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Reign Mobile Application for Hotspot Detection

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Abstract
Reign mobile hotspot detection system is a cross platform mobile application developed to help warn its users of hostile areas (i.e., areas prone to accident, flooding, kidnapping, civil unrest, etc.). It also has functionalities that allow users to report hazardous areas through a preconfigured e-mail, which includes the users current location and a description of the hazard being reported. The goal of this project is to explore the use of mobile computing, by means of mobile apps, to address some of the social and developmental challenges being experienced in Nigeria. Thus, we could adapt technology to improve social conditions as well as, possibly, save lives. The motivation for this project is the ubiquity of mobile computing, particularly when we consider that Nigeria with a population of over 140 million people is currently estimated to have a mobile broadband Internet penetration equivalent of about 30%. These users mostly connect through mobile devices with at least 100million unique mobile communication lines registered. The app was developed with HTML5 and JAVA programming languages, uses GPS coordinates to map locations and a push server to send alerts to registered users. Currently, the Android version of the app has been developed and is being tested. During the development and testing, we interacted with security and paramilitary institutions like the Police, Federal Road Safety Service (FRSC) and the Nigerian Metrological Agency (NIMET) in order to ascertain areas that are prone to hazards. Preliminary tests in Lagos and Abuja confirm the functionality and usefulness of the app.
Keywords: Mobile computing, hotspot detection, security hazards, crime detection and prevention, alerts.

1. Introduction

Since the invention of the Global Positioning System (GPS), many applications have being built to take advantage of its capabilities to more efficiently and effectively every tasks. With a GPS device, one is able to pin-point absolutely any location on the surface of the earth. The emergence of new technologies has also drastically changed the way we communicate. Mobile networks and devices are the latest inventions enable us to communicate using portable and wireless electronic devices. In the last few years the use of mobile devices has increased leading to drastic reduction in their cost, making them widely available. Mobile devices are now generally inexpensive, easy to use, convenient and equipped with a wide range of features, making them very desirable and useful in many situations. Every day new models are replacing the older ones to satisfy user demand and raise their expectations regarding the possibilities of mobile devices. With features like mp3 and video recording, MMS, Internet, and apps for social media and many other things, more users are being attracted to the mobile world. Most of us are now so heavily dependent our mobile phones in particular that we can't even imagine a world without our handsets. The indispensability of mobile devices is demonstrated in countries like Japan where mobile network operators provide immediate notification of earthquakes and other natural disasters to their customers free of charge. In the event of an emergency, disaster response crews can locate trapped or injured people using the signals from their mobile devices or the small flare detonator in the battery of every cell phone; an interactive menu accessible through the phone's Internet browser notifies the company if the user is safe or in distress. There is no doubt that mobile devices have made the life much easier and convenient. Keeping in touch with family and friends even from halfway across the world is something we now take for granted courtesy of mobile phones.

Mobile devices have also proved to be a big source of help in emergencies. Mobile devices are also known as lifesavers in helping people in emergency situation such as when one gets stuck in the middle of the road with no one to help, one can just use a mobile phone and call for help. Along with the obvious convenience and quick access to help in emergencies big and small, mobile devices can be both economical and essential for travellers trying to stay connected.

Like every coin have two sides, mobiles devices providing a lot of advantages also shows off few disadvantages such as the potential impact of the kind of electromagnetic fields generated by cellular phones on the human brain. Accumulating evidence indicate that microwave radiation from mobile devices may cause serious diseases and disturbances in the physiology. This includes an increased cancer risk and genetic damage, disturbed brain function and other effects. Mobile phone radiation and health concerns have been raised, especially following the enormous increase in the use of wireless mobile telephony throughout the world.

In this project, we harness the features of GPS on a mobile device to create an early warning system known as **REIGN** hotspot detection system that can help in crime prevention and detection of hazardous spots in

Nigeria. The system is designed as a mobile application to be installed and used on a GPS enabled mobile device. It will, among other things, pop a message on the mobile device on which the application has been installed whenever the device is within the co-ordinates tagged by the application. It is then up to the user to take appropriate action, such as avoiding the location or doing something to protect themselves. The application is different from the usual GPS mobile applications which are mostly used for surveillance and tracking.

