IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 14, Issue 1 Ser. I (Jan. – Feb. 2019), PP 42-48
www.iosrjournals.org

Mobile Enabled Vehicle Tracking System a Case of Long Distance Bus Companies in E. Africa

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Abstract: *The use of Global Positioning System (GPS) has remarkable contribution in tracking human behaviour ranging from stationed persons to those in transit, especially trans-border bus drivers. With the current road Carnegies in E.African routes there suffices need to track vehicles and drivers behavior from a central station. This not only curbs down bribery with traffic officers but also tames bus drivers hence reducing on accident prevalence. A design science research methodology was adopted with six major bus companies and a prototype (Me V track system) developed to assist in this Nobel cause. It was found to be handy in reducing fatal accidents in the region. However the research recommends that in an event that the GPS is incapacitated the SMS enabled notification can be of paramount importance.*
Keywords: *Global Positioning System, Mobile enabled, Bus Company, tracking*

Date of Submission: 01-03-2019 Date of acceptance:18-03-2019

I. Introduction

A decade ago technology visionaries were talking about a technology that people can use in their mobile phones to get direction, track their friends, and finally those kinds of services are starting with the help of Global Positioning System (GPS) that makes our life simpler and smoother. The GPS first began to materialize when Russia put Sputnik into space in 1957. The GPS program was approved in December 1973 in the United States and the first satellite was launched in 1978. In august 1993 GPS had 24 satellites in orbit and in December of the same year the initial operational capacity was established. In February 1994 the Federal aviation agency declared GPs ready for aviation use. And today this system includes the operation of 24 satellites that continually circle the earth and is used for a variety of functions that help you in map-making, land surveying, commerce and scientific affairs, such as synchronization of telecommunications networks, Bao-yen Tsui (2000).

The Global Positioning System (GPS) tracking system is the latest breakthrough of the technology aiming at improving people's lives. The GPS tracking system is reported to be used as a travel guide and as a tracking device of vehicles. No matter its application, GPS devices are good travelling companions. The GPS tracking system is also a perfect way around home construction site thefts. Indeed, recent news from the Tennessee reveals that GPS tracking devices have helped identify a rash of construction site thefts where many thieves were used to sneaking home appliances.

Of all the applications of GPS, vehicle tracking and navigational systems have brought this technology to the day-to-day life of the common man. Today GPS fitted cars; ambulances, fleets and police vehicles are common sights on the roads of developed countries, (Imtiyaz, 2006). Presently GPS is fully operational and meets the criteria established in the 1960s for an optimum positioning system. The system provides accurate, continuous, worldwide, three dimensional position and velocity information to users with appropriate receiving equipment, (Kaplan & Hegarty, 2006).

A Mobile Enabled Vehicle Tracking System combines the installation of an electronic device in a vehicle, or fleet of vehicles, with purpose-designed computer software at least at one operational base to enable the owner or a third party to track the vehicle's location, collecting data in the process from the field and delivering it to the base of operation (Claburn, 2009). Vehicle tracking systems have brought the Global positioning system (GPS) technology to the day-to-day life of the common man. Today GPS fitted cars; ambulances, fleets and police vehicles are common sights on the roads of developed countries, (Nayati, 2008).

The Mobile Enabled Vehicle Tracking System tracks the vehicles' location using a GPS enabled phone to always update the fleet managers about the vehicles' location after a minute and it has several features like speed monitoring. Drivers only need a mobile phone with an Internet connection to be tracked and dispatched efficiently. The Mobile Enabled Vehicle Tracking System also offers updates when the vehicle enters or leaves

a certain location, and mobile monitoring provides the exact location of the vehicles at different intervals through which the travelling speed is computed.

Human beings are entitled to food, shelter and clothing as basic needs, but mobility has of late portrayed itself as yet an emerging need. The establishment of the E.African community paved way for trans-border transportation and communication with ease. This saw numerous bus companies open and start operating from as far as Burundi through Mombasa; Juba through Dar Es Salaam in Tanzania. The bus companies in question include Onatracom, Trinity, Jaguar, Modern, Kampala coaches, Gaagaa and Buscar. Despite such an initiative, courtesy of E.African treaty, some bus companies have been on spotlight for causing fatal accidents due to over speeding and other related dubious activities. More still some filthy citizens take advantage and like to shift blame to these bus companies.

