



University of Nairobi
School of Computing and Informatics

**Instant GPS Based Motor Vehicle Accident Detection and Reporting
Solution**

BY

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P58/61426/2010

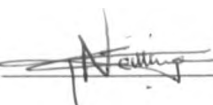
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Submitted in partial fulfillment of the requirement of the Masters of Science
in Computer Science

Declaration

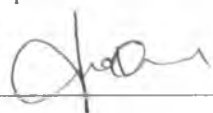
I Peter N. Njuguna declare that this project as presented in this report is my original work, and where there is work or contributions of other individuals, it has been dully acknowledged and also to the best of my knowledge, this project has not been carried out before or previously presented for any other university award.

Signature:  _____

Date: 01/10/2012 _____

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This research has been submitted as part of fulfillment of the requirements for the award of Masters of Science in Computer Science of the University of Nairobi with my approval as the university supervisor.

Signature:  _____

Date: 4/10/2012 _____

Andrew Mwaura

Abstract

Motor vehicle accidents are frequent incidents with disastrous results. The methods used to detect and report the accidents are slow and cumbersome, leading to avoidable losses and casualties. Accurate, reliable and electronically accessible motor vehicle accident data is unavailable in many developing countries. Instant GPS based motor vehicle accident detection and reporting solution has been developed using existing technologies to overcome these deficiencies.

The system consists of accident detection, vehicle tracking and accident surveillance modules. The accident detection module has impact sensors, signal conditioning electronics and accident detection logic unit. Active GPS device with three important capabilities including a GPS signal interface, digital input interface and a wireless interface with transmitting capabilities make up the vehicle tracking module. The surveillance module has a computer with an input interface for a wireless GSM enabled mobile phone. The computer hosts a database for recording accident incidents, accessible through a website. The recorded accident data is displayed at the client workstation against a GIS digital map backdrop, using customized software to authorized users of the system via the website and the internet technology. New accident incident will sound an alarm at the client side to alert the user. This enables authorized users, for example the police and ambulance paramedics to learn about an accident occurrence, allowing them to track and move to the accident site for evacuations.

Fifty impacts were generated in experiments using the prototype developed in this project. It was found that 98 percent of the impacts were recorded on the database as accidents, within an impressive average time of fifteen seconds and authorized web clients could access it immediately. Email alert messages were send to pre-configured contacts immediately on updating the accident occurrence.

Instant GPS based motor vehicle accident detection and reporting solution offers a feasible and in many ways ideal technique of detecting and reporting accidents. In addition, accident database allows for data mining analysis, with findings which can be employed to significantly reduce vehicle accidents.

Future studies could be conducted to come up with a technique on how mobile telephone technology can be employed to update new accident incidents into the accident database, especially for motor vehicles not fitted with the automatic detecting and reporting devices. Perhaps surveillance and notifications of accidents could be extended to mobile phone alerts via SMS.

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First and foremost, my appreciation goes to the almighty God for giving me these creative ideas, resources and ability to do this project and as such ascribe all credit to him. I also wish to express my sincere gratitude to Mr. Andrew Mwaura for the invaluable counsel and guidance towards the successful completion of this research project. Special thanks also to all my MSC lectures for sharing their knowledge during this MSC programme.

I am indebted to my friends and colleagues at the university for their assistance, support and teamwork over the period of this course.

Exceptional thanks and gratitude go to my university colleague Mr. James Obuhuma for his support and advice given on GPS devices and car tracking technology. I also thank my friends Polycarp Ameyia and Clement Gitonga for their time and tutelage in web user interface design and implementation. Likewise, I am beholden to my friends out there who assisted me in assembling the hardware, testing & evaluating the prototype and providing very useful insight into the project.

Last but not least, loads of appreciation goes to my wife Mumbi, Son Njuguna and daughter Wambui for their love and patience while I was reading and working on this project long days including weekends. My Parents, brothers and sisters encouraged me throughout this programme and I am indebted to them for cheering me on.

Dedication

I dedicate this research project to:-

1. My children SammyGrant Njuguna and CarrieJill Wambui, with a prayer that they will aspire to scale greater heights in their specialties and set future benchmarks as a worthy service to God and mankind.
2. The many victims of road accidents in Kenya especially those whose lives, injuries and losses could have been saved with fast and professional rescue operations.

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List of Abbreviations

- i) ECU - Electronic Control Unit
- ii) GPS - Global Position System
- iii) GSM - Global System for Mobile Communication
- iv) GPRS - General Packet Radio Service
- v) RDBMS - Relational Database Management System
- vi) ADC - Analog to Digital Converter
- vii) ISP - Internet Service Provider
- viii) ETSI - European Telecommunication Standard Institute
- ix) RTA - Road Traffic Accident
- x) SMS - Short Message Services
- xi) GIS - Geographical Information System
- xii) LAN - Local Area Network
- xiii) WAN - Wide Area Network
- xiv) SIS - System Internal Specifications
- xv) SES - System External Specifications

Chapter One: Introduction

1.1 General Introduction

According to the World Health Organization (WHO) global status report on road safety 2009, Kenya had 3,760 traffic deaths, the highest in East Africa region. Approximately 1.3 million people die each year on the world's roads, and between 20 and 50 million sustain non fatal injuries. Vehicle accidents episodes are reported on both the print and electronic news media. Governments have put in place various regulations to avert the catastrophe but to no avail. In this study literature review has been conducted on this subject, confirming that effective and timely measures of reducing accident morbidity, mortality and others losses are required.

When accidents occur, help to the victims is delayed mostly due to lack of the detection and prompt reporting. This project has come up with a scientific way of automatically detecting and reporting accidents to the responsible authorities. Existing technologies have been integrated in the development of this solution. These includes; impact sensors, Global Positioning System (GPS), Geographical Information System (GIS), GSM - Global System for Mobile Communication, GSM, Electronic Database System, the internet and web programming.

The study explicates how impact or crash sensors will be used to detect accidents. The chapter on methodology has details on how the impact sensors interlink the Electronic Control Unit (ECU) to form the impact sensing subsystem, which will subsequently interface with a Global Positioning System (GPS) device. The two subsystems are the basis of an automatic detection and reporting of an accident.

The study also has details on how the impact data is transmitted through GSM/GPRS network to a web based database where automatic recording of accidents is done. Clients using the internet technology can access the data against a backdrop of GIS digital maps. The database is a repository of critical accident data. A special software module for accessing the database has been developed for the police, whereby they can update data on motor vehicle accidents that are not automatically captured by the system.

The accident database is available for queries and data mining analysis. Analysis of the detailed accident data can bring out important information and knowledge usable in mitigation of the escalating incidents of motor vehicle accidents on our roads. For example, black spots can be noted easily facilitating the marking of such spots on the roads. Analysis can also help in categorizing the types and classes of vehicles likely to be involved in accidents.

Elaborate evaluation of the system prototype was carried out. The chapter on evaluation also presents summarized data on the results of the experiments carried out.

Instant GPS based motor vehicle accident detection and reporting solution is initially developed as a prototype which can straightforwardly be actualized in motor vehicles. It is envisaged that this solution will be of practical significance to various stakeholders in the motor industries. For example, the insurance companies will benefit by utilizing the system as a tool to determine the truthfulness of an accident occurrence as it may be claimed by a claimant. Researchers and general public will be allowed to access the database upon registration and proper authentication.

1.2 Statement of the problem and Purpose of the project

In section 1.1 the world health organization (WHO) report was cited, which establishes that vehicle accidents are rampant in our world today. There is lack of a system to promptly detect and report accidents when they occur. The consequent is extended delays in evacuation by the relevant bodies. This leads to deaths, injuries and losses that could otherwise be minimized or totally avoided. **Instant GPS based motor vehicle accident detection and reporting solution** as developed and demonstrated will play this vital role.

This research project has come up with a prototype of the solution by utilizing impact sensors, GPS and GSM technologies to sense vehicle accident impacts. The signals are transmitted to a database accessible using the internet. The database can be made accessible to the police, for prompt notification of accident occurrences, leading to quick evacuation. This will consequently reduce accident deaths, injuries and losses.

In many countries, including Kenya, a reliable single source of vehicle accident data does not exist. This solution will create a motor vehicle accident database, becoming a comprehensive and reliable resource of accident data and information. Users and researchers can utilize the database by carrying out queries and data mining processes, yielding important facts that can be used to mitigate the escalating problem of motor vehicle accidents.

1.3 Research Outcomes and their Significance to Key Audiences

At the completion of this project, we were able to determine that there are opportunities that exist for using impact sensors by integrating them to a GPS device. Impact sensors could submit electronic signal to a GPS device.

The research conducted using the system prototype established that a GPS device could convert impact electronic signal to data, and subsequently combine it with GPS location data, transmitting the same to a database server through GSM.

This research helped to determine the degree to which a web based server database can automatically update data transmitted from a GPS device through wireless GSM Network and also accept manual update from authorized users. The accuracy of vehicle details, location, time, and speed aspects logged automatically on the database were checked and seen to be largely correct.

By establishing an accident database with details on various accidents, this research has shown that web clients can access the accident database, and display accident occurrence details on GIS digital maps

1.4 Research Questions

- i) What possibilities exist for submitting impact electronic signals by interfacing impact sensors with a GPS device?
- ii) What degree of success can a GPS device convert impact electronic signal to data, and subsequently combine it with GPS location data?
- iii) To what scale of accomplishment can a GPS device transmit impact and location data to a database through GSM?
- iv) Can a web based database automatically update accident data transmitted from a GPS device through wireless GSM network and also accept manual update from authorized users? If yes, up to what measure?
- v) What opportunities exist for web clients to access the accident server database to view and enquire on accidents?

1.5 Aim and Objectives

1.5.1 General Objective

Develop a prototype system for timely and effective detection and reporting of motor vehicle accidents by sensing impact signals, consolidating and transmitting it together with the geographical coordinates of the impact site, date, time, vehicle speed and vehicle unit ID, using GPS and GSM to a web based database which will be used on the internet to display the accident occurrence and keep records of accidents for reference and research purposes.

1.5.2 Specific Objectives

- i) Interface impact sensor with a GPS device, and carry out experiments by initiating impacts that will generate electronic signals to be transmitted to a GPS device.
- ii) Configure GPS device to integrate digital impact signal with GPS location data and transmit the resultant raw data to a database server through GSM.
- iii) Develop a web accessible database and interface software that will automatically receive and update data transmitted from GPS devices through wireless network, and also with a provision for manual update from authorized users.

- iv) Create a web front end interface where web clients can access the accident database, displaying occurrence details on digital maps. Authorized users may carry out research queries and data mining processes on the database

1.6 Assumption and Limitations of the Research

- i) While it is practical to make the database available to the police and others for accident monitoring purposes, it will not be possible to compel them to act on the accident information received
- ii) The tests on the impact sensors were conducted in a different environment from where actual vehicle impact as a result of accident would occur. The assumption is that experiments to be carried out using the prototype would reasonably represent vehicle accident impact.
- iii) The database for this project will be hosted on my computer since the cost of hosting at an ISP (Internet Service Provider) is high. The assumption is that same results will be achieved where the database is hosted on a server available on the internet.
- iv) Total cost of the gadgets required in this project is high, limiting the research to use just one model of the gadget instead of a variety.
- v) Low IT literacy levels in the areas of jurisdiction of this solution may cause a challenge in implementation and use.
- vi) Willingness and corporation of the government and other authorities to provide research data on accidents and also to adapt the system is assumed
- vii) There is over reliance on third parties in order to implement this solution. These include GPS system, and mobile service provider. It can only be hoped that these parties will not change terms of engagement in the course of the project

1.7 Definitions of Important Terms

Vehicle impact sensors – These are very small devices fitted in a motor vehicle to detect collision and physical damage

Electronic Control Unit (ECU) – This is a crash sensor Electronic Control Unit which is central to all the sensors in a vehicle. It receives, and process electronic analog or digital signals received from the sensors. Based on the magnitude of the signals received, it makes decision whether to undertake certain action. For example it may deploy airbag, and in the case of the proposed project it will transmit a digital message to the GPS device to the effect that an accident has occurred.

Global Position System - Is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver with some technical limitations which are only removed for authorized users.

Global System for Mobile Communication (GSM) - is a digital mobile telephony system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

General Packet Radio Service (GPRS) - is a packet oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications (GSM). GPRS was originally standardized by European Telecommunications Standards Institute (ETSI) in response to the earlier packet-switched cellular technologies. It is now maintained by the 3rd Generation Partnership Project (3GPP). GPRS usage is charged based on volume of data. This contrasts with circuit switching data, which is typically billed per minute of connection time, regardless of whether or not the user transfers data during that period.

Multiplexer – A device that receives numerous signals in parallel and present them serially to the ECU in an orderly fashion because the ECU can only process one signal at a time.

Technometer – Wheel speed sensor

Trilateration – A process in geometry of determining absolute or relative locations of points by measurement of distances, using the geometry of circles, spheres or triangles. In addition to its interest as a geometric problem, trilateration does have practical applications in surveying and navigation, including global positioning systems (GPS). In contrast to triangulation it does not involve the measurement of angles.

Accelerometer – Device that measure acceleration/deceleration

Chapter Two: Literature Review

2.1 Background

Delay in evacuation of motor vehicle accident victims from the crash scene contribute significantly to morbidity and mortality. Victims lose cash and other valuables while vehicles damage is extended. Numerous studies have shown statistics and trends on accidents while others have demonstrated use of technology to track vehicles. Few studies report how accidents are detected and reported for evacuation purposes. Casual enquiries from police indicate slow and cumbersome methods of accidents detection and reporting. The review conducted in this study has not come across any existing automated method of detecting and reporting motor vehicle accidents.

With the location tracking capabilities of Global Positioning System (GPS) device, we may gather the location details of an accident vehicle. In addition, GPS devices are feed with impact signals generated by impact sensors fitted in a vehicle. In the event of an accident, the impact sensors will initiate a signal to the GPS device, triggering transmission of data about the crash to a database accessed by the police through the internet. This is a unique application of the technology and addresses key limitations in accident detection and reporting. In a world that is becoming more motorized, impact sensors in conjunction with GPS offers a timely, objective and potentially acceptable method of detecting and reporting accidents.

2.2 Motor Vehicle Accidents

Earlier studies indicate there exists motor vehicle accidents and the number of occurrences has been increasing over time especially in the developing world. Over time, governments have had to come up with more and more traffic rules and measures to mitigate the increasing rate of accidents but with little success.

There are various types of motor traffic on our roads. These includes trucks, buses, vans, cars, and motor cycles. All these types of vehicles are involved in accidents at one time or the other. Motor vehicle accidents can be categorized as follows:-

- i) **Vehicle collision** – Where two or more motor vehicles are involved
- ii) Rollover or overturning
- iii) Collision against stationary objects – For example collision against rocks, solid concrete, buildings and trees.
- iv) Knocking against pedestrians and animals

All accidents produce impacts with levels of magnitude that can be sensed by crash sensors.

According to Vaca, F. E. et al (2009), the accuracy of pre-hospital crash scene details and crash victim assessment has important implications for initial trauma care assessment and management. Similarly, it is

known to influence physician perception of crash victim's injury severity. My system will have the capacity to provide some of this vital data on instant basis, when the motor vehicle crash occurs, hence reducing the need of the doctors to rely entirely on the verbal account of the accident from the paramedics and the expensive scene of accident reconstruction and investigation.

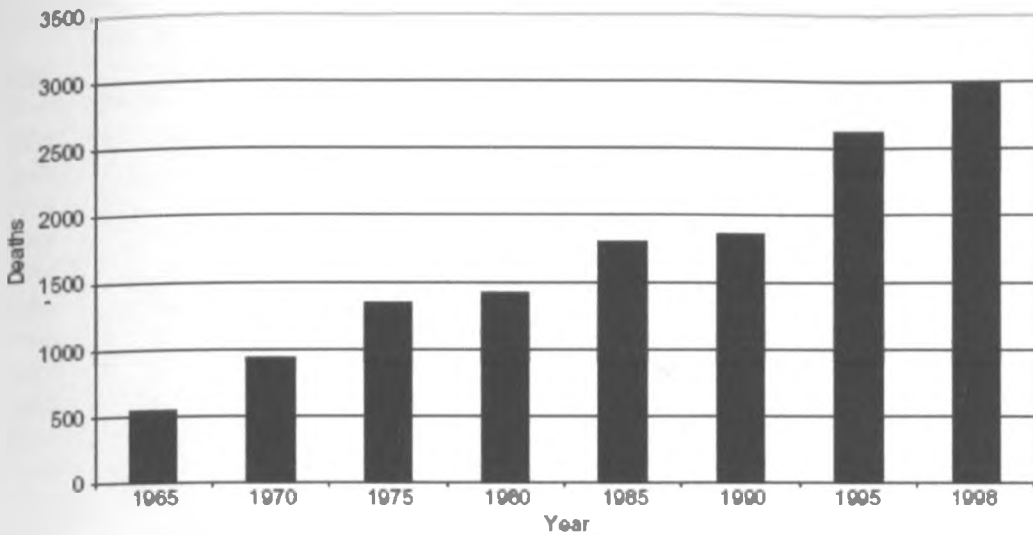
Vehicle accidents contribute the highest percentage of injury deaths in most places in the world today. In their study to examine the prevalence and distribution of deaths due to injury among adolescents 10 to 19 years using available post mortem data from Korle Bu teaching hospital, Accra Ghana, Ohene, S et, al (2010) found that in females, the highest mortality was from road traffic accidents, accounting for almost half (49%) of deaths. Vehicle accidents are a reality and my system will be important in reducing this vehicle accident mortality.

According to Hari, D (2008), automobile accidents account for the majority of trauma, and that the problem will worsen on a world wide scale as vehicles become more widespread in developing countries. In Mexico, the mortality rate from motor vehicle related trauma has increased steadily over the past 20 to 30 years, to the point where it is the leading causes of death in children and young adults. In a separate paragraph, Hari, D. (2008) has advocated for pre-hospital care saying the staggering morbidity and mortality of severe head injury could remarkably be reduced by simply securing and maintaining the airways and providing ventilation to such patients at the accident scene. When this measure was undertaken 90% mortality rate in the patients was dramatically decreased to 40%. Morbidity and mortality in these patients has declined during the past decade due to improvement in the pre-hospital care. He further concludes that this also facilitates timely medical and surgical interventions. He also noted that increase in sites of ambulance dispatch and increased training in pre-hospital trauma life support (PHTLS) course to the paramedics improved the process of pre-hospital care in Latin America city and resulted in decrease in pre-hospital deaths. This report shows the need for a system to instantly detect and report vehicle accidents.

2.2.1 Statistics on Injuries, Deaths and Damages

There are various sources of data on motor vehicle accidents in Kenya, including the Kenya police, the Kenya Roads Board, the hospitals, and media houses. Odero, W. et al (2003), however established that the police have a consolidated source since the reported cases of road accidents are always recorded in their systems.

Odero, W. et al (2003) presented the following graph showing road accidents fatalities over a period of time in Kenya based on data from NRSCK, 1992, Central Bureau of statistics, 1995, 1999.



Source: Based on data from NRSCK, 1992; Central Bureau of Statistics, 1996, 1999.

Figure 2.1 Road traffic injuries in Kenya

They also presented the following table (labeled as figure 2.2) showing statistics of road accidents in Kenya, spanning the years from 1965 to 1998.

As recorded on Transport Research Laboratory (2011), Kenya is rated amongst top countries in the world with the highest rate of road accidents. The country is 5th with highest number of accidents per licensed vehicles out of 29 selected countries worldwide according to a research they carried out. They further aver that unfortunately, road safety trends in Kenya are worsening with the reluctance of the 'Michuki policy', which advocated for a maximum speed of 80 KPH and that all vehicles must be fitted with safety belts. A new "policy" of reckless driving seem to be unfolding and taking over from the Michuki one

Statistics in a report by Kenya Roads Board (1999) indicates that about 1.17 million deaths occur each year worldwide due to road accidents. About 70 % of the deaths occur in developing countries. Out of 100,000 vehicles, about 510 are involved in fatal accidents in Kenya compared to 260 in South Africa and 20 in the UK. 65% of deaths involve pedestrians and 35 percent of pedestrian deaths are children

Amongst various modes of transport, public service vehicles were responsible for 23% of the road accidents compared to cars and utility vehicles that contributed to 37% of the total accidents. A high percentage of accidents are attributed to mass transport modes in Africa; In Europe, mass transportation is the safest means and accidents are mainly due to speeding and drunken driving common to passenger cars.

| Year | No. of crashes (b) | Total casualties* (a) | Mean casualties per crash (a/b) |
|------|-----------------------|--------------------------|------------------------------------|
| 1965 | 3,562 | 4,698 | 1.3 |
| 1970 | 5,163 | 7,756 | 1.5 |
| 1975 | 6,534 | 9,621 | 1.5 |
| 1980 | 6,162 | 10,313 | 1.7 |
| 1985 | 8,474 | 15,383 | 1.8 |
| 1990 | 10,306 | 18,930 | 1.8 |
| 1992 | 12,735 | 26,127 | 2.0 |
| 1993 | 12,355 | 24,440 | 2.0 |
| 1994 | 11,785 | 22,960 | 1.9 |
| 1998 | 14,342 | 28,492 | 2.0 |

* Includes fatal and non-fatal cases.

Source: Data from National Road Safety Council, 1992, and Central Bureau of Statistics, *Statistical Abstract*, 1999.

