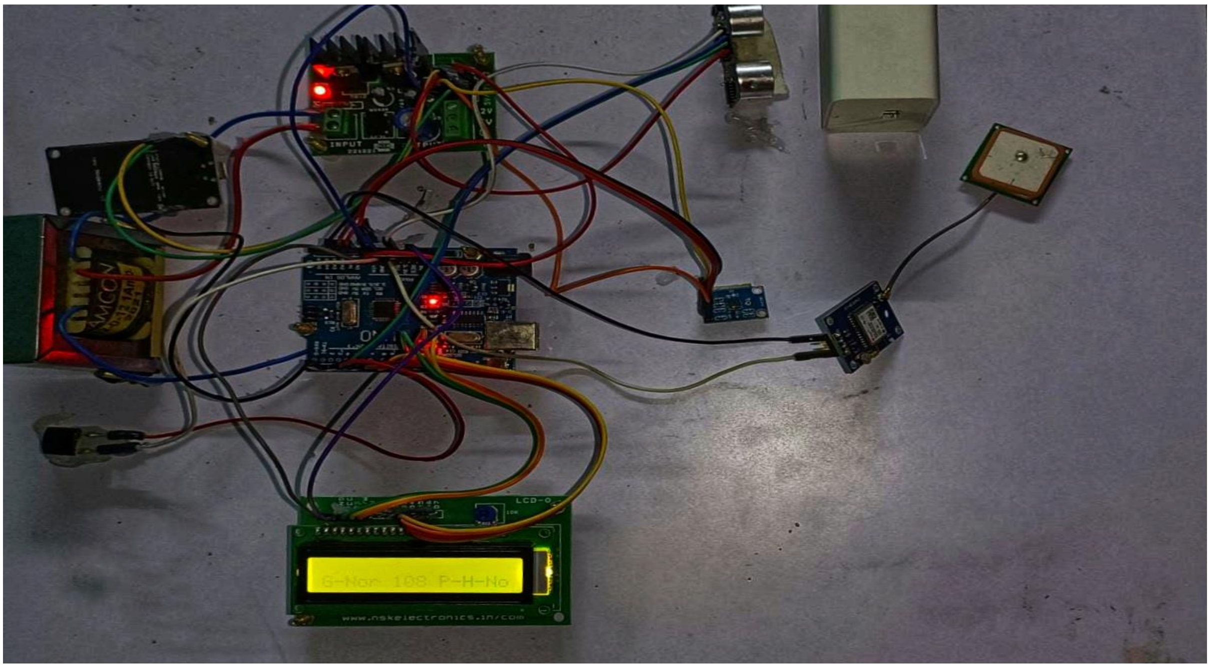


Pothole not detected (D<4) & Gyro detected

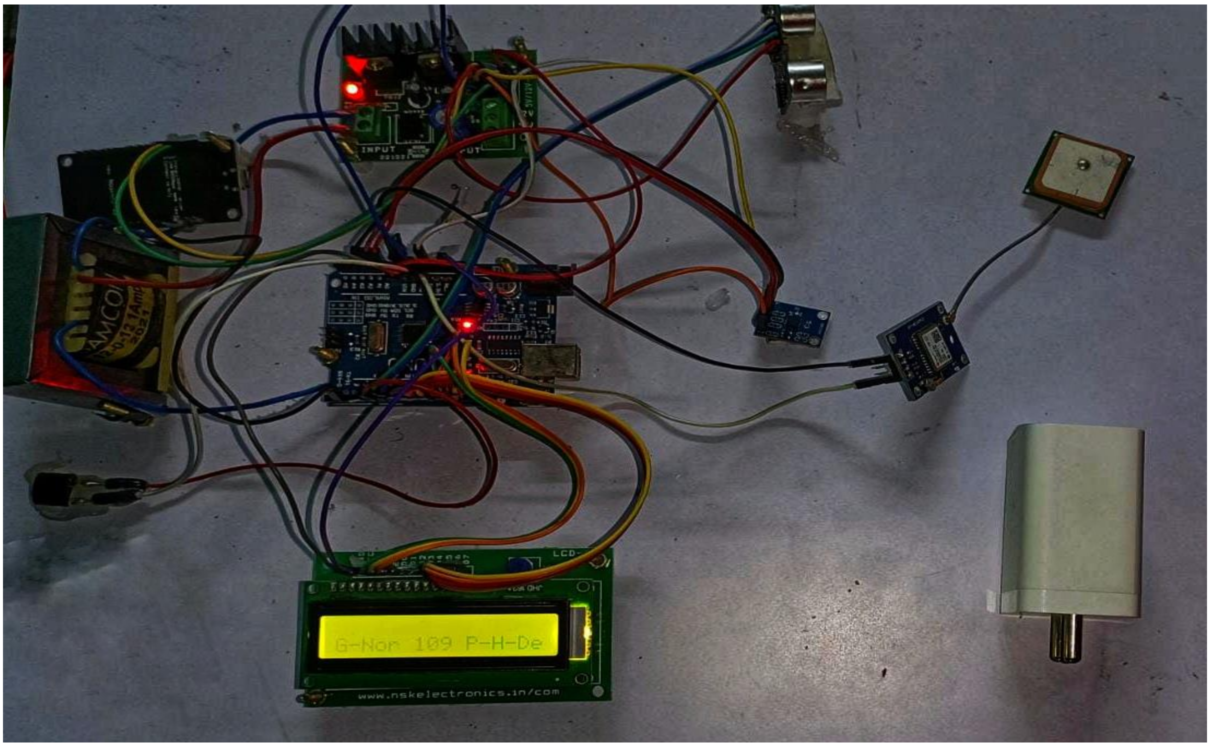


