A Robust Mobile-Based Incident Reporting System

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Abstract— *With the rampant occurrences of crime, societies have various methods for alerting the police when a crime strikes. Currently in many countries, report to the police occurs after the crime. The reporters are asked to make full statement that includes everything they can remember about the incident. The police then embark on investigation and they may or may not arrest the victim. In well-established organizations, buttons are installed which are pressed to notify the police in case of emergency. However, the buttons may be at far distance to be pressed during the incident. The use of a mobile phone is not limited to talking alone it is being used in making video, recording information and transmitting it to a phone or a computer as was being done by a computer. This paper develops an incident reporting system that uses mobile phone and wireless communication technology. The user at the crime screen long presses a key and a message from the client's phone is sent to the receiving phone be a police system or guardian system stating the location of the user. The paper also analyses the various wireless communication technology used in mobile communication technology determining their pros and cons*

Keywords—*Alert System, Java ME, Mobile Device, Reporting System, Crime, GSM, SMS*

I. INTRODUCTION

With the rampant occurrences of crime, societies have various methods for alerting the police when a crime strikes. Currently in many countries, report to the police occurs after the crime. The reporters are asked to make full statement that includes everything they can remember about the incident. The police then embark on investigation and they may or may not arrest the victim. In well-established organizations, buttons are installed which are pressed to notify the police in case of emergency. However, the buttons may be at far distance to be pressed during the incident. The use of a mobile phone is not limited to talking alone; it is being used in recording information and transmitting it to a phone or a computer. An alert system may be a calendar reminder or a notification of a new message such as e-mail, short message Service (SMS), instant messaging (IM) and a press of a button on walls or under desks to prompt the user to perform certain task. Police Alerting System is a supplemental mass warning system, urgent notification system that comprise of selection of methods which includes text messages (SMS) to mobile device, e-mail and early warning siren. In order to receive these urgent notifications, one may register a mobile device number to receive text messages. This paper develops an incident reporting system using mobile phone and wireless communication technology. The user at the crime screen (hereinafter called client) long presses a key and a message from the client's phone is sent to the receiving phone be a police system or guardian system (hereinafter called police) stating the location of the user. The paper also analyses the various wireless communication technology used in mobile communication whilst analysing their pros and cons

1.1 Overview of Wireless Communication Technology

Wireless Communication technology is a term relating to a computer network where there is no physical connection between the sender and receiver instead, they are connected by radio. It is a broad term to encompass all sorts of wireless technologies and devices, as well as cellular communications, networking between computers by means of wireless adapters and wireless computer accessories. Among the first wireless communication technologies is Global System for Mobile (GSM) Communications. GSM is an unlock digital cellular technology for transmitting voice and data services through the transmission of short message service (SMS) [1]. GSM is a technology on which other communication technologies like General Packet Radio Services (GPRS), Enhanced Data GSM Evolution/Environment and Universal Mobile Telecommunication Services (UMTS) were built. Fig. 1 below illustrates how information is transferred in GSM communication technology through GSM SMS center