Table 2.1: Trends in road traffic crashes and casualties in Kenya

2.2.2 Current Methods of Accident Reporting

Osoro, M. E. et al (2011) asserts that there are many road accidents that are not reported to the police. Saidi, H. S. (2003) in the conclusion of his paper asserts that injuries following road traffic accidents (RTA) are common in Nairobi. The response to injury is slow and haphazard

Information on road accident reach the police and/or other agencies, through various channels including physical reporting to the police station, telephone call by unauthenticated sources, casual discovery by police on patrol, etc. The deficiency of a systematic way of reporting road carnage is a serious fault resulting to avoidable deaths at the accidents scene (Saidi, H. S. 2003). Ponboon, S. et al (2005) in their research aimed at developing a road accident computerized system in Thailand observed there are problems of accident under-reporting and accident reported matching. This is due to the lack of asynchronous and efficient method of reporting and recording accidents.

2.3 Previous studies on Impact Sensors

Impact sensors used in vehicles are also referred to as crash sensors. Most vehicle manufactures say a vehicle has to experience an impact that generates at least 7G's of force before it will trigger an airbag, signifying an accident. For most vehicles, this would be the equivalent of hitting a solid barrier at 30.5 KPH to 38.6 KPH, or hitting another vehicle at a speed of 64.4 KPH.

Valeyev, K. et al (2010) presents that there are numerous sensors that are usually scattered all over an average modern day vehicle, used to determine the different types of accident impact.

- i) Accelerometers – Measure acceleration /deceleration
- ii) Impact sensors – Detects collision and physical damage
- iii) Pressure sensors – Detect physical pressure applied to the vehicle
- iv) Techometer – Wheel speed sensors
- v) Brake pressure sensors – Monitor brakes
- vi) Gyroscopes – Devices that detect rollovers

Phillips E. (2011) indicates that in design there are several different types of crash sensors:-

- ii) A commonly used sensor is the electromechanical “gas dampened ball and tube” design. The sensor is nothing more than a tube with a switch at one end and a gold plated steel ball at the other, held in place by a small magnet. When the sensor receives a hard enough jolt to knock the ball loose from the magnet, the ball roll down the tube, hits the switch and closes the circuit. The tube is slanted upwards so that the ball should return to it’s original position after an impact.
- iii) Another common crash sensor is the “Rolamite” design by TRW. Inside is a small metal roller that rolls forward under sudden deceleration and trips a switch.
- iv) “Spring and mass” crash sensors are used in some vehicles. A spring loaded weight is deflected by the impact to close a switch.
- v) Most newer vehicles have solid state crash sensors that contain either a piezoelectric crystal or a “micromechined accelerometer” chip that produces an electronic signal when jolted

The various sensors mounted in the motor vehicle are controlled by an electronic control unit (ECU). The ECU has to decide whether the impact is of an accident proportion or not before transmitting any signal to an external device, in this case to a Global Position System (GPS) device to be fitted in the vehicle. The ECU will be programmed to respond depending on the different combinations of data received from sensors. For example if an on-board gyroscope detect that the vehicle has flipped over, the ECU should transmit a message to that effect.

The impact sensors to be used in this system are based on accelerometer. A motor vehicle crash impact is sensed as when the rate of deceleration exceeds a certain pre-determined threshold. In their quest to develop an intelligent safety system (ISS) for vehicles applications, Hannan, M. A. et al (2010) noted that, the change in vehicle velocity, $\Delta v(t)$, is an essential parameter for crash detection and they used it in the development of their crash detection algorithm. They further averred that $\Delta v(t)$ is obtained by integrating the acceleration signal as shown below.

$$\Delta v(t) = \int a(t) dt = A\omega \int \cos(\omega t + \delta) dt \quad (3)$$

A suitable vehicle velocity threshold, V_{th} , is required to facilitate decision making as to whether or not a crash has effectively occurred. To detect a crash, they used the following algorithmic steps:-

- (i) If $\Delta v(t) \geq V_{th}$, then output = '1'; DECISION: Effective crash is detected
- (ii) If $\Delta v(t) < V_{th}$, then output = '0'; DECISION: Effective crash is not detected.

In this study, impact crash sensors must interface with a GPS device in order to trigger transmission of the vehicle crash data. Hannan M. A. et, al (2010) succeeded in a similar interface. They noted that the weight and crash sensors provided analog signals that were received by the A/D converter on the DAQ card. In a similar way, crash signal in my system will be received by the GPS device from the Electronic Control Unit of the impact sensors.

2.4 Global Positioning System (GPS) and GPS Devices

According to *Encyclopedia Britannica*, the Global Positioning System (GPS) is a space-based radio-navigation system that broadcasts highly accurate navigation pulses to users on or near the Earth. In the United States' Navstar GPS, 24 main satellites in 6 orbits circle the Earth every 12 hours. In addition, Russia maintains a constellation called GLONASS (Global Navigation Satellite System), and in 2007 the European Union approved financing for the launch of 30 satellites to form its own version of GPS, known as Galileo, which is projected to be fully operational by 2013. China launched two satellites in 2000 and another in 2003 as part of a local navigation system first known as Beidou ("Big Dipper"). In 2006 China, which had a limited participation in Galileo, announced plans to expand Beidou to a full GPS service known as the Beidou Navigation System. In 2007 China began launching a series of second-generation satellites, known as Beidou-2, or Compass. The constellation of 35 satellites is scheduled for completion in 2015.

Encyclopedia Britannica, also records that the user segment consists of the millions of GPS receivers (devices) that pick up and decode the satellite signals. Hundreds of different types of GPS receivers (devices) are in use; some are designed for installation in automobiles, trucks, submarines, ships, aircraft, and orbiting satellites, whereas smaller models have been developed for personal navigation.

As noted by Samper, M. J. et al, (2009), GPS project was started in 1973 to overcome the limitations of previous navigation systems, integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. GPS was created and realized by the U.S. Department of Defense (USDOD) and was originally run with 24 satellites. It became fully operational in 1994 and it's free to use.

As reported on Landairsea (c.2011), there are two types of GPS tracking devices currently on the market today. They are classified as “passive” and “active.”

- **Passive**

Since the Global Positioning System (GPS) serves as a receiver and not a transmitter, passive GPS Tracking devices lack a transmission device such as a cellular uplink module that sends the GPS data from the vehicle. Therefore, passive GPS Tracking devices, also known as data loggers, primarily function as recording devices.

GPS data loggers have an internal flash memory, a memory card slot or a USB port. They can store GPS data gathered from the vehicle or asset to which they are attached. The stored GPS data can be downloaded into a computer for further analysis. The GPS data recorded includes speed, location, and time or how long the device remained stationary.

Not all passive GPS tracking devices are created equal. When considering the purchase of a GPS tracking unit, comparisons should be made based on accuracy, sensitivity, frequency of sampling points, power sources, reliability, and the software that translates the data into an understandable, easy-to-use format.

- **Active**

Active or Real-time GPS Tracking Devices incorporate a method of transmitting the GPS information from a vehicle. Although satellite uplink of data is available, cellular data communications are the most common and the most cost effective. Automatic incremental updating provides a continuous source of tracking throughout a recording period. This provides for current as well as historical logging positions. The frequency of these updates are contingent upon the manufacturer’s design capabilities as well as the data plans the customer has chosen.

In this project the Active or Real-time GPS Tracking Devices from one of the common manufacturers will be used, which will demonstrate the manner in which vehicle impact data is received from impact sensors and the accident information is transmitted to a database.

2.4.1 Position Determination with GPS

All GPS devices work around a few basic geometric principles. These principles are summed up in trilateration. Trilateration uses the known location of two or more points of reference and the measured distance between the subject and the reference points to give an exact location for the subject. For example, a vehicle fitted with the proposed accident detection GPS based system stands at point B as shown in Fig. 3.2. The task will be to determine the accident vehicle position in the middle of nowhere and to find out where it is. The attached GPS device is ready for instances just like this one. P1, P2, and P3 represent satellites in the NAVSTAR GPS constellation. These satellites are constantly transmitting microwave signals. At the same time, these satellites transmit a signal with information concerning their current

location and the time that they were transmitted. The circles represent the path of the signal from the satellite at a specific time. The GPS device in used is designed to pick up these signals and record the time at which they arrive. Because the signals from the satellites travel at approximately the speed of light, knowing the difference between when the signal was generated and when GPS receiver picks it up. Then it calculates the distance between accident vehicle and the broadcasting satellite. This is a very simple physics equation ($\text{speed} \times \text{time} = \text{distance}$). When we combine this with the known location of each of the satellites (this information is contained in the signal that GPS device picks up), the GPS tracking device used in this project have all the information it needs to give us an exact location for the accident. So when triggered by the impact sensor, it transmits position information to a central database.

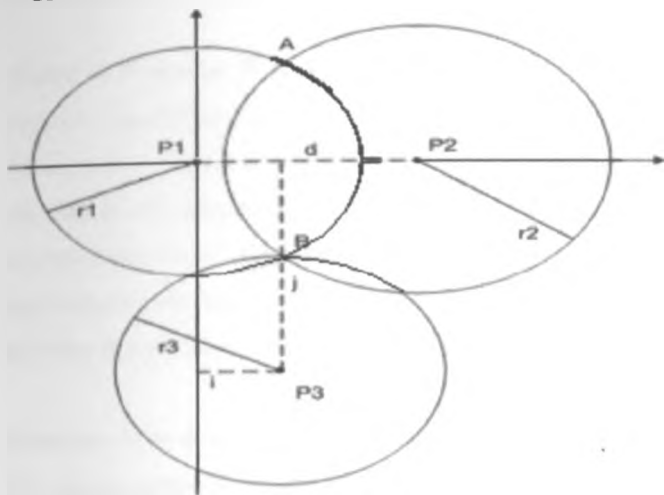


Figure 2.2 Position determination with GPS

2.4.2 Some Commercial Applications of GPS.

As reported by Howdoesvehicltrackingwork (c. 2011) there are several reasons worldwide for using GPS Vehicle tracking. They enlisted some of the reasons and uses for GPS vehicle tracking devices as below -

- Fleet Management
- SVR or Stolen vehicle recovery
- Field Service Management
- Asset Tracking
- Field sales
- Surveillance is easier when police and others with permission need to follow a vehicle movement such as a fleet tracking their driver.
- Trailer tracking with haulage and logistic corporations is possible.
- Transit tracking

Using the GPS device to relay accident impacts to a database will certainly be an added use of the technology.

According to Wiehe, S. E et al, (2008), GPS devices, in this case GPS enabled Blackberry 7520 cell phones were used to transmit the location coordinates, battery level, device ID, and timestamp data to a server running MySQL database. They concluded that GPS enabled cell phones offers a feasible and, in many ways, ideal modality of monitoring the location and travel patterns of adolescents and in addition, allows space and time specific interaction, probing, and intervention which significantly extends both research and health promotion beyond a clinical setting. In a similar way, my research will use GPS devices to transmit accident crash impact data to a database hosted in a computer using internet technology. The impact crash data will also include accident site location coordinates, device ID, and timestamp.

(Tanna, K.P. Kumar, P. & Narayanan, S. (2010)) used car door and engine sensors and GPS technology to instantly transmit an alert to the car owner in the event that the car is unlocked and driven in the absence of the car owner. This is similar to my system where impact sensors in juxtaposition with GPS device fitted in the vehicle will transmit accident signal. They noted “There are a variety of areas wherein a need exists for a system capable of identifying and tracking the geographical location of a remote valuable object, one such valuable object which requires constant surveillance is car”. My system will fit to serve a certain gap as in the above statement

(Khatoon, T. et al. (2010) proposed use of GPS technology to provide parcel information through online. This is one more use of GPS technology, which they concluded in their study that “it is easy to use, quick to install and affordably priced”. They further noted “that every man made innovation from cars and planes and ships down to cell phones and wristwatches can be outfitted with GPS technology. Over the last decade, increased number of emergency business and even family vehicles carry GPS devices and systems for their various tracking needs”. Accident detecting and reporting will be such other need for use of GPS technology as proposed in my project.

2.4.3 Technical Aspect of GPS Functionality.

To upload the vehicle accident data to a web server, the proposed system will utilize the existing knowledge of GPS tracking system framework. According to Alharaki, O. Alaijeri, F. S. & Akram M. Z. (2010), General Packet Radio Services (GPRS) is the main method of communication between the tracking device and the web server. GPRS is available and ideally suitable for data transfer over an always – on – line connection between central location and mobile devices. The cost is per kilobyte of data transferred, in comparison to SMS where cost is per message. Howdoesvehicletrackingwork UK. (c.2011), has come up with the following GPS tracking System Framework.

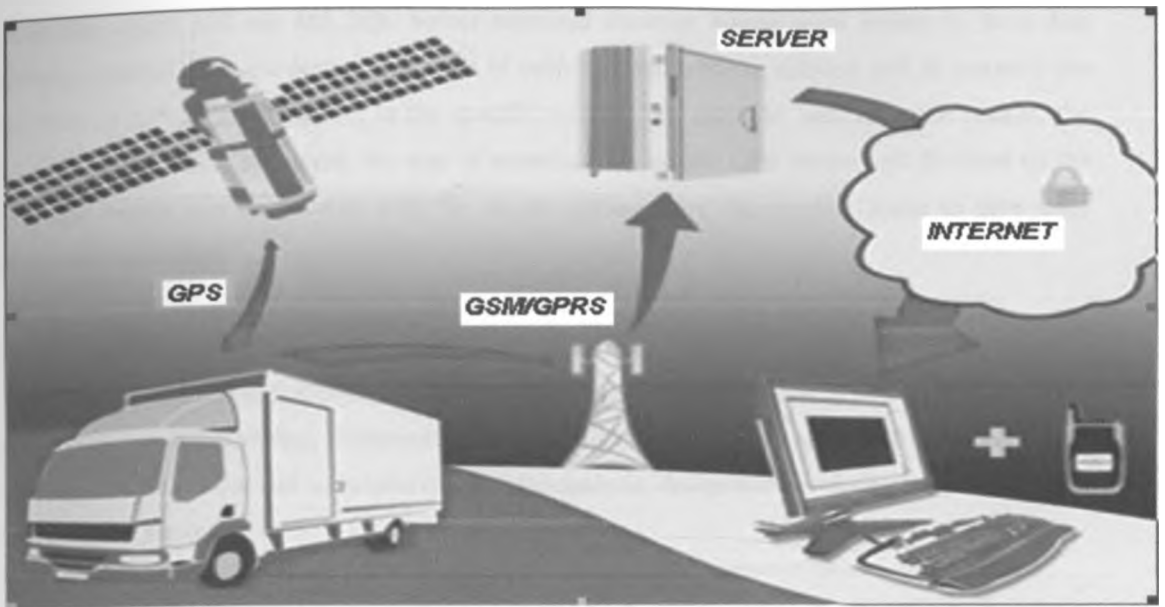


Figure 2.3 GPS Tracking System Framework

Encyclopedia Britannica has a good technical outlook of the GPS System as in the proceeding literature. They say a GPS device operated by a user on earth measures the time it takes radio signals to travel from four or more satellites to its location, calculates the distance to each satellite, and from this calculation determines the user's longitude, latitude, and altitude. The U.S. Department of Defense originally developed the Navstar constellation for military use, but a less precise form of the service is available free of charge to civilian users around the globe. The basic civilian service will locate a receiver within 10 meters (33 feet) of its true location.

In this project, the GPS device in use utilizes data that it receives from the satellites to produce accurate locations on a real-time platform in which it will calculate both longitude and latitude. Once the information is received, it is then sent from a GPS tracking unit to a GSM or GPRS, i.e. mobile phone network to the accident database hosted in a secure server.

2.5 Web Based Application and Database

Computer based databases have revolutionized data and information storage in terms of access and update speeds, data handling efficiency, and the huge volumes of data they are capable of storing. Before data can be stored on a database an interface application is required.

In this project I will use a software application that will be hosted in a web site. This application will "listen" to the incoming data from GPS devices, format the raw data received and append it into the database in a manner that will make sense to the users of the database.

For a start the project will use MS SQL Server relational database management system to store data automatically captured from accident sites. Details of vehicles fitted with the solution will be stored in the database prior to activating the system in the specific vehicle. For example, vehicle owner details, the vehicle category, the make and model, the year of manufacture, and the GPS device unit ID fitted on the vehicle. These details will be collated with the details coming from the accident scene to give more information on the accident.

In my proposed system, software application will be developed to interface the accident detection subsystem with the database and also to provide a front end to the database users (Pandey, D et al, 2011) proposed a requirements modeling framework using unified modeling language (UML) concepts. This model as shown in 2.3 below, will be helpful to me in the analysis, design and development of the database and software in the project.

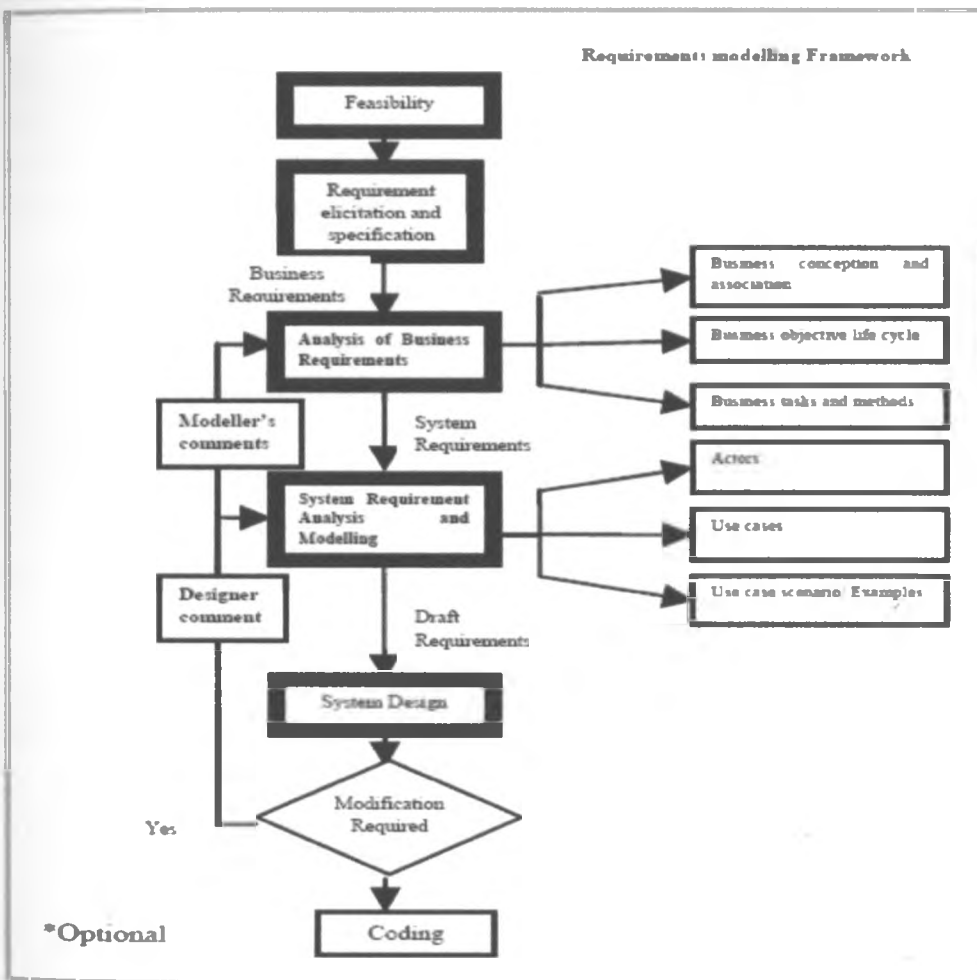


Figure 2.4 Requirement Modeling Process

According to Gupta, M. et al. (2011), there is a lot of data on the web, some in databases, and some in files or other data sources. The databases may be semi structured or they may be relational, object or multimedia

databases. These databases have to be mined so that useful information is extracted. My vehicle accident database will provide such web based information for data mining purposes in order to discover accident patterns that can lead to discovery of ways to reduce vehicle accidents.

The fact that vehicle accidents happen at various geographical locations, the aspect of location will form part of the data stored in the web server. Knowledge on spatial data mining will be required for effective use of the accident database. Hemalatha, M. N. & Saranya, N. (2011) defines spatial data mining as the process of discovering, motivating previously unknown, but potentially helpful patterns from large spatial datasets. This sort of data mining in the proposed system will help researchers and accident analysts to determine black spots and other crucial spatial data on accidents. They have discussed the major activities and research need in spatial data mining, which will be helpful to fulfill one of the objectives of my research and project.

The subject of database is widely studied. According to Hvorecky, J. & Drlik, M. (2007), the use of SQL and other professional tools is reduced to the cases when the wizards in MS Access are unable to generate the intended construct. In designing the database for the proposed project the MS SQL Server wizards will be used to speed up the process and take advantage.

Internet Databases are expected to be accessed by many people and as such their quality should be sound. (Tomozei, C. 2007) has suggested some crucial internet database quality metrics to be used at the data modeling step in database design. Data modeling is the first step in database design. He recommends that the following concepts should be taken into account in the process of internet databases application development: understandability, completeness, flexibility, reliability, and data protection. In constructing the vehicle database, these concepts will be used to ensure that the database will serve the purpose as expected.

Chapter Three: Methodology

3.1 The Conceptual Model of the System

The conceptual model of the system is as shown in Figure 3.1. The system consists of the vehicle tracking, accident detection and accident surveillance modules.