2. Related Work

Global Positioning System (GPS)

Since the release of the Global Positioning System (GPS) for civilian use by the United States military, it has continue to evolve and new products are constantly emerging on the market. In recent times, GPS products for vehicle tracking, theft prevention, surveillance and route mapping have proliferated. Also, with technological breakthroughs in mobile device development and better telecommunication networks, the mobile device has being put to different uses through the development of various kinds of mobile applications.

The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides location and timely information in all weather, anywhere on or near the Earth, as long as 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.

The GPS project was developed 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 Defence (USDOD) and was originally run with 24 satellites (GPS Navigation 2004). Originally the GPS was a military project, now it is considered a *dual-use* technology, because it has significant military and civilian applications (Parkinson, 1994).

GPS has become a widely deployed and useful tool for commerce, scientific uses, tracking, and surveillance. GPS's accurate time facilitates everyday activities such as banking, mobile device operations, and even the control of power grids by allowing well synchronized hand-off switching. It has also found application in disaster relief and emergency services, vehicle and aircraft tracking, navigation and surveying. It is also being used in consumer electronics. Military applications of GPS include target tracking, location of objectives, missile and projectile guidance, and search and rescue operations (Schuo and Zhu, 2003).

GPS devices may also have additional capabilities such as: containing maps, which may be displayed in human readable format via text or in a graphical format; providing suggested directions to a human in charge of a vehicle or vessel via text or speech; providing directions directly to an autonomous vehicle such as a robotic probe; providing information on traffic conditions (either via historical or real time data) and suggesting alternative directions; and provide information on nearby amenities such as restaurants, fueling stations, etc.

Mobile Devices and Networks

A mobile device sometimes called cell phone is an electronic device used to make mobile telephone calls across a wide geographic area, served by many public cells, allowing the user to be mobile. A mobile device can make and receive telephone calls to and from the public telephone network which includes other mobiles and fixed-line phones across the world. It does this by connecting to a cellular network provided by a mobile network operator. In addition to telephony, modern mobile devices also support a wide variety of other services such as text messaging, MMS, email, Internet access, short-range wireless communications (infrared, bluetooth), business applications, gaming and photography. Mobile devices that offer these more general computing capabilities are referred to as smart phones (Jaser, 2014).

All mobile devices have a number of features in common, but manufacturers also try to differentiate their own products by implementing additional functions to make them more attractive to consumers. The common components found on all phones are:

- A battery, typically rechargeable, providing the power source for the phone functions
- An input mechanism to allow the user to interact with the device. The most common input mechanism is a keypad, but touch screens are also found in some high-end smart phones.
- Basic mobile device services to allow users to make calls and send text messages.
- All GSM phones use a SIM card to allow an account to be swapped among devices. Some CDMA devices also have a similar card called a R-UIM.
- Individual GSM, WCDMA, IDEN and some satellite phone devices are uniquely identified by an International Mobile Equipment Identity (IMEI) number.

Low-end mobile devices are often referred to as feature phones, and offer basic telephony, as well as functions such as playing music and taking photos, and sometimes simple applications based on generic managed platforms such as Java ME or BREW. Handsets with more advanced computing ability through the use of native software applications became known as smart phones. The first smart phone was the Nokia 9000 Communicator in 1996 which added PDA functionality to the basic mobile device at the time. As miniaturization

and increased processing power of microchips has enabled ever more features to be added to phones, the concept of the smart phone has evolved, and what was a high-end smart phone one day is a standard phone the next (Rodrigues, Oliveira and Vaidya, 2010).

