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Node MCU Based Vehicle Monitoring System on Construction Sites and Its Applications Using IoT Method

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Abstract

The construction business faces a few difficulties on the location that incorporates checking of construction vehicles, precise bookkeeping, well-being of development hardware, mishaps, wastage of fuel because of driver's missteps or absence of value laborers on location interminably expanding interest for innovation which can wipe out or forever address the issues, developing worries of the above issues on building locales are expanding step by step which is now a greater danger to any development organization in our country. For countering these issues we can present a vehicle-checking framework for construction vehicles. A procedure is very protected and trustworthy. The idea is an installed application, which constantly monitors the working of construction vehicles and describes the situation with the particular vehicle or vehicles on appeal. The Node MCU chip interacts sequentially with an internet communication or internet of things (IoT) modem and Global Positioning System recipient. The internet communication or IoT modem is put to use to send the place of the vehicle from a remote spot constantly. The Global Positioning System recipient modem that utilization satellite innovation for its route framework will constantly give information like longitude, scope, distance voyaged, and so on. Whenever the solicitation from the client is shipped off the communication modem as Email or can follow on the Mobile App. The Project suggests the utilization of vehicle checking frameworks using IoT method on construction sites utilizing the most recent innovation

with a minimal expense procedure that will help the construction business to embrace the innovation and execute it in the field serenely.

Keywords: Construction business, construction vehicles, Node MCU, location, IoTIntroduction

1.1 General

The in-vehicle real-time monitoring system, or IVMS, is a system of electronic devices or a collection of devices used in vehicles to monitor driver and vehicle activities and assist in identifying ways to act, such as constant recording of vehicle movement, excessive speed, fast speed increase or tired driving, fuel noticing, two-way communication, geo-fencing, real-time location and more.

An IVMS device can send data to a recipient or store it for later retrieval. The data is then broken down to assess the driver's safety and driving techniques. This method of using in-vehicle checking structures aids associations with operational business cars in reducing the rate of failures and bothersome wear.

Numerous enterprises have taken on IVMS innovation, despite the fact that it is generally utilized by organizations in the public travel, mining, and oil and gas areas. As per the brand and sort of gear, these observing frameworks utilize different highlights and advancements.

1.2 Need of vehicle monitoring system on construction sites :

Numerous people accept that GPS following just applies to portable labor forces, which is a typical mix-up.It is viewed as that the main organizations that require vehicle global positioning frameworks inside their association are delivery and freightage firms. However, we wish to disperse this fantasy.This are qualified to be an intense client of vehicle checking administrations in the event that your association has a fixed arrangement frozen in place resources, similar as a development organization does. With armada following, it can ensure that the gear and vehicles remain where they ought to be and are utilized as per the arrangement. It will not at any point must be worried about the gear getting derailed or being mishandled.

It isn't unforeseen that the structure business is progressing rapidly alongside the stream as industrialization clears the globe. The apparatus utilized in this industry is very particular and application-explicit. Also, since the apparatus is very costly, it is important to keep up with, screen, and work it appropriately.Since they are so costly, these resources are additionally powerless against robbery.

Literature Review

1.1 Introduction

The following section present the brief summary of the work carried out by various re- searchers on vehicle monitoring system.

1.2 Review of Literature

- **Taku Murakami, Et al (2002)** sought to improve the server's data analysis capabilities and the connection to repair histories and other data stored by other systems. In the end, it is a hope to develop a system that enables precise estimation of machine life expectancy and effective repair scheduling [21].

- **Gian Luca Foresti and Lauro Snidaro (2005)** stated this system for actual-time traffic tracking in poor lighting circumstances has been shown here as part of a study that aimed to increase road safety. The system accounts for variations in lighting and tracks vehicles using an widened Kalman filter and a Two D state vector with constituents that correspond to each vehicle's speed and position . To accurately explain the motion of moving vehicles, an affine model that takes scale changes & translations into account is used [27].

- **Sun Guo-lei and Cao Yan (2007)** states that in this study, it will introduce the global development of MIS and GIS based on C/S structure. The limitations imposed by this framework may lead to various deficiencies. We'll keep working to make this system better in real applications while also commencing research and development based on B/S structures in an effort to enhance the use of GIS [26].

- **Shengli Song, Et al (2011)** claimed that the system's real-time monitor ability and dependability will be effectively upgraded and promoted with in-depth study of the main technologies. The technology is especially flexible and open, making it easy to upgrade and grow. It will therefore satisfy the needs of the clients and customers [11].

- **Jiang Yulian (2013)** analyzed the test findings indicate that the terminal can successfully avoid accidents by monitoring the status of moving cars and dangerous products in vehicles in real-time utilizing electronics, communications, and computer technologies [19].

- **Qingwu Li, Et al (2015)** stated that the nodes created by their technology may be mounted on mobile sensing vehicles as well as urban highways to provide basic information and assist mobility while enhancing sensing coverage. Together, the nodes constitute a large-scale IVIoT. The system can recognize and track vehicles in real-time by extracting the visual tags from the vehicles. Since the vehicle's visual tag serves as its sole means of identification, it is crucial in the pursuit of automobiles with phoney licence plates and other illicit activity [23].

- **Dimil Jose , Sanath Prasad (2015)** Based on cloud computing infrastructure, the suggested tracking system The sensors keep an eye on the vehicle's speed, driver condition, and fuel level. With the aid of a GSM-capable gadget, all data was sent to a cloud server. Every vehicle has a GPS antenna to help you

find the location. Alcohol sensors are put to track the status of the driver in order to prevent drunk driving. The proposed technique effectively prevents highway accidents [28].

- **Lingjun Tang, Et al (2016)** have come to the conclusion that the system as a whole consists of two components: construction vehicle detection and foreground detection. The dump trucks & hydraulic excavators, two of the most often utilised engineering vehicles, are investigated in construction vehicle detection. To identify a hydraulic excavator, an inverse-V featured framework model of a mechanical machine-like arm and temporal-spatial reasoning are established. In this journal, SCPSR is also introduced for the identification of dump trucks. This technology develops the first intelligent surveillance application on state-owned land and demonstrates good results in identifying hydraulic excavators and dump trucks in online footage taken by stationary cameras. Future research should concentrate on investigating more potent detection features and methods [18].

- **P.Jyothi (2016)** demonstrated that it is made up of an LPC2148 Board combined with various hardware components. The temperature of a vehicle component can be determined using a temperature sensor. GSM and GPS receiver modules are used to determine location and receive communication data. The DC motor's speed is managed by the PWM driver [25].