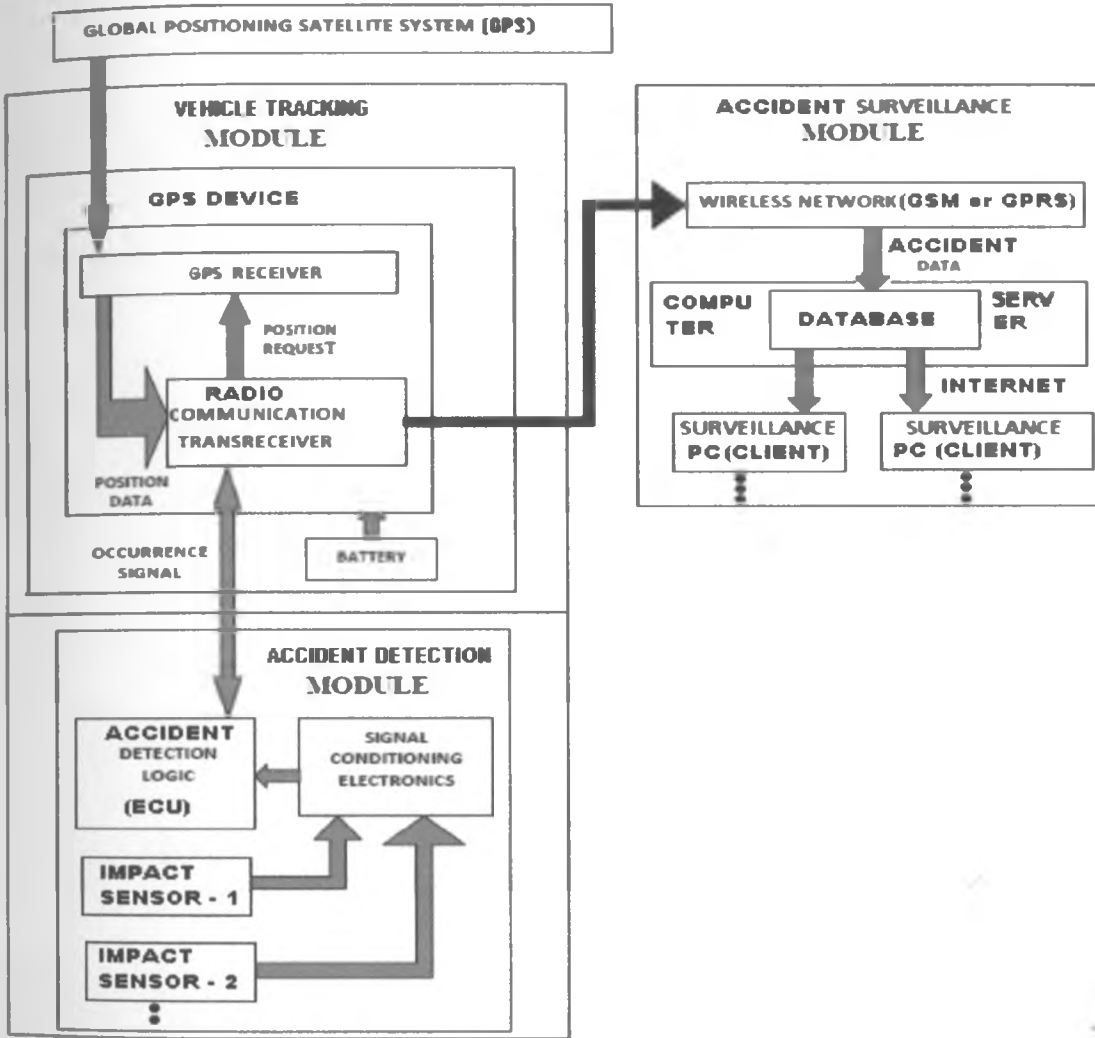


Figure 3.1 Conceptual model of the Accident Detection and Reporting System

3.1.1 Accident Detection Module

It consists of impact sensors, Electronic Control Unit (ECU for accident detection logic processing) and signal conditioning electronics. The impact sensors senses all vehicle impacts and sends the appropriate signal to the processor (ECU). The Electronic Control Unit (ECU) continuously checks the status of the sensors and determine impact signal that meets a pre-set threshold. It also sends the accident occurrence signal to the communication transceiver component of the GPS Device. The signal conditioning Electronics converts the signal to the desired form with the help of transducers, amplifier and filters.

3.1.2 Vehicle Tracking Module

It is comprised of a GPS unit composed of GPS receiver and the radio communication transceiver. The GPS unit receives signals from satellites in global positioning satellite system. These signals are processed to identify the geographic location of the GPS receiver according to the well known GPS technology. The GPS device is powered by the battery or some power adapter. The GPS device in use operates in such a manner so as to conserve the consumption of the power. The GPS device has a communication transceiver, which is a cellular-based transceiver used to receive accident occurrence signal and transmit signals to the wireless GSM network for interfacing with server database and subsequently enabling the display of the accident detected.

3.1.3 Accident Surveillance Module

This is a prototype based on a computer consisting of wireless network, database, the internet and www (world wide web) clients. The wireless network used utilizes GSM and GPRS technology and is facilitated by Safaricom mobile telephone provider. The database is hosted on a computer, for access by all accident detection GPS devices. To access and display accident data as stored on the database, clients use the internet technology. Authorized clients receive accident occurrence details on their workstations showing the details of the vehicle and the location.

Web Interface

The host computer maintains all information received from all vehicle units installed in different vehicles into a central database. The computer receives information from accident GPS devices through a GSM phone attached to it. This information is saved into a database and has an interface capable of displaying the information on the database and also responding to HTTP requests from client stations. To generate an answer to requests, a software module will read data from the database. This software is programmed in C# (pronounced as C Sharp) and it is interpreted by web browsers.

This solution can be launched on the internet by hosting this on a server based at an ISP (internet service provider). It is accessible from the internet to users through a web interface. Accident occurrences on the database are displayed on web client station and can be displayed on GIS based digital maps. In a practical scenario motor vehicles will be installed with accident detection units. Therefore the database must be able to manage and distinguish information sent by all vehicles units. For this purpose information must be available to server about all vehicles that are installed with accident detection units. Whenever accident detection unit is installed, information about the vehicle is stored in the database. The front end software has a module for this maintenance through web interface. Access to the database is restricted to authorized users only and therefore information about all special users of the system must be maintained.

3.2 Accident Database Design

The following is the structure of the accident database.

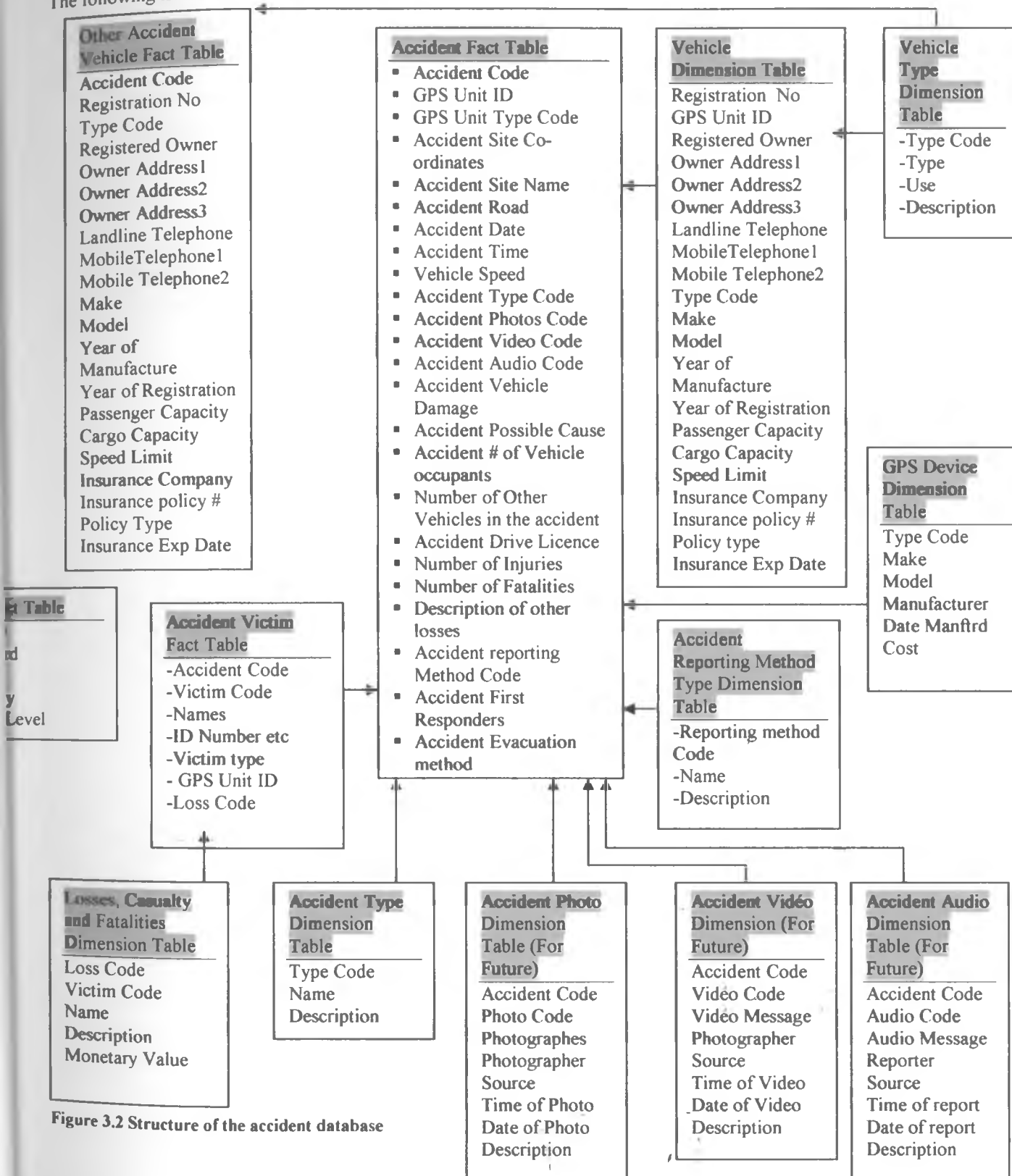


Figure 3.2 Structure of the accident database

3.3 The Methodology

In this section, the project processes in the hardware, software, and evaluation are covered in this order respectively. The methodologies for each are as presented in this section.

3.3.1 Hardware Methodology

In order to develop the system hardware, the following steps were carried out:-

- Feasibility study for the hardware
- Acquisition of the Hardware
- Assembling of the hardware into the system modules
- Testing of the Modules
- Integration of the system modules
- Testing the Integrated system

Figure 3.3 illustrated the hardware methodology, which is also explained in detail under this section

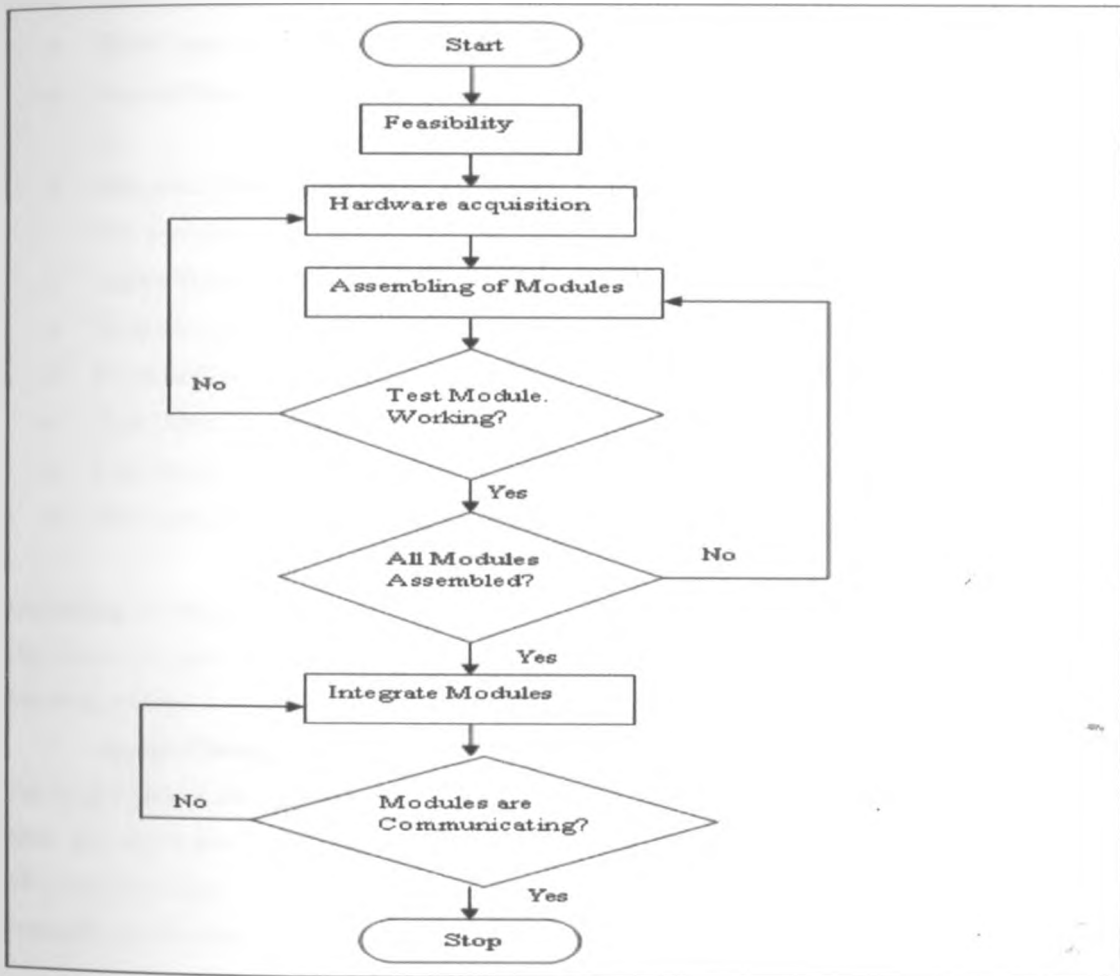


Figure 3.3 Flow-chart Showing the System Hardware Methodology

Feasibility Study of the Hardware

This was the first step and involved carrying out a feasibility study for the hardware required in this project. Feasibility study was carried out based on key factors including availability, affordability, usability, serviceability, functionality and time. The hardware was subjected to the technical requirements of the system.

Acquisition of the Hardware

The following is the list of hardware and communication links that was acquired -

- **GPS Device** – The model acquired is able to receive broadcast radio signals from the GPS satellites and transmit data through GSM wireless network. It also has an interface for digital input which is utilized to link with the detection module.
- **GPS Communication Link** – This is freely available.
- **GSM Communication Link** – This link is provided by Safaricom telephone provider.
- **Impact Sensor** – A variety of sensors were used including impact sensors from a Subaru Forester car.
- **Electronic Control Unit (ECU)** – This is used for impact logic processing and a Subaru forester unit was used.
- **Impact Signal Cable** – Necessary for linking the ECU and the GPS Device.
- **GSM Phone/Modem** - A cell phone/modem with GSM capabilities were used.
- **Personal Computer or Laptop** – My personal Laptop computer was used.
- **Data Cable Linking the GSM Phone with the Computer.**
- **Lead Battery / Power Adapter** – Used a power adapter for this purpose.
- **Two SIM cards** - SIM cards were purchased from Safaricom Mobile provider.

Assembling the System Modules

After the acquisition of the hardware, the system modules were assembled, each at a time, starting with the detection module.

- **Accident Detection Module**

The Impact Sensor and the Electronic Control Unit were put in place whereby a distance of at least half meter was maintained from each other and a physical interface was established using a special electric cable with a socket at both ends to facilitate smooth interface with the gadgets. The ECU was powered by a through a power adapter.

- **Vehicle Tracking Module**

A GPS Device was put in place, and powered by a battery. It was tested to ensure it could receive spatial data from the GPS satellites and digital input from Electronic Control Unit. A GSM enable SIM card sourced from Safaricom mobile telephone service provider was installed on the GPS device to facilitate transmission of data.

- **Accident Surveillance Module**

This is the module, where a computer for hosting accident database was installed. The computer was linked to a GSM cell phone capable of receiving data from GPS Device. A GSM enabled SIM card from Safaricom telephone service provider was installed on this phone to facilitate communication. To link the GSM phone and the Computer a special USB data cable was used. One client workstation was installed to be used in accessing the database using web interface and internet technologies.

Testing the Individual Modules

The three modules as assembled were tested individually. This was to ensure functionality of the hardware and a stable inter-gadget communication that is vital in the transmission of accident data. For a modules which did not function as expected, the faulty hardware was replaced and another test carried out.

Integration of the System Modules

The system modules having been assembled and tested as discussed above were integrated and the envisaged hardware prototype of the system was in place. This was done as explained below -

- **Integration of the Accident Detection and Vehicle Tracking Modules**

A physical interface was established between accident detection and vehicle tracking modules using a special cable. This interface provided the media for transmitting impact signal from the Impact Sensors to the GPS device. To achieve this, a special cable with a secure plug was used in this project. The GPS device has a special input port that facilitated this interface.

- **Integration of the Vehicle Tracking and the Accident Surveillance Modules**

This interface is not physical since data is transmitted through wireless GSM Network. However tests were done to ensure the modules could communicate and transmit data.

Testing the Entire System

After the integration, a test to ensure the perfection of communication between all modules was conducted. This is important because accident data transmit through the hardware as assembled in the prototype and ultimately reach the database running on the computer in the surveillance module.

3.3.2 Software Methodology

Software applications and a database were developed in this project and the Waterfalls Software development life cycle model was used. This model is depicted in the diagram below -

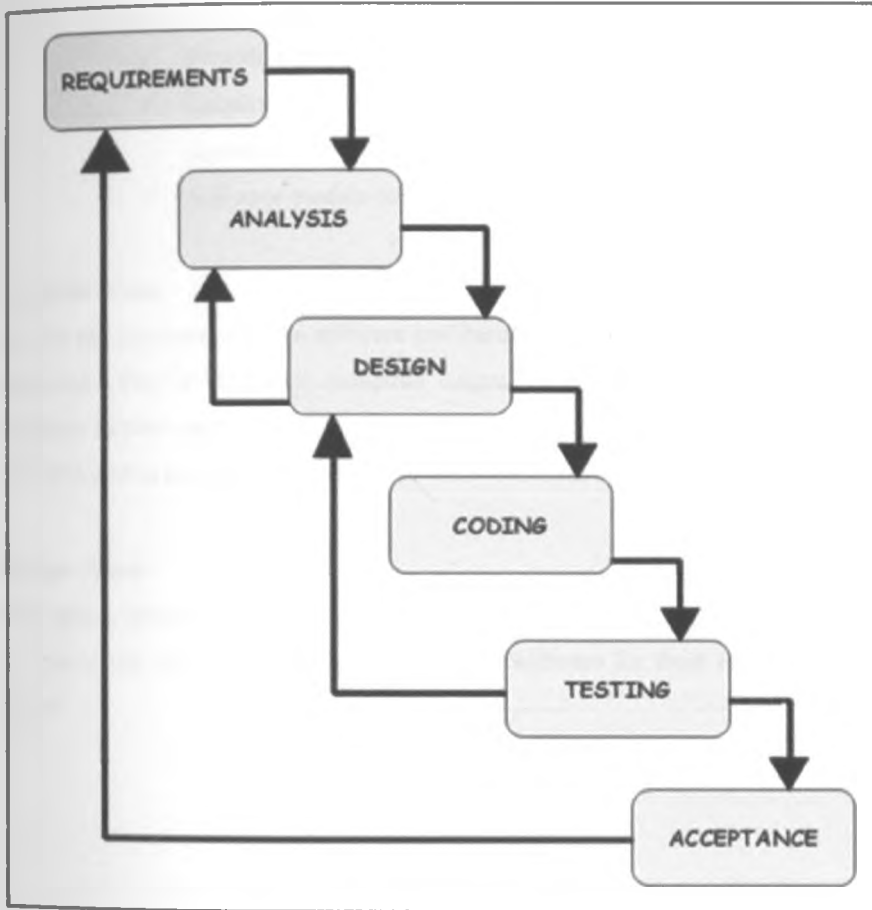


Figure 3.4 Waterfalls Software Development Life Cycle Model

Explanation of the Waterfall Model

The waterfall model is designed such that until the preceding phase is complete, you cannot move on to the next phase of development. Progress flows in a downward fashion, similar to the way rushing water, from a height, flows downwards, hence the name "waterfall" was conferred onto this programming model.

However the model used here is modified to enable iteration.

Requirements Phase

In this first phase what was needed to be designed and its function, purpose etc were understood. The following is a list and details of the requirements which the various software were going to satisfy.

- Software for creating and maintaining the accident database – The function of this software is to provide an environment for creating, managing and maintaining the accident database.
- Software for the interface between the GPS device and the accident database This software was designed to remain active waiting for incoming data from the GPS devices installed in the vehicles. The software application accept raw data from the GPS devices and subsequently format it before updating on the vehicle accident database.
- Software for front end, web access. This is a web based application developed for the following:-
 - ✓ Provide a means of manual update on the accident database
 - ✓ Enquiry and viewing of the accident database, whereby display will be effected using digital maps
 - ✓ Software module for system maintenance and administrative tasks

Analysis Phase

As per the requirements, the software and hardware needed for the proper completion of the project were analyzed. The C# (C Sharp) computer language and html were used for designing the software and the database system used is MS SQL Server 2005. A ready made software application was used for interfacing the GPS device and the database.

