

IOT BASED POTHOLE DETECTION SYSTEM

Project report submitted in partial fulfillment of the requirement

for the degree of

Bachelor of Technology

In

Computer Science and Engineering

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To



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CERTIFICATE

Candidate's Declaration

We hereby declare that the work presented in this report entitled **IoTBased Pothole Detection System** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** submitted in the department of Computer Science & Engineering and Information Technology, Jaypee University of Information Technology, Waknaghat is an authentic record of our own work carried out over a period from August 2018 to May 2019 under the supervision of **Dr. Hemraj Saini**, Assistant Professor (Senior Grade), Computer Science & Engineering and Information Technology.

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

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This is to certify that the above statement made by the candidate is true to the best of my knowledge.

Dr. Hemraj Saini

Assistant Professor (Senior Grade)

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Dated:

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ABSTRACT

The significance of the road framework for the general public could be contrasted as the significance of veins for people. India is a developing nation which does not have the appropriate support of the street, over 95% of the general population utilizes road transportation. Because of this pinnacle utilization of street transports, there are numerous potential outcomes of potholes on streets which prompt accidents. Other significant purposes behind such accidents are the head on head crashes. This task means to create a Pothole Detection and Notification System. The principal segments of the undertaking are the Accelerometer, Ultrasonic Sensor, Wi-Fi Module, GSM, with Arduino Uno, and the Raspberry Pi Board. This task would be given to government street temporary workers to redress the potholes and keep away from mischance and help in rush hour gridlock examination. Likewise, our point is to make security frameworks moderate for each vehicle in the nation.

Keywords: Arduino; ultrasonic sensor; accelerometer; GPS; Bluetooth; IoT.

Chapter-1

INTRODUCTION

1.1 Introduction

Internet of Things (IoT) is the system of devices, for example, electrical machines, physical gadgets and different things installed with sensors and actuators that empower the articles to set up an association with various frameworks which thusly trades information. Everything is exclusively distinguished through its distinctive implanted registering however it is worked in the current foundation of the Internet.

IoT detected the items and remotely constrained by getting to over the current framework of the system, making more open doors for a different mix of this present reality into the PC based savvy frameworks, and results in improved precision, monetary advantages and proficiency to decreased human inclusions. At the point when the expansion is finished with the actuators and sensors, it encompasses robotization in different fields, for example, keen power plants, astute transportation, shrewd homes, savvy matrices and brilliant urban areas. A developing nation without a doubt needs a system of solid and travelable streets to fulfill the need of regularly expanding traffic. Nonetheless, numerous nations, for example, Sri Lanka, have streets dabbled with potholes, yet no street observing framework to watch the street condition. Lately, the harm to the surface because of mileage moves toward becoming extravagant to fix.

There are a few focal points of having a successful street surface observing framework, however they are very costly. Such a framework can distinguish issue zones early and the pertinent experts can be cautioned in time to take preventive measures. Preventive measures continuously set aside extra cash. Plus, the examining of the information gathered through an observing framework prompts a superior comprehension of the street weakening procedure, which will prove to be useful when new street systems are being arranged. In spite of the fact that, over the long haul, an observing framework enables the expense of street support to exceed its underlying speculation cost, creating nations dependably search for a minimal effort mechanical assembly to tackle their concern. The suitability of this checking framework relies upon its capacity to robotize the way toward

recognizing the state of the street surface (for example potholes) by breaking down the increasing speed information close by. In this paper, we present anew and straightforward procedure for mechanizing the pothole identification process.

The applications for web associated gadgets applications are broad. There are plenty of classifications which have been proposed, the greater part of which are

- Infrastructure administration: farming, ecological observing, fabricating, vitality the executives, building and home mechanization, metropolitan scale organizations
- Consumer application: smart houses and homes
- Enterprise: media
- Other fields: transportation, medicinal services, restorative

Each field finds an application on IoT in view of capacity to organize implanted gadgets with restricted assets. Every such framework gathers information and data from the normal biological system in detecting the extent and discovers the applications in the fields of urban arranging and ecological detecting. Pothole recognition has been the point of much research before and new courses for dodging different kinds of impediments in a different environment have been tested upon. Be that as it may, the spotlight has been generally on impediment shirking via self-ruling operators and that excessively was, for the most part, restricted, making it impossible to expelling obstructions. These would, in general, make the recognition instrument exceptionally framework particular and very little reasonable for general purposes. The way that a gadget isn't completely independent does not imply that it can extricate no advantage from a deterrent location framework. Actually, regardless of whether the client has satisfactory power over a gadget, he/she may at present profit by such a discovery instrument. Initially, a human client, for example, a man pushing an infant carriage or a basic supply truck may not continuously be sufficiently mindful to distinguish each deterrent in transit and hazard the inconvenience of waking a dozing child or scrambling the basic supply things everywhere. Likewise, clients who utilize wheelchairs may need such a framework particularly on the off chance that they confront trouble moving their head and watch out for low or discouraged impediments physically. The framework can likewise be useful to manual products change trucks in vast stores and so forth where an extensive measure of products heaped up for brisk dislodging does not experience the problem of unpredictable

attaching, along these lines risk falling if the wheel of the truck is shocked by a pothole or something like that.



Figure 1.1 A pothole

Presently however, much work has been improved the situation identifying different sorts of projecting snags, discouraged obstruction identification has been fairly ignored since it is normally less clear. Techniques that have been gone for were generally mechanical (anticipated parts from the vehicle that identifies potholes simply after it contacts them/falls in them) or dependent on picture preparing. These either signify the expense or make the physical gadget superfluous cumbersome and clumsy. This undertaking was therefore adapted to address the issues of the clients who have moving control over their vehicles yet may discover it exceedingly helpful to have a basic impediment, and particularly potholes, recognition gadget. In view of that, examine was directed to discover the correct degree of necessities of the clients. It was discovered that all wheelchair seats clients were firmly against self-ruling shirking by their vehicle. With the proposed system an attempt has been made to endorse drivers to ward off the accidents caused due to potholes and precarious slopes. In case of emergency help and accident cases, sending the real-time location to the registered number can save lives.

1.2 Problem Statement

The key road anomaly, i.e. potholes has been causing mayhem for the commute. It can be caused due to internal factors like pavement erosion by water seeping under it, due to a change in the climate like heavy rainfall, or external factors such as poor construction management and heavy traffic. Other factors for this include mole rats tunneling under the road and mechanical damage. Potholes are inflicting major effects such as engine damage, traffic coagulations, vehicle damage and accidents which are leading to deaths. Potholes have had huge economic impacts and are causing troubles to our daily routines as well. Few of the approaches to fix the potholes include regular inspection of roads,

establishing hotlines, creating awareness among the public and requesting them to inform the local authorities and implementation of modern technologies such as automated systems.

The detection of potholes using automated systems is highly studied about now. The identification and fixing of the problem may reduce the fuel consumption, wear-tear, and maintenance cost of vehicles. Automation of systems not only reduces the human labor that goes into the detection of potholes but also saves a lot of time and are a lot more efficient. The paper focuses on the current challenges with the existing technology and how the proposed idea would be a boon to solve the present-day problems with road commute due to disturbances like potholes using automated systems overcoming the negatives of the already existing work

1.3 Challenges Involved

- Client gadget must have the capacity to detect the pothole. It will be an additional favourable position on the chance that it can describe the pothole telling the seriousness.
- Placement of sensor focuses is a critical factor. It ought to be so that the information ought to be effectively recorded.
- Communication between sensor point and customer gadget can have numerous issues which ought to be settled. A portion of the issues that correspondence can confront is an obstruction, Low throughput because of the area of sensors, end to end reliability.

1.4 Objectives

With the increase in world's population, there has been increasing load on the infrastructure. Streets have been overflowed with the vehicular activity. It has turned out to be progressively hard to deal with this activity. This is the main inspiration driving making a vehicle sufficiently insightful to help the driver in different perspectives. One of the increasing problems the roads are facing is worsened road conditions. In view of numerous reasons like downpours, oil slicks, street mishaps or inescapable wear and tear make the street hard to drive upon. Unforeseen obstacles on street may cause more mischances. Likewise in view of the terrible street conditions, fuel utilization of the vehicle expands; causing wastage of valuable fuel. Due to these reasons, it is imperative

to get the data of such terrible street conditions. Collect this data and convey it to different vehicles, which thus, can caution the driver. As a matter of first importance, there are different strategies to get the data about the street conditions. At that point, the data must be passed on in the way which can be comprehended and utilized by the driver. We in this venture endeavor to plan and assemble such a framework. In this system, the access point collects the information about the potholes in the region of a remote passage and cautions the driver about it through a buzzer. Here 'region' is a client characterized term. Ideally, the region is every rout till the next access point.