A ***mobile operating system***, also known as a mobile OS, a mobile platform, or a handheld operating system, is the operating system that controls a mobile device or information appliance—similar in principle to an operating system such as Windows, Mac OS, or Linux that controls a desktop computer or laptop. However, they are currently somewhat simpler, and deal more with the wireless versions of broadband and local connectivity, mobile multimedia formats, and different input methods. (Schepers, 2005)

Typical examples of devices running a mobile operating system are Smart phone, personal digital assistants (PDAs), tablet computers and information appliances, or what are sometimes referred to as smart devices, which may also include embedded systems, or other mobile devices and wireless devices.

Applications of GPS and Mobile Devices

It is now widely recognized that mobile phones and other devices are fast becoming the most common means of electronic communication worldwide as well as being the major working tool on the go for a significant number of people (SSI Knowledgewatch, 2012). Mobile devices have also become the platform of choice for accessing the Internet, becoming more common than the desktop computer. (White House, 2012). Most organizations and businesses are now, consequently, providing mobile platforms for accessing their services.

It is also widely expected that information and educational services, including distance education, be provided on mobile computing devices (smart phones, tablets, etc.) (LaBelle, 2011; Drill, 2014). For example, a survey of farmers found out that 94% of respondents had a cell phone, and over 70% said they access agriculture-related information and services on their phone (Walter, 2011).

Mobile devices have been employed in transportation research to collect accurate traffic data (Herrera, et al., 2010). They have also found various uses in medicine where they are being used for monitoring rates of exercise and weight loss (Boyce, Padmasekara and Blum, 2012).

There are various efforts being undertaken to incorporate mobile devices, not only into the remote delivery of educational materials, but to also bring these devices into the classroom for effective teaching and learning (Morrison, Leah, Harvey and Masters, 2014).

GPS and mobile devices are also increasingly being used in tracking and monitoring. One of the most common application of tracking devices is in vehicle tracking and fleet management. Similarly, parents are finding out that there are an increasing number of mobile applications to help them keep tabs on their children and family members (Luckerson, 2012).

The use of mobile devices and apps in the provision of support for vulnerable individuals suffering from various types of disabilities and debilitating health conditions has also being recognized. People suffering from sensory disabilities, diabetes, mental health problems, epilepsy or communication issues can obtain help through the use of appropriate mobile devices and apps (Kevin, 2011).

Technology in crime control

The ability of modern technology to assist in law enforcement and crime control has long been recognised. Reichert (2001) claims that there two general types of technological innovations that led to "dramatic changes in the organisation of police". These he refers to as information based technologies - soft technologies and material based technologies - hard technologies. Some of these new technologies include offender risk classification tools, threat assessment protocols, software programs developed to prevent identity theft, and to protect data privacy, new tools for monitoring the location and movement of at-risk populations, such as mentally ill offenders and sex offenders, and most recently, new assessment tools designed to identify individuals who are likely homicide offenders (or victims) within a specified timeframe. Information technology has also been used to prevent crime by the use of newly developed computer software and creation of devices to monitor individual transactions and communications, on the cell phone, over the internet, and on various web-based social media sites (Byrne and Marx, 2011).

Crime analysis by plotting has long been relied on to give law enforcement officers an idea of the pattern of crimes in their jurisdiction. For this purpose, law enforcement agencies had to collate and plot the data after crimes have occurred. The possibility of using GPS and mobile devices has now raised the possibility of detecting "hotspots" in real time (Sorenson, 1997).

It is expected that the use of GPS and mobile apps in crime fighting will dramatically increase in the coming years (Shillingford and Groussman, 2014).

Crime in Nigeria

Crime causes loss of live and property as well as overwhelming fear of insecurity. These have serious consequences for democracy, economic development, social capital and associational life generally. Nigeria has

witnessed upsurge in crimes during the past two decades. Increasing incidences of armed robbery as well as other forms of crimes, accidents and hazards have led to a paralyzing fear which has in turn affected economic and social life in the country. Similarly the crimes of kidnapping and terrorism have been on the increase in various parts of the country. It is, therefore, imperative to embrace the use of technology to protect lives and property. Such a technology is a mobile app that can alert users when they get to areas notorious for some forms of crime.