- **T.G.Deepika,Et al (2017)** observed that there are various existing models that are being implemented individually. All these models are implemented as a single unit. The data collected from these models are being updated frequently in the database, which can be viewed by the owner. Hence this system provides more information about the driver. The history of the driver can be verified during the payment times. Also the data security added in this project is more helpful to secure the system from the hacker using SHA-1 & SALT algorithm. The proposed system can be added with more features and can be used as an assist for the government transportation [20].

- **S. Kumar Reddy Mallidi,V. V. Vineela (2018)** concluded that by employing the SVMS, accidents will be quickly identified with a severity rating and immediately reported to authorities. The amount of fatalities and serious injuries from accidents will be reduced with prompt medical care. Additionally, this could aid with traffic diverting, which would save time and money. The frequency of car thefts will gradually decline as a result of this because it will also assist the user in locating and managing the stolen automobiles [17].

- **Ebenezer Narh Odonkor, Willie K. Ofosu (2020)** states that the planned vehicle loading monitoring system should be put into place in order to help prevent vehicle overloading. The engine lock mechanism may stop both vehicle malfunction and collisions. This might potentially take the place of the current technique, which requires drivers to halt for hours at weighing stations before the total weight of their vehicles is recorded utilizing weighing sensors set into the concrete of the roadway. The use of this

technology in cars will assist to lessen overloading, which frequently results in traffic accidents and the destruction of infrastructure, whether in Ghana or anyplace else in the globe [22].

- **Ricardo Salazar-Cabrera , Et al (2020)** validated that this proposal looked at low-energy communication technologies (LoRa, BLE), investigated techniques to detect vehicle emissions to aid in decision-making, and measured fuel usage to assess the outcomes and take appropriate action. This demonstrated that the proposal took sustainability of ITS services into account [24].

- **Chendong Zhu, Et al (2022)** states that first, because UAVs are so adaptable, safety inspections at building sites are conducted much more effectively and with fewer dangers to inspectors. Second, it compensates for the absence of image recordings at the location of the road construction. The target recognition and tracking algorithm lowers the manual workload and increases the security manager's efficiency in gathering on-site [29].

2. Methodology

3.5 Flow Chart of Prototype Preparation

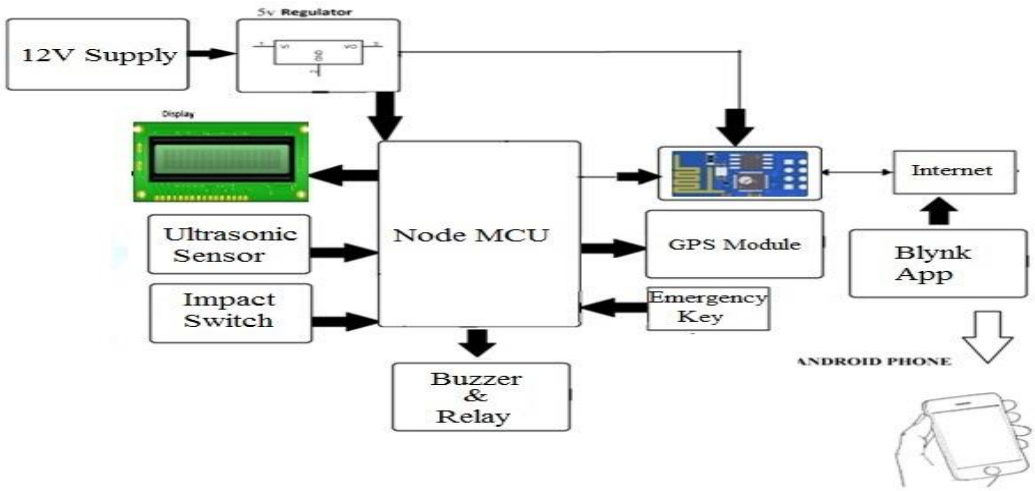

Fig 3.2 Flow Chart of Prototype Preparation

Further The Work is divided in 2 parts Hardware Components and Software Components. This project is based on IoT Method

3.6 Materials Required

3.6.1 Hardware Components

3.6.1.1 Node MCU V2

With only a couple of lines of Lua code, you can rapidly model your Internet of Things (IoT) item utilizing the open-source Hub MCU firmware and improvement unit.

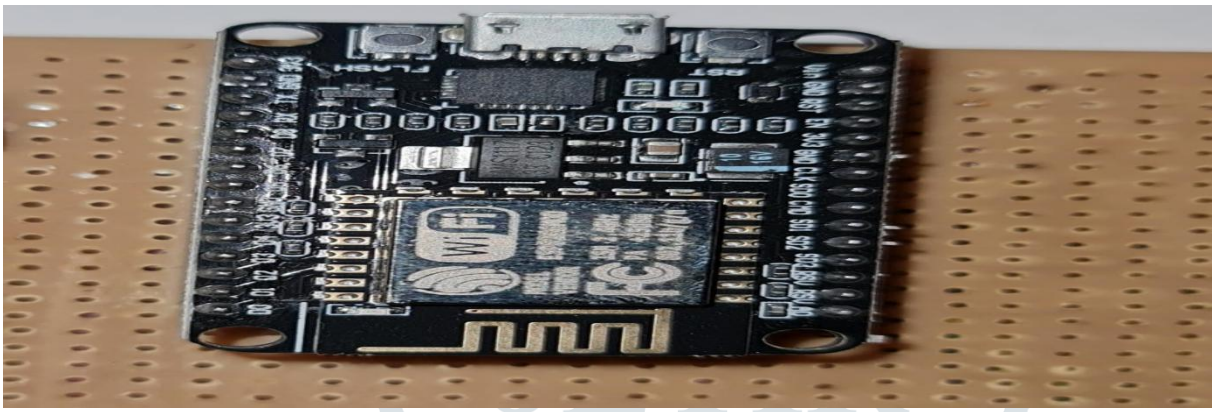

Figure 3.4 Node MCU V2

3.6.1.2 GPS Module

The u-blox6 position engine's outstanding performance is brought to the tiny NEO form factor by the NEO-6 module series. Low cost and low power consumption were priorities in the design of the u-blox6. For low-power applications, intelligent power management is a breakthrough. These receivers offer numerous connecting options and high levels of integration capability in a compact design.