Gyro detected with the Longitude & Latitude values printed via GPS

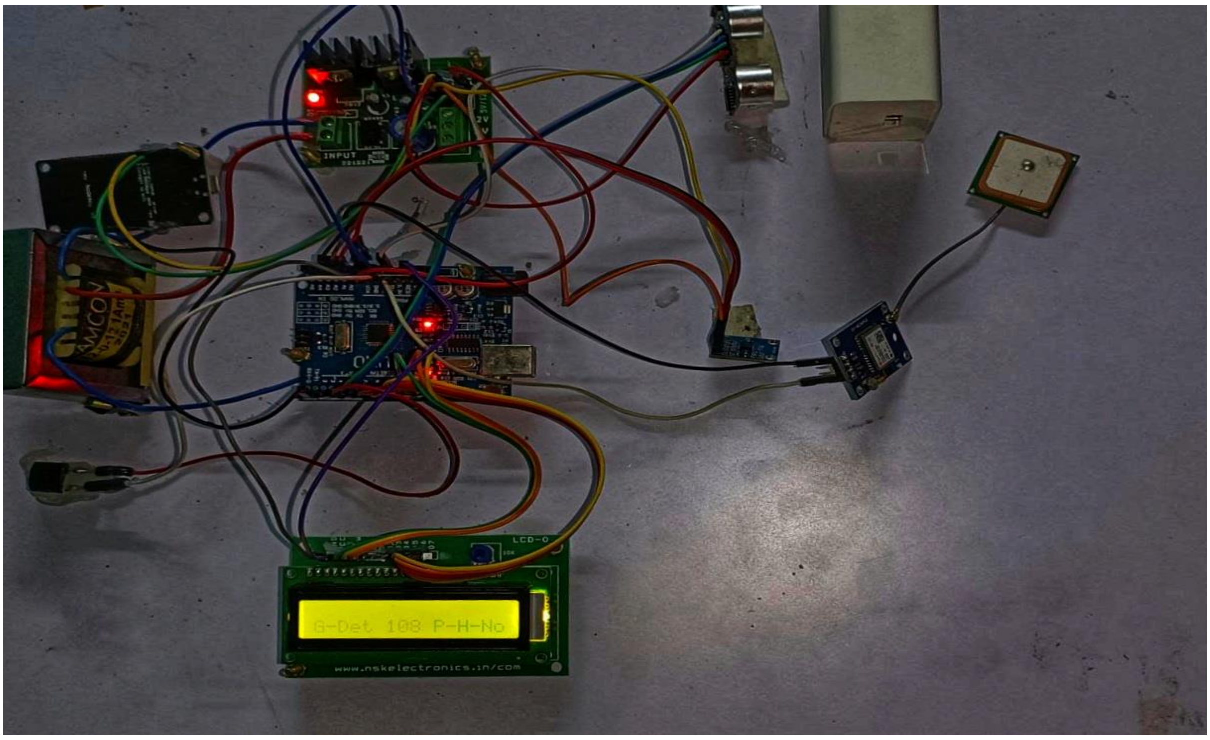