Mobile Application Architecture

Mobile application development is the process by which application software is developed for small low-power handheld devices such as personal digital assistants, enterprise digital assistants, tablet computers and mobile phones. These applications are either pre-installed on phones during manufacture, or downloaded by customers from various mobile software distribution platforms.

A mobile application is normally structured as a multi-layered application consisting of user experience, business, and data layers. When developing a mobile application, you may choose to develop a thin Web-based client or a rich client. When building a rich client, the business and data services layers are likely to be located on the device itself. When building a thin client, the business and data layers will be located on the server. Figure 1 illustrates common rich client mobile application architecture with components grouped by areas of concern (Microsoft, 2008).

The proposed system is a mobile device application which is specially designed to work with the Global Positioning System and to alert of the possibility of danger whenever the user of the mobile device is in an area which has already being tagged as a hotspot. It is developed taking into consideration and assumption, the following;

- The GPS co-ordinates are accurate and are capable of locating every spot in Nigeria.
- All information obtained about crime/hazard hotspot and the crimes/hazards capable to be committed in these areas are precise.
- Mobile devices in which the application shall be installed will be GPS enabled which includes Androids and blackberry devices amongst others.
- Mobile device communications with the GPS satellite does not result in erroneous information.

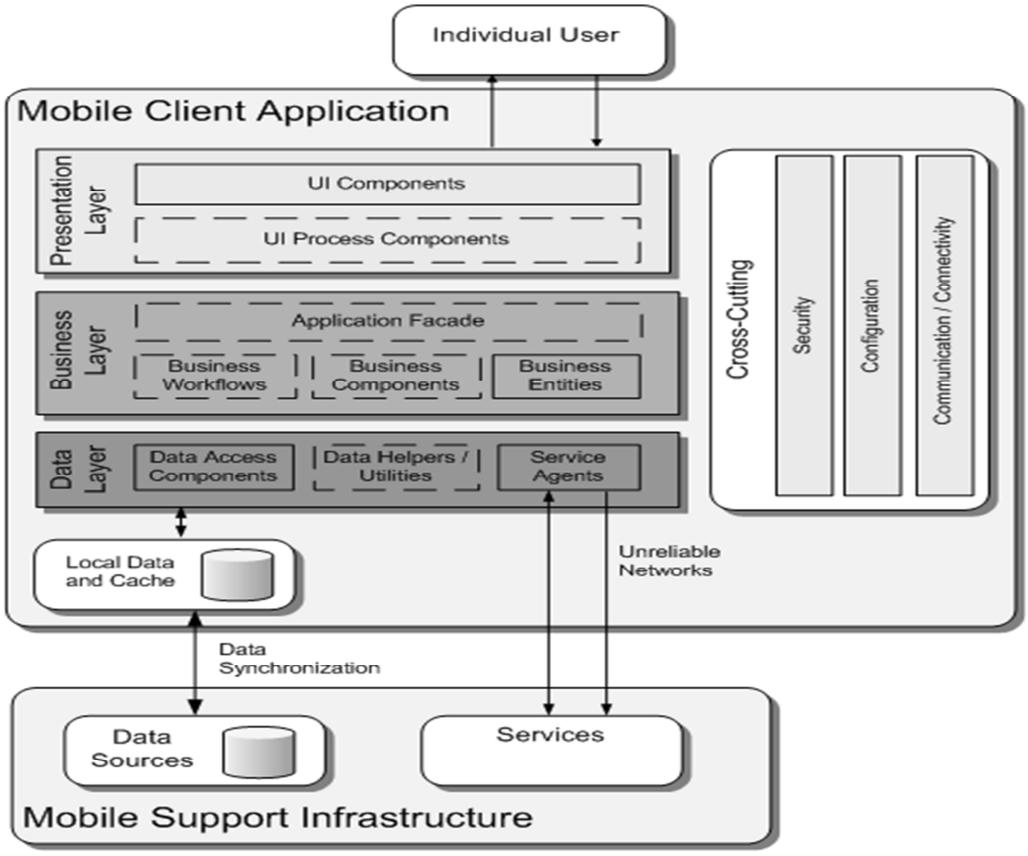


Figure 1: Client mobile application architecture (www.google.com

3. Design of the Reign Application

This work uses the advantages of both the GPS and the mobile device to create an early warning system of hotspots amongst other features in Nigeria. The system, "Reign Mobile Hotspot Detection System" is a mobile application which capable of running on mobile operating systems like Symbian, Android, Blackberry, etc,. It equally utilizes the GPS capability of the device, but it does not perform any monitoring (tracking and surveillance), rather it alerts.