Furthermore, several traffic police reports have presented discipline (31%) and over speeding (38%) alongside use of drugs and alcohol (28%) as key contributors to most fatal accidents on our road (Traffic Police Report, 2017). More still the traffic officers have been blamed for taking bribes which has escalated accidents along major E.African routes. This leaves partner states perplexed. Although there maybe various remedies some of which have been implemented already, amalgamation of conventional and technological means suffices. For example, TRAC-IT is used to track an individual's travel behavior using a Personal Digital Assistant (PDA) platform linked with a Global Positioning Systems (GPS). The system works across various modes of transportation and automatically analyzes the data collected from the device to give personalized feedback advice, based on its server side expert system. TRAC-IT captures travel patterns regardless of mode, automates the collection of travel characteristics like time, and distance, transmits the data to a database, conducts the analysis of the household's travel patterns using a travel advisory feedback system, and provides advice to the individuals in the household about trip chaining using transit, biking, and walking as well as carpooling options (Center for Urban Transportation Research, 2008). This study thus sought to design a proposed mobile enabled vehicle tracking system (Me V Track) in E. Africa with specific objectives as to: Examine the current vehicle tracking system in selected bus companies (requirements gathering); and develop a prototype for mobile enabled vehicle tracking system in E. Africa.

II. Literature Review

A vehicle tracking system is an electronic device installed in a vehicle to enable the owner or a third party to track the vehicle's location. Most modern vehicle tracking systems use Global Positioning Systems (GPS) modules for accurate location of the vehicle. Many systems also combine a communications component such as cellular or satellite transmitters to communicate the vehicle's location to a remote user. Vehicle information can be viewed on electronic maps via the Internet or specialized software (Embarc Information Technology, 2009).

Relatedly, cell tracking, mobile GPS and cell phone tracking applications are gaining particular attention from individuals, phone companies and application designers. Today, mobile communications means more than simply making a telephone call while on the move. The most up to date mobile phones have GPS position features to track cell phone position. These features, in addition to others like SMS texting, internet access along with the capability to apply other software programs help make smart phones essential gadgets. Some third-party software applications help to Trace-cell location however GPS satellites are not constantly available, such as when the cell phone is inside a building for example an office, mall, or perhaps in an automobile. That doesn't mean cell phone locating is not really possible, however it does mean there are other techniques to Track cell-phone than only GPS. One more issue with mobile phone GPS location may be the possibility of draining the battery. It is significant to have the capacity to remotely adjust the frequency of getting GPS location. Picking real-time or periodic sampling affects both the resolution of finding position along with how long the battery will last, (Imtiyaz, 2006).

In addition Global System for Mobile communication (GSM) is a cellular network that mobile phones use to acquire connectivity in their immediate vicinity. These networks operate in different frequency ranges, mainly between 900 MHz and 1800 MHZ. It uses a narrowband variation of Time Division Multiple Access (TDMA), which allows eight simultaneous calls on the same radio frequency. SMS (Short Message Service) is a protocol for sending and receiving text messages over GSM networks. The text can comprise of words, numbers or an alphanumeric combination. A message can go up to 160 characters of text in length using GSM coding. GPS (Global Positioning System) is a satellite based navigation system made up of a network of 24 satellites placed into the orbit. These satellites transmit coded information which allows us to identify locations on earth precisely by measuring the distance from the satellites. The Vehicle Tracking System (VTS) also uses GPS to take the location, speed, direction and time data via satellite from the Global Positioning System to the GPS + GSM receiver in a vehicle and also transmits it to a central computer connected to a private network or the internet. It is an electronic device installed in a vehicle to enable the owner or a third party to track the vehicle's location. Most of these systems combine with mobile phones through SMS to communicate the vehicle's

location to a remote user. There are many levels of sophistication, but what all systems have in common is a GPS receiver and software to put the tracking results on a map. The Vehicle Tracking System has several applications such as stolen vehicle recovery, fleet management, asset tracking, field service management, field sales and trailer tracking (Wajirakumara, 2008).