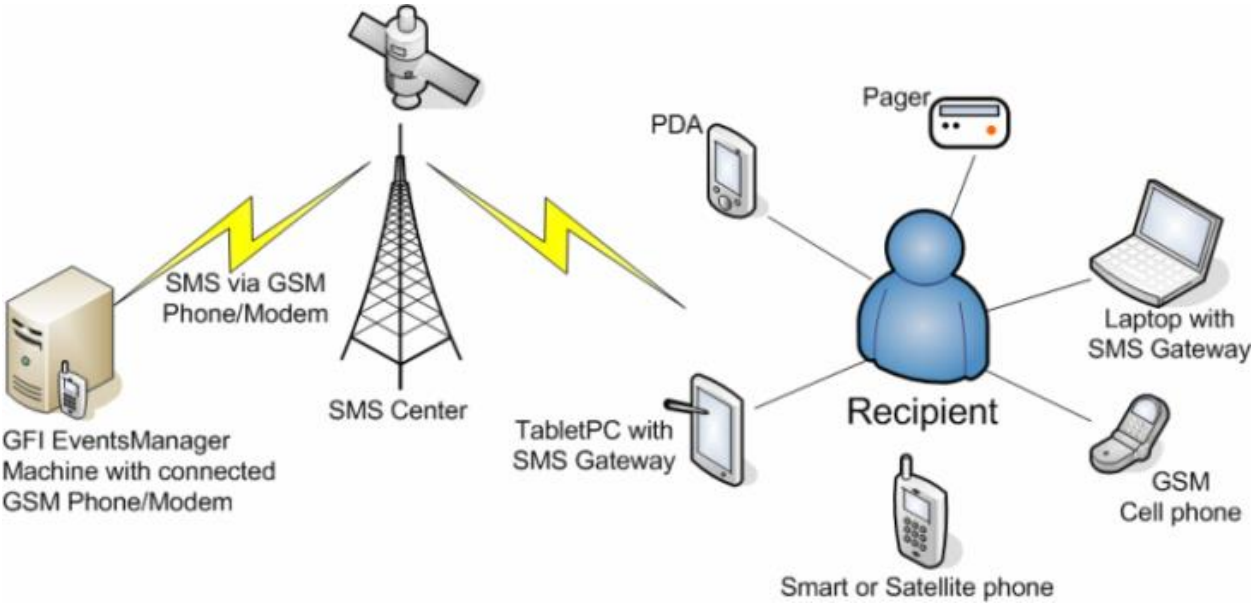

Fig. 1: Information Transfer in GSM Technology

From Fig 1 above, GSM phones and modems are connected to one another through SMS Center that receives data from one end and routed it to the required recipient. Another technology for communication is GPRS. It adds packet data internet protocol service to the GSM network [2], [3]. EDGE is an enhancement of the GSM wireless technology [2]. EDGE ensures retransmission of data when it fails which ensures reliable data transfer unlike GPRS which simply ignores it [4]. Thus EDGE produces less packet loss making it good communication technology [5]. The UMTS is based on EDGE technology but offers greater data transfer. It allows simultaneous voice and data communication [6]. High-Speed Downlink Packet Access (HSDPA) is an improvement of UMTS built on the implementation of a new Wideband Code Division Multiple Access (WCDMA). HSDPA ensures data reliability as well as to speed up transfer rates [7]. HSDPA only handles the downlink while the uplink is handled by a related technology called High-Speed Uplink Packet Access (HSUPA). The grouping of both equally technologies are more often called High Speed Packet Access (HSPA).

1.2 Java ME and Location Tracking Mechanisms

Java Platform Micro Edition (Java ME) is a platform designed for embedded systems and mobile devices. Java ME allows programmers to use the Java programming language and related tools to develop programs for mobile wireless information devices such as cellular phones and personal digital assistants (PDAs). Java ME consists of programming specifications and a special virtual machine which allows a Java ME-encoded program to run on the mobile device [8]. There are two programming specifications for mobile phones: Connected Limited Device Configuration (CLDC) and the Mobile Information Device Profile (MIDP). CLDC handles the application program interface (APIs) as well as the virtual machine features needed to support mobile devices. Mobile Information Device Profile (MIDP) adds to the Connected Limited Device Configuration (CLDC) the user interface, networking and messaging details needed to interface with mobile devices. Mobile Information Device Profile (MIDP) includes MIDlet, a small Java application similar to an applet but one that conforms to Connected Limited Device Configuration (CLDC) and Mobile Information Device Profile (MIDP) and is intended for mobile devices [8], [9]. Major limitations of mobile devices include limited processing power, limited storage capacity and excessive power consumption when using communication technology [10], [11].

The location of an object can be determined through Global Positioning System (GPS) [12], NFC [11], Bluetooth technology [13], [14] and WiFi [15]. GPS requires line-of-sight communication and thus its accuracy is usually affected when used indoor. The other mechanisms based on communication technologies are affected by distance. Object cannot be tracked when the object is far away from its access point. To access the location of a Java ME mobile device, the location API defined in JSR-179 is used which is available in MIDP 2.0 [8]. This API requires a minimum platform of CLDC 1.1 since the API needs floating point math support. The location API contains classes and interfaces that provide three main features:

- Obtaining information about the location of a device
- The possibility to create, edit, store and retrieve landmarks
- The possibility to obtain the orientation of a device

Location API needs a connection to a Location-providing method which generates the locations. The most commonly used methods for location tracking are device-based, network-based and hybrid methods [9]. Fig 2 illustrates the location API MIDlet model in Java ME application