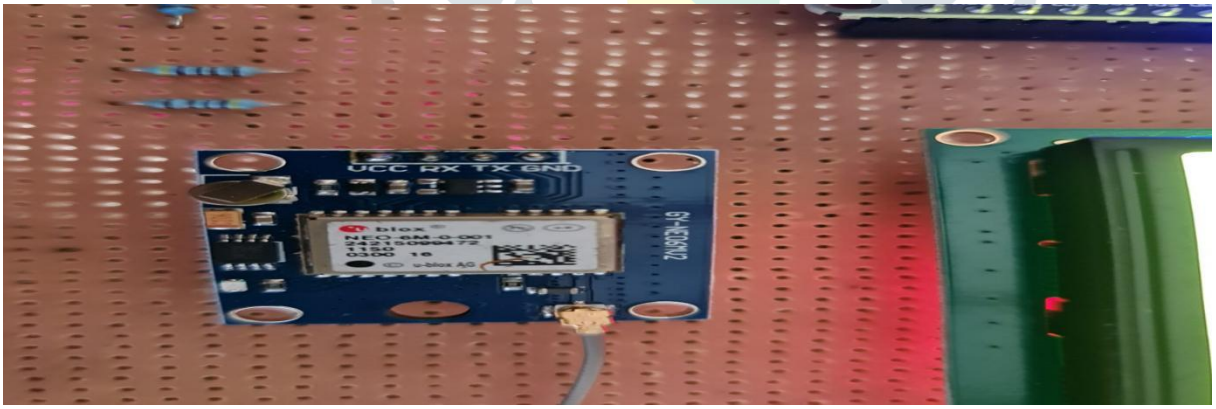

Figure 3.5 Neo 6M GPS Module.6.1.3 Ultra Sonic Sensor

The 2cm–400cm non-contact measurement feature is offered by the ultrasonic ranging module HC–SR04, and the ranging precisely is up to Three mm.

Figure 3.6 Ultrasonic Ranging Module HC - SR04

3.6.1.4 Impact Switch

Switches that detect impacts, shocks, or abrupt forces are called crush switches or impact switches. Impact switches lock the circuit closed when the can collapses under impact. When a switch is impacted, a contact is closed, which sets off a mechanism, whether it be an automatic reaction or a delay followed by an explosion.

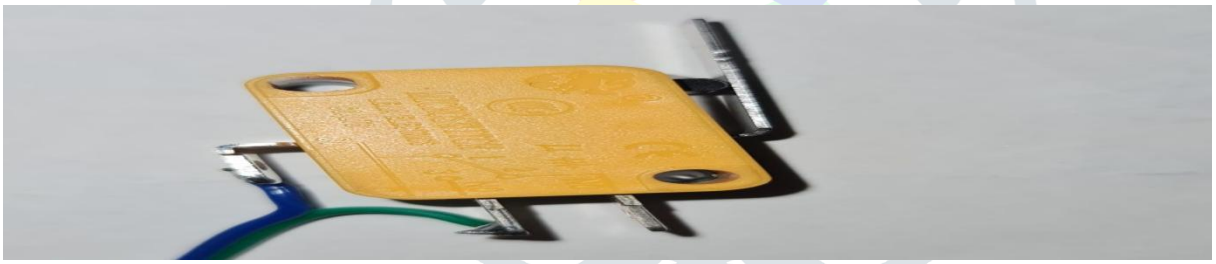

Figure 3.7 Impact Switch

3.6.1.5 Buzzer and Relay

The buzzer and relay is adopted with following features :

- It is always Sealed
- Operating power: Three -Six V DC / Twenty five mA
- Extremely compact Design, ultra thin in construction
- No noise of electrical while in use
- Very Low consumption of current though quite high pressure of sound level

Figure 3.8 Buzzer

3.6.1.6 LCD Display :

- The LCD display module no ADM1602K-NSW-FBS/3.3V is adopted with this following features :

1. Five x Eight dots with cursor
2. Sixteen characters * Two lines display
3. Four-bit or Eight -bit MPU interfaces
4. Built-in controller (ST Seven Thousand Sixty Six or equivalent)
5. Various Display Mode & Backlight Variations
6. ROHS (Restriction of Hazardous Substances in Electrical and Electronic Equipment) Compliant

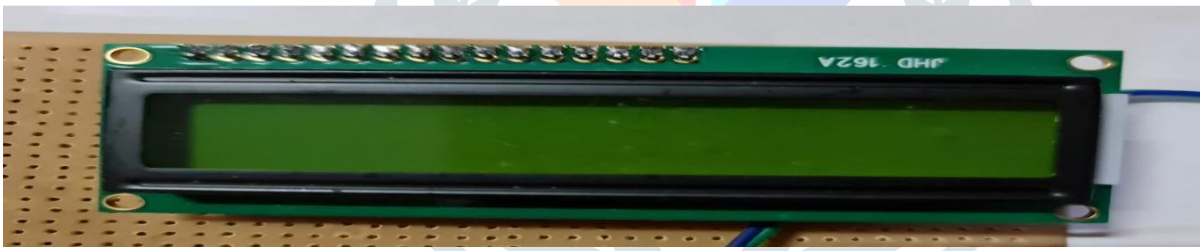

Figure 3.9.LCD DISPLAY
Module No ADM1602K-NSW-FBS/3.3V

- **I2C interface for LCD**

A fantastic I2C interface for 2x16 and 4x20 LCD displays is this LCD2004. This project can run out of resources if used a standard LCD shield due to the limited pin resources. It simply need two I2C lines with this I2C interface LCD module in order to display the data. It truly doesn't cost any more resources to use this LCD module if it already have I2C devices in this project. Fantastic for projects based on Node MCU.

3.6.1.7 Power Supply 5 V

We have used ERD 5V 1A Adaptor SMPS 5W PS-10/5V PS024 adapter for this project as shown in Fig 3.10 .

Figure 3.10 5V Adaptor

3.6.2 Software Components (Integration of Software Components)

3.6.2.1 Arduino Integrated Development Environment (IDE) :

The Arduino Software (IDE), also referred to as the Arduino Integrated Development Environment (IDE), has menus, a message area, a text console, a toolbar with buttons for essential operations, and a text editor for creating code. It establishes a link with the hardware to upload files and communicate with programmes.

3.6.2.2 Coding in Arduino IDE

Note: The first firmware will be deleted by the NodeMCU when we use it with the Arduino IDE, so in the event that you need the Lua SDK back, utilize the "flasher" to reinstall the firmware. From their Github web page at https://github.com/nodemcu/nodemcu-flasher, you can download the flasher.

Step 1: Utilize a miniature USB link to interface the NodeMCU to your PC or PC.