Basic Conceptualization

The main entities in the work include:

- The GPS satellites
- The GPS enabled mobile device
- A PUSH Server containing alert messages and Geo-coordinates
- Mobile device user

Features of the System

The Reign Mobile Hotspot Detection System, which is capable of warning users of the potential dangers in specific locations, will bring another dimension to security and is designed with the following attributes:

- Ability to be installed on any GPS enabled mobile device.
- Ability to work at the background without disrupting other functions of the device like GPRS, UTMS, 3G and other network.
- Dynamic in nature, which will enable the updates of new locations and type of crimes or hazards.
- Stores list of locations mapped into coordinates (latitude and longitude) and their corresponding crime or hazard messages in a PUSH server.

System Design

Some of the considerations in the design of the application include:

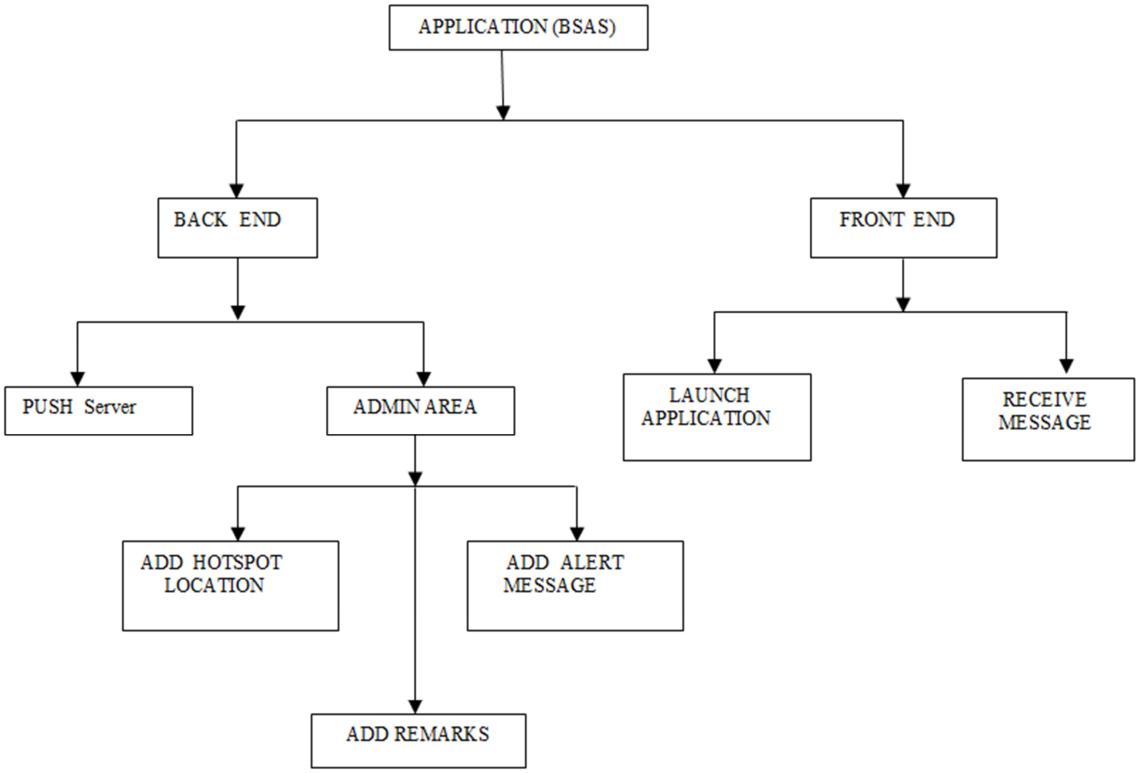
- The design is centred on a graphical user interface, which is to ensure that the user's experience with the application is optimum.
- Also considered is the various screen sizes of mobile devices, since all screens are not of the same size. The application was designed to be able to fit the screen of all devices. Another consideration is the format of the screen which includes portrait and landscape.
- The application has been designed to work in the background in order not disrupt the operation of the device by displaying on the screen while the device is performing some other function. It will only pop out a message when attention is needed or it is to alert the user.