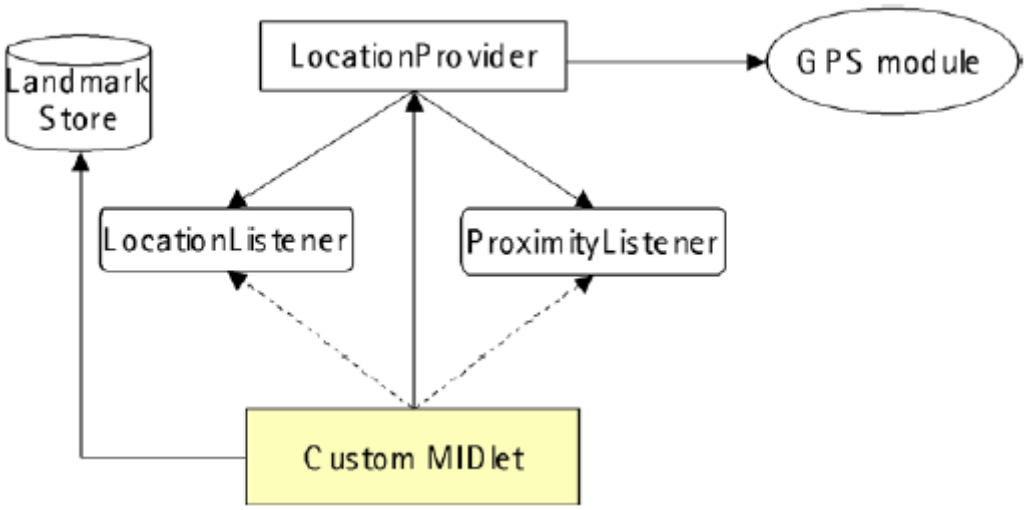

Fig. 2: General Location API MIDlet Model (Source [9])

1.3 Short Message Service Technology

Short Message Service (SMS) is the text communication service component of phone, web or mobile communication systems, using standardized communications protocols that allow the exchange of short text messages between fixed line or mobile phone devices. SMS text messaging is the most widely used data application in the world because data transfer is characterized by the exchange of short alphanumeric text messages between digital line and mobile devices [16]. SMS, commonly referred to as text messaging, is a service for sending short messages of up to 160 characters or 224 characters if using a 5-bit mode to mobile devices, cellular phones, Smartphones and PDAs. However, SMS messages do not require the mobile phone to be active and within range and will be held for a number of days until the phone is active and within range. SMS messages are transmitted within the same cell or to anyone with roaming service capability. They can also be sent to digital phones in a number of other ways. SMS is supported by all Global System for Mobile Communications (GSM) mobile phones and is also available on third generation (3G) wireless networks. SMS messages are also sent via Web-based browser applications, instant message (IM) applications and Voice over Internet Protocol (VoIP) applications, such as Skype. An SMS message is sent from a device to a Short Message Service Center (SMSC), which, in turn, communicates with mobile networks to determine the subscriber's location. Then, the message is forwarded as a small data packet to the destination device. Subsequent messages sent by the original source device undergo the same process [17]. SMS as used on modern handsets was originated from radio telegraphy in radio memo pagers using standardized phone protocols and later defined as part of the Global System for Mobile Communications (GSM) series of standards in 1985 as a means of sending messages of up to 160 characters, to and from GSM mobile handsets. Since then, support for the service has expanded to include other mobile technologies such as American National Standards Institute (ANSI) Code Division Multiple Access (CDMA) networks and Digital AMPS, as well as satellite and landline networks. Most SMS messages are mobile-to-mobile text messages through the standard supports other types of broadcast messaging as well [18].