Design Phase

This phase involved coming up with an algorithm or flowchart of the programs for the software code written in the next stage. A flowchart of the Software for front end, web access is as per the flowchart below.

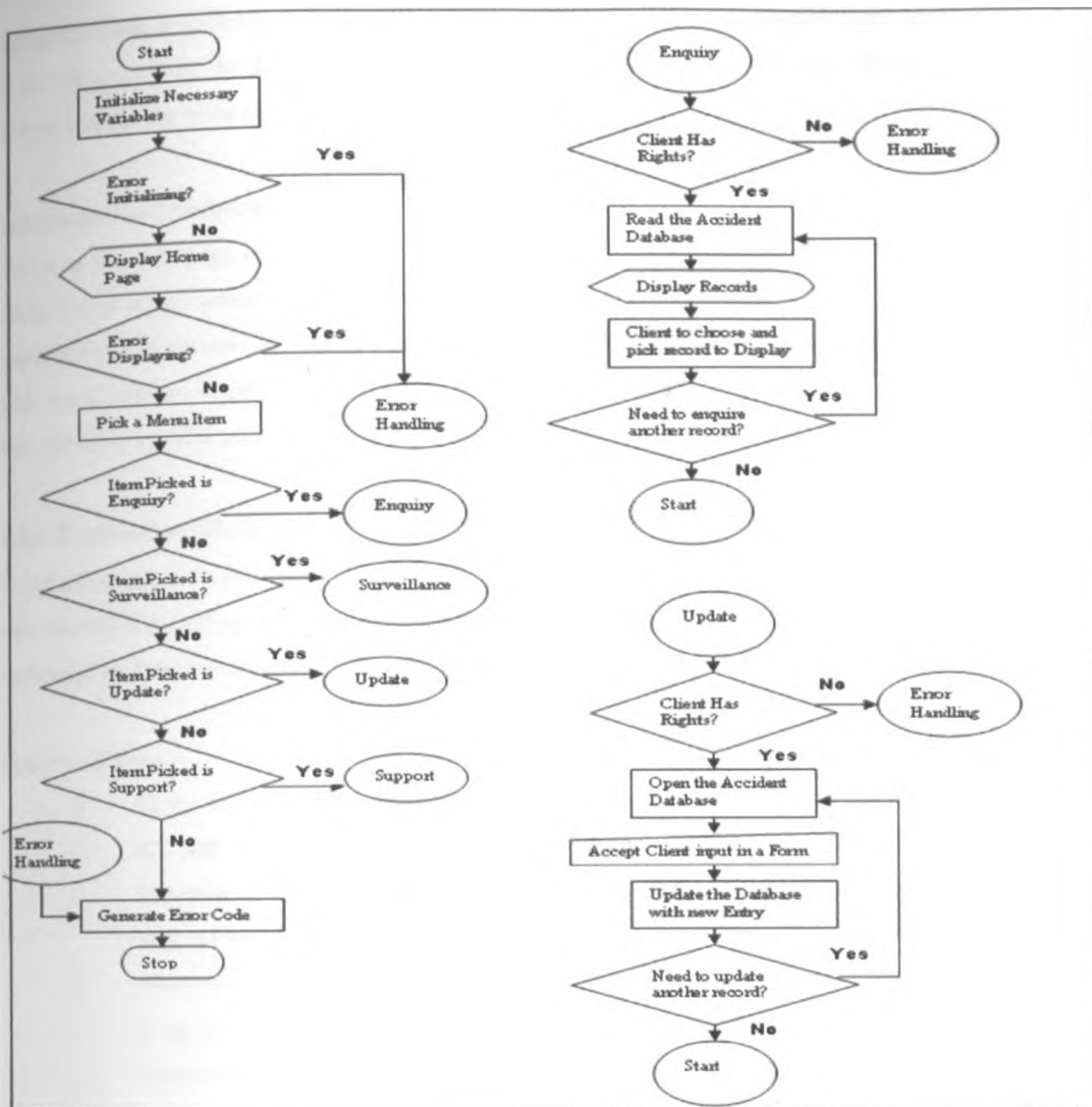


Figure 3.5 Flowchart – Front End Software Design.

Coding Phase

Based on the flowchart designed above, the actual coding of the software was carried out in C# (C Sharp) programming language. There are other modules not represented in this flowchart, but they are similar to the ones presented. In this stage the idea and flowchart of the Instant Vehicle Accident Detection and Reporting system was physically created or materialized. The proper execution of the previous stages ensured a smooth and easier implementation of this stage.

Testing Phase

At this phase the coding of the application was already complete, and it was time for testing the written code. Testing was to check if there were any flaws in the designed software and if the software design was

as per the listed specifications. Where flaws were found, the software development process had to step back to the design phase. In the design phase, changes were implemented and then the succeeding stages of coding and testing were again carried out.

Acceptance and Maintenance Phase

This was the last stage of the software development in this project as per the waterfall model. A proper execution of all the preceding stages ensured a working system as per the provided requirements and most importantly also ensured satisfying usage. At this stage, there was need to provide the project demo users with some support regarding the software and system developed. If further enhancements are necessary, then the development process must begin anew, right from the first phase, i.e., requirements.

3.3.3 Evaluation Methodology

Experiments were carried out to evaluate the system. Data on certain performance measures of the system were recorded at various points of the system. This data was subjected to various pragmatic analysis which were used to draw results and the conclusion.

Sources of Data

- i) Data was collected in experiments conducted at the completion of the prototype to determine the rate of success that the impact sensors transmit data to a GPS device upon an impact. Statistics on simulated impacts showing the failed and successful cases were stored in MS SQL server database for further analysis and presented in graph.
- ii) According to the design of the prototype, for each instance of an impact, the GPS device is to integrate the impact signal and spatial data from the GPS. Successfully integrated data is transmitted to a database. Success rate of this process was recorded in MS SQL server for further analysis and presented in graph.
- iii) Web based database received and subsequently updated new impact data. Success rate at which the database functioned in this respect was recorded in MS SQL Server for further analysis and presented in graph.
- iv) The correctness of accident data as updated on the database is crucial in this project. The vehicle details, the location, time and speed aspects of the accident make up the accident data. Statistics was taken on the success rate in this respect and recorded in MS SQL server for further analysis and presented in graph.
- v) Clients using internet technology should be able to access the accident database efficiently. The efficiency of this process is important to the success of the project. Data was collected on the time taken for the client to receive information requested from the database and recorded in MS SQL server for further analysis and presented in graph.

Data Analysis Methods

All experimental data collected as in 3.3.3 above was subjected to analysis, leading to conclusions that vindicate this research project.

- i) The data on the experiments/tests on the impact sensors
- ii) Data collected on the performance of the completed system.

These data were recorded in MS SQL Server database. Scripts in the form of stored procedures were created and used in the data analysis. Stored procedures can take in variables and can contain formulas within their body and ones executed on a data source they can produce results in the form of a table which can be plotted and further analyzed.

3.4 Justification of the Conceptual Model and Methodology Used

The methodology for the overall solution in this project as stipulated in the sections above involves hardware, software and evaluation components. The components were tackled in this order.

The hardware was considered at the top because the other components ride on it. Hardware was viewed in modules to simplify the prototype development process. The various stages in the hardware process enables iteration to and fro so that if the proceeding stage require more or different construct from the previous stage, it can be repeated once again. The methodology enables change in one hardware module, without affecting the others. This leads to quick fixes in case of problems somewhere in the system

In the software methodology, the modified waterfalls software development life cycle model has the advantages of iteration, where one is able to repeat previous tasks if an error is discovered well on the development cycle. The methodology has simplicity, leading to less time spent on the project.

Over 50 accident instances were simulated using the system in this project. The data was stored in the accident database for accident alert and any required retrieval. The methodology used did not require additional resources and so was critical in saving time and money.

3.3.4 Limitations of the Methodology

- i) While the waterfall methodology used has its advantages like simplicity, there is a limitation in that the project cannot finish a phase of a software product's lifecycle perfectly before moving to the next phases and learning from them. As the designer of the system one may not have known exactly what requirements are needed before reviewing a working prototype. One may change requirements constantly and this will consequently change the design and the programs. This effectively means invalidating a good deal of working hours, which means increased cost, especially if a large amount of the project's resources has already been invested. If further enhancements to be made to the

existing software, then the development process must begin anew, right from the first phase, i.e., requirements.

- ii) Based on the hardware methodology used, it was not possible to test the system in an actual vehicle accident because of cost implications on a damaged motor vehicle. However impacts were simulation and used in this research instead.
- iii) The hardware methodology indicates a design with multiple impact sensors and clients, while in actual sense the prototype used one sensor and one client due to cost implications.
- iv) The software methodology does not indicate how the accuracy of motor vehicle accidents data logged in the database by the police was verified.

Chapter Four: Implementation Overview and Testing

4.1 Implementation Overview

This section outlines the personnel, information, software and procedures that were committed for the successful implementation of the Instant GPS Based Motor Vehicle Accident Detection and Reporting Solution.

4.1.1 Personnel Involved

- The author of this document was directly involved in all the stages of the implementation process.
- The project supervisor guided the project
- Informal consultation with several colleagues at the university and friends in the computer industry.

4.1.2 Software and documentation used

The following software products, tools and documentation were used during the project implementation process:-

- MS SQL Server 2005 – The RDBMS (Relational Database Management System) used for creating and maintaining the accident database and carry out queries used in the analysis of accident data.
- C # (C Sharp) programming or development software used for developing the software in the MS Visual studio 2005 development environment.
- Mozilla Firefox web browser was used for browsing the accident web site
- Google Maps and Arcview 3.2a GIS (Geographical Information System) for display of accident site on digital maps.

4.1.3 Hardware and gadgets used

The following hardware, gadgets and tools were used during the project implementation process:-

- Impact sensors used to sense impacts
- Electronic Control Unit used for logic processing to determine impacts meeting a pre-set threshold for an accident.
- Special electrical cables with plugs and sockets to link the impact sensors with the Electronic control unit.
- Special cable linking the ECU with the GPS device. Through this media, impact signal transmit to the GPS device and subsequently to the web based database through the GSM network
- Power Adapter linked to power the ECU and the GPS device.

- GPS Device to communicate with the GPS satellites and transmit accident data through wireless GSM Network.
- SIM Card – Inserted in the GPS device to facilitate communication in GSM using the infrastructure of a local mobile telephone operator.
- GSM Cell phone. This is fitted with a SIM Card to facilitate reception of data from the GPS device fitted with the accident detection gadgets (as the case would be when the solution is implemented on vehicles).
- USB cable to link the GSM Phone with the computer hosting the database server.
- A Computer Web Server– This computer is used to host the accident database and the software that facilitates the clients to interact with it i.e. the website.
- Computer workstation – Using the workstation installed with an appropriate web browser, clients interact with the accident database, where new incidents are displayed on a digital map using GIS software. The client computer can link to the database computer using LAN, WAN, or the internet networks.

4.1.4 Project Implementation Steps Overview

After effecting the amendments on the project proposal as advised by the panel, I undertook to implement the project with the following implementation steps:-

Step 1 – Acquisition of hardware, software and all associated tools as listed in above sections.

Step2 – Assembling and testing of the hardware modules. This was done in accordance with the methodology.

Step3 – Integration of the hardware modules into one system in accordance with the methodology. Tests were carried out to ensure proper functioning of the system.

Step 4 – Installation of Software. The Computer was installed with the MS XP operating system software. Other software were installed on the computer including MS SQL Server 2005, MS Visual Studio, and Arcview GIS 3.2a .

Step 5 – Development of software, testing and implementation. The software was developed according to design presented in methodology using C# (C sharp) programming software and asp in visual studio development environment. The software was tested as spelt out in the testing section of this document.

Step 6- Impact simulation and transmission of data. This involved a mechanical process, subjecting the impact sensors to a level of impact that would generate a signal to be transmitted to the GPS device and subsequently to the accident database.

Step 7 - Data review to check on the efficiency of the system. This involved checking to confirm that impacts generated were logged in as data on the accident database and the time the system took to complete this process.

Step 8- Data review performed on the database accident instances recorded, with the objective to ensure correctness and integrity. For example to authenticate the accident date and time, site coordinates and vehicle details.

Step 9 - System documentation and development of a user manual for the system.

4.2 Testing

In testing, the objective was to determine if the system achieved the requirements as previously specified. Testing started early in the development of the system, but thoroughly carried out after the development of the entire system. Both the hardware and software elements of the prototype were tested as detailed in the following subsections.

4.2.1 Hardware testing

The Detection module

Impacts were initiated against the impact sensors. Impacts with magnitudes less than the pre-set threshold for an accident were not transmitted beyond the ECU (electronic control unit) device. This test was significant in that small vehicle impacts are not accidents and should not be reported as so. The impact sensors in the prototype returned positive results in these tests.

The Tracking Module

The GPS device was tested to:-

- i) See if it could receive GPS satellite signals and generate spatial or location data for the accident scene.
- ii) To establish that it could receive impact signal from the impact detection module in the prototype.
- iii) To determine if it could integrate the spatial and impact data relating to a specific accident and transmit the same to a remote database using wireless GSM network. The tests returned positive results according to the laid down requirements.

The Surveillance Module

This module was tested to:-

- i) Confirm if the GSM phone could receive from the GPS device the complete accident data.
- ii) Determine if the GSM Phone could link appropriately with the computer server hosting the accident database and transmit the data received from the GPS to the database.
- iii) Establish that the hosting computer could function as a database and web server. The memory, speed, monitor resolution of the computer and other features were tested. The computer's ability to link with a network in order to provide server services to clients accessing the accident database was also tested.

4.2.2 Software Testing

The software in this system was subjected to various tests to determine that set requirements were met. The various types of tests carried out are as below:

i) Module or Unit Testing

A module in this system was seen as a collection of executable program statements that can be called from any other module in the program and has the potential of being independently compiled. Module testing involved testing each individual module or subprogram in the system. In cases where the modules contradicted the system internal specifications, corrections were done on the design, and code. Much of the modules testing was conducted during the system development using test cases designed using both the white and black box techniques.

ii) Integration Testing

Also called interface testing, was conducted to verify that the merging modules could work correctly as a whole without contradicting the systems internal and external specifications. This test was done using test cases designed using both the white and black box techniques.

iii) System Testing

System testing was conducted to verify that the integrated system (as a whole) was structurally and functionally sound, to attain the system objectives. System test was done using test cases designed using black box technique. The tests as specified below were conducted as adapted from Eldon Y. L. 1990.

Structural system tests carried out included:-

- Compliance test – To check if the system was developed in accordance with standards and procedures
- Configuration test – To check if the system could work under minimum and maximum configurations
- Documentation test – To check if the user documentation is accurate
- Maintainability test – To check if the system is easy to maintain and that the internal logic documentation is accurate
- Operations test - Can the system be executed in a normal operational status?
- Performance test - Does the system achieve desired levels of performance or efficiency under certain workload and configuration conditions?
- Portability test - Is the system compatible, installable and maintainable?
- Recovery test - Can the system be returned to an operational status after a failure?
- Reliability test - Does the system meet the reliability objective?
- Security test - Is the system protected in accordance with its level of importance?
- Storage test - Does the system have enough main and secondary storage?

Functionality tests carried out included:-

- Auditability test - Does the system provide audit trails and meet other auditing standards?
- Control test - Do the controls reduce system risk to an acceptable level?
- Error-handling test - Can errors be prevented or detected and then corrected?
- Inter-systems test - Can data be correctly passed from one system to another?
- Manual support test - Does the people-computer interaction work?
- Parallel test - Are there unplanned differences between the old and the new systems?
- Requirements test - Does the system perform as specified?
- Usability test - Are the system and documentation user-friendly?

iv) Installation Testing

The objective of this test was to find installation errors. Test cases checked to ensure that the compatible set of system options has been selected by the user, that all parts of the system exist, that all software modules have been properly interconnected, that all files have been created and have the necessary contents and that the hardware configuration is appropriate. This test was done using test cases designed using black box technique.

v) Software Acceptance testing

This test was carried out to ensure that the software system meet known system external specifications, and acceptance criteria. The system was executed in as near the user's operational environment and host computer configuration as possible. This test was done using test cases designed using black box technique.

4.2.3 Test Case Design Technique

For each of testing, test cases were designed. The following techniques for designing test cases were used:-

- i) White- Box technique
- ii) Black – Box technique

White-Box technique (also called structured, code based, or logic driven) required the examining of the internal structure of the system and derive the test cases and data from the program logic described in the system internal specifications (SIS), of the program source code.

Black-Box technique (also called functional, data driven or input/output technique) did not require the tester to know the internal structure of the system. The test cases and data were derived solely from the system requirements definition or the system external specifications (SES).

Chapter Five: Evaluation of the System and Results

After full implementation and testing of the system, evaluation of the prototype was done with the aim to determine if the developed system is delivering the expected results. The following areas were evaluated to provide answers to the research questions set at the feasibility study of the project, which are in line with the project objectives and requirements.

5.1 Evaluation to determine the possibilities for using impact sensors by interfacing them with GPS device and submitting impact electronic signals?

To ascertain this, 50 impacts were initiated against the impact sensors used in the prototype. The success rates of impact signal transmission were recorded in a table in MS SQL server database. The detailed data is as presented in appendix IV.

5.1.1 Evaluation Results for the Interfacing of the Impact Sensors and GPS Device

Using MS SQL server data query and analysis tools, the data was analyzed and the following table presents a summary of the statistics taken in this experiment.

| Number of Accident Impacts | Sensor Integration Failure | Sensor Integration Success |
|----------------------------|----------------------------|----------------------------|
| 50 | 1 | 49 |

Table 5.1 Evaluation results of Interfacing Impact Sensor with GPS Device

The Pie Chart below is a representation of the evaluation summary in the above table.

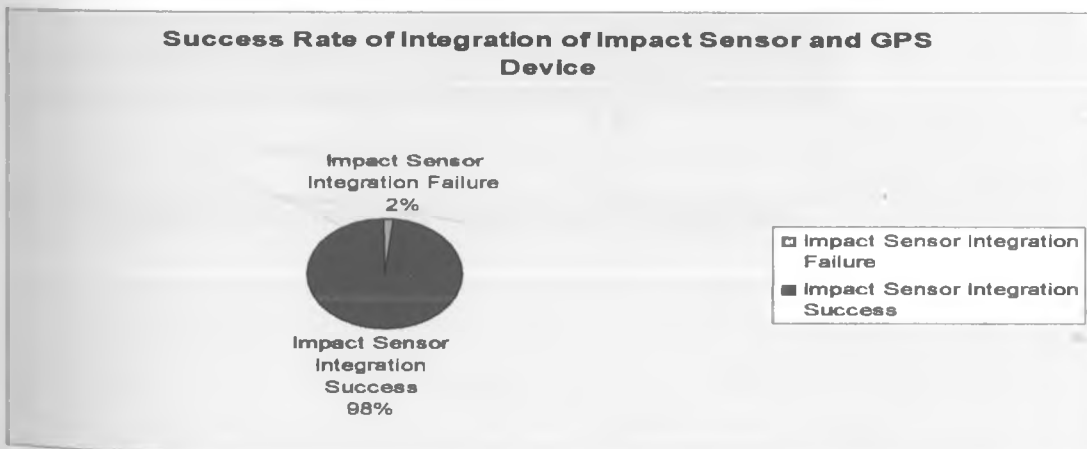


Figure 5.1 Pie Chart Showing the success rate of Interfacing Impact sensor and GPS Device

5.1.2 Reasons for experiencing incidents of failure in the Impact Sensor and GPS device Interface Evaluations.

During the tests carried out in evaluation it was determined reasons why an impact sensor may fail to transmit impact signal successfully to an integrated GPS device are:-

- The impact generated is too weak below the set threshold.
- When the physical interface has been interfered with causing disconnection.
- When the GPS device is not powered
- If the Electronic Control Unit (ECU) is not powered

5.2 Evaluation to measure the success rate at which the GPS device is able to combine the accident impact data and the spatial data before transmitting it to the web based database.

In carrying out this evaluation, 50 impacts were initiated against the impact sensor used in the prototype. The aim was to generate impact signal for transmission to the GPS device and subsequent integration with the GPS current spatial data at the time of the accident simulation. The success rate of this integration was recorded in a table in MS SQL server database. The detailed data is as presented in appendix IV.

5.2.1 Evaluation results for the ability of the GPS device to consolidate impact data with the GPS location or spatial data.

Using MS SQL server data query and analysis tools, the data was analyzed and the following table presents a summary of the statistics taken in this experiment.

| Number of Accident Impacts | Impact & Spatial Data Integration Failure | Impact & Spatial Data Integration Success |
|----------------------------|---|---|
| 50 | 1 | 49 |
| | | |

Table 5.2 Evaluation results of Integrating impact data and GPS spatial data

The Pie Chart below is a representation of the evaluation summary in the above table.