7.2 HARDWARE SIMULATION



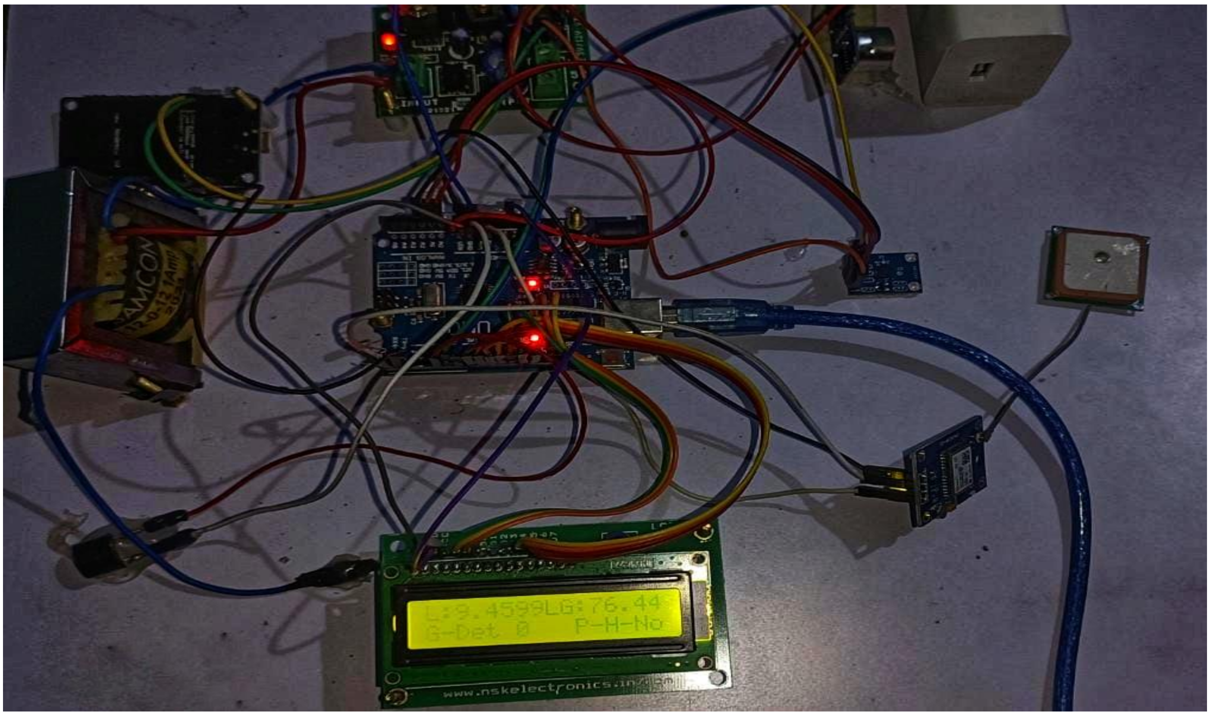
Pothole not detected & Gyro not detected