1.5 Methodology

There are four guideline parts to the data collection setup; The PDA, sensor bit, data logging terminal, and a human manager. As the vehicle comes the road the sensor assembles the vertical (Y) speeding up, and level (X) increasing speed of the vehicle, on numerous occasions every second; the sensor accumulates 100 models for consistently.

Regardless of the way that the sensor gets both Y and X. reviving, only the Y expanding speed is used for this investigate in light of the way that the vertical advancement of the vehicle can be clearly mapped to the improvement right when the vehicle falls into a pothole (Fig 3). The level piece of the expanding speed also changes when a vehicle goes over a pothole, anyway we limit the degree of this examination to dismembering so to speak the vertical section of the animating. For all of these precedents, the PDA introduces the present GPS bearings to the PC. So GPS encourages for every model will be recorded in the data archive.

Despite that, for exploratory purposes, manual pothole recording ought to be finished. Right when the human customer feels that the vehicle is going over a pothole, he responds by giving a banner to the data logging terminal. This data is moreover recorded with the accelerometer readings and the GPS sorts out. Subsequently, it will in general be checked whether the recognizable proof computation truly separates a pothole close that region.

Choosing a sifting procedure

The main period of the separating procedure is to evacuate the clamor brought about by the motor vibration and poor stun engrossing nature of the vehicle from the signs recorded amid perception. To separate between the vibrations brought about by the potholes and the clamor, we accepted that the vibrations are of low recurrence and the commotion is of higher frequencies. Along these lines, by utilizing a low-pass channel, we would most likely refine the flag.

Chapter-2

LITERATURE SURVEY

2.1 Approach

The framework is ordered into three subsystems which are Sensing, Localization and Communication. The three subsystems work autonomous of one another, yet have one basic base point they spin on is information. Fundamentally, Sensing framework creates the information, Communication gathers, co-ordinates and disseminates the information, and Localization utilizes the information and produces data for the driver.

2.1.1 Sensing Subsystem

This system uses 'Accelerometer' to distinguish potholes and a change in the keeping away from point. We use the Ultrasonic feeler which is a apparatus used to calculate the sliding doors to an inquest by using resonance rays. It allocates relinquish by transfer a echo signal at a precise replicate and alteration in for that sound signal to rebound back.

- **Vision-based strategy:**
- This scheme uses 'Camera' seeing that a feeler to gaze at the highway in favour of every potholes. The camera gets photos ceaselessly. These photos are associated with picture taking care of counts like edge area. This requires an impressive proportion of getting ready occasion and influence. Close at hand are various structures approach probable. However in meantime, the rejoinder instance of the actions obligatory like windowing difficulty for image getting all set figure is as so far broad. This practice has one good quality spot over the erstwhile is, it can tell apart a hole without experience it for example motor vehicle does not by several widen of the head need to understanding the depression to categorize it. Depiction of a pothole ought to be conceivable dependent on bulk of dip. Various other methods for obstacle area are RADAR nevertheless they have slight use in dip acknowledgment. Vision-based detecting is additionally generally utilized in different computerization applications and mechanical technology. Applications incorporate confinement, mapping, direction, object acknowledgment, or impediment recognizable proof.
- **Vibration based strategy:**

This system uses 'Accelerometer' to recognize potholes. This is a tool that gauge indicate precise outer surface control on feeler. For instance if the mechanism is immobile, it willpower display some scrutinizing identifying with earth gravitational supremacy. An accelerometer declining uncomplicatedly in space will exhibit nil scrutinizing. The planning of the accelerometer is customarily extremely undeviating. The machine is mostly used to estimate tremor or partiality. It is normally used in iTouch in addition to a combine of cameras to make out proclivity and transform the face of outlook of the prove.

Table 2.1: Comparing both approaches

	Vision based	Vibration based
Sensor used	Camera	Accelerometer
Response time	High	Low
Sensing time	While approaching the pothole	While going through the pothole
Processing	Complex image processing algorithms	Readings are directly used
Maintenance cost	High because of delicate parts like lens	Low
Characterization of pothole	Based on the size	Based on the vibrations

Here we accept the latter practice that is Vibrations based tactic given the short feedback point, usage moment and sustain price of the contraption.

2.1.2 Communication Subsystem

This subsystem is in charge of detecting the information i.e. the scope and longitude of the area of the pothole. A GPS gadget decides the area of a vehicle to which it is appended. This position will be recorded at standard interims. The pothole's area information can be transmitted to an information base which enables the benefit's area to be shown while breaking down the track later. This communication subsystem is responsible for detection pothole location and conveying it.

- **Whole Wi-Fi inclusion:**

This is additionally a famous methodology in a few proposed frameworks which are security situated e.g. Vehicle Infrastructure Integration. In this methodology, passages are sent out and about so every now and again that vehicle will never be out of system inclusion. Or possibly Access focuses are planted at incessant interims where they are required for instance clumsy regions, hazardous turns. In our methodology, we can put passage for the greatest inclusion or where the street conditions are particularly terrible. Passageway continues broadcasting the situation of the pothole in its range. Also, vehicles can give prompt input of new potholes or non-existent potholes which are recommended by the Access point. Here passage can likewise help vehicle in finding the area of the pothole. Be that as it may, this methodology requires an expansive introductory speculation for conveying the passages.

- **Open transport as an Access point:**

In this methodology we utilize Public transport, for example, Busses for city or town inclusion or ST transports for roadway inclusion. In this methodology Access point itself is moving. This sort of approach has been recently utilized for gathering information from booths in provincial areas. Alternately in our methodology, we are utilizing open transport for dispersing the information to different vehicles. For this situation passage itself is moving, subsequently, we can give a Sensor gadget to the passageway. This will spare per private vehicle cost of gadget by exempting them from detecting application. Open transport vehicle will detect the potholes on its way and communicating data about that to alternate vehicles cruising by. Vehicles outfitted with the customer gadget can get this information. Be that as it may, this methodology has a few issues. The inclusion isn't tremendous. as data about just those potholes are accessible which are secured by open transport and there might be streets on which the transports don't drive. Additionally, transport just has data about its own course which might possibly be valuable for the vehicle as Vehicle can take anyway. So vehicle must have some path by which they know which information will be helpful for them.

- **Hotspot approach:**

Hotspots are customarily known to give Internet associations at open spots like cafés. For those situations, it is utilized to give some support of the general population. The equivalent approach is utilized can be utilized in our undertaking as pursues. In this

methodology Access, focuses are sent at chosen places where vehicle focus is more similar to Traffic signals, petroleum siphons. This system can provide the complete road reflection. In the intellect, it know how to find data as of several car have the client mechanism. Subsequently where on earth the vehicle can depart the motor vehicle can form data for that street It be able to propose the chance to point looking at analysis without truly executing an Access point on those roads. This approach can even be associated locally for some exacting district; which have more than ever high combination of potholes. In any case, this approach in like manner powers a couple of difficulties.As passageway is absent at the genuine place, the vehicle needs to locate its own way; hence restriction is troublesome.

Table2.2: Comparison between communication approaches

	Entire WiFi coverage	Public transport approach	Hotspot approach
Deployment	Deploy access point wherever you want the coverage	Only on the public transport vehicles	At particular location where vehicle density is high
Coverage	Wherever access points are deployed	Wherever public transport vehicle go	Wherever the vehicle goes
Cost of access point deployment	High	Medium	Low
Cost of client device	Medium	Low	High
Localization	Relatively easy	Difficult	Difficult

For the correspondence subsystem, we pick the third Hotspot approach due to its inclusion and adaptability. But since of this restriction winds up troublesome.

2.1.3 Localization Subsystem

Confinement System utilizes the information given by Access Point to discover the pothole's area and in the long run break down territories. After the sensor information is gotten, it is prepared it is sent to the cloud and put away. Scope and longitude of pothole area Data are brought from the cloud to plot the area. We imagine the pothole discovery framework as a foundation benefit later on, utilized by different applications.

- **GPS (Global situating framework):**

As we as a whole realize this is an exceptionally prevalent area discovering framework. It is additionally the first and till as of late the main worldwide and completely practical area discovering system. It depends on the correspondence with 24 satellite circling around the earth. It fills in as pursues. These 24 satellites are spinning around the earth in 6 unique ways. Hypothetically at any point, you require a point to point association with somewhere around 4 satellites to get your position. It fundamentally takes 4 estimations to decide 4 parameters x,y,z,t . And after that speaks to in the frame comprehended by the client like scope/longitude. In genuine setting, It may even require fewer satellites in the event that one of the parameters is known. For instance, dispatches cruising in the ocean know their elevation to be zero. Additionally more the satellites you can associate with additional exact area you will get. GPS areas can get as exact as up to 15meters. So in our framework information about potholes is put away as far as x,y,z parameter. Likewise, a long length of an awful street perhaps spared as a $[(x1,y1,z1),(x2,y2,z2)]$ which show the begin furthermore, end of an awful street. This information can be utilized by vehicles straightforwardly. As when they get the information from the passage the spots where potholes are there can be indicated particularly on the GPS delineate. As indicated by the seriousness of the pothole or street it tends to appear with distinctive brilliance. Additionally, when the vehicle detects another pothole it stores the relating GPS parameters in its neighborhood and gives as a criticism to prompt the access point.