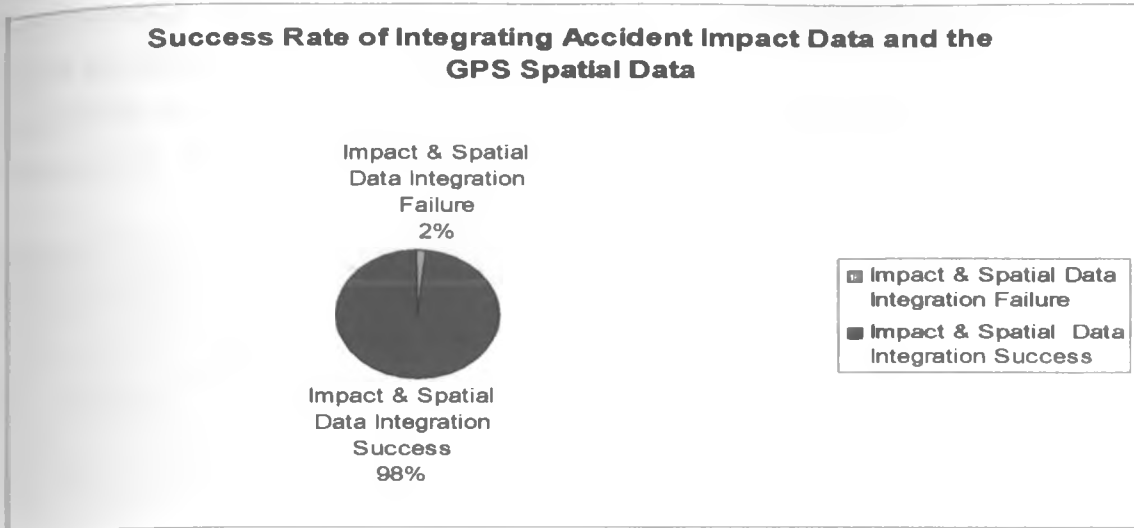


Figure 5.2 Pie Chart showing the success rate of Integration of Impact data and GPS spatial data

5.2.2 Reasons for incidents of failure in the Evaluation for the GPS device ability to consolidate impact data with the GPS location data.

In this evaluation, it was found out some reasons why the GPS device may fail to integrate impact signal data with the geographical data from the GPS system. These are:-

- When the GPS device has just started after power on. It takes a mean time of 1 minute and 40 seconds for the GPS device to start functioning.
- When the GPS aerial is not installed in place.
- When the GPS device is hindered from the sky by obstructing objects like buildings etc.

In all these cases, impacts initiated are transmitted with zero padded geographical coordinates.

5.3 Evaluation to determine the success rate at which the web based accident database received and updated the critical accident data accurately.

The time taken and the success rate of the accident incident update were recorded in a table in MS SQL server database. Successful update is in respect of the vehicle details, the accident location in geographical coordinates of longitudes and latitudes, date and time of the accident and the vehicle speed at the time of the accident. Using data that was generated by initiating impact on the sensors from the previous evaluations, 50 instances of impacts were analyzed. The detailed data is as presented in appendix IV.

5.3.1 Evaluation results for the ability of the web based accident database to receive and update the critical accident data accurately.

Using MS SQL server data query and analysis tools, the data was analyzed and the following table presents a summary of the statistics taken in this experiment

| Details | Correct | In-Correct |
|-----------------|---------|------------|
| Vehicle Details | 50 | 0 |
| Location Data | 46 | 4 |
| Date and Time | 48 | 2 |
| Speed | 44 | 6 |

Table 5.3 Results on the accuracy of Various Aspects of Accident as updated on the Accident Database

The graph below is a representation of the evaluation summary in the above table

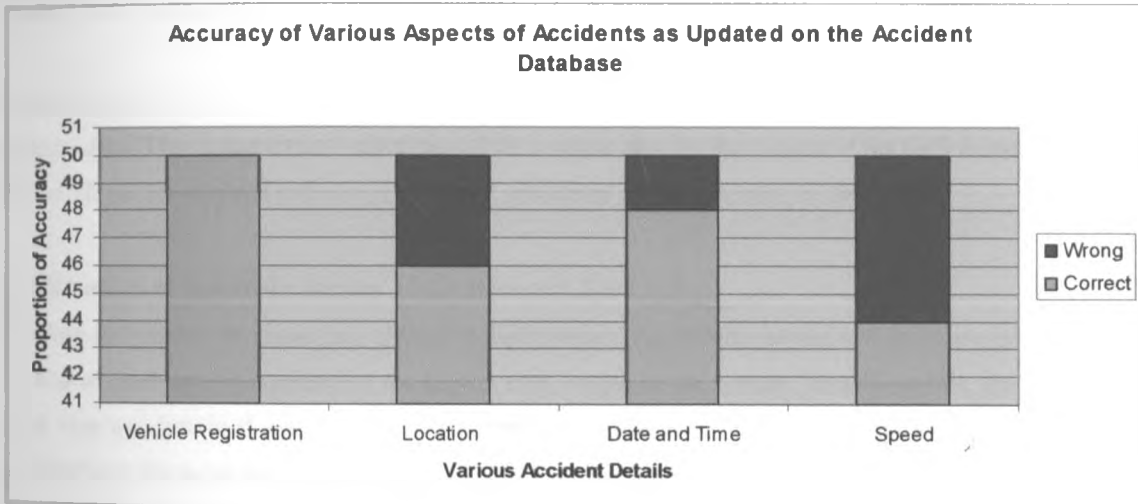


Figure 5.3 Accuracy of Various Aspects of Accident as updated on the Accident Database

Explanation of Results in Section 3.3.1 – Vehicle Details

The GPS Device transmitted to the database its GPS units ID that corresponds with the one that already exists on the database, enabling the system to unveil all other details of the vehicle supposedly involved in an accident impact. Most important information on display at each impact incident is the vehicle registration number. The evaluation achieved 100% success rate in this test.

Explanation of Results in Section 3.3.1 - Location

To determine the accuracy of the location coordinates submitted to the database on each impact, a different GPS device – a cell phone handset with GPS capabilities – was used. Coordinates of the impact site as updated on the database was compared with details on the cell phone handset. The following table is a sample of the spatial data comparison on the two devices.

| GPS Device Coordinates | | Cell phone GPS Coordinates | | Variations | |
|------------------------|---------------|----------------------------|---------------|------------|-----------|
| Latitude | Longitude | Latitude | Longitude | Latitude | Longitude |
| 01 16 02.44S | 036 50 36.89E | 01 16 02.44S | 036 50 36.89E | Nil | Nil |
| 01 16 02.90S | 036 50 37.10E | 01 16 02.81S | 036 50 36.91E | -0.11 | -0.19 |
| 01 16 02.67S | 036 50 36.18E | 01 16 02.67S | 036 50 36.18E | Nil | Nil |
| 01 16 01.70S | 036 50 38.70E | 01 16 01.70S | 036 50 38.70E | Nil | Nil |
| 01 16 01.20S | 036 50 37.67E | 01 16 01.20S | 036 50 37.67E | Nil | Nil |
| 01 16 03.40S | 036 50 38.15E | 01 16 04.01S | 036 50 38.30E | 0.61 | 0.15 |

Table 5.3.1 - Spatial data comparison on the two GPS devices.

It was ascertained from review on GPS literature, one reason why GPS device could sometime give wrong location data. This is due errors introduced on the location data by the owners of the GPS System. However the variations are minimal and would not affect successful implementation of the system

Explanation of Results in Section 3.3.1 - Date and Time

The date and time of an impact are critical in this research. As such the aspect was seriously evaluated with the aim to establish the accuracy of the impact time logged in the system. To achieve this, the GPS device clock was synchronized with another clock used for comparison. The time of the impact was read and recorded and the same was compared with the impact time logged on the database. The following table is a sample of the date and time comparison on the two clocks.

| GPS Database record on | | External Clock record on | | Variations | |
|------------------------|----------|--------------------------|----------|------------|----------|
| Date | Time | Date | Time | Date | Time |
| 20/05/2012 | 13:15:00 | 20/05/2012 | 13:04:45 | Nil | 00:10:20 |
| 20/05/2012 | 13:35:10 | 20/05/2012 | 13:22:50 | Nil | 00:12:20 |
| 20/05/2012 | 13:56:33 | 20/05/2012 | 13:40:15 | Nil | 00:13:18 |
| 27/05/2012 | 14:09:56 | 27/05/2012 | 14:00:56 | Nil | 00:09:00 |
| 27/05/2012 | 15:20:03 | 27/05/2012 | 14:59:43 | Nil | 00:20:21 |
| 27/05/2012 | 15:28:23 | 27/05/2012 | 15:18:02 | Nil | 00:10:21 |
| 27/05/2012 | 15:38:46 | 27/05/2012 | 15:30:30 | Nil | 00:08:16 |

Table 5.3.2 - Date and time Comparison on the two clocks.

Based on the data recorded in the table shown above, time variations of less than 15 second were considered as successful cases. This is because it takes some seconds for the impact signal to reach the GPS device where transmission to the database starts, with the GPS clock sensing the time. Cases where time variation exceeded 15seconds were considered failures.

Factors that caused the GPS device to relay impact signals with delay are:-

- Weak GPS signal
- Poor GPS coverage
- Congestion on the GPS Network

The GSM Network used in this research is Safaricom, which has a wide coverage in Kenya especially along all main roads. Therefore, determining the GSM provider to use is critical in achieving desired results.

5.4 Evaluation to measure the efficiency at which clients are able to access and view the database.

The measures of efficiency considered are:-

- i) Successful login
- ii) Successful Accident data Enquiry and Display
- iii) Successful Display of accident data on a GIS Digital map
- iv) Success in receiving new accidents alerts while logged in
- v) Success in manually updating accident data on the database

Fifty logins were done and data on the above measures was taken and recorded on MS SQL server database table. This data is presented in appendix IV.

5.4.1 Evaluation Results for the efficiency at which clients are able to access and view the database.

The following is a summary of the client access efficiency data as analyzed using MS SQL server data query and analysis tools.

| Access Efficiency Measures | Success | Failure |
|----------------------------|---------|---------|
| Login | 50 | 0 |
| Enquiry and Display | 48 | 2 |
| Display on Digital Map | 45 | 5 |
| Alert on New Accident | 46 | 4 |
| Manual Update | 50 | 0 |

Table 5.4 Accident Database Client Access Success Measure

The graph below is a representation of the evaluation summary in the above table.

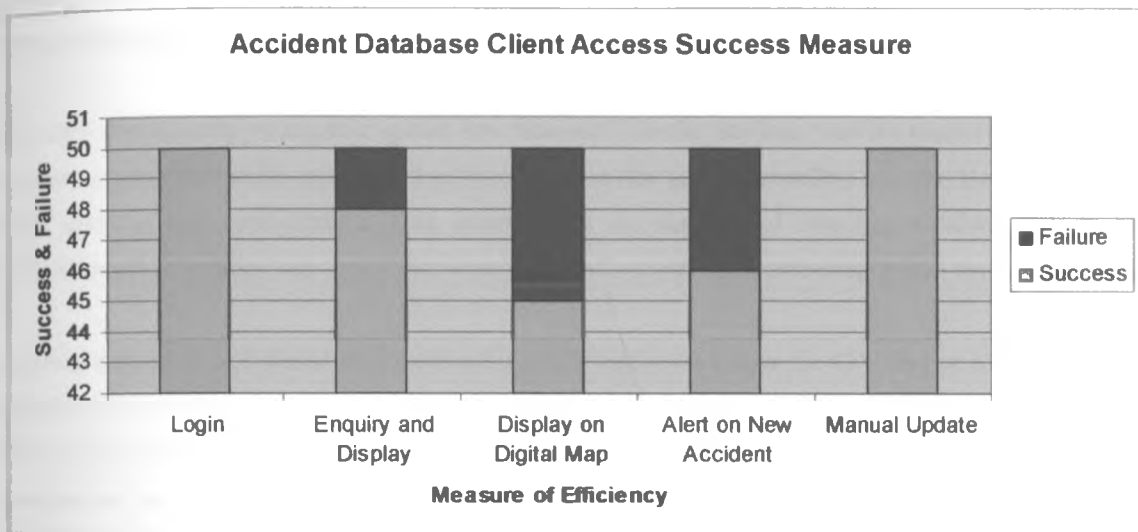


Figure 5.4 Accident Database Client Access Success Measure

Chapter Six: Discussion and Conclusion

6.1 Discussion

The methodology used in this project was easy to implement from all the facets. The objectives were simple to understand and the evaluations carried out came up with results that vindicated the project.

It was confirmed that the impact sensors can transmit impact signals to a GPS device through a physical interface in form of an electric/data cable connected to a special port on the GPS device. The results from the experiments carried out as explained in chapter five indicate a success rate of 98%.

The GPS device could put together spatial data received from the satellites with the impact signal from the impact sensors. The results experienced in the evaluation also gave an excellent success rate of 98% and as such asserting this configuration. This demonstrates the viability of detecting accident impacts and determining their location and time – vital aspects in performing rescue activities to save the victims.

Combined accident and spatial data were successfully transmitted from the GPS device to a remote web based database using GPS wireless network. Although other systems have demonstrated this capability before, it has been proved in this project that motor vehicle accident impact signals can be transmitted to a database on the web platform where it could be widely accessed. The evaluations conducted in this area were overwhelmingly encouraging with vehicle details updated correctly at the rate of 100%, the accident location coordinates at 92%, impact date and time at the rate of 96% and the vehicle speed at the rate of 88%. Therefore these results demonstrate the viability of this solution.

The ultimate objective is to enable authorized users of the system to be able to access accident information. Evaluations carried out to measure the success level of clients accessing the accident database returned positive results. Clients could login the web page, perform enquiries and display detailed accident information on their workstations, receive new accident alerts on the screen, manually update the system with details of accidents not automatically captured in the system and even be able to display an accident on a GIS digital map, pointing to the actual location of an accident site. This in upshot means that accidents can instantly be reported to authorized personnel and agencies as and when they occur with all the necessary details to guide the authorities in rescue missions.

The various evaluations carried out in the project facilitated accumulation of up to 50 records of simulated accidents. The sample data on vehicle accidents is similar to what researcher in this area can query and

carry out data mining exercises, discovering new knowledge on accidents; knowledge which in turn would be useful in mitigating motor vehicle accidents.

6.2 Conclusion

The technologies used are supported widely in scholarly literature, a few of which were cited in this research project. Other literature cited alludes that there exist a gap in prompt motor vehicle accident detection and reporting mechanism. Indeed this research comes in handy, as a technology for near instant detection and reporting of motor vehicle accidents thereby saving lives.

The evaluation results vindicated this project and efforts will be made to implement it in vehicles with the aim to reduce motor vehicle accident's related morbidity, mortality, losses and damages.

Further research can be carried out to enable:-

- i) Accident reporting by authorized users through mobile phones
- ii) Instant accident alert to be sent to specific mobile phones including the police and other emergency services.
- iii) Data warehousing and data mining models on accident data to discover new knowledge and accident patterns that would help in reducing motor vehicle accidents.
- iv) Determinations on how the different impact sensors can be used to transmit impact signal for the various type of accidents.
- v) Use GPRS in place of GSM network as used in this project to transmit data to a web based accident database.
- vi) Determine how well the system would function in case of multiple accidents involving many vehicles fitted with the accident detection system
- vii) Cryptography can be used to encrypt the transmitted accident signal from the GPS device, and decrypt it at the surveillance software, thus reducing the risks of brute-force attacks

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Appendices

Appendices are in the order below:-

Appendix I – Project Schedule

Appendix II – Project Budget

Appendix III – Photos and Technical Features of the System Hardware Prototype

Appendix IV – Sample Code

Appendix V – Screen Displays

Appendix VI – User Manual

Appendix I – Project Schedule

The Project Schedule

The project schedule is presented in the Gantt chart below.

Time in Months (year 2012)

| Activities | Jan | Feb | Mar | Apr | May | Jun | Jul |
|---|-----|-----|-----|-----|-----|-----|-----|
| Feasibility, Analysis, Design & Proposal Writing | █ | █ | █ | | | | |
| Obtain Hardware & Software | | | █ | █ | | | |
| Hardware Module Assembly, Integration and Testing | | | █ | █ | █ | | |
| Software Installation and Programs Development (Coding) and Testing | | | | █ | █ | █ | |
| Implementation, System Experimentation, Maintaining Data | | | | | | █ | █ |
| Data Analysis, Documentation and Further testing | | | | | | | █ |

Appendix II – Project Budget

Project Budget

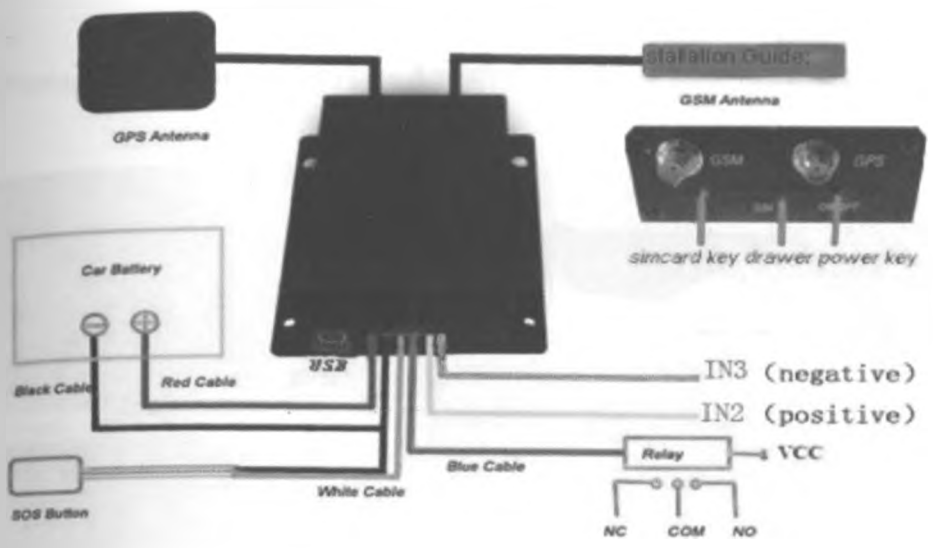
| | Item | Complete By | Budget KShs. | Comments |
|---|---|----------------------------|--------------|---|
| 1 | Feasibility & Proposal | 10 Mar 2011 | | |
| 2 | Give First Presentation | 16 th Mar 2012 | 1,000 | Printing and Binding |
| 3 | <ul style="list-style-type: none"> ▪ Obtain Vehicle Impact Sensor, GPS Mobile Device, GSM Phone and SIM Cards. ▪ Analysis of the Software | 31 st Mar 2012 | 30,000 | Cost of the devices |
| 4 | <ul style="list-style-type: none"> ▪ Design the Front End Software ▪ Assemble Hardware Modules | 14 th of April | 1,000 | Hardware Assembling tools |
| 5 | <ul style="list-style-type: none"> ▪ Development of the software ▪ Integration of Hardware Modules | 12 th May 2012 | 10,000 | Cost of the RDBMS and Development Software |
| 6 | <ul style="list-style-type: none"> ▪ Testing ▪ Obtain Data | 26 th May 2012 | 1,000 | Impact Sensor Testing, Auto Capture of experimental accident data from the system prototype |
| 6 | Progress Presentation | 11 th Jun 2012 | 1,000 | Printing and Binding |
| 7 | Complete the testing and Data analysis | 10 th July 2012 | | |
| 8 | Final Presentation | 23 rd July 2012 | 1,000 | Printing and Binding |
| 9 | Miscellaneous | | 5,000 | |
| | Total | | 50,000 | |

Appendix III

Photos and Technical Features of the System

Hardware Prototype

(i) The GPS Device Used



- Red Light
- Off
- Flashing (every 0.1 second)
- On
- Flashing (on for 1 second and off for 2 seconds)
- Power key

SOS button

MINI USB interface

SIM slot

GSM antenna interface

GPS antenna interface

Screw slots

Interfaces

Interface

Power (DC IN)

GND

IN1

OUT1

IN2

Line

Red line

Black lines

White line

Blue line

Yellow line

Power is off or charging is complete

Low power

Charging

Working

Switch on/off CT02

Remarks: Default is switched off.

SOS button is with power lines. When it is pressed, CT02 will send out SOS alarm.

It is used to upgrade firmware or set tracker. (User has to use USB232 serial port converter to work.)

It is to put in SIM card. SIM card should activate GPRS function.

It is to connect GSM antenna.

It is to connect GPS antenna.

Four screws are used to fix tracker on vehicle.

Function

DC input(Connected directly to battery positive). Valid voltage:9 V-36V. 12V is suggested.

It can be connected to battery negative pole or car body.

Low level input, negative trigger. It is connected to GND (Black line) to compose SOS button.

Effective output is 0V, ineffective output is OD output.