Pothole detected & Gyro not detected

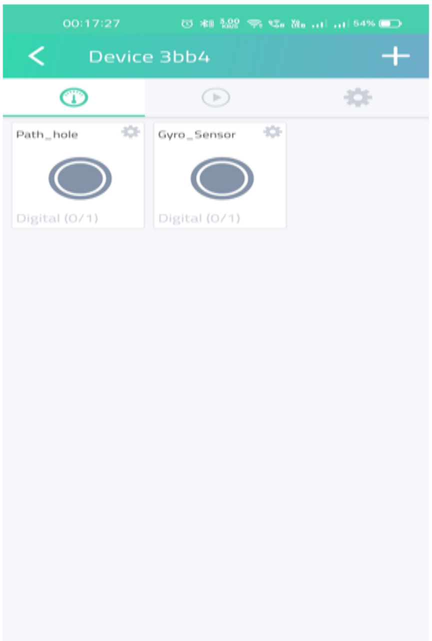


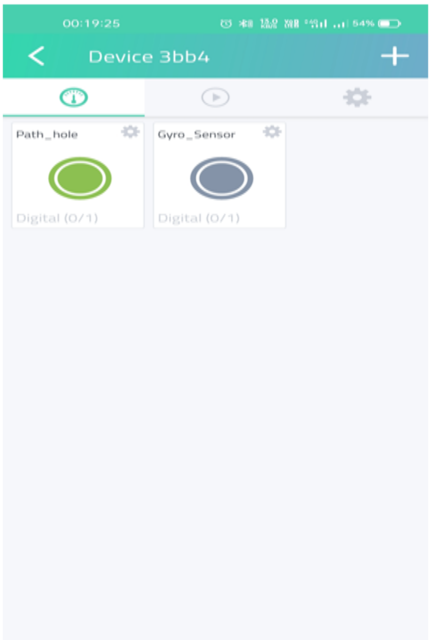
Pothole not detected & Gyro detected

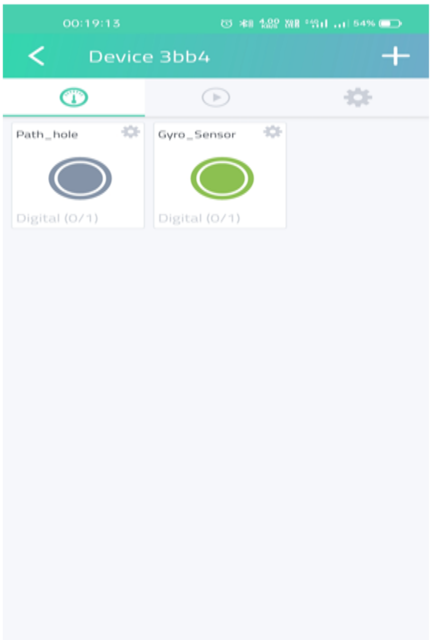


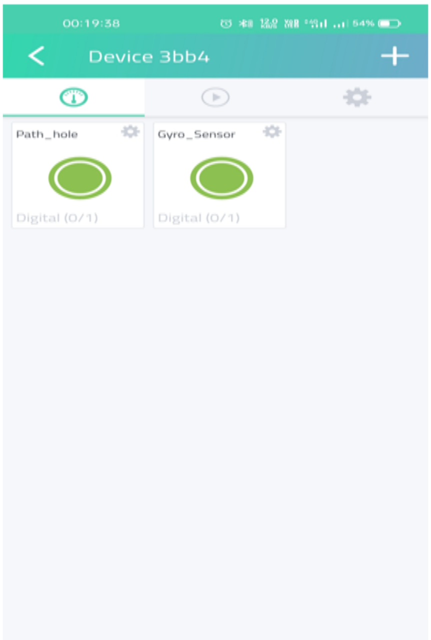
Gyro detected with the Longitude & Latitude values printed

7.3 NOTIFICATION ON CAYENNE









7.4 ADVANTAGES

- The operational cost for this project is low and reasonable.
- It has got higher efficiency in working.
- It also provides precise and accurate readings of accelerometer values.
- The presented project can provide significant help to Government Authorities to gather information on potholes and humps. This can help in road maintenance.
- Only a few components are required for this project.
- All the components are easy to assemble.

7.5 DISADVANTAGES

- Raspberry Pi has got higher memory storage than Arduino.
- GPS drains battery fast, this requires either battery replacement or recharge.

CHAPTER 8

CONCLUSION

Maintenance of the good roads plays a very important role in the growth of the country. Poorly maintained roads can lead to potholes which causes severe accidents. To overcome the damage caused by poor roads, the pothole and hump detection model has been proposed and implemented in this paper.

The proposed system basically serves two purposes; it automatically detects the potholes and humps and sends the information regarding this to the vehicle drivers, so that they can avoid accidents. The proposed work designed an IoT prototype to collect data which can be used to detect potholes and humps. This prototype is embedded with three sensors. The data from these sensors is collected by the controller and transmitted by IoT. This is a cost efficient solution for detection of humps and potholes. This system is effective even in the rainy season when roads are flooded with rain waters as well as in winter during low visibility. This system helps us to avoid dreadful potholes and humps and hence to avoid any tragic accidents due to bad road conditions. Thus, we proposed an efficient method to recognize a pothole on a road from the viewpoint of cost and implementation.

8.1 SCOPE FOR FUTURE WORK

This work can be taken into more detail and more work can be done on the project in order to bring modifications and additional features. The proposed framework employments sensors which are financially less exorbitant. As the sensors are cost-efficient, they have their restrictions like less run, less exactness, less coordinate examination like picture handle methods. Usage of cameras or laser innovation can boost the exactness of the information collection with their own drawbacks of complexity and more exorbitant. Another modification that can be brought to this model is that the values could be stored into the server-cloud storage. This data can be further analysed and can be used to give real time alerts to all the vehicles passing through the location.

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