Yet, there are a few issue with this innovation. As a matter of first importance it is exceedingly costly. For keeping up as well as even the GPS collector is exorbitant. Another issue with GPS It needs an unmistakable perspective of circling satellite; so it doesn't work legitimately in-entryways what's more, fundamentally in the recently shaping urban ravines where it is required the most. Likewise, it has a high operational expense on the off chance that it is made to work progressively, as it needs to refresh its area at continuous.

2.2 Literature Survey

2.2.1 Wolverine: Traffic & Road circumstance inference using Smartphone Sensors (IEEE 2012)

Creators:

Ravi Bhaoraskar, Nagamanoj ankadhara ,Bhaskarana Ramana ,Purushottama Kulkaarni

Favorable circumstances:

- 1) Bring into play of a bring collectively server. Weights
- 2) Some filter frameworks and pushed AI techniques are to be associated with energize upgrading. The planned arrangement use sensors at hand resting on cellular phones. The manuscript concentrate to perk up the figure focus to using GPS, accelerometer, and magnetometer feeler reading for enlargement and street situation identifiable attestation.

2.2.2 Using a Mobile feeler system for street surface monitor: Pothole Patrol

Creators:

Jakoab Eriksson, Levwis Giraod, Brit Huill, Rain Newton, Samauel Mudden, HariBalakrishnan

Favorable circumstances:

- 1) A unswerving AI come up to, manuscript illustrate that can distinguish potholes and further offensive street surface peculiarity from accelerometer facts.

Disadvantages:

- 1) Position of accelerometers inside the vehicle may influence the nature of the flag. This paper explores a utilization of portable detecting: identifying and revealing the surface states of streets. This system, uses the taking an interest vehicles, gathering information from vibration and GPS sensors, and preparing the information to evaluate street surface conditions by means of cautious determination of preparing information and flag highlights.

2.2.3 Road Condition Detection Using Smartphone Sensors: A Survey

Authors:

GunjanChugh, Divya Bansal and Sanjeev Sofa

Advantages:

The area of strange street condition can be identified and spared in open source activity server farm later on.

Disadvantages:

1) Continuous Internet is required.

2) Data ought to be accumulated before applying. The purposes behind broadening research in this field are –

- It will guarantee wellbeing and solace to different street clients
- Smooth streets will prompt less vehicle harm and government investment.
- The accessibility of ease sensors in Smartphones
- The quick increment in the rate of cell phone clients.

In this way, it is objective of the task to create framework which can identify street conditions utilizing minimal effort sensors present in cell phone.

2.2.4 Road Conditions Detection Using Arduino Based Sensing Module and Smartphone

Authors:

Syuan-Yi Chen, Annie Shih and Chun-Yi Hsiao

Advantages:

1) The vehicle can get close-by street conditions data effectively.

2) Traffic administration

3) Road mischance aversion

Disadvantages:

1) Continuous web is needed.

2) Sensing module ought to be mounted remotely The point of the undertaking is to create a street condition identification device(RCDD), which comprises of an Arduino based detecting module and a UI on android cell phone. It is structured and actualized for vehicles. The Arduino based detecting module is intended to identify the street conditions continuously and send the outcome with crude information to the cell phone. The cell phone gets the information from detecting module, the planned Android UI application will check the situation with anomalous street condition on Google Maps utilizing the GPS of cell phone. Subsequently, the vehicle can acquire street conditions data by means

of the information shared by adjacent vehicles continuously. As per the guide, the drives can change their driving examples to enhance driving security, solace and proficiency

2.2.5 Real Time Pothole Detection utilizing Android Smartphones with Accelerometers(IEEE 2011)

Authors:-

ArtisMednis , Girts Strazdins , ReinholdsZviedris , GeorgijsKanonirs , Leo Selavo

Advantages:

- 1) 90% of genuine information is utilized.
- 2) Pothole recognition calculations for organization on gadgets with restricted equipment/programming assets

Disadvantages:

- 1) 7% pothole groups were not identified by any of utilized calculations.
- 2) When the speed of the vehicle is low then the potholes in their will not be identified for guaranteeing street condition and surface quality, it ought to be checked persistently and fixed as fundamental. Different ease sensors can be utilized for accumulation of such information. The paper is portraying a versatile detecting framework for street condition location utilizing android OS based advanced mobile phones.

PRODUCTS > FEATURES v	Pothole Patrol	Wolverine – Road Condition Estimation	Road Condition Estimation using Smartphone Sensors
	PRODUCT 1	PRODUCT 2	PRODUCT 3
Ultrasonic Sensor	✓	✓	✓
Accelerometer	✓		
Database linkage		✓	✓
Sensor Rechecking			✓

Table 2.3: Comparison table of existing products

Existing online applications and their features –

- Road Quality Audit
 - Record from android app
 - Inaccurate GPS reviews



Fig 2.1: Road Audit Application

- Spothole App
 - Map manually using camera
 - Pothole locations visible in map

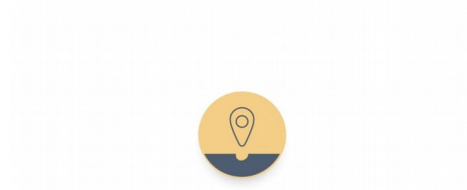


Fig 2.2:Spothole Application

- Pothole Finder
 - Terrible User Interface
 - Not user friendly

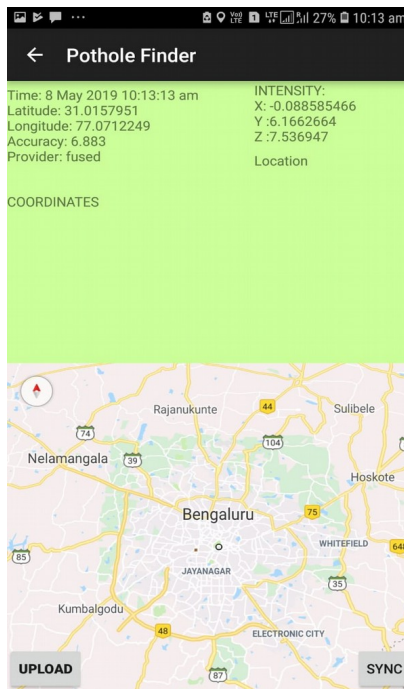


Fig 2.3: Pothole Finder Application

- Pothole Marker
 - Malfunction in the android app
 - Applications doesn't respond



Fig 2.4: Pothole Marker App

Chapter-3

SYSTEM DEVELOPMENT

The project design requires different components for designing the device's system. Various use case diagrams, class diagrams, activity flow diagrams are drawn to:

- Understand the procedure of how the device and its interface will be built
- The dependability of various parts and components on each other
- Overall flow of information among various components

3.1 Hardware Requirements

3.1.1 Ultrasonic Sensor

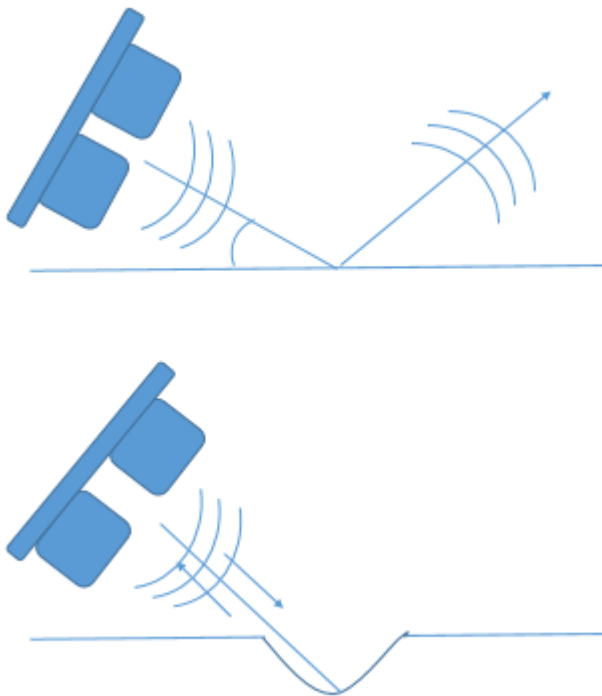


Fig 3.1 : No pothole case and pothole detection case

This sensor comprises of a transmitter and a beneficiary. The transmitter sends a ultrasonic flag of 40 Hz which, in the event that it hits a protest which reflects it back, returns and is gotten by the collector.