Step 2 : Download and introduce the drivers in sync. Here is the URL to the driver download page for Macintosh, Linux, and Windows: https://github.com/nodemcu/nodemcu-devkit/tree/ace/Drivers.

Step 3: Begin the Arduino IDE, select Inclination from the document menu, duplicate the URL http://arduino.esp8266.com/stable/bundle esp8266com index.json to exrta board chief URLs, as found in the screen capture beneath, and afterward click alright.

Step 4: Installing the Board,Utilize the board manager by selecting it under Tools -> Board., starting with "nodemcu"

After that, click install, restart the Arduino IDE, and choose the most recent version from the drop-down option.

Under the tools -> board menu, you ought to be see the newly created installed boards if everything has been installed correctly.

3.6.2.3 Testing of Node MCU

Let's now test our configuration by executing a blink sketch on our NodeMCU.

Step 1: From the "example for NodeMCU 1.0" area inside the example menu, open the example blink application.

Step 2: Use the micro USB cord to connect the NodeMCU to your computer.

Step 3: After choosing the board, port, and uploading the application, the built-in LED should begin blinking.

3.6.2.4 Blynk App

Blynk app Working :-

Blynk is a platform with apps for iOS and Android that allows users to remotely control devices like Arduino, Raspberry Pi, and others. It can create a project of graphic interface by simply dragging & dropping widgets on a digital dashboard. The Internet of Things was the focus of Blynk's design. It has several amazing features, like remote hardware control, sensor data display, data storage, data visualisation, and many more.

3.6.3 Google Maps

Google has developed a mapping programme for desktop computers and mobile devices called Google Maps. It offers two-dimensional (2D), satellite, and 360-degree street views (Street View).Google Maps provides high-resolution satellite imagery. The introduction of an intuitive mapping and satellite photography tool by Google's mapping engine led to an increase in interest in satellite photographs.

Results and Discussion

4.1 Testing of the System

4.1.1 General

Testing program consists of tests on Location, Accident Alerts, Fuel Monitoring, Emergency Switch of monitoring system. Each test performed is described in detail as follows.

4.2 GPS Location Test

Area and timing administrations are given through GPS, a route framework. The essential advantage of GPS is the capacity to follow a vehicle's area. To find itself, it depends on at least four satellites. These are utilized in this undertaking to follow the whereabouts of the car. The scope and longitude readings of the vehicle are displayed on the LCD screen, and the information is likewise messaged to the email address.

The data from which below graphical representation has been determined can be found on following link below.

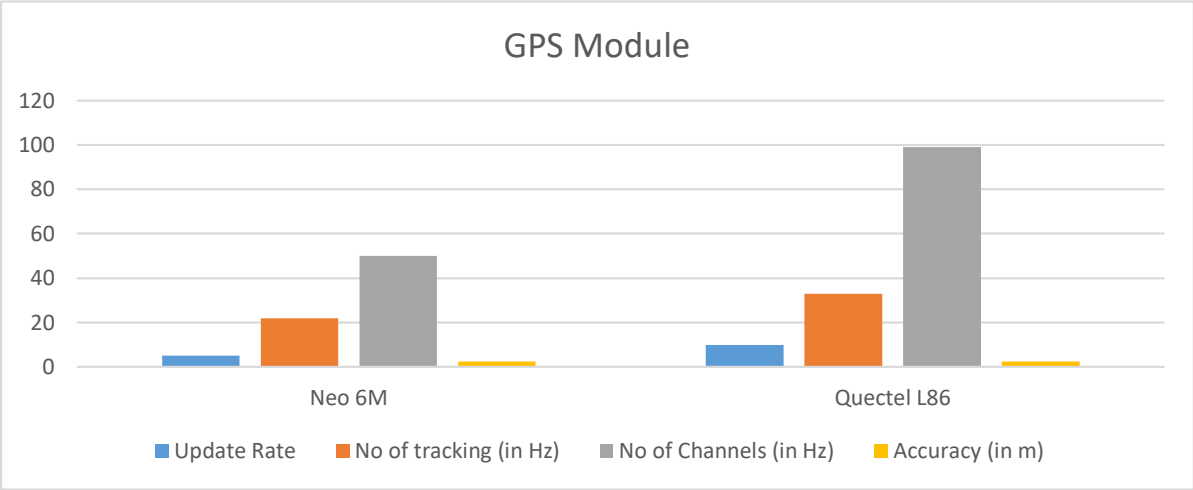

Figure 4.1 Graphical Representation of GPS Module
Source (https://www.seeedstudio.com/blog/2019/11/06/arduino-gps-modules-which-one-to-use-guide-and-comparisons/)

Figure 4.1.1 Testing of GPS Location

4.3 Accident Alerts Test

We have used a KW7 switch to sense the vehicle has been impacted same as modern day cars are used to identify impact during accidents and opening of airbags. The Switch identify the type of impact and communicate the user accordingly on the Email ID with proper location on Google maps.

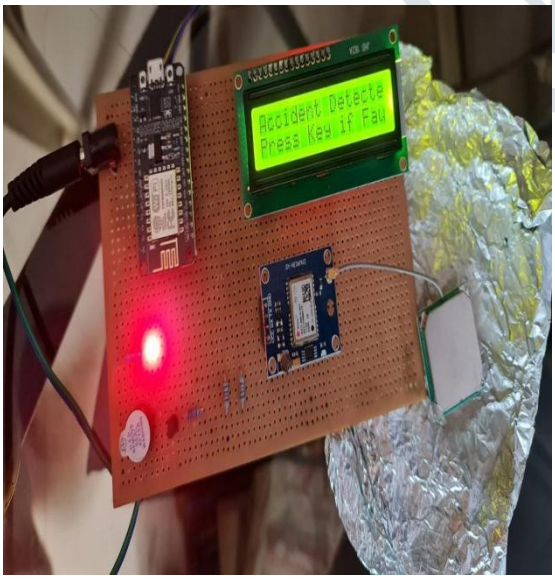

Figure 4.2 Testing of Accident Alert

4.4 Fuel Monitoring Test

For monitoring the fuel level and usage of vehicles like trucks, fuel tankers, boats, construction machinery, generators, stationary tanks, etc., the fuel-level sensor is the ideal answer. Because the sensor is independent of the car's electronics, it can identify and report fuel theft in real time, alerting the driver even when the car is off.

We have carried out this testing using ultra sonic sensor for fuel monitoring hypothetically considering Water container as a Fuel Tank of vehicle, Water as a fuel in the container. We got the result quick and accurate while experimenting.

Sonar is employed by the HC-SR04 Ultrasonic Distance Sensor to gauge a distance to an item.