The overall structure of the Reign application is shown in figure 2. The system is divided into two major segments, the user end and the administrative end. The user end is the part of the application visible to the user of the system; it is from this end that the user is alerted when in a crime or hazard hotspot. The administrative end is the segment from which hazard hotspots and the corresponding alert messages are added to the system. Following are the algorithms for the user and administrative ends of the system;

(a) Algorithm 1: User end

```
10      Run the application
20      click start to enter user
30      if application is not in user end,
40      goto 20
50      else,
60      continue
70      keep system running in background
80      for (system =start ; system =stop)
 90          get()  geo-coordinates
100             if (geo-coordinate = crime hotpot)
101                 print corresponding alert message
102                 else if, goto 90
103              end if
103     end
```


Figure 2: Hierarchical structure of the application



(b) Algorithm 2: Administrative end

```
10      Run the application
20      click add hotspot
30      if application is not in administrative end,
40      goto 20
50      else,
60      continue
70      for (system =start ; system =stop)
80          get()  geo-coordinates
 90         get() hotspot name
 100        get() remarks
101         get() file name (city)
102         save
103     end
```

4. Implementation and Testing

PhonGap Framework

The application was developed on the PhoneGap framework. PhoneGap is a growing technology used to develop cross platform mobile applications. It is a HTML5 application framework that is used to develop native applications through web technologies. This means that developers can develop mobile applications with their existing knowledge of HTML, CSS, and JavaScript. With PhoneGap, developers don't have to learn languages like Objective-C for the iPhone.

Applications developed using PhoneGap are hybrid applications. These applications are not purely HTML/JavaScript based, nor are they native. Parts of the application, mainly the UI, the application logic, and communication with a server, are based on HTML/JavaScript. The other part of the application that communicates and controls the device is based on the native language for that platform. PhoneGap provides a bridge from the JavaScript world to the native world of the platform, which allows the JavaScript API to access and control the device.

PhoneGap essentially provides the JavaScript API with access to the device capabilities like the camera, GPS, device information, and others. It uses HTML5, JavaScript, and CSS3 to develop mobile

applications. These are standard technologies in the web world. By using PhoneGap, a developer with little or no native language background can start developing mobile applications for all of the popular mobile platforms. Although PhoneGap provides access to standard native features of mobile applications, its plug-in framework is flexible enough to extend and add new features, if required.

Technology Platform

The programming languages used in the development of the application are HTML5, JavaScript, CSS3. The coordinates and the messages that used to alert users of the possibility of crimes or hazards in their present locations are stored in a PUSH Server.

Operation of the Proposed System

Anyone with a GPS enabled mobile device can install the application but it should be noted that the it has only been loaded with data for cities in Nigeria. The user can install the application by running the installer file on the mobile device and selecting the appropriate configuration.

Once the application is installed on the mobile device and running (in the background), it communicates with the GPS satellites and takes note of every location the user goes with the device. At each location, the application compares the present spot with the list of spots that have being tagged as hotspots and stored in the PUSH server. If it does not match any the application keeps running at the background, but if it matches any the application pops out the corresponding message which has been associated with that location.

Launching the Application

In order for the application to be launched on the mobile device in which it has been installed, it must be started. The following procedure is followed (Figure 3):

- Depending on the device and the operating system, go to the folder where installed applications are located;
- Select Reign;
- Click or tap on it to run application.