Fig 3.2: Ultrasonic

Sensors

The sensor gives the aggregate time of trip of the sound and the separation can be computed from it. Regularly, strong hindrances in the way can be recognized the accompanying way: sensor would confront the way and keep giving most noteworthy estimation of time (nothing close enough to mirror the flag) until the point that the sensor encounters a snag and gives a shorter time esteem. In any case, thusly is sufficient just for strong obstructions that stand out in a generally plain way; not for discouraged deterrents, like a pothole or staircase and so forth. To distinguish the last sort of snags, the gadget utilizes the sensors to some degree diverse way. When the sensors are mounted on the vehicle, they adjust themselves towards the way so that, the flag they discharge ricochets of the ground comfortable basic edge. This outcomes in the flag failing to come back to the recipient, in this way the sensor gives the most elevated estimation of time. Presently if a pothole is there in transit , the flag voyages somewhat more remote and quite often hit the ground (the side of the pothole) at a greater edge than the basic edge and along these lines reflects back to the sensor which yields a much lower estimation of time, and in this way , 'identifies' the pothole .

As the ultrasonic sensor just gives the season of trip of the blasted, computations are made as pursues to discover the transformation incentive to get the separation in centimeters. In the event that the speed of sound in air is meant as V_{air} m/s and the season of trip of the ultrasonic burst is T s, at that point the separation gone by the beat before it hit the snag is given by: $2 V T D_{air} \times =$ But V_{air} at room temperature 72 °F (22.2 °C) is 344.8 m/s. So the separation in cm is given by $D = 0.03448T$

Since the datasheet for this sensor makes reference to that estimation that the sensor gives is subject to the encompassing temperature, at first a temperature sensor was utilized monitor the temperature and modify the separation esteems appropriately. In any case, it was discovered that the distinction out yonder estimations caused by temperature is just that of a couple of millimeters though the venture manages removes as far as a few centimeters. So the temperature sensor was taken off to decrease cost. The motivation behind why this sensor was picked was that different sensors are either exceptionally delicate and will recognize the smallest hindrance (like the laser sensor) or they are expensive.

Organization of the sensor in the vehicle:

At the point when the accelerometer is sent on the vehicle, there are numerous things that ought to be thought about to get the exact perusing.

- When the accelerometer is sent in a genuine vehicle its perusing may be one-sided due to the stun assimilation arrangement of the vehicle lessens the impact of the potholes. So the genuine readings are additionally founded on how great stun retention framework vehicle has. Or then again the position of accelerometer ought to be with the end goal that the impact of stun assimilation is negligible.
- Also the diverse position of the accelerometer would give distinctive readings. For instance, we keep gadget in the boot(at the back of the vehicle) vibrations will be more contrasted with the front.
- For an expansive vehicle, for example, Trucks or ST transports; Readings at both front and back may be altogether different and both perhaps imperative with the end goal to portray the range the street. So in excess of one accelerometer are required for portrayal.

3.1.2 Accelerometer

The accelerometer is a type of physical sensor used to identify a shaking movement. It is a gadget that estimates proper acceleration ("g-force").



Fig 3.3: Accelerometer

As we are using the accelerometer sensor, a couple of nuts and bolts of the accelerometer are as per the following:

- Hardware, programming, and the client are melding in manners recently thought to be the stuff of sci-fi. Hardware like gyroscopes, touch screens, and accelerometers is enabling programming to recognize physical client subtleties. Never again is a keypad the main decision for interacting with your telephone. On the occurrence of straightforward gestures and movements can and do give a progressively common and vivid client experience.
- An accelerometer is characterized as an instrument for measuring the time rate of change of speed concerning magnitude or bearing.
- In our undertaking, we will utilize accelerometer to discover the speed of the vehicle and the angle vehicle is measuring with the street for example the slope angle.
- By measuring the measure of static acceleration because of gravity, you can discover the angle the gadget is tilted at as for the earth.

3.1.3 The Global Positioning System (GPS)

The Global Positioning System (GPS) is a navigation system that is based on space which provides the time and location related information in every weather phenomenon, be it at any place near or on the Earth where there the line of sight to four or more GPS satellites is obstructed. GPS RECEIVER: The Global Positioning System (GPS) is a satellite-based route framework made up of somewhere around 24 satellites. GPS works in any climate

conditions, anyplace on the planet, 24 hours daily, with no membership charges or setup charges. A GPS following unit is a gadget that employs the Global Positioning System to decide the area of a vehicle, individual, or other resource for which it is connected. This position will be recorded at normal interims. The recorded area information can be put away inside the following unit, or it might be transmitted to an information base (Central Location), or web associated PC, utilizing a cell (GPRS or SMS), radio, or satellite modem inserted in the unit. The square chart of the proposed framework is appeared in the figure. The controller module is utilized to accumulate data about potholes and bumps and their topographical areas and this data is sent to the server. Ultrasonic sensor is utilized to measure the separation between the vehicle body and the street surface and this information is gotten by the processor. The separation between vehicle body and the ground, on a smooth street surface, is the limit remove. Limit esteem relies upon the ground freedom of vehicles and can be designed in like manner. On the off chance that the separation estimated by ultrasonic sensor is more noteworthy than the edge, it is a pothole, in the event that it is littler, it is a protuberance else it is a smooth street. The GPS beneficiary catches the area directions of the recognized pothole or the protuberance.

The information about pothole accumulated by the proposed system is appeared on the LCD and moreover send to the driver's mobile phone. The information fuses significance of the pothole or stature of the projection what's more, its region encourages. The detachment between the vehicle zone and the pothole territory set away in database is figured. In case the detachment between the two is inside 100 meters, an alert message springs up on the screen.

- In the application we will use, it will give the exact pothole location to the user.
- An alternative would be that many of the smart phones, Androids have Assisted GPS (AGPS) chips that are installed on them.
- AGPS chips containing Android smart phones can also contain a receiving end for the GPS satellites even in the absence of a proper network or a data plan. Instead, it requires the time to synchronize with GPS satellites.

3.1.4 Raspberry Pi Board

It is similar in size to a PC which is credit card sized, which can be connected with any HDMI input gadget or RCA video input gadget and a console is required for activity. When it is introduced the HDMI and console are likewise not required for its task as you would then be able to work it by different methods, for example, ssh for the interface of command line and and VN C if graphical client the interface is wanted. The primary specialized characteristics of the recent model of Raspberry Pi otherwise called Model B have the following highlights:

- Ethernet RJ45 101100
- ARM CPU 700 MHz
- USB 2.0 x 2
- Composite RCA and HDMI (1.4)
- SDRAM 512 MB

The Raspberry Pi being little as a Visa server still has the abilities of working as a typical PC it can play 10S0p goals recordings without lagging. It has a low cost moderately when contrasted with machines in the market and can fill in as a server for light traffic, for example, web traffic or DNS servers or NTP servers, which can keep running on low power additionally for instance it very well may be controlled by versatile batteries which can go about as UPS (Uninterrupted Power Supply), when there is a power cut and inform about the power slice to the system directors.



Fig 3.4: Raspberry Pi Board

The Raspberry Pi runs Linux based operating frameworks and there is a specific variant of Linux based bit known as Raspian which can run practically all programs which are Linux perfect. Henceforth in this undertaking we have utilized 'python' content written in python for movement recognition.

3.1.5 Arduino Uno Microcontroller

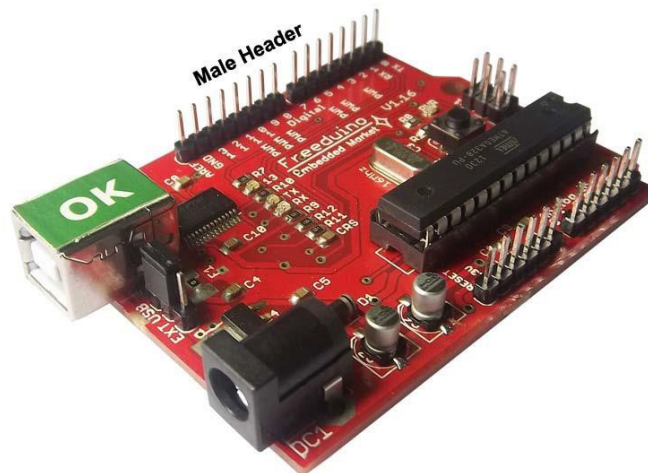


Fig 3.5: Arduino Uno

Arduino is a device on behalf of construction PCs with the purpose of canister classify and organize a extra remarkable determine of the corporeal planet than your employment post. The Arduino is linked by an assortment of sensors which drive their reading for prepare to the Arduino. The a range of sensors this scheme has our: Ultrasonic feeler and Accelerometer. It's an Open-source corporeal figure period contingent on a elementary Microcontroller floorboard, and a movement fact for compose encoding for the panel.