The HC-SR04 uses non-contact ultrasound sonar to determine how far away an item is. It is made up of two ultrasonic transmitters (basically speakers), a receiver, and a control circuit. The high frequency ultrasonic sound from the transmitters bounces off any surrounding solid objects, and the receiver listens for any return echo. The timing of the signal's transmission and reception is then calculated by the control circuit using that echo. This time and some clever math may then be used to determine the distance between the sensor and the reflected object!

Figure 4.3 Fuel Monitoring Testing

4.5 Emergency Switch Test

It is the switch which is built for special cases during some emergency or any assist required by the vehicle operator.

For this purpose a switch has been introduced which will directly send a alert email to the owner/organization for assist or help with location of the vehicle. It is just a simple switch which is integrated in our Node MCU while experimenting it was observed that we were getting exact locations and alert where quick and fast as compared to the GSM model which takes sometimes too long to respond.

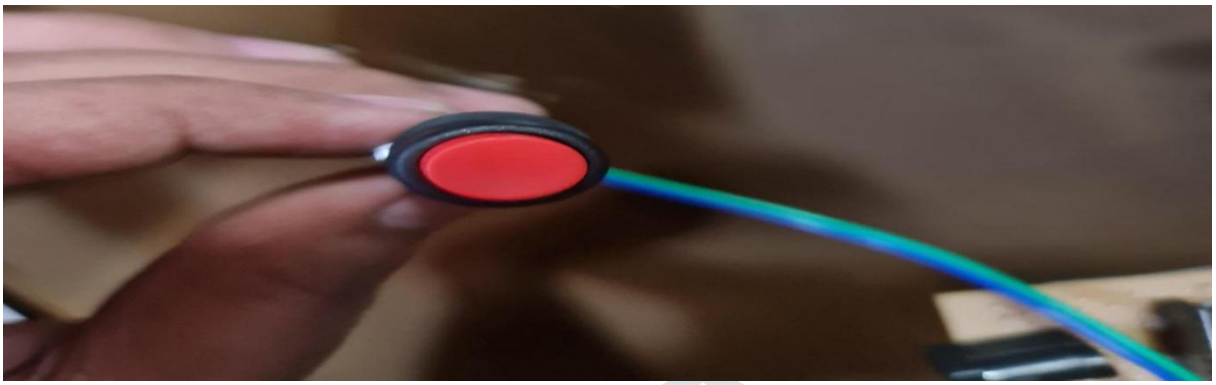

Figure 4.4 Emergency Switch Testing

4.6 Display of Results

4.6.1 Location

When we request location of construction vehicle from the blynk app the system will accept receive the request and then the owner/user whose email has been registered in the system will get the email link with the message and coordinates in this format as shown in fig 4.5.

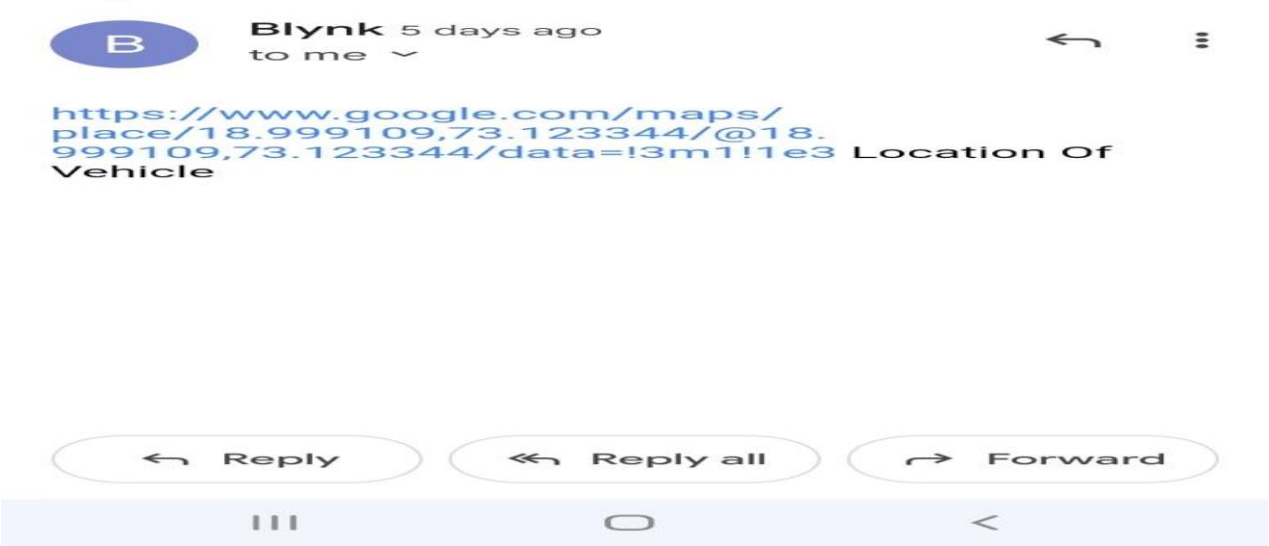

Fig 4.5 Display of Location Mail

After clicking on the email link it will be redirected to the google maps for the location of the vehicle and location will be displayed on google maps from any web browser or any smart phone as shown in the Fig 4.5.1.