Ineffective: maximum 45V

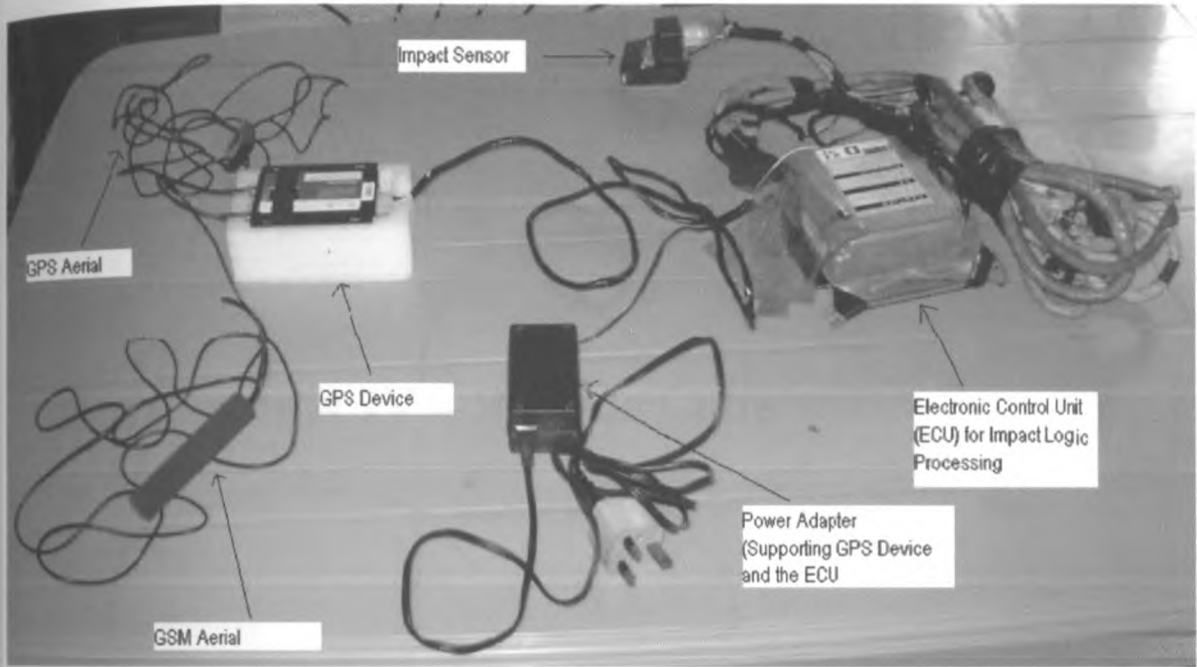
Effective: maximum 500 mA

High level input, positive trigger.

Green line

Effective: High level input.
Ineffective: low level input (0V) or OD input.
Low level input, negative trigger.
Effective: Low level input
Ineffective: High level input (1-45V) or OD input.

ii) Photograph of the Prototype - Accident detection and Vehicle tracking modules



Appendix IV – Sample Code

1. C # (C SHARP) CODE FOR THE LOGIN SCREEN

```
using System;
using System.Data;
using System.Configuration;
using System.Collections;
using System.Web;
using System.Web.Security;
using System.Web.UI;
using System.Web.UI.WebControls;
using System.Web.UI.WebControls.WebParts;
using System.Web.UI.HtmlControls;
using System.Data.Common;

public partial class frmLogin : System.Web.UI.Page
{
    string strMsg = "";
    DataAccess.DataAccess DataClass;
    protected void Page_Load(object sender, EventArgs e)
    {
        this.Form.Attributes.Add("autocomplete", "off");
    }
    protected void cmdLogin_Click(object sender, EventArgs e)
    {
        if (Page.IsValid == false)
        {
            return;
        }
        else
        {
            bool flag =
            GetUserInfor(txtUsername.Text,txtPassword.Text );
            if (flag == false)
            {
                txtUsername.Text = "";
                return;
            }
            else
            {
                Response.Redirect("frmmain.aspx");
            }
        }
    }
    protected void btnLogin_Click(object sender, EventArgs e)
    {
        Label3.Text = "";
        bool flag = false;
        try
        {
            DataClass = new DataAccess.DataAccess();
            OleDbDataReader rs = DataClass.GetDBResults(ref strMsg,
            "sp_GetUserFact", "@UserID", txtUsername.Text);
            if(strMsg!="")
            {

```

```

        Label3.Text = strMsg.ToString();
        flag = false;
    }
    if (rs.Read())
    {
        Functions.Functions fn = new Functions.Functions();
        double pwd= fn.EncryptPassword(UserID , password ,
LateTime.Parse(rs["UpdatedOn"].ToString()));
        if (pwd.ToString() == rs["Password"].ToString())
        {
            flag = true;
        }
        else
        {
            Label3.Text = "Invalid Password.";
        }
    }
    else
    {
        Label3.Text = "Invalid Username.";
        flag = false;
    }
}
catch(Exception ex)
{
    Label3.Text=ex.Message;
}
return flag;
}
}

```

2. C # (C SHARP) CODE FOR THE ACCIDENT PAGE, WITH THE SPECIAL GsmComm Library AND CODE TO READ SIM CAR SMS

```

using System;
using System.Data;
using System.Data.SqlClient;
using System.Configuration;
using System.Collections;
using System.Web;
using System.Web.Security;
using System.Web.UI;
using System.Web.UI.WebControls;
using System.Web.UI.WebControls.WebParts;
using System.Web.UI.HtmlControls;
using System.Data.Common;
using System.Globalization;
using System.Threading;
using GsmComm.PduConverter;
using GsmComm.PduConverter.SmartMessaging;
using GsmComm.GsmCommunication;
using GsmComm.Interfaces;
using GsmComm.Server;
using System.Windows.Forms;
using AccidentTableAdapters;

```

```

using System.IO;
using System.Net.Mail;

public partial class frmAccident : System.Web.UI.Page
{
    private delegate void SetTextCallback(string text);
    private GsmCommMain comm;
    string Email;
    private string portName="COM9";
    private int baudRate=19200;
    private int timeout=300;
    private DataSet dsImportReadFile;
    //private DataSet dsImport;
    private const string filename = @"C:\messages_text.xml";

    string strMsg = "";
    Functions.Functions fn ;
    DataAccess.DataAccess DataClass;
    protected void Page_Load(object sender, EventArgs e)
    {
        CultureInfo culture =
(CultureInfo ) Thread.CurrentCulture.Clone();
        culture.DateTimeFormat.ShortDatePattern = "dd-MMM-yyyy
HH:mm:ss";
        culture.DateTimeFormat.LongTimePattern = "";
        Thread.CurrentThread.CurrentCulture = culture;
        this.Form.Attributes.Add("autocomplete", "off");
        //fn.ClearFields(this.Page);
        loadgrid();
        if (IsPostBack == false)
        {
            loadDeviceTypes();
            loadAccTypes();
            loadReportingMethodTypes();
        }

        comm = new GsmCommMain(portName, baudRate, timeout);

        if (!comm.IsConnected())
        {
            bool retry;
            do
            {
                retry = false;
                try
                {
                    comm.Open();
                    //comm.EnterPin("1966");

                }
                catch (Exception)
                {
                    //if (MessageBox.Show("Unable to open the
port.", "Error")

```

```
        //      MessageBoxButtons.RetryCancel,
messageBoxIcon.Warning) == DialogResult.Retry)
        //      retry = true;
        //else
        //()
        //      return;
    }
    while (retry);
}
```

```
    ReadSMS();
    if (comm.IsOpen())
    {
        comm.Close();
    }
```

```
    FileInfo fi = new FileInfo (filename);
    if (fi.Exists)
    {
        SaveXML();
        loadgrid();
    }
```

)

```
public void SaveXML()
{
```

```
    DataTable t = new DataTable();
    Accident ds = null;
    SqlConnection connection = null;
    DataSetAdapter adapter = new DataSetAdapter();
```

```
    try
    {
```

```
        ds = new DataSet();
        dsImportReadFile = new DataSetAdapter();
        dsImportReadFile.ReadXml(filename);
        //dsImportReadFile.Merge(ds);
```

```
        connection = new
SqlConnection ( ConfigurationManager.AppSettings["ConnectionString"].ToString());
```

```
        connection.Open();
```

```

        // loop through the dsIMPORT table
        if (dsImportReadFile.Tables["Message"].Rows.Count != 0)
        {
            if (dsImportReadFile.Tables["Message"].Rows.Count >
0)
            {
                for (int i = 0; i <
dsImportReadFile.Tables["Message"].Rows.Count; i++)
                {
                    //string AccCode = "0011" + i;
                    string AccMethod = "001";
                    string UnitType = "001";
                    DateTime systemDateTime = DateTime.Now;
                    string AccidentType = "001";
                    decimal speed = decimal.Parse(
dsImportReadFile.Tables["Message"].Rows[i]["Speed"].ToString());

                    SqlCommand command = new SqlCommand(
                        "INSERT INTO t_Accident (GPSUnitTypeCode,AccTypeCode,
AccDateTime,SystemDateTime,AccSiteCoordinates,VehicleSpeed,GPSUnitID,Ac
cReportingMethodCode) " +
                        "VALUES ('" + UnitType + "','" + AccidentType + "','" +
dsImportReadFile.Tables["Message"].Rows[i]["DateTime"] + "','" +
systemDateTime + "','" +
dsImportReadFile.Tables["Message"].Rows[i]["Coodirnates"] + "','" +
speed + "','" + dsImportReadFile.Tables["Message"].Rows[i]["Sender"] +
"',,'" + AccMethod + "','" + ")");

                    adapter.InsertCommand = command;
                    adapter.InsertCommand.Connection =
connection;

                    adapter.InsertCommand.ExecuteNonQuery();

                }

            }

            // Polycarp to advise on the usage of this function. It
is causing no record to be automatically updated as expected

        }

    }
    FetchEmailAddress();
    FileInfo fi=new FileInf (filename);
    fi.Delete();

}
catch { }

}
/// <summary>
/// Reads SMS from the SIM Card into an XML file
/// </summary>
public void ReadSMS ()

```

```

{
    string storage = PhoneStorageType.Sim;
    try
    {
        // Read and serialize all short messages from storage
        into an XML file.
        DecodedShortMessage[] messages =
        comm.ReadMessages(PhoneMessageStatus.All, storage);

        if (messages.Length != 0)
        {
            //Output(messages.Length.ToString() + " message(s) read.");

            Output("Exporting the messages to " + filename +
"...");
            System.Xml.XmlWriter xmlWriter = new
System.Xml.XmlTextWriter(filename, System.Text.Encoding.UTF8);
            // Change default writer settings to produce readable
            output
            xmlWriter.Formatting =
System.Xml.Formatting.Indented;
            xmlWriter.Indentation = 4;

            xmlWriter.WriteStartDocument();
            xmlWriter.WriteStartElement("SOSMessages");
            foreach (DecodedShortMessage message in messages)
            {
                xmlWriter.WriteStartElement("Message");
                string Sender = string.Empty;
                string timestamp = string.Empty;
                string text = message.Data.UserDataText;
                //string Longitude = string.Empty;
                //string Latitude = string.Empty;
                string Speed = string.Empty;
                string coordinates = string.Empty;
                string Longi = string.Empty;
                string Latitu = string.Empty;
                //string isSOS = text.Contains("SOS Alarm");
                //text.Substring(text.IndexOf("!") - 9, 9);

                if (text.Contains("SOS Alarm"))
                {
                    if(!text.Contains("Last:"))
                    {
                        if (message.Data is SmsDeliverPdu)
                        {
                            SmsDeliverPdu deliver =
(SmsDeliverPdu)message.Data;

                            string strTime =
text.Substring(text.LastIndexOf(",") + 1, 5);
                            string strDate =
text.Substring(text.LastIndexOf(",") - 10, 10);

```

```

10);
        Sender = text.Substring(text.IndexOf(":") + 1,
        timestamp = strDate + " " + strTime;
//timestamp=text.Substring(text.LastIndexOf(":")+11, 16);
        coodirnates = text.Substring(text.IndexOf(",")
+ 1, 49);

        Latitu =
coodirnates.Substring(coodirnates.IndexOf("=") + 1, 13);
        Longi =
coodirnates.Substring(coodirnates.LastIndexOf("=") + 1, 14);
        coodirnates = Latitu.Trim() + " " +
Longi.Trim();
        Speed = text.Substring(text.LastIndexOf("=") -
19, 5);

    }
}
else
{
    break;
}
Sender.Trim();
xmlWriter.WriteElementString("Sender",
timestamp.Trim());
xmlWriter.WriteElementString("DateTime",
coodirnates.Trim());
xmlWriter.WriteElementString("Coodirnates",
Speed.Trim());
xmlWriter.WriteElementString("Speed",
xmlWriter.WriteEndElement();
}
xmlWriter.WriteEndElement();
xmlWriter.WriteEndDocument();
xmlWriter.Close();
Output("Done.");
Output("");

if (!comm.IsOpen())
{
    comm.Open();
}
comm.DeleteMessages ( ete: scope.All, storage);
}

}

catch (Exception ex)
{

```



```

        ShowException(ex);
    }

}

private void Output(string text)
{
    txtOutput.Text = text;
    txtOutput.TextMode= TextBoxMode.Multiline;
}

private void Output(string text, params object[] args)
{
    string msg = string.Format(text, args);
    Output(msg);
}

private void ShowException(Exception ex)
{
    Output("Error: " + ex.Message + " (" +
ex.GetType().ToString() + ")");
    Output("");
}

protected void loadDeviceTypes()
{
    LblMessageLine.Text = "";
    try
    {
        fn = new Functions.Functions();
        DataClass = new DataAccess.DataAccess();
        DbDataReader dr = DataClass.GetDBResults(ref strMsg,
"sp_ViewGPSDeviceType");
        if (strMsg != "")
        {
            LblMessageLine.Text = strMsg.ToString();
            return;
        }
        fn.FillCombo(dr, "TxtGpsUnitType", this.Page);
        dr.Close();
        dr.Dispose();
        fn = null;
        DataClass = null;
    }
    catch (Exception ex)
    {
        LblMessageLine.Text = ex.Message;
    }
}

protected void loadAcctypes()
{
    LblMessageLine.Text = "";
    try
    {

```

```

        fn = new Functions.Functions();
        DataClass = new DataAccess.DataAccess();
        DbDataReader dr = DataClass.GetDBResults(ref strMsg,
"sp_ViewAccidentType");
        if (strMsg != "")
        {
            LblMessageLine.Text = strMsg.ToString();
            return;
        }
        fn.FillCombo(dr, "TxtAccType", this.Page);
        dr.Close();
        dr.Dispose();
        fn = null;
        DataClass = null;
    }
    catch (Exception ex)
    {
        LblMessageLine.Text = ex.Message;
    }
}
protected void loadReportingMethodTypes()
{
    LblMessageLine.Text = "";
    try
    {
        fn = new Functions.Functions();
        DataClass = new DataAccess.DataAccess();
        DbDataReader dr = DataClass.GetDBResults(ref strMsg,
"sp_ViewReportingMethods");
        if (strMsg != "")
        {
            LblMessageLine.Text = strMsg.ToString();
            return;
        }
        fn.FillCombo(dr, "TxtAccReportMethod", this.Page);
        dr.Close();
        dr.Dispose();
        fn = null;
        DataClass = null;
    }
    catch (Exception ex)
    {
        LblMessageLine.Text = ex.Message;
    }
}
protected void cmdClear_Click(object sender, EventArgs e)
{
    //FetchEmailAddress();
    //return;
    clear();
}
protected void cmdAdd_Click(object sender, EventArgs e)
{
    bool IsAdded= addeditdelete(1);
    if (IsAdded == true)
    {

```

```

        LblMessageLine.Text = "Accident Record Added
Successfully.";
    }
    else
    {
        return;
    }
}
protected Boolean addeditdelete(int newrecord)
{
    DateTime accDate_Time =
DateTime.Parse(RadDatePicker1.SelectedDate.ToString());
    string datetime =
(accDate_Time.AddHours(double.Parse(DropDownList1.SelectedValue)).AddMi
nutes(double.Parse(DropDownList2.SelectedValue)).AddSeconds(double.Pars
e(DropDownList3.SelectedValue))).ToString();
    DateTime Date_Time = DateTime.Parse(datetime.ToString());
    bool flag = false;
    LblMessageLine .Text = "";
    try
    {
        DataClass = new DataAccess.DataAccess();
        DbDataReader rs = DataClass.GetDBResults(ref strMsg,
"sp_AddEditDeleteAccident",
"@AccidentCode", TxtAccidentCode.Text,
"@GPSUnitID", TxtGpsUnitId.Text,
"@GPSUnitTypeCode",
TxtGpsUnitType.SelectedValue ,
"@AccSiteCoordinates", TxtAccSiteCoord.Text,
"@AccSiteName", TxtAccSiteName.Text,
"@AccRoad", TxtAccRoad.Text,
"@Speed", TxtVehicleSpeed.Text,
"@AccTypeCode", TxtAccType.SelectedValue ,
"@AccVehicleDamage", TxtAccVehDamage.Text,
"@AccCause", TxtAccCause.Text,
"@NoOfPass", TxtNoOfAccupants.Text,
"@NoOfVehiclesInv", TxtNoOfVehiclesInv.Text,
"@DriverCode", TxtDriverLicenceNo.Text,
"@NoOfInjuries", TxtNumberInjured.Text,
"@NoOfFatalities", TxtFatalities.Text,
"@LossDescription", TxtOtherLosses.Text,
"@ReportingMethod",
TxtAccReportMethod.SelectedValue ,
"@FirstResponders",
TxtAccFirstResponders.Text,
"@AccEvacuationMethod",
TxtAccEvacuationMethod.Text ,
"@AccDateTime", Date_Time,
"@NewRecord", newrecord);

        if (strMsg != "")
        {
            LblMessageLine.ForeColor =
System.Drawing.Color.Red;
            LblMessageLine.Text = strMsg.ToString();
            flag = false;
        }
    }
}

```

```

        else if (strMsg == "")
        {
            clear();
            loadgrid();
            flag = true;
        }
    }
    catch (Exception ex)
    {
        flag = false;
        LblMessageLine.Text = ex.Message;
    }
    return flag;
}
protected void cmdUpdate_Click(object sender, EventArgs e)
{
    bool IsEdited= addeditdelete(2);
    if (IsEdited == true)
    {
        clear();
        LblMessageLine.Text = "Accident Record Updated
Successfully.";
    }
    else
    {
        return;
    }
}
protected void cmdDelete_Click(object sender, EventArgs e)
{
    bool IsDeleted = addeditdelete(3);
    if (IsDeleted == true)
    {
        clear();
        LblMessageLine.Text = "Accident Record Deleted
Successfully.";
    }
    else
    {
        return;
    }
}

protected void loadgrid()
{
    //LblMessageLine.Text = "";
    DataClass = new DataAccess.DataAccess();
    DataSet rs = DataClass.GetDBResultsDS("sp_ViewAccident");
    RadGrid1.DataSource = rs;
    RadGrid1.DataBind();
}

protected void showdrivers(object source,
Telerik.Web.UI.CommandEventArgs e)
{
    if (e.CommandName == "Select")

```

```
{  
    lblRegNo.Text = "";
```

```
GetVehicleRegNo(e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["GPSUnitID"].ToString());
```

```
    TxtAccidentCode.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccidentCode"].ToString();
```

```
    TxtGpsUnitId.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["GPSUnitID"].ToString();
```

```
    TxtGpsUnitType.SelectedValue =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["GPSUnitTypeCode"].ToString();
```

```
    TxtAccSiteCoord.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccSiteCoordinates"].ToString();
```

```
    TxtAccSiteName.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccSiteName"].ToString();
```

```
    TxtAccRoad.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccRoad"].ToString();
```

```
    RadDatePicker1.SelectedDate = DateTime.Parse(
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccDateTime"].ToString());
```

```
    TxtVehicleSpeed.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["VehicleSpeed"].ToString();
```

```
    //RadDatePicker2.SelectedDate = DateTime.Parse(
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["SystemDateTime"].ToString());
```

```
    TxtAccType.SelectedValue =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccTypeCode"].ToString();
```

```
    TxtAccVehDamage.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccVehicleDamage"].ToString();
```

```
    TxtAccCause.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccPossibleCause"].ToString();
```

```
    TxtNoOfAccupants.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccNoOfVehicleOccupants"].ToString();
```

```
    TxtNoOfVehiclesInv.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["NoOfOtherVehiclesIntheAcc"].ToString();
```

```
    TxtDriverLicenceNo.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccDriverCode"].ToString();
```

```
    TxtNumberInjured.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["NoOfInjuries"].ToString();
```

```
    TxtFatalities.Text =
```

```
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["NoOfFatalities"].ToString();
```

```

        TxtOtherLosses.Text =
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["DescriptionOfOtherLosses"].ToString();
        TxtAccReportMethod.SelectedValue =
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccReportingMethodCode"].ToString();
        TxtAccFirstResponders.Text =
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccFirstResponders"].ToString();
        TxtAccEvacuationMethod.Text =
e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccEvacuationMethod"].ToString();
        System.DateTime AccDateTime =
DateTime.Parse(e.Item.OwnerTableView.DataKeyValues[e.Item.ItemIndex]["AccDateTime"].ToString());
        DropDownList1.SelectedValue = AccDateTime.Hour.ToString();
        DropDownList2.SelectedValue = AccDateTime.Minute.ToString();
        DropDownList3.SelectedValue = AccDateTime.Second.ToString();
        cmdAdd.Enabled = false;
        cmdDelete.Enabled = true;
        cmdUpdate.Enabled = true;
        TxtAccidentCode.Enabled = false;
    }
}

```

```

protected void RadGrid1_NeedDataSource(object source,
Telerik.Web.UI.GridNeedDataSourceEventArgs e)