II. SYSTEM DESIGN AND ARCHITECTURE

The system has two sections. Only one section can be used at a time. The user set the section before usage. The sections are client and police. Both sections are combined into a single application. Before each section can be used, the system has to be initialized. The initialization is done once although settings can be updated any time. With the client system, the user provides his/her name, address and a single police telephone number. However, the police system has the police person’s name, police station name and unlimited telephone numbers of other police officers. Parents can use the police section to track their wards when their wards place their parent’s number instead of police. When the police system receives a message from a client system, the police system automatically broadcast the message to other police systems using the telephone numbers in its system and then updates the central database. Messages receive from other police system remain on the phone

and they are not broadcasted to other phones. When parents use the police system to monitor their wards, the parents can initialize their system with police numbers and other numbers such as that of their spouse. The parent system therefore automatically forward messages received from the ward to the appropriate security officers. Below is the algorithm for the system operation

1. Start program automatically when device is turned on or after installation
2. If program is initialized then run in the background and go to step 5 otherwise go to step 3
3. Initialize the program
    - 3.1 If Client section is selected, user provides the name, address and one emergency contact (usually police) number
    - 3.2 If Police section is selected, user provides the name, address which can be the police station name for actual police officer or the guardian (parent) address. Unlimited number of police numbers or guardians can be added.
4. Device then runs in the background
5. If the default key (Home key) is long pressed then
    - 5.1 If section is police then display program with the section active. This allows the system to be initialized. Go to step 3
    - 5.2 Otherwise, if section is client
        - 5.2.1 The GPS system of the phone if available is automatically turns on.
        - 5.2.2 Determine the location of the user; say L_1 and L_2 where L's are the coordinates
        - 5.2.3 After a continuous long press, the message is sent to the phone whose number is stored. The message to be sent reads "Client_Section: Incident at L_1 and L_2 coordinates"
        - 5.2.4 Program immediately returns to background state. No feedback message is given to the client.
6. If police device receives message
    - 6.1 If the message is preceded with "Client_Section:" then
        - 6.1.1 Reformat the message and precede it with "Police_Section:"
        - 6.1.2 If the police device supports HTTP then save the data into the central database system using the phone number, location and time as primary keys otherwise append "_NO_HTTP" to the message
        - 6.1.3 Display message on the device
        - 6.1.4 Broadcast the message to other police devices whose numbers are stored on the device
    - 6.2 If the message is preceded with "Police_Section:" then display the message on the device
    - 6.3 If the message is preceded with "Police_Section:" and terminated with "_NO_HTTP" then display the message on the device and attempt to save the message to the central database system

      In this case, multiple attempts to save the data are allowed but only one data will be saved. Since the primary keys will be the same across the devices which attempt to save the data. After the first successful saving, the rest will be ignored by the database management system. System ignores error message obtained during data saving.
    - 6.4 The police presses exit to return the program to the background state

The flowchart below, Fig. 3, summarises the algorithm behind the system implementation