Arduino be able to be used to build smart equipment, attractive commitment from a assortment of switch or sensors, and calculating a grouping of light, motors, and extra corporal yield. Arduino adventures stay singular, The sheet can exist accumulate by hand or purchase preassembled. The Arduino indoctrination speech is an completing of cabling, a next to corporal register point, relies winning meting out intellectual medium encoding circumstance.

It was proposed to provide understudies a sensible & straightforward way of deal with plan ordinary things. Going with clear Integrated Development Environment that continuously runs on ordinary PCs and grant to create program for Arduino utilize C & C++.

There are different sundry Microcontrollers stages open for bodily register Phidgets, Parallax, and a choice of others bid practically indistinguishable expediency. These gadgets receive the disordered nuance of Microcontroller indoctrination & encompassing it with an easy to-handle bunch. Arduino in like manner flourishes the route toward working, offering some positions for educators, and understudies, and attracted learners above a variety of structures:

- Cheap – the sheets of Arduino are commonly standing out from different other microcontroller's stages. The most conservative interpretation of the module could be collected by hand, & the previously amassed modules cost less under expenditure plan.
- Compatibility - The Arduino programming continues running on Macs, OSX, Windows and Linux running structures.
- Easy and discrete encoding condition - The Arduino programming condition is not stiff to be used by amateurs, yet sufficiently flexible for flow edge customers to abuse too. To educators, it could be accommodatingly established on the programming condition, so understudies figure out ways to program in that condition will be alright with the appearance of Arduino
- Broad programming & Open-source- The Arduino writing computer programs is appropriated as unfasten font instrument, to be had for extension by practiced software engineers. The idiom can be reach out through & C++ libraries, & public needing to recognize the fastidious nuance could create the jump from Arduino to the C programming language. In this manner, you could incorporate AVR-C code clearly into Arduino programming.
- Convenient equipment & Open-source and - The Arduino relies upon the microcontroller of Atmel. The strategy for the module is appropriated underneath a

artistic Commons grant, experienced course originators be able to make their self variation of the unit, expanding & improving it. In reality, commonly fresh customers could develop the board variation of the unit to perceive how it capacities and put aside some money.

Difference between Microcontrollers & Microprocessors

Microprocessor	Microcontroller
It is just a processor. Memory and I/O components have to be connected externally	Micro controller has external processor along with internal memory and I/O components
Since memory and I/O has to be connected externally, the circuit becomes large.	Since memory and I/O are present internally, the circuit is small.
Cannot be used in compact systems and hence inefficient	Can be used in compact systems and hence it is an efficient technique
Cost of the entire system increases	Cost of the entire system is low
Due to external components, the entire power consumption is high. Hence it is not suitable to be used with devices running on stored power like batteries.	Since external components are low, total power consumption is less and can be used with devices running on stored power like batteries.
Most of the microprocessors do not have power saving features.	Most of the micro controllers have power saving modes like idle mode and power saving mode. This helps to reduce power consumption even further.
Since memory and I/O components are all external, each instruction will need external operation, hence it is relatively slower.	Since components are internal, most of the operations are internal instruction, hence speed is fast.
Microprocessor have less number of registers, hence more operations are memory based.	Micro controller have more number of registers, hence the programs are easier to write.
Microprocessors are based on von Neumann model/architecture where program and data are stored in same memory module	Micro controllers are based on Harvard architecture where program memory and Data memory are separate
Mainly used in personal computers	Used mainly in washing machine, MP3 players

Table 3.1: Difference between microprocessor and microcontroller

3.2 Software Requirements

3.2.1 Arduino IDE: The Arduino Software is an Integrated Development Environment (IDE) which outfits us by a utterance computer which cause us make the policy to be exchange to the Arduino. This is completed utilize the Java speech and the code write in program the board is specific language which is only a great deal of C & C++ limits. It is wished-for to make acquainted to encoding with masters & various amateurs fresh to indoctrination enhancement. It fuses rules critique chief with features, for instance,

sentences structuring feature, propagation coordinate, & modified space, and similarly geared up for incorporate and transfer project to the floorboard by means of a solitary tick. A program or code created for Arduino is known as a "Sketch". It was written in the Java programming language. It is utilized to both, compose and transfer different projects to sheets good with Arduino, yet in addition, with the assistance of outsider centers, other merchant advancement sheets.

Arduino programs are written in C & C++. The Arduino IDE, go by an item files called "Wiring" beginning the opening Wiring make an effort, making various typical information assignments much more straightforward. IDE (Integrated Development Environment) which is executed on our PCs is utilized to both, compose and transport PC code to substantial board. The customers then simply need to describe two abilities to build a runnable cyclical ability agenda:

- Setup(): a facility which run previously at the initiate of series that canister there settings
- Loop(): a faculty which is call more than once until the board control is set to off.



Figure 3.6 ARDUINO IDE

On Arduino IDE, to code, a file is created which is said to be a sketch. The sketch is later booted on the Arduino board which also eventually performs the required data collection and more processing tasks according to the code.

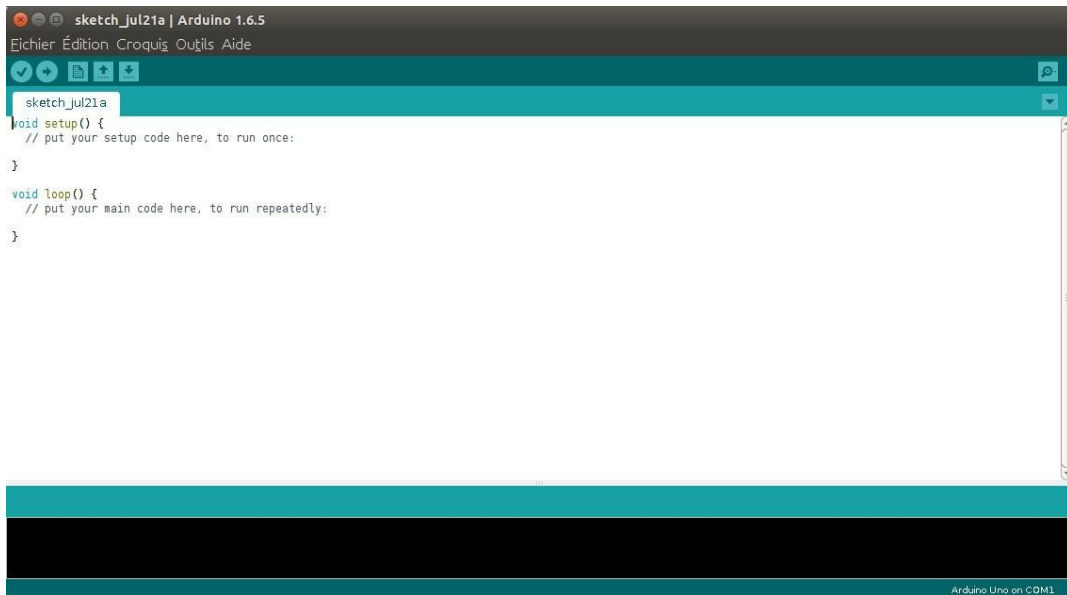


Fig 3.7Arduino Sketch

3.2.2 Python IDE and PySerial Module:

This is the python language IDE (Integrated Development Environment). The data is sent by the Arduino. It uses a serial communication to the PC also later that data is processed with python after writing a python script. The access for the serial ports is encapsulated by the PySerial Module. It fetches everything that is coming from the arduino using library of pySerial. Serial port access is given using this module which in turn allows the communication via the same. It also gives a common API across the very different operating systems, including Linux, BSD and Windows