```

```
{
```

```
}
```

```
protected void clear()
```

```
{
```

```
    fn = new Functions.Functions();
```

```
    fn.ClearFields(this.Page);
```

```
    cmdAdd.Enabled = true;
```

```
    cmdUpdate.Enabled = false;
```

```
    cmdDelete.Enabled = false;
```

```
    TxtAccidentCode.Enabled = true;
```

```
    lblRegNo.Text = "";
```

```
}
```

```
protected void Timer1_Tick(object sender, EventArgs e)
```

```
{
```

```
    if (!comm.IsOpen())
```

```
    {
```

```
        comm.Open();
```

```
    }
```

```
    ReadSMS();
```

```
    comm.Close();
```

```
}
```

```
protected void TxtGpsUnitId_TextChanged(object sender, EventArgs e)
```

```
{
```

```
    GetVehicleRegNo(TxtGpsUnitId.Text);
```

```
}
```

```
protected void GetVehicleRegNo(string GpsUnitID)
```

```

    strMsg = "";
    LblMessageLine.Text = "";
    try
    {
        DataClass = new DataAccess.DataAccess();
        DbDataReader rs = DataClass.GetDBResults(ref strMsg,
"sp_GetVehicleInfo",
        "@GPSUnitID", GpsUnitID );
        if (strMsg != "")
        {
            LblMessageLine.Text = strMsg;
            return;
        }
        if (rs.Read())
        {
            lblRegNo.Text = rs["RegistrationNo"].ToString();
        }
    }
    catch (Exception ex)
    {
        LblMessageLine.Text = strMsg;
    }
}
protected void FetchEmailAddress()
{
    strMsg = "";
    LblMessageLine.Text = "";
    try
    {
        DataClass = new DataAccess.DataAccess();
        DbDataReader rs = DataClass.GetDBResults(ref strMsg,
"sp_GetEmailAddress");
        if (strMsg != "")
        {
            LblMessageLine.Text = strMsg;
            return;
        }
        if (rs.Read())
        {
            Email = rs["AccidentReportEmail"].ToString();
            SendEmailAlert(Email, rs["RegistrationNo"].ToString(),
rs["AccSiteCoordinates"].ToString());
        }
    }
    catch (Exception ex)
    {
        LblMessageLine.Text = strMsg;
    }
}
protected void SendEmailAlert(string sendTo, string RegNo, string
Coordinates)
{
    try
    {

```

```

        MailMessage message = new
MailMessage("peterngeru@gmail.com", sendTo, "Accident Tracker System",
"You Car "+RegNo +" Has Been Involved In An Accident At "+ Coordinates
);
        message.IsBodyHtml = true;
        SmtpClient client = new SmtpClient("smtp.gmail.com", 587);
        System.Net.NetworkCredential SMTPUserInfo = new
System.Net.NetworkCredential("peterngeru@gmail.com", "penge7119");
        client.UseDefaultCredentials = false;
        client.EnableSsl = true;
        client.Credentials = SMTPUserInfo;
        client.Send(message);
        LblMessageLine.Text = DateTime.Now + ": Mail Sent
Successfully";
    }
    catch (Exception ex)
    {
        LblMessageLine.Text = DateTime.Now + ": " + ex.Message;
    }
}
}

```

3. JAVA SCRIPT CODE FOR THE GIS (GOOGLE MAPS) API

```

<%@ Page Language "C#" AutoEventWireup="true" CodeFile "mapGUI.aspx.cs"
Inherits "mapGUI" %>

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">

<html xmlns="http://www.w3.org/1999/xhtml" xmlns:v="urn:schemas-
microsoft-com:vml">
    <head>
        <meta http-equiv="content-type" content="text/html; charset=UTF-
8"/>
        <title>Instant Motor Accident Tracker on GIS</title>
        <script
src="http://maps.google.com/maps?file=api&v=2&key=ABQIAAAAjU0EJ
WnWPMv7oQ-
jjS7dYxSPW5CJgpdg0_s4yyMovOaVh_KvvhSfpvagV18eOyDWu7VytS6BilCWxw"
type="text/javascript"></script>
        <script type="text/javascript">

var map = null;
var geocoder = null;

function initialize() {
    if (GBrowserIsCompatible()) {
        map = new GMap2(document.getElementById("map_canvas"));
        map.setCenter(new GLatLng(37.4419, -122.1419), 1);
        map.setUIToDefault();
        geocoder = new GClientGeocoder();
        //alert(this.address);
        showAddress("<%=string1%>");
    }
}

```



```

    }
}

function showAddress(address) {
    if (geocoder) {
        geocoder.getLatLng(
            address,
            function(point) {
                if (!point) {
                    alert(address + " not found");
                } else {
                    map.setCenter(point, 15);
                    var marker = new GMarker(point, {draggable: true});
                    map.addOverlay(marker);
                    GEvent.addListener(marker, "dragend", function() {
                        marker.openInfoWindowHtml("Accident <%=string2%>");
                    });
                    GEvent.addListener(marker, "click", function() {
                        marker.openInfoWindowHtml("Accident <%=string2%>");
                    });
                    GEvent.trigger(marker, "click");
                }
            }
        );
    }
}
</script>
</head>

<body onload="initialize()" onunload="GUnload()">
    <p>
        <asp:Label ID="address" name="address" runat="server"
Text=".."></asp:Label>
    </p>
    <div id="map_canvas" style="width: 600px; height: 400px"></div>
</body>
</html>

```

```

using System;
using System.Data;
using System.Configuration;
using System.Collections;
using System.Web;
using System.Web.Security;
using System.Web.UI;
using System.Web.UI.WebControls;
using System.Web.UI.WebControls.WebParts;
using System.Web.UI.HtmlControls;
using System.Data.Common;
//
mapGUI
//
public partial class mapGUI : System.Web.UI.Page
{
    string strMsg = "";
    DataAccess.DataAccess DataClass;

```

```
String Coordinates = HttpContext.Current.Request["Coordinates"];
String RegNo = HttpContext.Current.Request["RegNo"];
public String string1;
public String string2;

protected void Page_Load(object sender, EventArgs e)
{
    address.Text = "Coordinates for <b>" + RegNo + "</b> Are <b>" +
Coordinates + "</b>";
    string1 = Coordinates;
    string2 = RegNo;
}
}
```

Appendix V – Sample Screen Displays

The System has many screens where users interact with the system. The screens are designed with the user in mind to make the system as user friendly as possible. Security has also been inbuilt and only authorized users can access the system. The following are just a few of the screens from the system. Others not presented here are more or less the same in terms of features and navigation

1. The Login Screen.

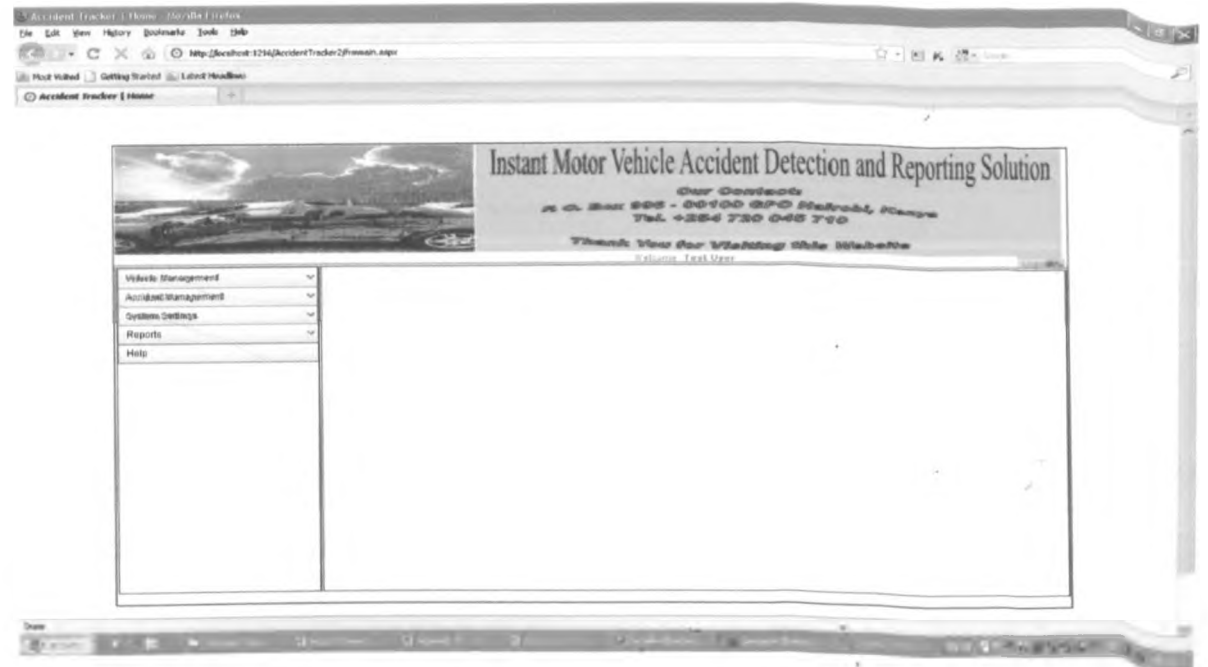


Instant GPS Based Accident Detection and Reporting Solution
Please Login Below to Access

Username: admin
Password: *****
Login



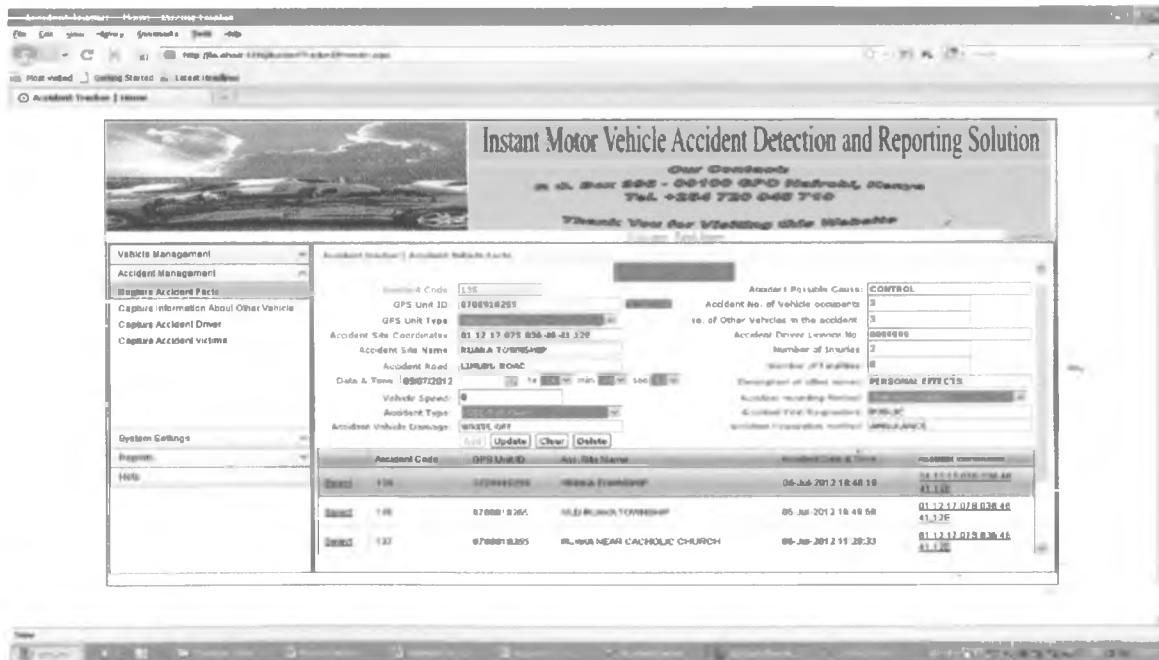
2. Home Page with Main Menu (also Serving as Site Map)



3. Vehicle Management Screen



4. Accident Facts View Screen



5. User Maintenance Screen

Instant Motor Vehicle Accident Detection and Reporting Solution

Our Contact:
A. G. Box 552 - 40700 8th Street, Tampa
Tel: +888 730 045 730
Thank You for Visiting Our Website
Welcome Test User

Accident Tracker | Manage System Users

User ID: admin
Full Name: Frances Adams/Dyer
Category: System Administrator
Profile: System Administrator
Password: [input type="password"]
New Password: [input type="password"]
Buttons: Add, Update, Delete, Clear, Reset Password

| User ID | Name | Access Level | Category |
|-----------|----------------------|--------------|---------------|
| admin | System Administrator | 001 | Normal |
| Edwin | Edwin Foreback | 001 | Normal |
| John@ap | John@ap Agency | 001 | Normal |
| SUPER-GER | Super User | 001 | Administrator |

6. Report Access Screen

Instant Motor Vehicle Accident Detection and Reporting Solution

Our Contact:
A. G. Box 552 - 40700 8th Street, Tampa
Tel: +888 730 045 730
Thank You for Visiting Our Website
Welcome Test User

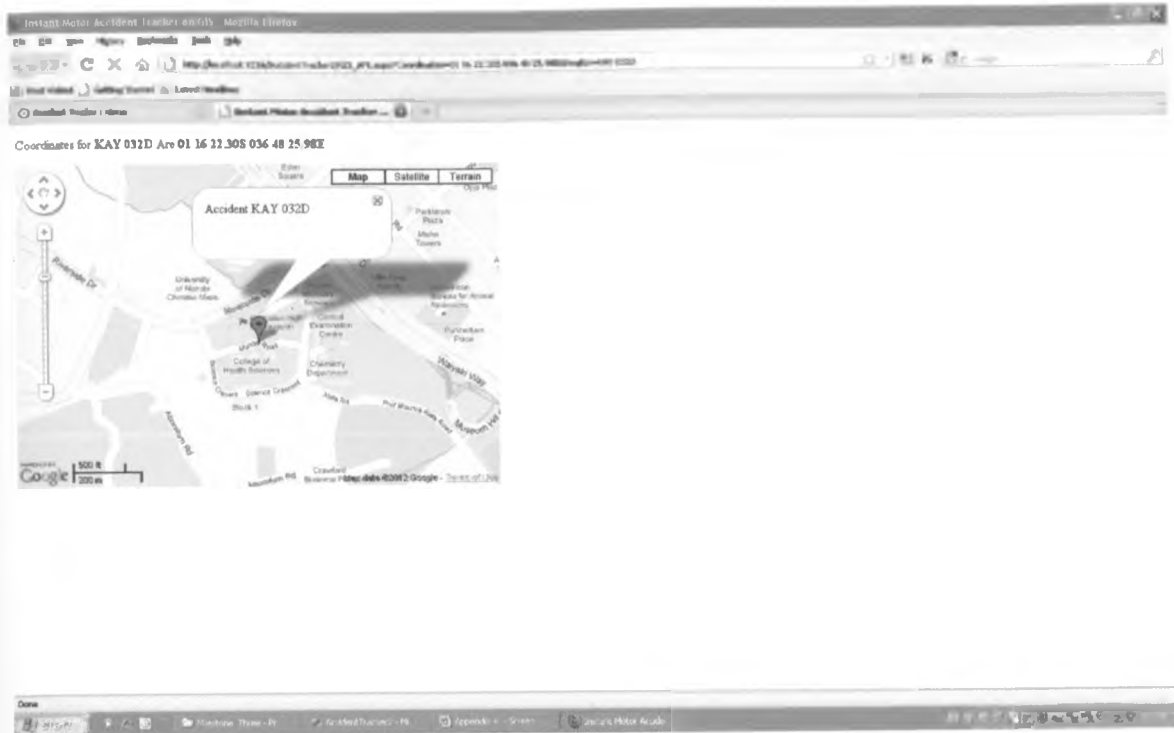
Accident Tracker | SYSTEM USERS REPORT

Start Date: 08/01/2012
End Date: 08/01/2012
View Report

Select View: [dropdown] Export

| USER ID | FULL NAME | CATEGORY | CREATED ON | CREATED BY |
|-----------------------|-----------|----------|------------|------------|
| No records to display | | | | |

7. GIS Interface



Appendix VI – User Manual

Instant GPS Based Motor Vehicle Accident Detection and Reporting Solution

“Accident Tracker System”

User Manual

Version 1.1

August 2012

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P O Box 996 – 00100

Nairobi, Kenya

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| Glossary | The glossary provides definitions and descriptions for terms and phrases used in the system. | xxvii |

Section 1. Introduction about this document

1.1 Introduction to the Manual

This manual is divided into the sections shown in the table of contents. In brief, the document contains information on the usage of the Instant GPS based Motor Vehicle Accident detection and reporting System, also christened as Accident Tracker System. The system was initially developed by the author of this document as a prototype for the MSC computer science project at the University of Nairobi.

1.2 Related documents

Refer to the following for additional information:

- The project proposal document presented at a panel at the school of computing on 16/03/2012
 - The project report with more details on how the project was carried out.
-

1.3 Feedback and amendments

Who

This manual has been prepared by Peter N. Njuguna, UON, School of Computing and Informatics, MSC in Computer Science.

There are no Amendments to this manual so far but can be issued as required.

Feedback

Every effort is made to ensure the content of this manual is appropriate, accurate and complete.

Your feedback will help me to:

- identify changes required
- continually improve this manual

If you would like to suggest an amendment/addition to this manual, please communicate with me using any of the contacts provided, or through the School of Computing and Informatics, University of Nairobi.

Section 2. System Overview

System overview

The purpose of this section is to provide a high-level overview of the system: what it does and why it does it.

2.1 Introduction to the system

Purpose

The primary purpose of this system is to instantly detect and report motor vehicle accident by utilizing the existing technologies of impact sensors, GPS, GPRS/GSM, Internet and GIS. This will lead to quick evacuation by the relevant bodies, consequently reducing accident deaths, injuries and losses.

Objectives

The objectives are to:

- i) Integrate impact sensor with a GPS device, and carry out experiments by initiating impacts that will generate sufficient magnitude of electronic signal to be digitally transmitted to a GPS device.
- ii) Configure GPS device to integrate digital impact signal with GPS location data and transmit the resultant raw data to a database server through GSM/GPRS.
- iii) Develop a web accessible database and interface software that will automatically receive and update data transmitted from GPS devices through wireless network, and also with a provision for manual update from authorized users.
- iv) Create a web interface which web clients can use to access the accident database, displaying the accident occurrence details on digital maps. Facilitate an accident database which interested users can used to carry out data mining processes on the database for more information and research purposes

Benefits

The benefits are:

- Motor Vehicle accident will be reported instantly with the benefit of quick evacuation of victims, leading to less deaths, injuries and damages.
 - Reliable data on motor vehicle accidents will be available easily in electronic form through the internet.
-

2.2 Business process

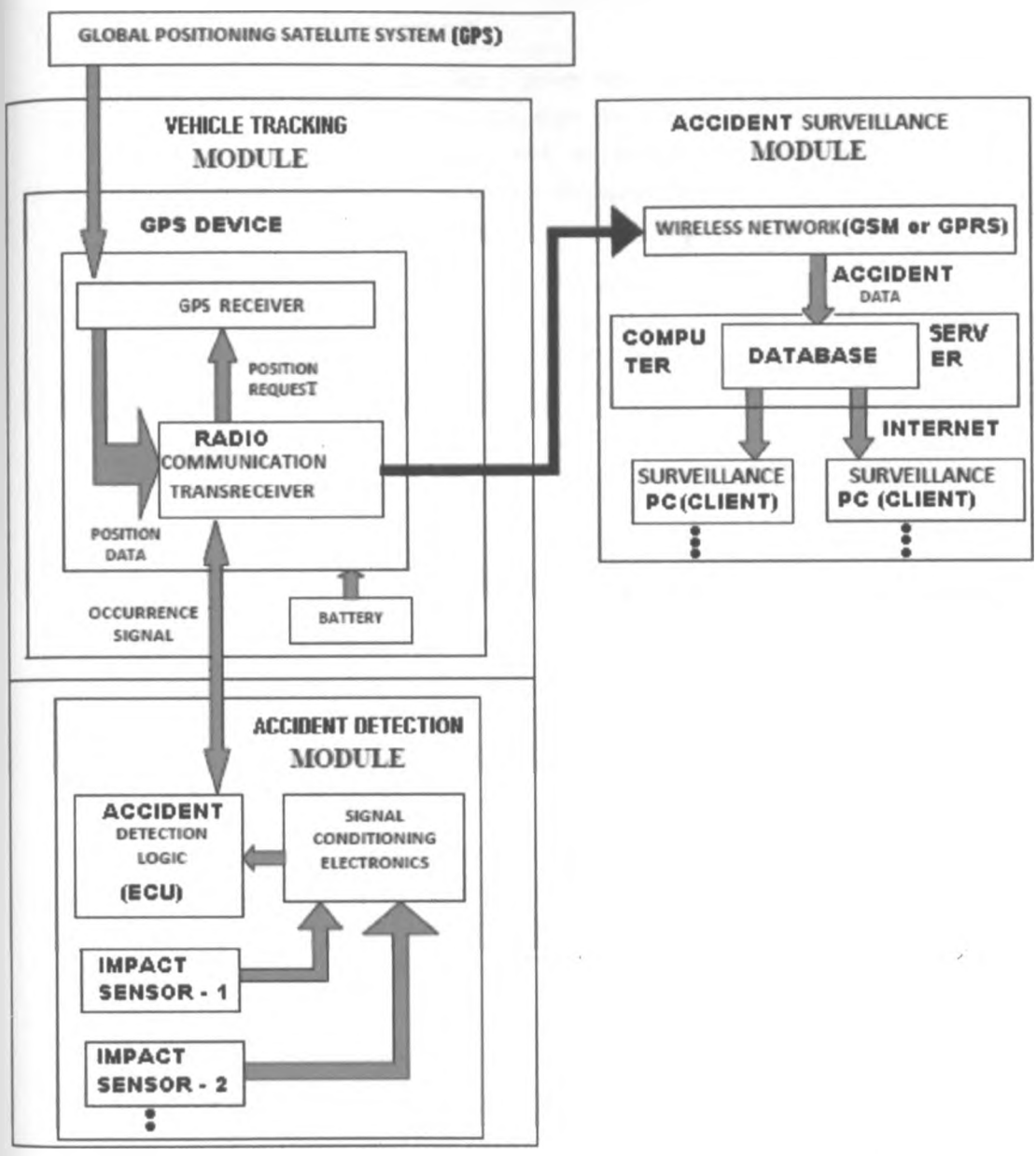
Business process

The table below shows the steps that illustrate how the System will be integrated to become part of the process from when a motor vehicle accident occurs to when victims are evacuated and accident scene cleared

| Stage | Description |
|-------|--|
| 1 | Accident occurs. This is the actual occurrence of an accident |
| 2 | Accident is detected. The conventional means are unreliable. New system will automatically detect an accident and instantly report it. The conventional methods are slow and unreliable. |
| 3 | Police visits the accident scene. They will only move after receiving the report on an accident. |
| 4 | Evacuation of victims. Victims are evacuated to hospitals etc. The faster the process, the more chances of saving lives. |
| 5 | Clearance of the accident scene. The police usually clear the scene of an accident by towing damaged vehicles and removing other debris. |
| 6 | Recording of the accident data. The police manually append a record of the accident occurrence in their books. Manual Recording is not always accurate. This system will automatically update the accident data with manual update also possible. |

2.3 System processes and functions

The diagram below provides an overview of what the System does.