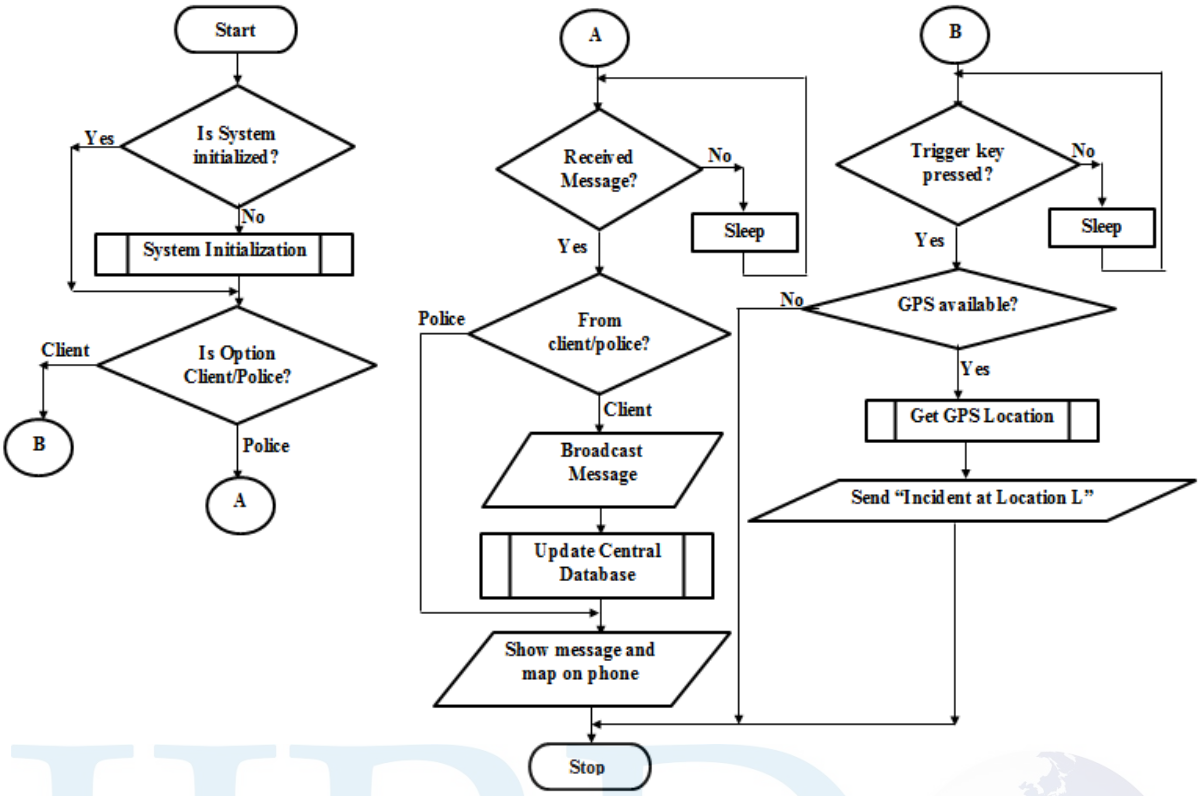

Fig 3: Flowchart for System Design

Data communication between the phones is done through GSM and the communication between phones and central database system is by any communication technology supported by the phones which includes GPRS, WCDMA or HSPA using the Hypertext Transfer Protocol supported by the MIDP. Fig 4 illustrates the interaction between the system components

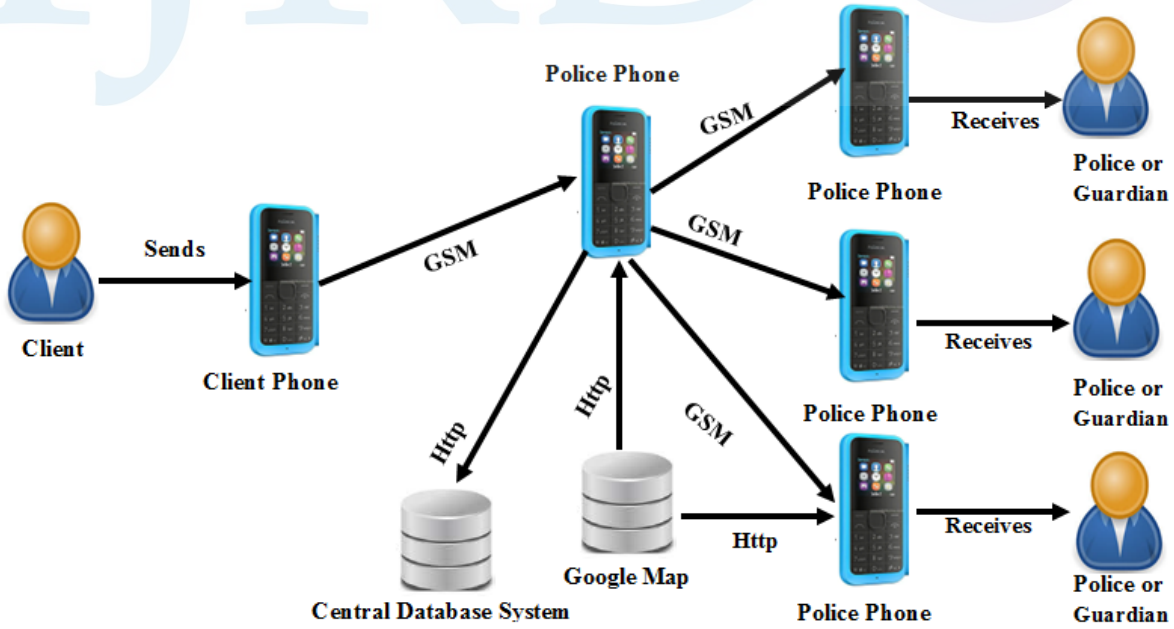

Fig 4: System Interaction between Components

Fig 5 on the other hand depicts how data is transferred within the system. Data flow diagram is used to illustrate data transmission as shown below:

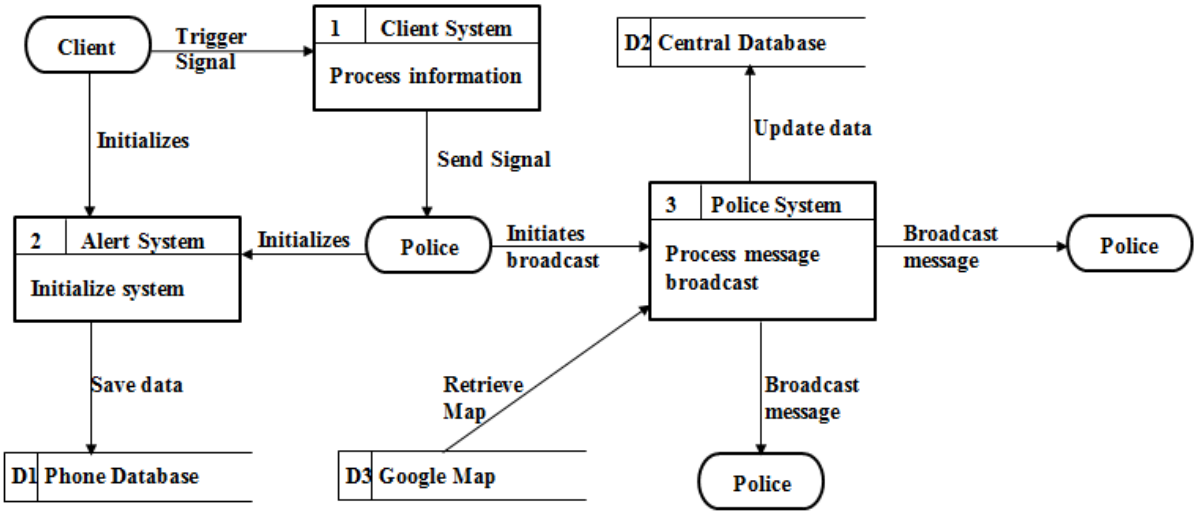

Fig 5: Data Flow Diagram with the System

The central database system is developed using PHP and MySQL DBMS. It is a web-based application. The client has no access to this application. Administrators of the police or guardians have access to the data for making analysis and decision about incident rate in locality. The following steps are required to determine the location of the client device

1. Create an instance of javax.microedition.location.Criteria class. This is used to select the location provider. A typical code of the instantiation is given in Fig 6 below

```
import javax.microedition.location.*;
...
    Criteria cri = new Criteria();//the default setting
    cri.setCostAllowed(true);//the default setting
    cri.setPreferredPowerConsumption(Criteria.NO_REQUIREMENT);
```

Fig 6: Creating a Criteria object

2. Create a LocationProvider instance and use it to query the GPS module for the current location. The getLocation() method has a timeout parameter that indicates how long the application is willing to wait in seconds for the data. A typical code is given in Fig 7 below

```
LocationProvider prov = null;
double latitutde, longitude;
try{
    prov = LocationProvider.getInstance(cri);
    Location loc = prov.getLocation(60);
    Coordinates coor = loc.getQualifiedCoordinates();
    if (coor != null){
        latitude = coor.getLatitude();
        longitude = coor.getLongitude();
    }
}catch(Exception e){}
```

Fig 7: Querying GPS module for Coordinates

3. The application cannot wait for 60 seconds when there is an incident to retrieve the GPS coordinates. This is time critical application and thus the GPS coordinates will be updated every 60 seconds. To do this, the LocationListener interface with two abstract methods is implemented. The methods are locationUpdate (LocationProvider provider, Location location) and providerStateChanged (LocationProvider provider, int newState). The listener is registered using

setLocationListener(LocationListener listener, int interval, int timeout, int maxAge) method. A typical code is given in Fig 8.

```
prov.setLocationListener(this, 60, -1, -1);

public void locationUpdated(LocationProvider lp, Location lo){
    if (lp != null && lo.isValid()){
        Coordinates coor = loc.getQualifiedCoordinates();
        if (coor != null){
            latitude = coor.getLatitude();
            longitude = coor.getLongitude();
        }
    }
}
public void providerStateChanged(LocationProvider lp, int ti){
    if (lp == LocationProvider.OUT_OF_SERVICE ||
        ti==LocationProvider.TEMPORARILY_UNAVAILABLE){
        System.out.println("GPS inactive")
        Utility.gpsTurnOn();//a method for turning GPS on
    }
}
```