Vehicle Location System

A Vehicle Tracking system operating from a Systems Operating Centre (SOC) must provide an accurate present location. The location can be defined in a standard manner referring to national and international mapping principles and at a definition level that permits a realistic chance for the police to find the vehicle (such as within 100m) with details to street name and major physical feature level. Gardner & Hartley (2002) alluded that the system provider can state the positional accuracy and the area effectively covered by the system.

Also taking an example of the Fleet Monitoring System (FMS) which is used to monitor transportation processes, the FMS analyses incoming messages, determines actual data and compares it with the planned data. Furthermore, it monitors whether all planned events occur as expected. The Fleet Monitoring System can analyze messages sent from the vehicles in order to identify discrepancies between actual and planned data. Furthermore, it can be used to revise the planned data and to update the database of the logistics system. As it can automatically detect unexpected incidents and ambiguities, dispatchers do not need to manually analyze all messages sent by the vehicles. Furthermore, the Fleet Monitoring System supports the dispatchers in reacting quickly to possible disturbances in the transportation processes (Goel & Gruhn, 2009).

Design

Design Science research methodology was employed where selected drivers, bus companies got involved. A joint requirement engineering technique was used to collect data. Six bus companies were involved in this survey: Kampala Coaches and Gaagaa for South Sudan; Onatracom and Trinity for Rwanda-Burundi; Jaguar and gateway for Democratic Republic of Congo (DRC). These were selected basing on their remarkable experience and the number of buses used. Data was collected by interviewing the drivers and company managers at their respective booking offices in Kampala. The Me V Track stored and organized the data generated from the various tracking processes. The system stored the authentication, coordinates, phone, staff and vehicle details in its database. The Me V Track was responsive to the user's needs. The system did not acquire and maintain data that the users would not need in the tracking process. The location of a vehicle was determined by a GPS enabled Phone which was placed in the vehicle. As the vehicle moved the GPS enabled phone sent location coordinates to the server after a desired time interval (60 seconds for testing purposes).

The system depended on GPS and Java-enabled mobile phone that was supported by JME (Java Micro Edition) platform. The whole architecture was client-server based. The client (GPS and Java enabled mobile phone) ran a java application and the server ran a PHP application. MYSQL was used to implement a server based database while Ajax PHP library was used to process data on the server. The Geographical Positioning System (GPS) satellite system was employed by the Java application on a mobile phone for the purpose of obtaining location data. In order for the mobile application to operate, the mobile phone had to have wireless application protocol (WAP). A database component that enabled the storage, modification, and extraction of information from the database was included. The system was run with test data collected from different points in a location to check whether the system behaved as expected. This was done using benchmarks and program animations. Testing involved internally checking the implemented system to identify errors and weaknesses and to correct them before presenting it to the intended users.