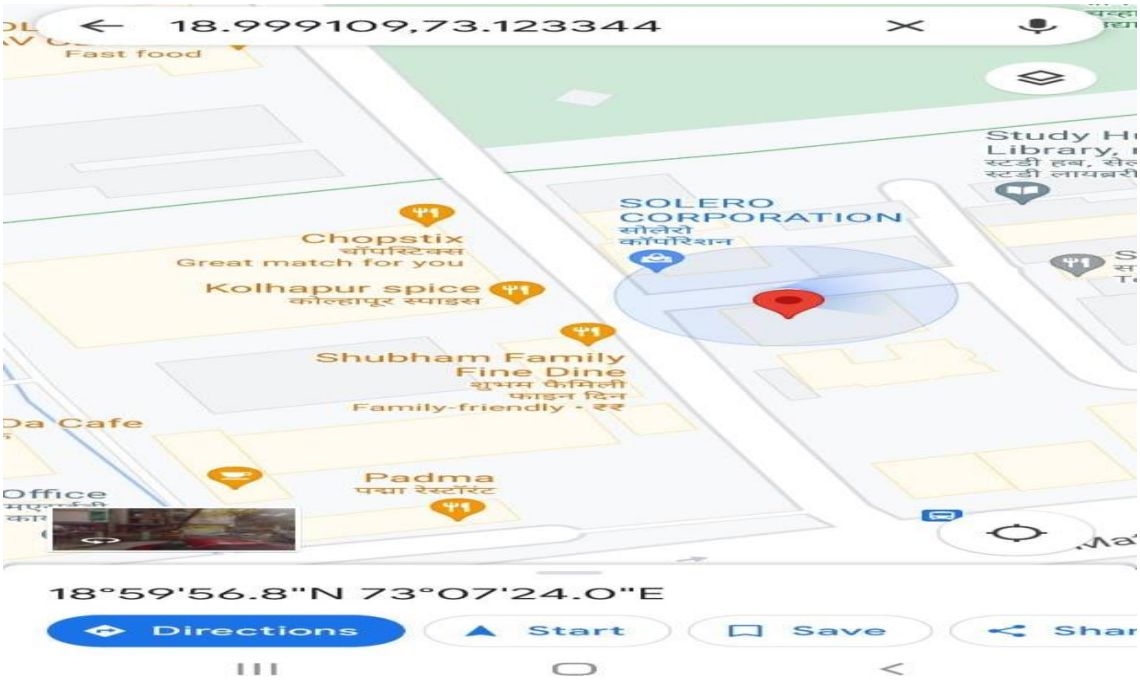

Fig 4.5.1 Display of Location Result

4.6.2 Accident Alert

When the Impact switch installed in the construction vehicle will sense the impact the vehicle monitoring system will immediately send an email link of location and coordinates with the message to the registered email id where the accident has been occurred as shown in fig 4.6.

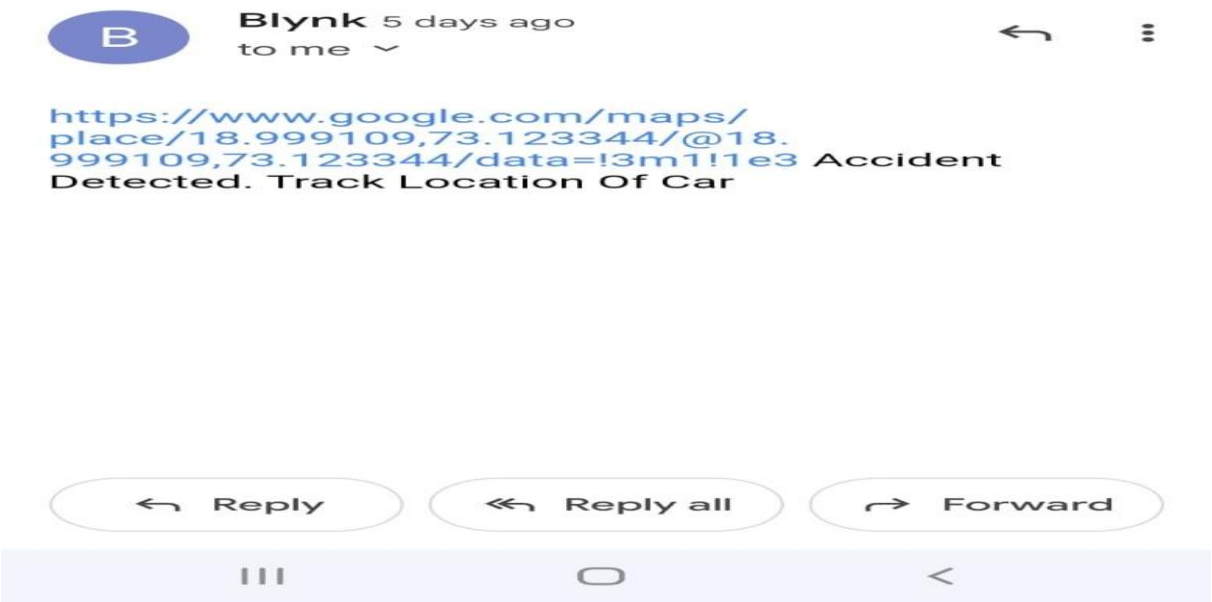

Figure 4.6 Display of Accident Alert Mail

After clicking on the email link it will be redirected to the google maps for the location of the vehicle and location will be displayed on google maps from any web browser or any smart phone as shown in the Fig 4.6.1.

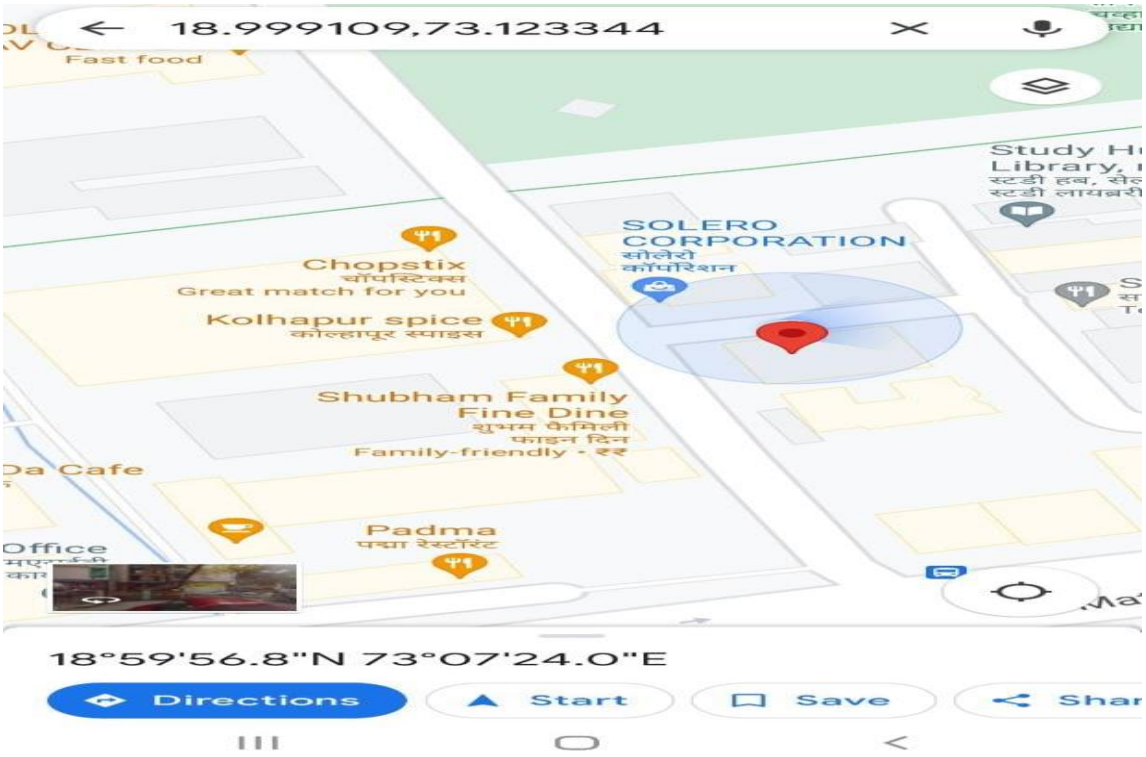

Figure 4.6.1 Display of Accident Alert Result

4.6.3 Emergency Key

If the operator of construction vehicle presses the emergency key an then the vehicle monitoring system will send an alert to the registered email id same as the accident alert and location with the note as shown in Fig 4.7.