The application then tries to search for GPS signals.

Launching the application opens up a screen showing its features (Figure 4):

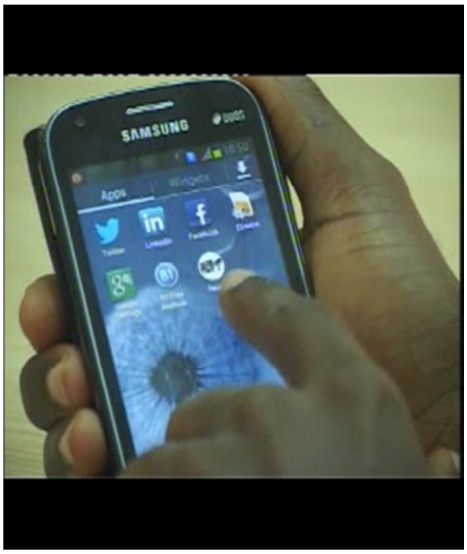


Figure 3: Launching the Reign app.

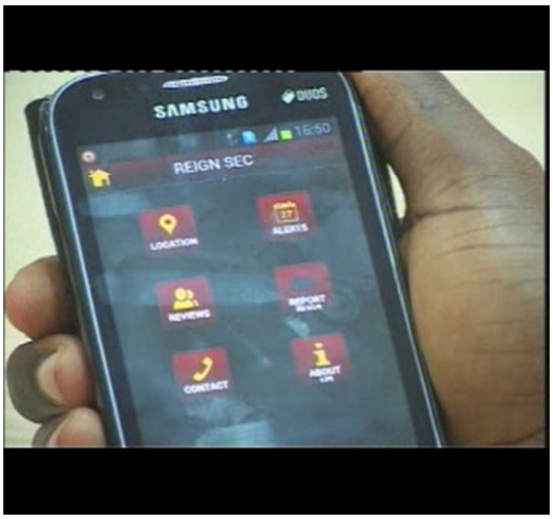


Figure 4:Features of the Reign app

Click/Tap on Location in order to determine your current location using Google Map (Figure 5).

Clicking or tapping the “Send location Threat” feature, the user will be able to send hazard or threats information to a preconfigured e-mail. They can also use it to call for help (Figure 6). Figure 7 shows a sample of message received on a user device.

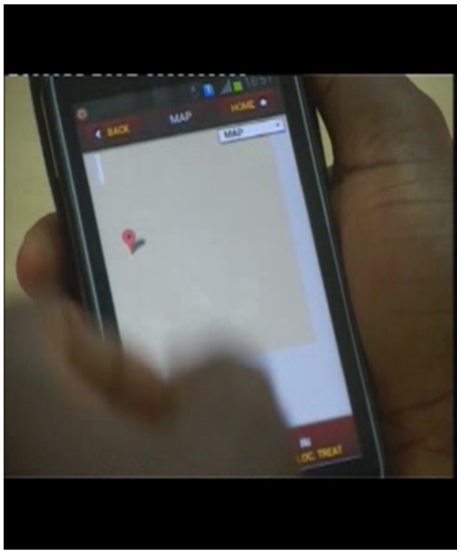


Figure 5: Current location of user during implementation.