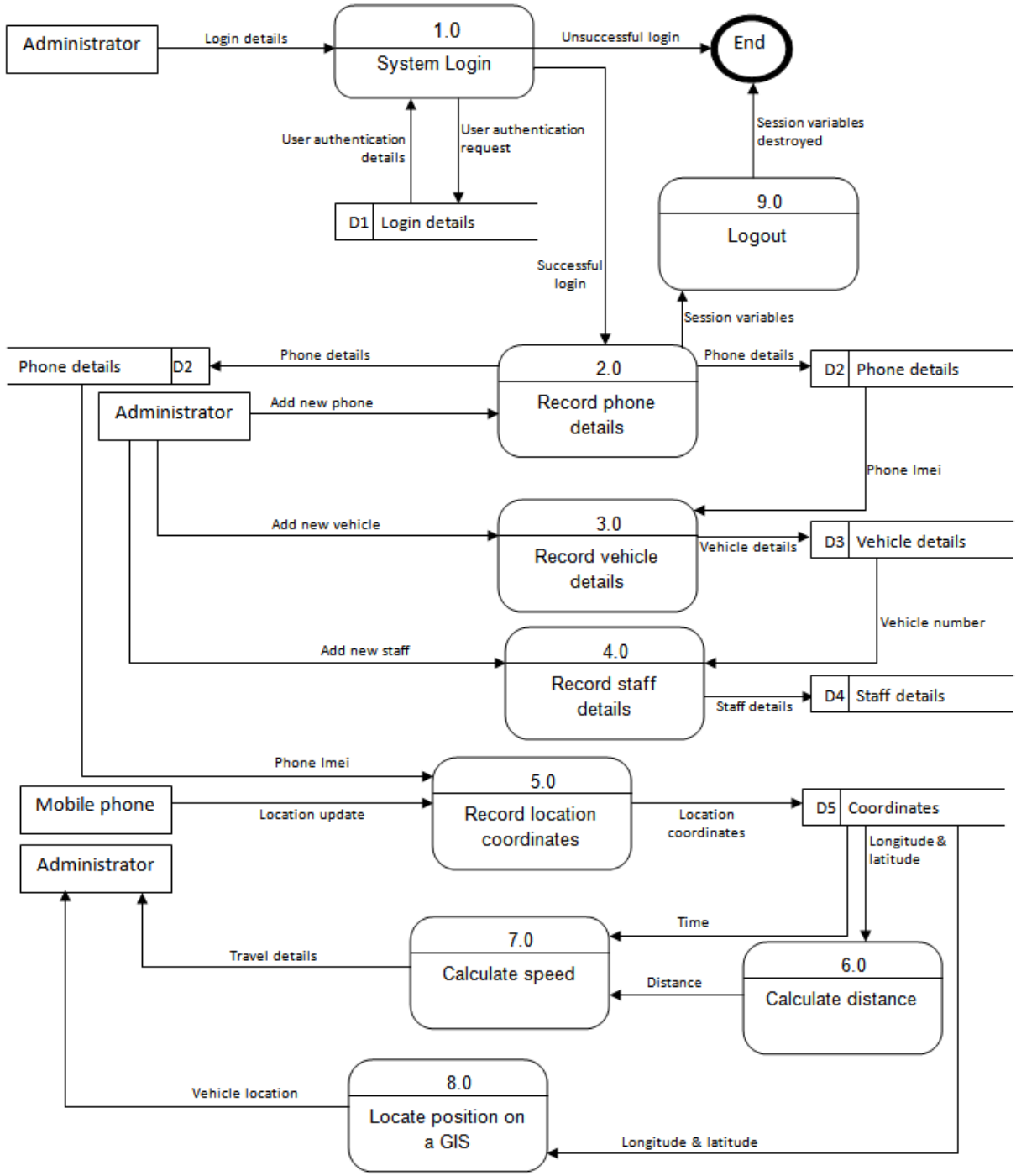

Figure 1: Illustration of Context level Diagram

The functional requirements include

i. The mobile application shall be able to capture the latitude, longitude and altitude from a GPS enabled phone.
ii. The mobile application shall be able to send GPS data through HTTP connection.
iii. The server side application shall be able to calculate distance between two geographical points.
iv. The system shall be able to calculate speed at which the vehicle is travelling.
v. The system shall be able to locate the route the vehicle is taking.
vi. The system shall trigger an alarm in case of over speeding.

Speed Calculation

Speed was calculated from the distance between two geographical points and time taken to travel between these points using the following logic:-

Let A =distance between latitude and B =distance between longitude

A=degrees to radians (lat1) - degrees to radians (lat2)
B = degrees to radians (lon1) - degrees to radians (lon2)
C = sine $(A/2)^2$ + (cosine (lat1)*cosine (lat2))*sine $(B/2)^2$
D = 2* arctangent (√(C), √(1 - C))
Distance = d*radius of the earth
Speed = Distance/Time interval

3. Findings and Conclusion

The Mobile Enabled Vehicle Tracking System was able to track the vehicles' location using a GPS enabled phone to always update the bus managers about the vehicles' location every minute and had several features like speed monitoring. Drivers only needed a mobile phone with an internet connection to be tracked and dispatched efficiently. The Mobile Enabled Vehicle Tracking System also offered updates when the vehicle entered or left a certain location, and mobile monitoring provided the exact location of the vehicle at different intervals through which the travelling speed was computed. The research thus concludes that the Me V Track can be significant in inculcating discipline among bus drivers in E.African region.