Core functions

The core functions in the System are described below. The structure of this section has been based on these functions

| Function | Description |
|--------------------|--|
| Accident Detection | Under this function / module, the impact sensors installed on a motor vehicle sense the accident impact and transmit the impact signal to the GPS device in the vehicle tracking module. |

| | |
|-------------------------------|---|
| Vehicle Tracking | This module has a GPS device that receives location information from GPS satellites. It also receives impact signal from the accident detection module and the information is sent to the accident surveillance module via GSM or GPRS wireless network. |
| Accident Surveillance module | This module has a server database hosted on the internet. It receives all accident information from the vehicle tracking module to be found in all vehicles installed with the solution. The accident information is made available to all authorized users of the system using the internet technology of server client network. |
| Vehicle management Function | This function is within the application software that provides interface to the accident database as hosted in the accident surveillance module. Vehicles fitted with accident tracking technology have their details updated in the database using this function. |
| Accident management Function | This function is also within the application software that provides interface to the accident database as hosted in the accident surveillance module. All details of a particular accident are updated here. These include details on:- the accident itself, other vehicles involved in the accident, all victims in the accident and finally multimedia recording of information on the accident e.g. photos, audio and video records. |
| System Configuration Function | There are various parameters that are required in the system. These are maintained under this function. They include the maintenance of system users, accident types, GPS device types, types of accident losses, accident reporting methods and type of vehicles. |
| Reports | The application has a module for reports, with various pre-formatted reports available, which can also be exported to various types of formats including MS excel, MS word and PDF. |
| Help | This function is also available in the software application. System users can find information about the system, contact details and also access this user manual for information on the usage of the system. |
| | |

2.4 The Instant GPS Based Motor Vehicle Accident Detection and Reporting System and other systems

Other systems

The table below gives the details of the relationships between the Instant GPS based motor vehicle Accident Detection and Reporting System and other systems.

| System | Description |
|----------------------|--|
| The Accident Tracker | This is the system that is developed and used as in this manual. The |

| | |
|--|--|
| | interface application is developed in C# (Sharp) within the Microsoft Visual studio 2005 development environment. |
| SQL Server 2005 | This is the database engine upon which the accident system database is built and placed on. |
| The Internet and World Wide Web (WWW) | This is the infrastructure which facilitates access to the accident detection system and the accident tracker system by the web clients. |
| Web Client | Using any web browser, one can link to the accident tracker system as a client through the internet |
| Geographical Information System (GIS) | The GIS will be used to display on digital map the actual site of an accident. |

2.5 Key concepts

In order to use the system effectively, you need to understand the following key concepts:

- Internet – Global Network of Computers
- GPS Tracking using satellites
- GIS especially the concept of spatial data and digital maps

Section 3. System Basics

Introduction

This chapter describes the basic system functions that you need to be familiar with in order to use the instant GPS based motor accident reporting and detection system

3.1 Screen layout

The diagram below illustrates the standard layout of the screen.



| Area | Description |
|-------------|--|
| Top | This area in all screen shows the signage and the name of the system |
| Left | The Menus- Arranged as tabs representing main functions. These will further disclose further submenus |
| Right | The screen where information and data pertaining to the function selected is displayed. |
| Bottom | Interactive message area. This is the area where all user interactive messages appear when one is operating on the system. |
| Last Bottom | Grid showing existing records of the function, selected. Using the grid, one can |

| | |
|--|--|
| | recall an existing record for enquiry, editing or deleting purposes. |
| | |

3.2 Menus

Menus are used to navigate through the system and to select tasks you want to perform.



Menu features

Selecting menu options

You can select a menu option by:

- Clicking on the menu option
- Highlighting the menu option and pressing enter

3.3 Entering data

Entering data into fields

The table below describes some of the commonly used fields and how to enter data into them.

| Field | Description |
|-------|-------------|
|-------|-------------|

| | |
|-----------------------------------|--|
| Key Fields | These can take alphanumeric characters and they can not be left empty, e.g. They are mandatory. They are indicated with an asterisk (*) Character at the beginning of the field label. Key fields are also labeled in blue colour. |
| Names, Addresses and Descriptions | These fields can take alphanumeric characters and can also be saved when empty. |
| Number Fields | These fields can only take numeric data. |
| Date and Time | In all instances date and time is selected from a calendar displayed. The selected date and time is input to the field. Date and time can also be posted directly in the field in the dd/mm/yyyy format. |
| | |

Mandatory fields

Mandatory fields are fields where you must enter information and are marked with asterisk. If you do not enter information into a mandatory field, the system will not move the cursor from the field.

3.4 Logging on and off

Logging on

To log on, follow the steps below.

| Step | Action |
|------|---|
| 1 | Access the web site using the given URL which is the path that points to the site where the web pages are hosted. |
| 2 | Login screen allowing authorized users to access the system will be displayed. |
| 3 | Enter the provided user identification (ID) |
| 4 | Enter the password (secret term) of a maximum 10 Characters |

Logging off

To log off, follow the steps below.

| Step | Action |
|------|--|
| 1 | Locate the Log off command button at the right top corner of the screen. |

| | |
|---|--|
| 2 | Either click the button or highlight it and press enter. |
| 3 | This will close the system and return you to the web browser |

3.5 Printing

Printing

To print, follow the steps below.

| Step | Action |
|------|---|
| 1 | Log on the system. |
| 2 | Access the report menu option. |
| 3 | Select from the available list of reports the one to print. |
| 4 | Choose and select the printer to send the printing job to, from the list of printers available. The report will be printed. |

Section 4. System Function

Introduction

This chapter describes how to use the various system functions as listed in section 2.3.

4.1 Accident Detection Function

When: This procedure is carried out when a vehicle is installed with the system hardware for the first time

Who: This procedure is carried out by a trained technician on the hardware requirements of the Instant accident detection and reporting system.

Before you begin, you need:

- The Impact sensors hardware system
- The Vehicle tracking GPS Hardware System

Procedure

The table below describes the process for Accident Detection Function

| Stage | Description |
|-------|--|
| 1 | Install the vehicle with the impact sensor hardware to detect accident and a GPS tracker device. |
| 2 | Power the Impact sensor Electronic Control Unit (ECU). |
| 3 | Interlink the ECU to the GPS Device so that impact signals are transmitted to the GPS device |

Next....

When you have completed this procedure you need to link the GPS Device to the GPRS network

4.2 Vehicle Tracking Function

When: This procedure is carried out when a vehicle is installed with the system hardware for the first time

Who: This procedure is carried out by a trained technician on the hardware requirements of the Instant accident detection and reporting system.

Before you begin you need:

- The Impact sensors hardware system
- The Vehicle tracking GPS Hardware System

Procedure

The table below describes the process.

| Stage | Description |
|-------|---|
| 1 | Install the vehicle with a GPS tracker device. |
| 2 | Install the tracker device with a SIM card from one of the GSM phone providers |
| 3 | Configure the GPS device to receive impact signal from the accident detection function |
| 4 | Configure the GPS device to receive spatial data from the GPS Satellites System. |
| 5 | Configure the GPS device to consolidate the impact data and the spatial data, transmitting the integrated data to the accident surveillance function. |

Next....

When you have completed this procedure you need to connect to the surveillance module.

4.3 Accident Surveillance Function

When: This procedure is carried out when setting up the system.

Who: This procedure is carried out by the system developer assisted by experts at an ISP and mobile service providers.

Before you begin, you need:

- GPRS/GSM Network
- Server Hardware to host the site
- Access to the internet
- Database Software
- Web Client software
- Web Client workstation

Procedure

The table below describes the process for Accident Surveillance Function

| Stage | Description |
|-------|---|
| 1 | Identify the GSM service provider and acquire a SIM card, for use with the GPS device |
| 2 | Identify an ISP (Internet Service provider) and host the accident tracker software and database on the site. The ISP will avail with public IP and Port for use in aiding the GPS devices to hit the server Alternatively establish the accident database on a computer connected with a GSM phone which can receive accident impact data from GPS devices. |
| 3 | Configure the installed system and test to ensure that GPS devices are able to communicate and transmit impact and spatial data to the database server. |
| 4 | Configure the Installed system and test to ensure that web clients using web browser are able to access the web site especially to see new impacts are reported on the database. |

Next....

When you have completed this procedure you need to do system maintenance and update all system parameters and create users of the system.

4.4 Vehicle Management Function

When: This procedure is carried out after the system is fully installed and in place

Who: This procedure is carried out by system users with administrative rights.

Before you begin, you need:

- Fully installed system and access rights to the system
- Details of a vehicle fitted with a GPS Device and Impact detection systems

Procedure

The table below describes the process for vehicle management.

| Stage | Description |
|-------|--|
| 1 | Have the vehicle in consideration installed with the detection and tracking modules |
| 2 | Get all the details of the vehicle as found on the Log book and also the addresses of the owner. |

| | |
|---|---|
| 3 | Login into the system using a user ID with administrative profile. |
| 4 | Access the main menu option 'Vehicle Management' and the subsequent Submenu |
| 5 | Complete the form that opens by entering the correct details of the vehicle and click on the add button to save the new record. In case of editing and deleting, the update and delete buttons are used respectively. |

4.5 Accident Management Function

When: This procedure is carried when monitoring for accidents and also when updating more details on accident occurrence.

Who: This procedure is carried out by users in the system with rights to access this module.

Before you begin, you need:

- Fully installed system and respective access rights to the system.
- In case the need to access is to update new details on an accident, then there is need to have these details ready.

Procedure

The table below describes the process for Accident Management Function

| Stage | Description |
|-------|---|
| 1 | Get all the details and facts about an accident – only if the need is to update accident information. If need is to do accident surveillance this is not necessary. |
| 2 | Login into the system using a user ID with necessary rights. |
| 3 | Access the main menu option 'Accident Management' and the subsequent Submenus. |
| 4 | Complete the forms that opens by entering the correct details of the accident and click on the add button to save any new record. In case of editing and deleting, the update and delete buttons are used respectively in all cases. |
| 5 | For Accident Surveillance, once you login and open the accident module, the system will display any new occurrence of an accident and sound an alarm calling for your attention. This is very important function and indeed the center of this system. For any accident, a click on the location or geographical coordinates will take you to a digital map pointing to the location of the accident. |

4.6 System Configuration Function

When: This procedure is carried out when there is need for maintaining users and other system related tasks

Who: This procedure is carried out by the system administrator

Before you begin, you need:

Fully installed system and respective access rights to the system

Procedure

The table below describes the process for system configuration system.

| Stage | Description |
|-------|---|
| 1 | Get all the details and facts about the aspect of system to be configured or updated. |
| 2 | Login into the system using a user ID with necessary rights. |
| 3 | Access the main menu option 'System Configuration' and the subsequent Submenus. |
| 4 | Complete the forms that open by entering the correct details of the accident and click on the add button to save any new record. In case of editing and deleting, the update and delete buttons are used respectively in all cases. |

Section 5. System Screens and Fields

In this section

Important screens and fields of the front end software are presented in this section. There are many other screens and fields that are not presented here, but the user will easily follow and understand based on the knowledge gained on the ones explained below.

5.1 Login Screen

Description

This is the screen one will first access and it is used to login to the application.

Diagram

A diagram showing the layout of the login screen. At the top, a dark grey header box contains the text 'Instant GPS Based Accident Detection and Reporting Solution' and 'Please Login Below to Access'. Below this is a white rectangular box containing a 'Username:' label, a text input field, a 'Password:' label, another text input field, and a 'Login' button.

Done

Key fields

Important characteristics of the critical fields are described below.

| Field | Description |
|---------|---|
| User ID | Alphanumeric Characters minimum 6 and maximum 15. It is a Mandatory |

| | |
|----------|--|
| | field and must be unique for each user. |
| Password | Alphanumeric Characters minimum 6 and maximum 10. The password is the key to the system and should be kept secret. |

5.2 Vehicle Registration Screen

Description

This is the screen where details of all vehicles that are installed with the accident tracking solution are maintained.

Diagram



Key fields

The key fields are described below.

| Field | Description |
|---------------------|---|
| Registration Number | The vehicle registration number is maintained in this field. It is mandatory and can take alphanumeric characters. The maximum length of the field is 10. |
| GPS Unit ID | Vehicles fitted with accident tracking devices have a GPS device, with a unique unit identification number. When an accident involving that |

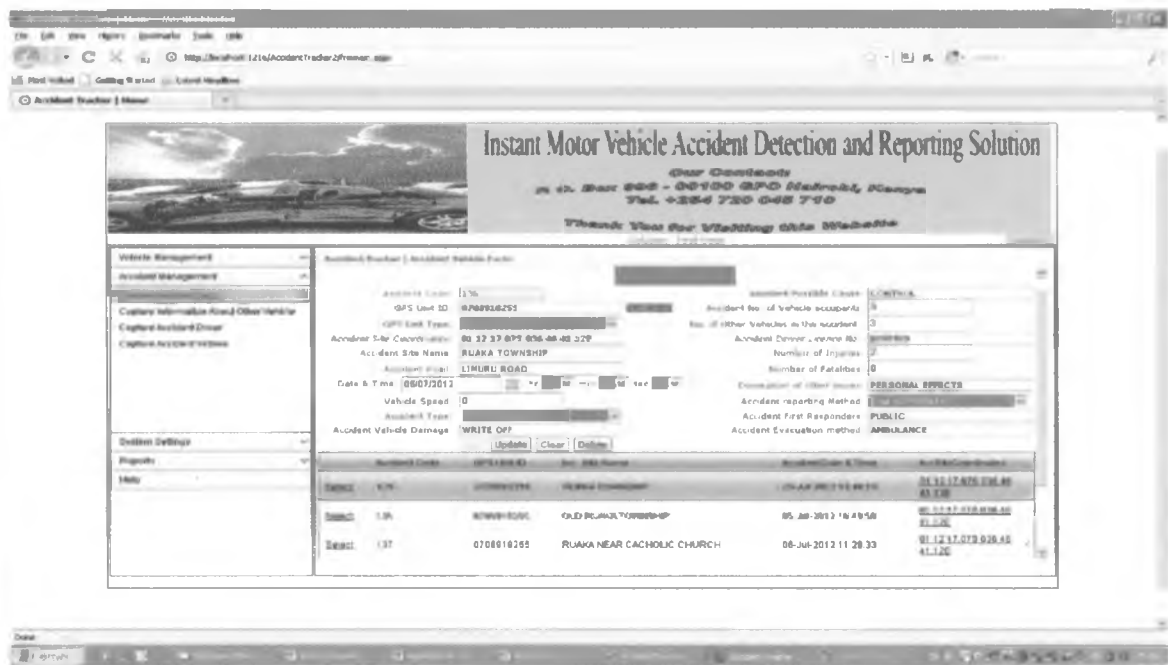
| | |
|--|--|
| | vehicle is reported in the system, the GPS Unit ID will help to point to the vehicle as maintained in this function. It is a mandatory field in this screen. |
| | |

5.3 Accident Management Screen

Description

This screen is the core of this system, where important details on accidents are displayed after automatic update on the database. When monitoring accidents, this is the screen to keep on display.

Diagram



Key fields

The key fields are described below.

| Field | Description |
|---------------|--|
| Accident Code | This is the Key field in the accident table. It can take in alphanumeric characters maximum 10. It is a Mandatory field and must be unique for each accident. The contents are auto generated in case of accidents reported automatically in the system. |

| | |
|---------------------------|---|
| GPS Unit ID | Vehicles fitted with accident tracking devices have a GPS device, with a unique unit identification number. When an accident involving that vehicle is reported in the system, the GPS Unit ID will help to point to the vehicle as maintained in the vehicle management function. It is a secondary key in this table. |
| Accident Site Coordinates | This field takes in the geographical coordinates of the site of an accident. It is updated automatically in accidents involving a vehicle fitted with the accident tracking solution. By clicking on this field, a GIS digital map pointing to the exact site of the accident is opened. |
| Accident Date & Time | This field takes in the date and time of the accident and it's also updated automatically when an accident involving a vehicle fitted with this solution happens. |

Section 6. System Reports

In this section

Two important reports of the system are disclosed. The system has many other reports which are easy to access and use. A report generator will be integrated with this system in the next release to enable users to format and print their own reports in accordance with their needs.

6.1 Vehicle Details reports

| | |
|---------------------|--|
| Format | Generated in Rich text format and can be printed in PDF, Word, etc. |
| Size | Can be of any size depending with the details requested and the number of vehicles printing for. |
| Requirements | Requirements to view, Adobe Acrobat, word etc |

Purpose

To bring out vehicle details as maintained in the system.

When

Vehicle details are required.

Prepared by

The system administrator and other authorized users of the system

Used by

The system users, the owner of the vehicle and other agents.

Filing

The report can be filed in soft copy and if printed no a hardcopy, the same should be filed in a file to be kept safely. Unauthorized agents should not be able to access this report

Instructions

To print this report, access the system at the reports menu option.

6.2 Accident Details reports

| | |
|---------------------|---|
| Format | Generated in Rich text format and can be printed in PDF, Word, etc. |
| Size | Can be of any size depending with the details requested and the number of accidents printing for. |
| Requirements | Requirements to view, Adobe Acrobat, word etc. |

Purpose

To bring out accident details as maintained in the system.

When

Accident details are required.

Prepared by

The system administrator and other authorized users of the system.

Used by

The system users, the owner of the vehicle involved in the accident and other agents.

Filing

The report can be filed in soft copy and if printed on a paper, the same should be filed in a file to be kept safely. Unauthorized agents should not be able to access this report.

Instructions

To print this report, access the system at the reports menu option.

Section 7. Troubleshooting and Error Messages

Introduction

This section answers some of the most frequently asked questions about, or frequently encountered issues with, using the instant accident detecting and tracking system. The section also covers the different types of error messages you can get, what they mean, and what you need to do.

7.1. Login issues

Question 1: Unable to Login

| Possible Cause | Investigation | Solution |
|--|-------------------------------|---|
| You may not be added as user in the system | Confirm with the System Admin | Only Attempt Login when added as a user in the system |

Question 2: Wrong Password

| Possible Cause | Investigation | Solution |
|------------------------|----------------------|--|
| Wrong password entered | Confirm the password | Ask the System Administrator to reset the password |

7.2 Data Capture Error Messages

| | |
|------------------------|---|
| Message | Update Successful |
| Meaning | The operation is successful |
| Cause | When a successful operation is carried out |
| System action | The system allows you to move to another operation or quit the system |
| Action required | Nothing |

| | |
|------------------------|---|
| Message | SQL Generated Messages |
| Meaning | The SQL Database will generate numerous error messages and which will be displayed at the message area of the screen in red. Each message is specific and easy to understand. |
| Cause | Any unsuccessful operation on the system |
| System action | Specific to the error message |
| Action required | Complete the operations as advised in this manual |

Glossary

Introduction

The glossary provides definitions and descriptions for terms and phrases used in the system and also in this user manual.

Vehicle impact sensors – These are very small devices fitted in a motor vehicle to detect collision and physical damage

Electronic Control Unit (ECU) – This is a crash sensor Electronic Control Unit which is central to all the sensors in a vehicle. It receives, and process electronic analog or digital signals received from the sensors. Based on the magnitude of the signals received, it makes decision whether to undertake certain action. For example it may deploy airbag, and in the case of the proposed project it will transmit a digital message to the GPS device to the effect that an accident has occurred

Global Position System (GPS) - It is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver with some technical limitations which are only removed for authorized users

Global System for Mobile Communication (GSM) - is a digital mobile telephony system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

General Packet Radio Service (GPRS) - is a packet oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications (GSM). GPRS was originally standardized by European Telecommunications Standards Institute (ETSI) in response to the earlier packet-switched cellular technologies. It is now maintained by the 3rd Generation Partnership Project (3GPP). GPRS usage is charged based on volume of data. This contrasts with circuit switching data, which is typically billed per minute of connection time, regardless of whether or not the user transfers data during that period.

Multiplexer – A device that receives numerous signals in parallel and present them serially to the ECU in an orderly fashion because the ECU can only process one signal at a time.