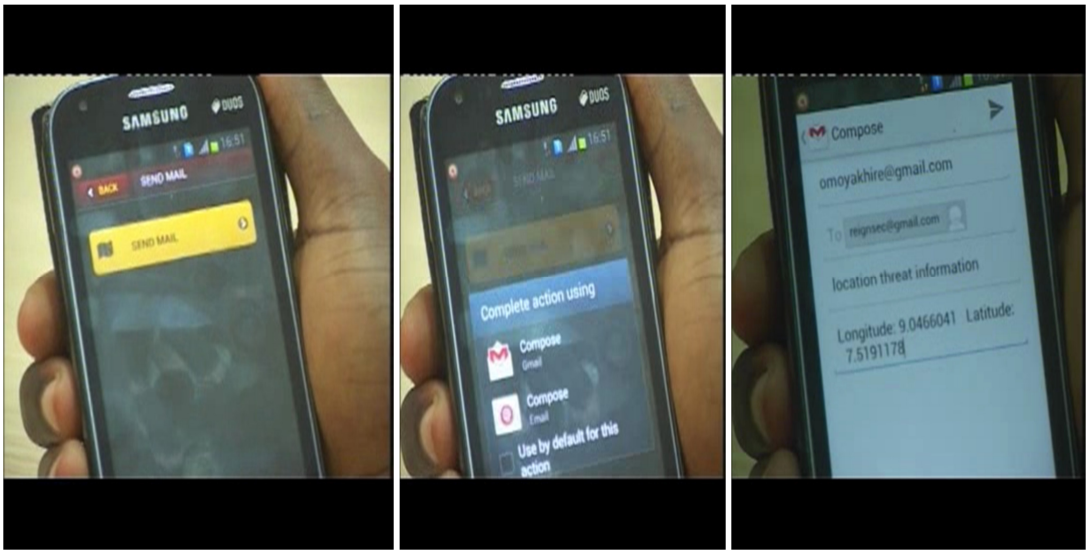


Figure 6: Sending Location Threats alongside the location coordinates

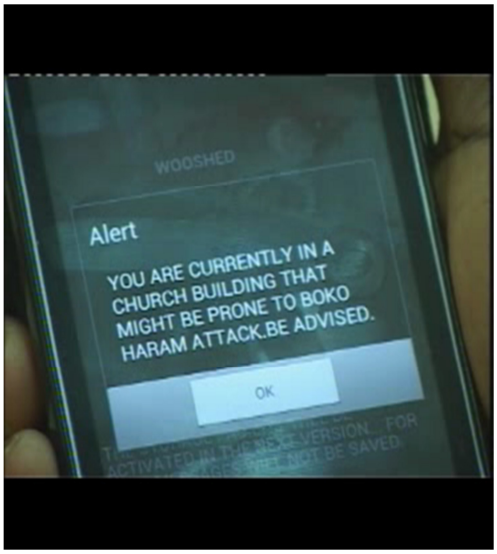


Figure 7: An alert message that was received within the preconfigured area

Testing

In order to make the system practical, the crime and hazard data for the application must be obtained from a reliable source. This is achieved by collaborating with the local police and other security agencies to obtain the patterns and types of crime in different locations over a period of time. This ensures that the application is reliable and useful.

Preliminary testing of this application in Lagos, Abuja, and Ogun states of Nigeria has shown precise and accurate notification to the users of the application. It also has been able to capture correctly threats, users details and the precise location of the threats that have been reported.

The tests also confirmed that the application does not interferes with the normal operation of any mobile device; a message only pops up when the user enters a hotspot.

5. Conclusion

The motivation for this project was, amongst other reasons, to ascertain the possibility of mobile computing been used as a tool to save lives, if properly implemented. This system which is a cross platform application and developed to help alert its users of hostile/hazardous areas (i.e., areas prone to accidents, flooding, civil unrest, bombing etc.,), targets Nigerian users who mostly access the Internet through mobile devices, with at least 100million unique mobile communication lines already registered by the telecommunication companies.

After successful implementation and testing of the application in three states of Nigeria, namely, Abuja, Lagos, and Ogun, the results showed that the application is capable of successfully alerting users to the possibility of hazards in a particular location. It should also be stated that it is left for the user to decided on what action to be taken after they get the notification, as the nature of the message received by the application are merely advisory. It also has been able to capture correctly threats, user details and the precise location of the threats that have been reported.

- The system does not come without its own limitations and below are some that have being observed;
- The system will not function properly where there is little or no GPS signals. Examples of such places include in the forest or in an enclosed area.
- The accuracy of the system depends on the information obtained from the police and relevant authorities about a location being a potential hotspot.
- The system can only advice or warn of the possibility of crime/hazards occurring in a location but cannot tell if the location is crime or hazard free.
- The system can only provide locations that are already captured by Google Maps.

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