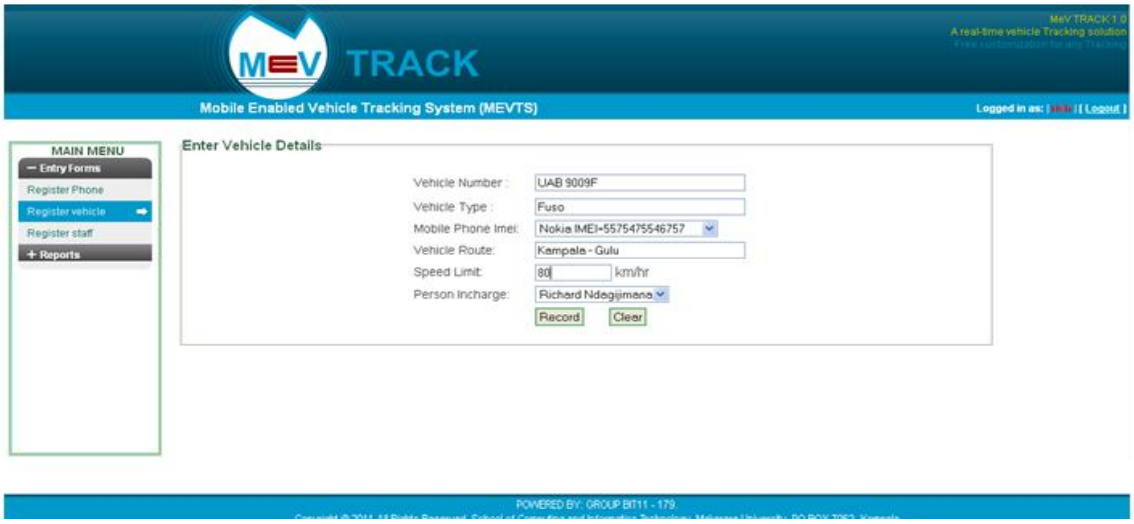

Figure 2: Vehicle Registration Component

Figure 3 is used to input vehicle details to the database. Every vehicle registered required a phone and driver, the *Mobile Phone IMEI* and *Person In charge* are directly fetched from the database and populated in the list. This was done to prevent the system user from entering wrong foreign keys.

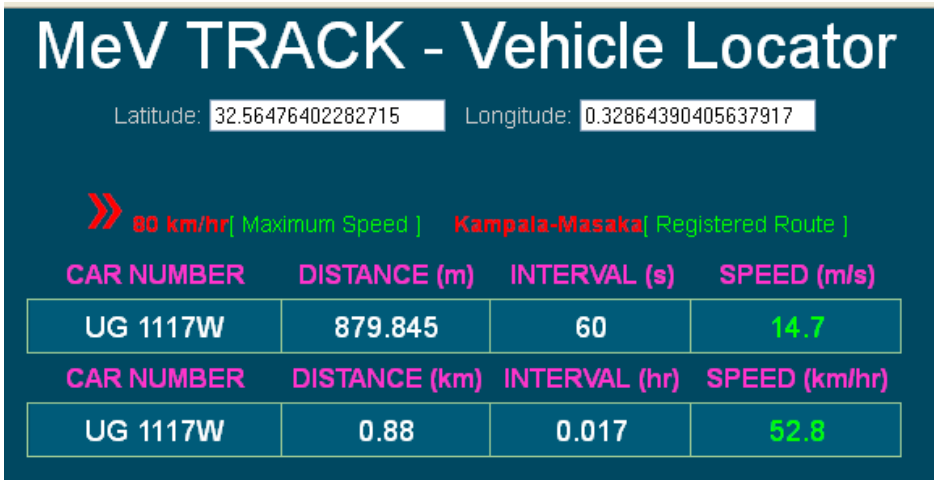

Figure 3: Distance and Speed Calculation

This interface shows the calculated distance from two geographical points and speed at which a vehicle was travelling between these two points. When a vehicle speed exceeded the maximum speed the system generated an alarm tone at the sever side indicating the administrator of a speed violation. The travel information on this page was updated automatically after the refresh time that was set.