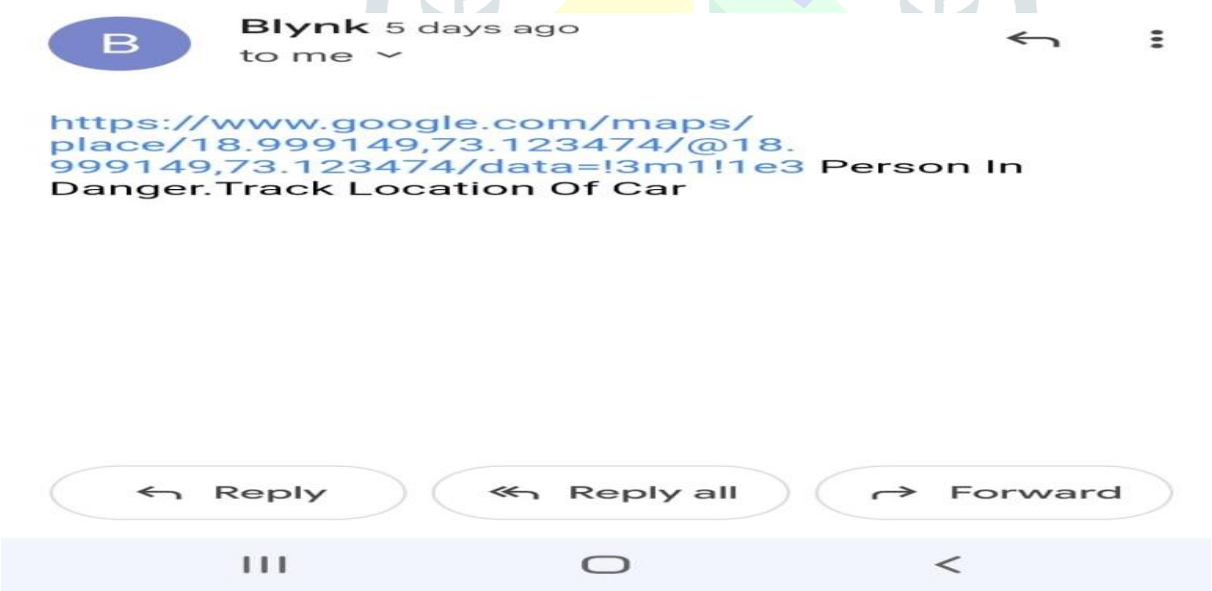

Figure 4.7 Display of Emergency Switch Mail

After clicking on the email link it will be redirected to the google maps for the location of the vehicle and location will be displayed on google maps from any web browser or any smart phone as shown in the Fig 4.7.1.

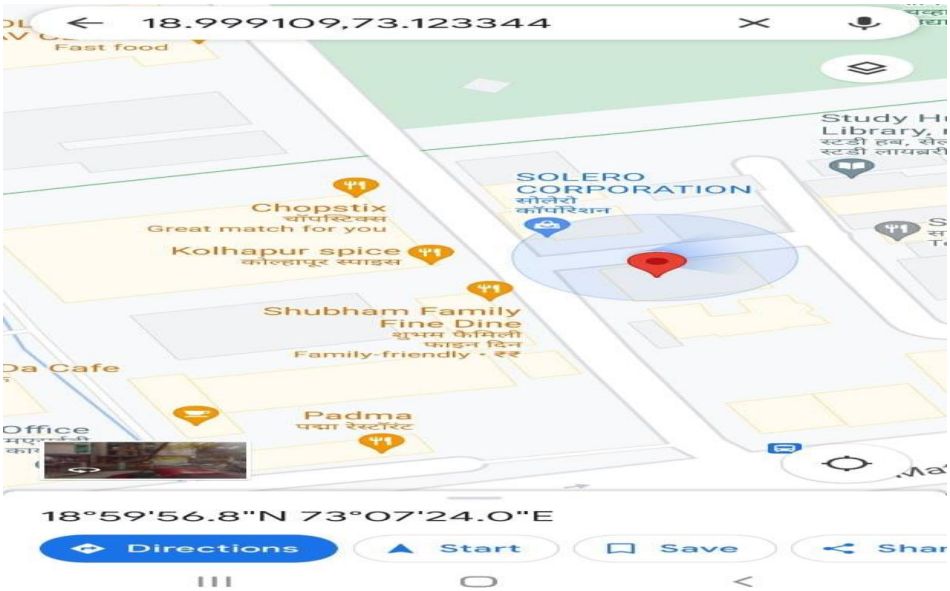

Figure 4.7.1 Display Of Emergency Switch Result

4.6.4 Fuel monitoring

We will receive the results of fuel monitoring on our blnyk app if the fuel level goes up number will increase if it goes down number will decrease in blue section left side as shown in the Fig 4.8.