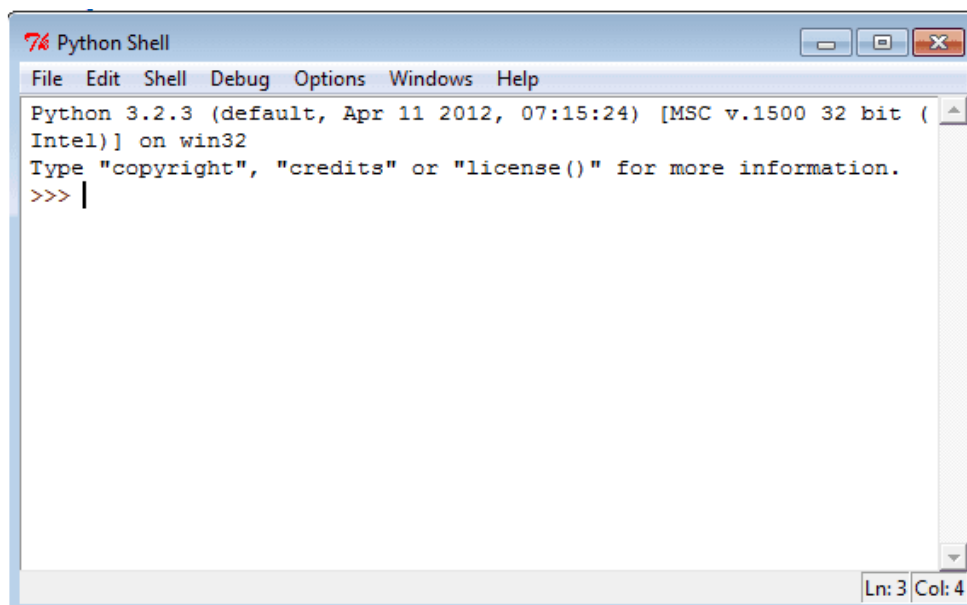


Fig 3.8: Python IDLE

3.2 Design& Diagrams

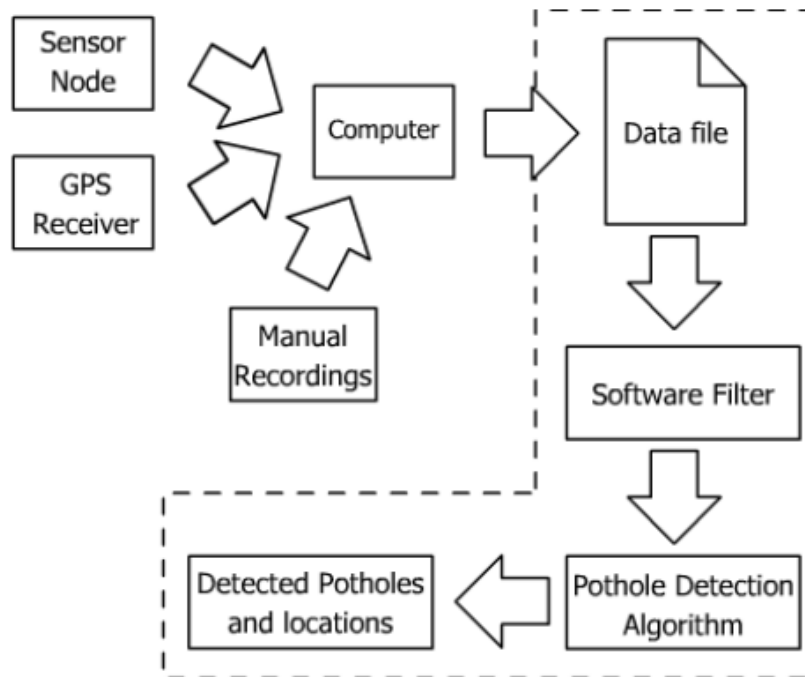


Fig 3.9: The block diagram of the data collection and the analysis process

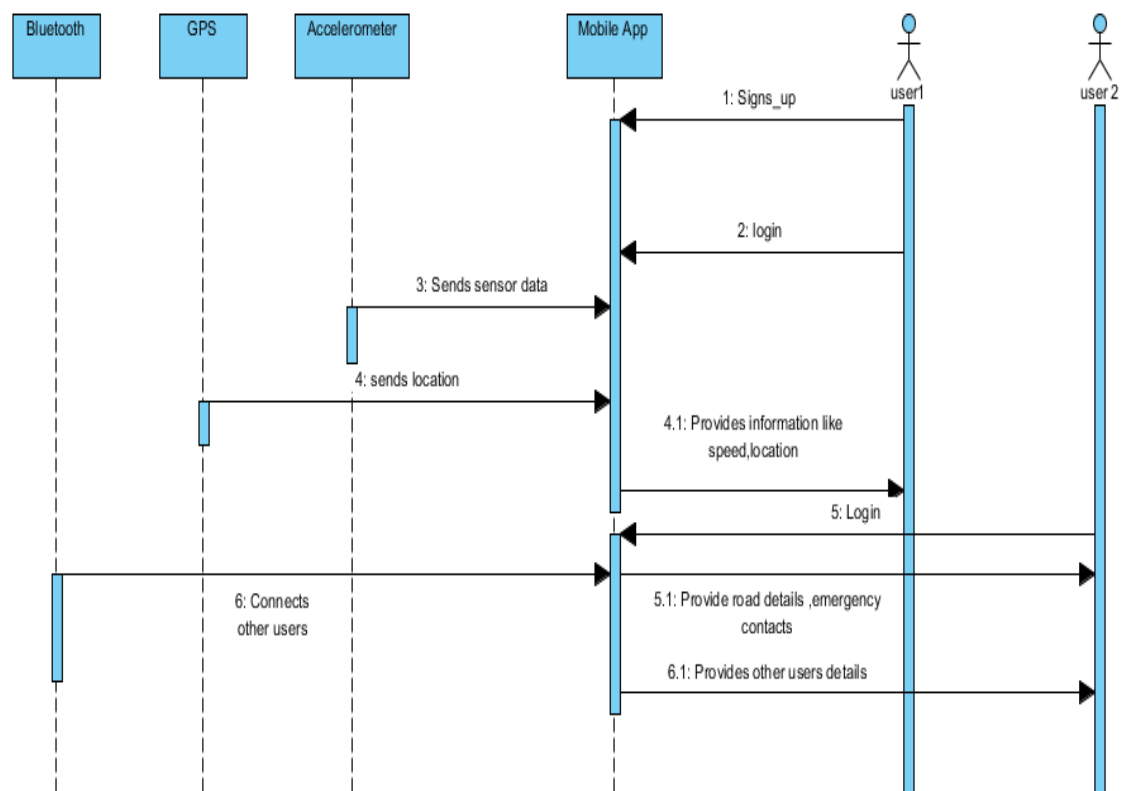


Fig 3.10: Sequence diagram

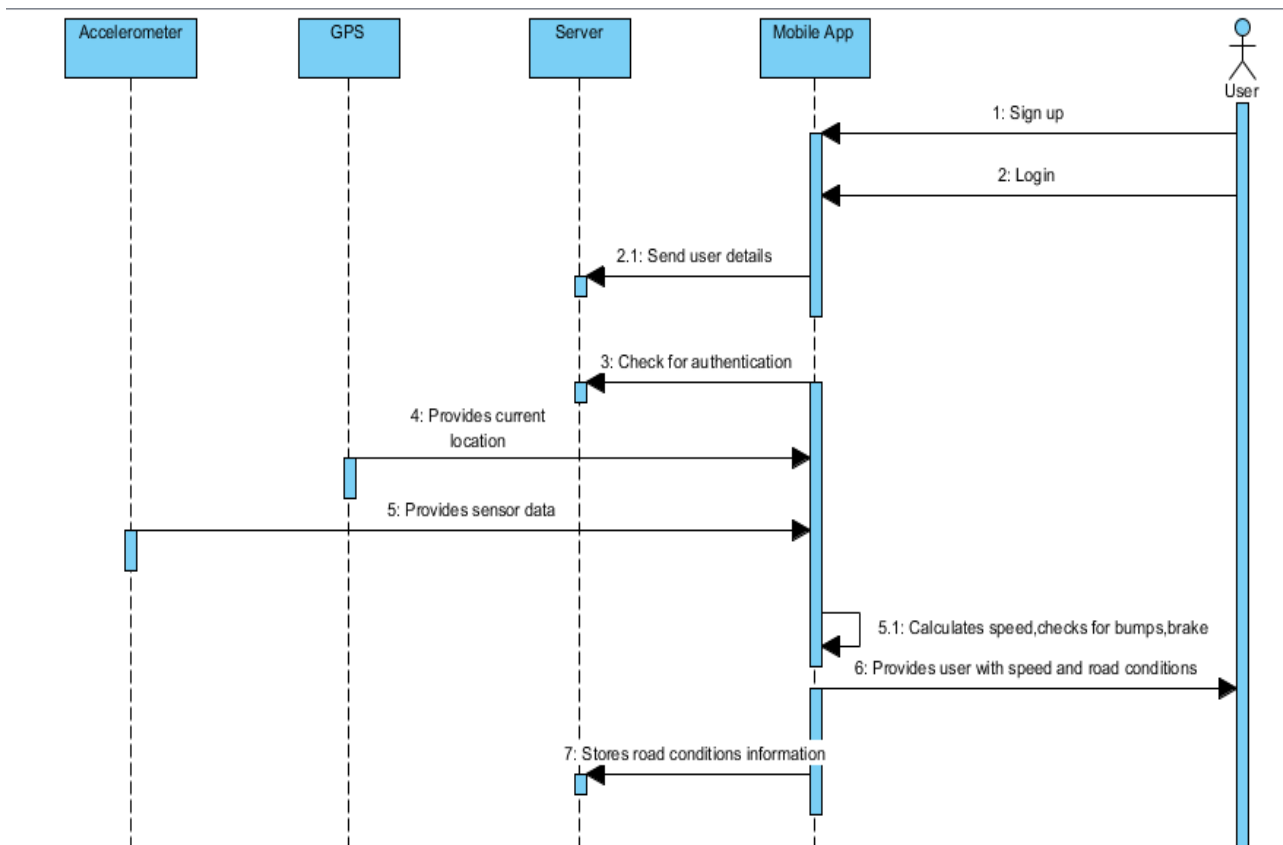


Fig 3.11: Database connection diagram

3.3 Algorithmic functions

3.3.1 getVals()