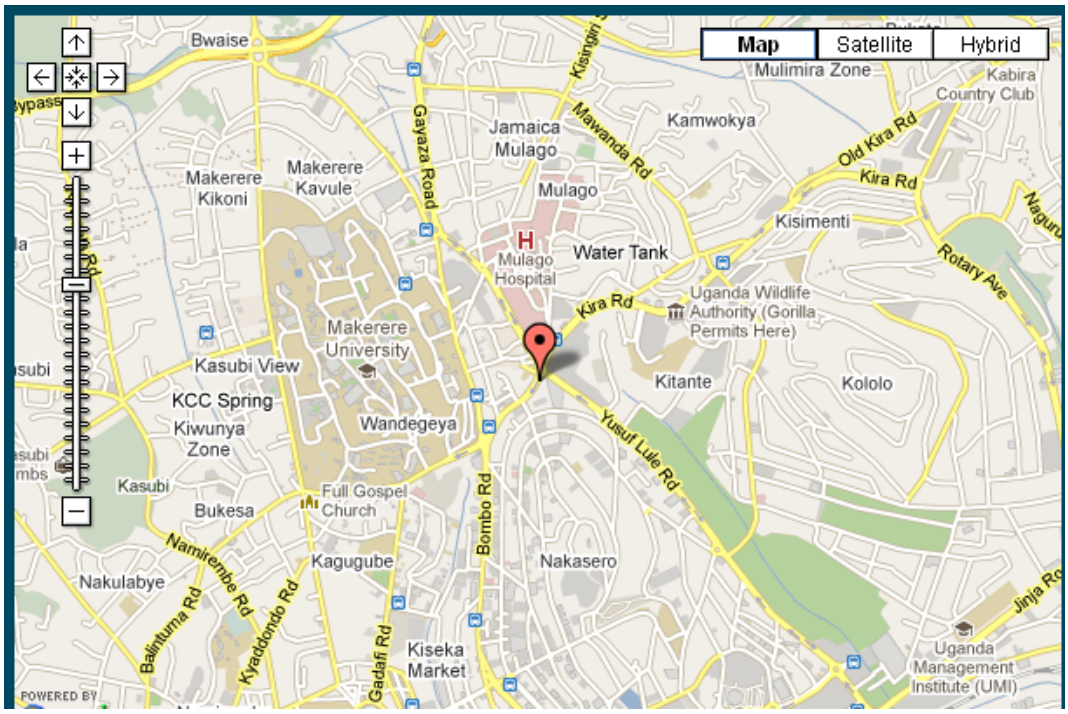

Figure 4: GIS Component Showing Satellite View

This component shows the location of the vehicle being tracked on a Google map. After every 60 seconds the page refreshed and the pointer pointed on the current location. This component displayed the location in three different views. Map (shows map and names of places), Satellite (shows location appearance) and Hybrid (shows location appearance and names of places)

Figure 5: GIS showing actual location of the vehicle and its environment

Satellite view helped the user to know whether the vehicle is in an urban or rural area.

5 Recommendations and future work

i. Researchers who intend to add onto this topic should consider using other programming languages and database designs that will make the system more interactive.
ii. The potential of this project can be further explored to improve on its functionality and features.
iii. The use of the cell ID from a SIM card over telephone masts is a feature that this project has not implemented but will later integrate with time. This will help to locate the vehicle in case GPS satellites can't be contacted by the mobile phone.
iv. This project requires vast quantities of research done at design and implementation of Mobile Enabled Vehicle Tracking System

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IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) is UGC approved Journal with Sl. No. 4198, Journal no. 45125.

Conrad M. Mubaraka. " Mobile Enabled Vehicle Tracking System A Case Of Long Distance Bus Companies In E. Africa." IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) 14.1 (2019): 42-48.