Fig 8: Implementing LocationListener Interface

4. Once the location coordinates (latitude and longitude) are obtained, they are sent along the SMS message to the police system. To get the actual location on the police phone, the Google Static Map API is embedded in the application. With the help of URL parameters sent through a simple HTTP query string, the map of the area is obtained as response. A typical code is given in Fig 9.

```
HttpConnection con = null;
InputStream in = null;
Image map = null;
int zoom=14, width, height;
width = this.getWidth();//map width same as screen width
height = this.getHeight()/2;//map height half of screen height

String url="http://maps.google.com/maps/api/staticmap?center=";
url += String.valueOf(latitude)+","+String.valueOf(longitude);
url += "&zoom="+String.valueOf(zoom);
url += "&size="+width+"x"+height+"&sensor=true";

try{
    con = (HttpConnection)Connector.open(url);
    con.setRequestMethod(HttpConnection.GET);
    in = con.openInputStream();
    map = Image.createImage(in);
    //displaying map on canvas
    if (map != null){
        g.drawImage(map, 0, 0, Graphics.LEFT | Graphics.TOP)
    }
}catch(Exception e){}
//close resources
```

Fig 9: Displaying Client Location on Police Phone

III. SYSTEM IMPLEMENTATION AND TESTING

The program was implemented sparingly so that clients are protected from their predators in case of harmful incident. If at a robbery point, a robber finds out that a client is sending a distress signal, the client may loss his/her life. Users are allowed to select their own image during initialization. Fig 10 below shows a typical interface that sends signal to police or guardian.

Fig 10: Client Interface for Sending Distress Signal

When the home key is long-pressed, the message will be sent automatically. When the screen is activated, users can only press the power key to deactivate and cancel the sending. The user has the privilege to select a special key to cancel sending. The exit button when pressed will also send the message to the police or guardian. This is intentionally done so that when the device is found in wrong hands, the culprit will unintentionally complete the task for the user. When the screen is active for two seconds without cancellation, the messge will be sent to the police or guardian automatically. Once the message is sent or cancelled, the system immediately returns to background status.

However, at the police or guardian end the message is visible with the location. The latitude and longitude coordinates are provided to the police or guardian. If the police or guardian's phone supports HyperText Transfer Protocol through HttpConnection Class, the roadmap of the location will be retrieved from Google static map and display on the phone with a label. The Exit button of the police system when pressed returns the phone to background status. Fig 11 below shows a typical message received from client. The phone supports HttpConnection class and thus the map of the location is displayed.

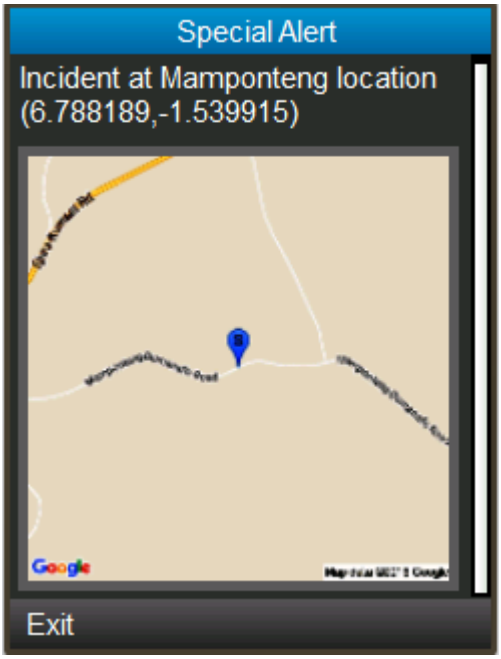

Fig 11: Sample Alert Message Received by Police or Guardian

IV. CONCLUSIONS

An improved mechanism for reporting incident has been designed. The strengths of the system are

- Client interact minimally, making it advantageous to report crime without being noticed within an approximation of 3 seconds, report could be sent to the respective security agencies
- Information is kept in a central database for future analysis
- A police phone which does not have HTTP support does not prevent the data from being saved into the database.

However, the system is limited by

- Client device which does not support GPS poses a challenge in determine the location of the user and hence such phones cannot be used.
- Messages submitted are fixed and cannot be altered.

Future work focuses on using hybrid mechanism involving both GSM and GPS to locate the user.

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