Receive the input from ultrasonic sensors & accelerometer

3.3.2 sendData()

Send data serially using Bluetooth module to android smartphone every 2 seconds

3.3.3 getData()

Receive the data sent by Bluetooth module serially

3.3.4 isDetected()

check if data is abnormal i.e. above threshold value

3.3.5 pinpoint()

Get Longitude and Latitude (eg. 37.459545, -122.125468) from Google Maps API and pin it on Google Maps

3.3.6 average()

Calculate average every 2 seconds

3.3.7 Connecting to Whatsapp

Steps for using WhatsApp on Raspberry Pi

Step 1:- Installation of necessary packages

```
Command :- sudo rpi-update
sudo apt-get install python-dateutil
sudo apt-get install python-setuptools
sudo apt-get install python-dev
sudo apt-get install libevent-dev
sudo apt-get install ncurses-dev
```

The Yowsup library can then be downloaded.

```
Command :- git clone git://github.com/tgalal/yowsup.git
```

Use cd command to get into the Yowsup folder and install the library.

```
cd yowsup
sudo python setup.py install
```

Step 2 :- WhatsApp registration

```
python yowsup-cli registration --requestcode sms --phone
91xxxxxxxxxx
--cc 91 --mcc 405 --mnc 035
python yowsup-cli registration --register xxx-xxx --phone
91xxxxxxxxxx
--cc 91
```

If your registration is successful you will get a confirmation message.

Step 3:- Using WhatsApp

```
sudo nano /home/pi/yowsup/config
```

Add the following lines into the config file.

```
## Actual config starts below ##
cc=39 #if not specified it will be autodetected
phone=39xxxxxxxxxx
password=xxxxxxxxxxxxxxxxxx
```

To begin using WhatsApp use the yowsup-cli demo.

```
yowsup-cli demos --yowsup --config
/message send 91xxxxxxxxxx "Your message"
```

The replies will be displayed on your Raspberry Pi.

3.3.8 Algorithm

```
const int trigPin = 9;           // defines pins numbers
const int echoPin = 10;
long duration;                  // defines variables
int distance;
void setup()
{
  pinMode(trigPin, OUTPUT);     // Sets the trigPin as an Output
  pinMode(echoPin, INPUT);     // Sets the echoPin as an Input
  Serial.begin(9600);          // Starts the serial communication
}
void loop()
{
  digitalWrite(trigPin, LOW);   // Clears the trigPin
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);  // Sets trigPin on HIGH state for 10 micro seconds
  delay(100);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH); // Reads echoPin, returns sound wave travel time
  distance = duration * 0.034 / 2; // Calculating the distance
  Serial.print("Distance: ");
  Serial.println(distance);     // Prints the distance
  if (distance > 25)
    Serial.println("this point needs repair");
}
```

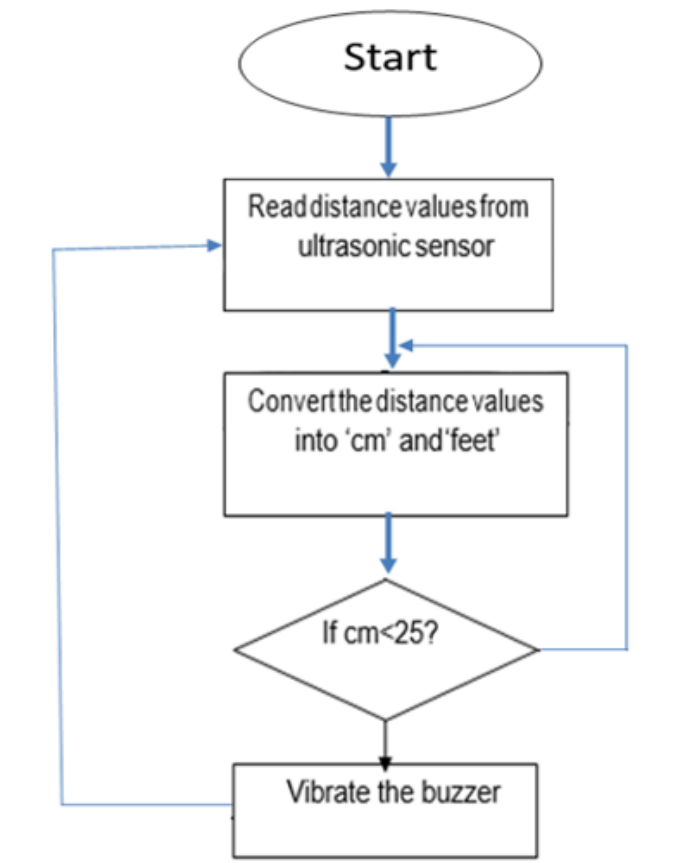



Fig 3.12 Ultrasonic Module Algorithm

3.4 Computational

Accelerometer

The values which will be taken from the sensor would be analog and later will be stored into a variable. The analog input from the sensor is required to map between x-axis (100-110); y-axis (230-270) ; z-axis (110-120) because elevation reading is measured. So, mapping for this can be done using the follow function:

`map(output_value,420,20,0,150).`

The reading for the sensor in low elevation is 100 and for high elevation it is 250. So, we mapped it from the range of 100-250 using map function.

UV Sensor

Give strict, non-contact split estimation surrounded by a 3 cm to 3 m choice. A simple pulse in/out communication needs only 1 I/O pin.

Sensor Used	Range
UV Sensor	(3 to 8) as per reading
Accelerometer	x-axis (100-110) ; y-axis (230-270) ; z-axis (110-120)
Bluetooth Module	For connectivity only
GPS Reading	Latitude reading (eg: 27.0083 for JUIT)

Table 3.2: Instrument specifications

3.5 Experimental

The following accident data from the government of India sources reiterate our need to focus upon pothole detection and amendments. According to the data given by the police department of different States and Union Territories, potholes make up for 6,424 road accidents and hence 2,324 people killed during 2016.

[Source of Data: Government of India, Ministry of Road Transport & Highways, New Delhi]

Table 3.3: Road accidents, fatalities and injuries by vehicle type in 2016 and 2017