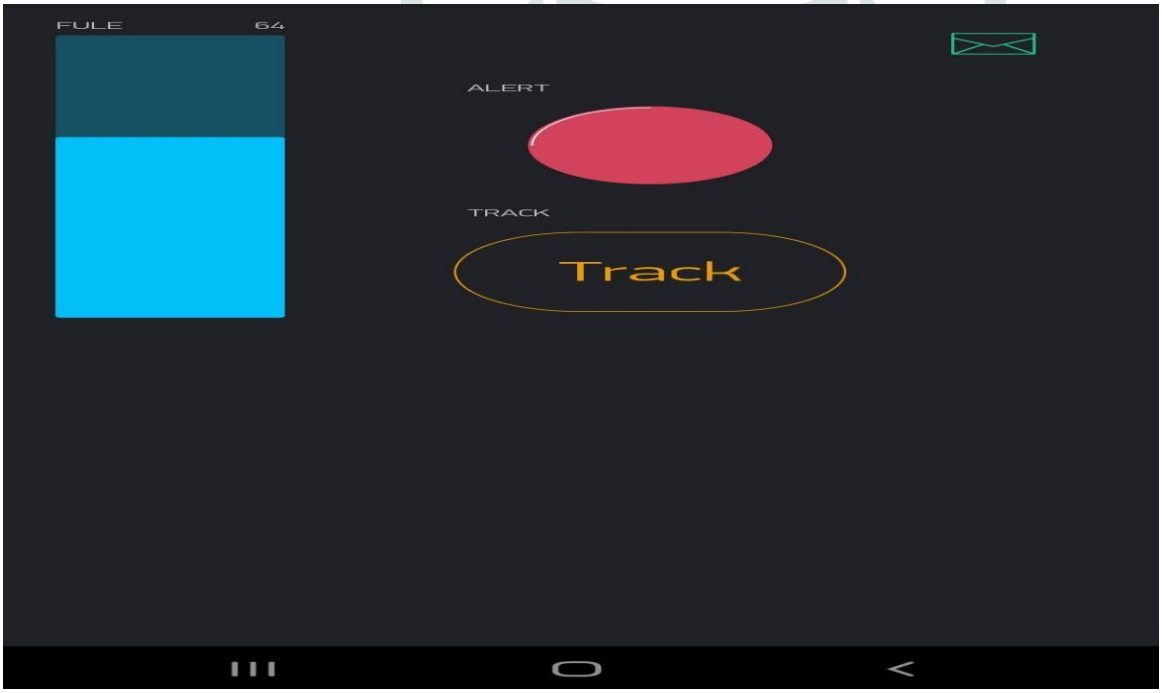

Fig 4.8 Fuel Monitoring Display of Result

In Fig 4.8.1 it can been seen that another fuel monitoring result which shows the number 56 as fuel level.

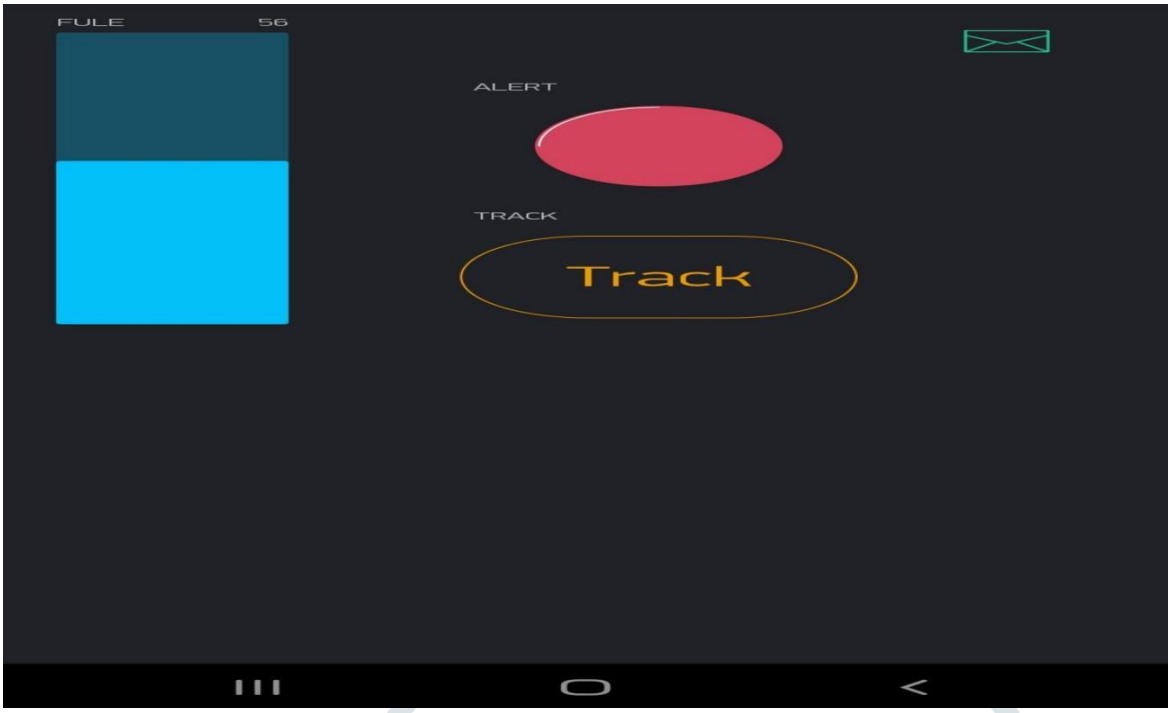

Fig 4.8.1 Change in Fuel Monitoring Level Result

Conclusion

5.1 General

There are various vehicle monitoring system available in the market which conforming to be the best and that will suit Indian construction sites conditions. For the study conducted the most widely used locally available hardware and software components were selected. Testing of prototype were conducted to determine the suitability for conducting the work and found out the prototype are suitable for the study.

5.2 Location

Our proposed construction vehicle monitoring system prototype offers a reliable alerting system for position tracking. The notification system has the ability to alter this situation. The device aids the owner in having regular access to information about the vehicle's position. Knowing the driver's integrity toward the owner is helpful and can also help to save money.

5.3 Accident Alert System

The system's other primary goal is to improve an accident victim's chances of survival on construction sites or off the construction sites. By sending an alarm Email as soon as an accident happens, this device enables paramedics or help to arrive at the accident scene in the shortest amount of time. As a result, the communication lag is reduced and the accident victim can receive prompt medical attention. It is crucial in pinpointing the locations of accidents that happen around midnight.

5.4 Fuel Monitoring

The HC- SR04 ultra sonic sensor for fuel monitoring was selected after successive trials this sensor for fuel monitoring will help greatly to the owner of the construction vehicles on sites by giving accurate results in real time. The goal was to provide real time fuel monitoring to owners of the construction vehicles anytime anywhere on their finger tips because on construction sites wastage and stealing of fuel from the vehicles are very common. With the help of this system it will be some relief to the owners.

5.5 Emergency Button

Another add on of this project is an Emergency button which will be provided inside the vehicle so in any case vehicle driver requires any assistance/help or any emergency owner will able to know and act as soon as possible for it.

5.6 Final Conclusion

The suggested monitoring system can send notifications to the owner and monitor the construction vehicle's real time fuel level check, accident alert, vehicle emergency, and geographic information (location). This proposed vehicle monitoring system will improve the construction business dependability and management. The use of information technology and electronics equipment in construction sector will likely to increase.

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