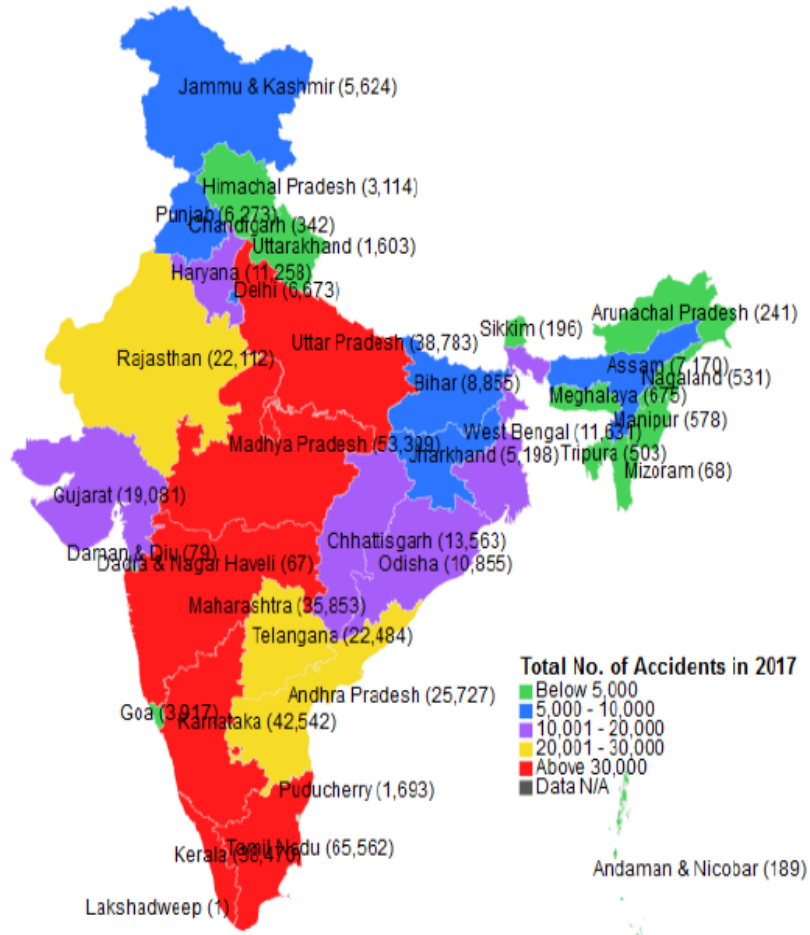


Fig 3.13: State-wise total accidents

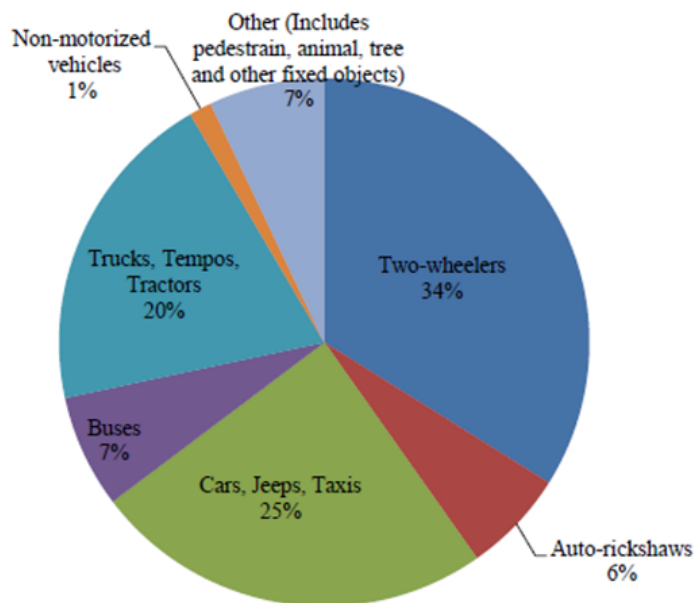


Fig 3.14: Share of different vehicle types in road accidents in 2017

Chapter-4

PERFORMANCE ANALYSIS

4.1 Introduction

In chapter 4, we discuss the outcome we got in our project of Pothole Detection System using Internet of Things. Here in, we record the intensity of potholes, there location and high slopes of roads is detected by our sensors. We will analyze the outcome of program and the website interface. We will also view the print screen of the program result.

4.2 Testing

Experiment 1: A solitary pothole on a flawlessly decent street.

On a consummately decent plain street, when the vehicle experiences a pothole, for this situation when the avoidance of the edge in the accelerometer went down to - 150 and back to 50, proposes that there is a pothole in that area. At the point when the pothole is distinguished than the GSM instantly tracks the area of the pothole and send it to the cloud which is considered the application on an android telephone.

Experiment 2: Multiple potholes on street.

On a street, when the vehicle experiences different potholes, for this situation with a diversion of the edge in the accelerometer redirecting all the more every now and again then it proposes that there are various potholes out and about. At the point when the potholes are identified then the GSM tracks all the area of the potholes and sends it to the driver.

4.3 Result of Programming

- When a pothole comes near or below this device, its details gets recorded.
- Both, ultrasonic and accelerometer sensor is activated.
- And then a notification is sent to Whatsapp that some pothole has been detected.
- The notification to Whatsapp mentions that a pothole has been detected.

Okay, now the detection is taking place and we can observe it by looking at the output window.



Fig 4.1:Whatsapp Notification

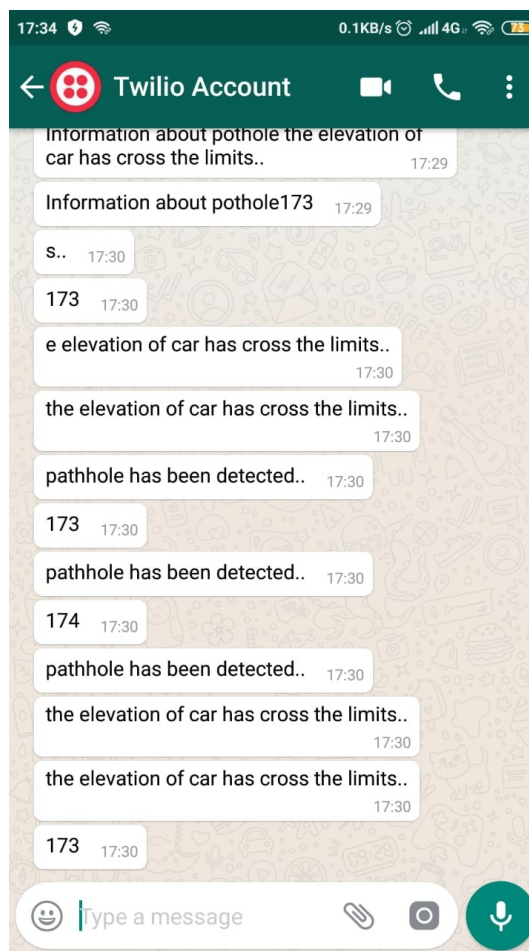


Fig 4.2:Alert on Whatsapp

Chapter-5

CONCLUSION

5.1 Conclusions

From the project completed up to now, we can reason that this framework can demonstrate to be a promising framework. Whenever executed on a substantial scale, spilling information can give us intriguing insights. Furthermore, this framework can distinguish false cautions and ready messages, which is exceptionally urgent part. Besides, the information from this sensor can add to the earlier outcomes from different frameworks.

As per the constant street conditions assessment, the strange street condition can be distinguished and spared in rush hour gridlock focus. The drives of the vehicles can be get adjacent street data from different vehicles by means of dynamic warning signs or to deal with their pouring practice for recuperating heavy security, solace and effectiveness.

5.2 Future Scope

The framework can be made helpful as a piece of keen city crusade. Additionally, applying AI methods in arranging information can assist the framework with adapting to changing components like nature of the street and vehicle type the clients use. Furthermore, the information gathered can be sent to the legislature with the goal that they can take the consideration for improving the street conditions.

1) First step is store every one of the information for example client data and street condition information (knocks and sharp turns with their precise area) on a server which is completely scrambled.

Encryption will guarantee that security of the client is safe and this way street conditions can be all around checked and clients can be furnished with full subtleties of the street while he is driving on it for example on the off chance that any sharp turn or knock is arriving. This would make driving increasingly protected and secure.

2) In the event that the client is driving in a territory where there is no net availability, at that point the application ought to hold every one of the information in the telephone's inner memory itself and when the web association is again settled the whole information is sent to the server. That is we will attempt to make our system defer tolerant.

3) To make the application react to crisis naturally. On the off chance that an unexpected brake is connected after which the vehicle quits moving, the server will make an impression on the application to know whether client is fine.

4) The affirmation of this message will be time delicate. On the off chance that the client reacts back to the server's message on schedule, at that point client will be recorded safe and in the event that no reaction is acquired in a specific term of time, at that point the server will consequently send crisis to vehicle's present area.

Vehicle type	2016			2017		
	No. of Accidents	Persons killed	Persons injured	No. of Accidents	Persons killed	Persons injured
A. Motorized Vehicles						
Two-wheelers	1,62,280 (33.8)	44,366 (29.4)	1,53,060 (30.9)	1,57,723 (33.9)	44,092 (29.8)	1,48,907 (31.6)
Auto-rickshaws	31,440 (6.5)	6,767 (4.5)	39,680 (8.0)	29,351 (6.3)	6,762 (4.6)	35,682 (7.6)
Cars, Jeeps, Taxis	1,13,267 (23.6)	32,599 (21.6)	1,25,773 (25.4)	1,13,737 (24.5)	31,183 (21.1)	1,23,156 (26.1)
Buses	37,487 (7.8)	12,088 (8.0)	50,686 (10.3)	32,145 (6.9)	10,651 (7.2)	44,330 (9.4)
Trucks, Tempos, Tractors	1,01,085 (21.0)	39,504 (26.2)	91,784 (18.6)	92,818 (20.0)	37,505 (25.4)	87,453 (18.6)
Other motor vehicles	13,255 (2.8)	5,886 (3.9)	11,607 (2.3)	-	-	-
Sub-total of (A)	4,58,814 (95.5)	1,41,210 (93.6)	4,72,590 (95.5)	4,25,774 (91.6)	1,30,193 (88.0)	4,39,528 (93.3)
B. Non-motorized vehicles	4255 (0.9)	1728 (1.2)	3799 (0.8)	6,376 (1.4)	2798 (1.9)	4992 (1.1)
C. Other*	17,583 (3.6)	7,847 (5.2)	18,235 (3.7)	32,760 (7.0)	14,922 (10.1)	26,455 (5.6)
Total (A+B+C)	4,80,652	1,50,785	4,94,624	4,64,910	1,47,913	4,70,975

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