Emergency, Tracking and Anti-theft System for Android Mobiles

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Abstract

One of the most important requirements that should be achieved in the meantime is, providing Safety & Emergency service as soon as possible when someone needs it.

Hence, a software system has been designed and developed called "**Emergency & Anti-Theft**" that will send SMS & Emails with the accurate current location to someone who can provide help in a very short time.

The system is used for the following situations, an accident, fire, kidnapping, or phone theft, also it can work as a tracker. It is capable of getting the current location from GPS, Wi-Fi, GPRS ,or even from the nearest service provider towers and get the location, so no matter where a person is, there must be a way to get his/her location.

The system has been tested by many users and for different situations and proved its efficiency, ease of use, and reliability due to the new features it has provided.

This system has been implemented using ADT (Android Development Tools) and Eclipse as the GUI with the packages provided by the SDK (Software Development Kit) manager.

Keywords: Emergency, Tracking, Antitheft, GPS, Wi-Fi, GPRS.

1- Introduction

In today's fast moving life services based on location has very much importance in everyone's life. As the trend is of smartphones, mobiles, and all the gadget emerging today it's very important for the mobile user to have the location based services. Location based service can be elaborate as the services which uses the users geographical location which consist of X and Y coordinates, which is generated by GPS, Wi-Fi, and GPRS which acts as positioning device.
Sending the current location if done manually by a human will take a significant amount of time in order to explain where the person is exactly located and maybe the one who has been requested for help, may not really understand or get the exact location of the person who asked for help if he has got a serious injury.

So if someone had an accident on a highway with his car, then he will need an immediate assistance as he was driving at a high speed for being on a highway, such speed may cause injuries that make the person unable to reach his phone to make a phone call or send an SMS to get help.

Another example, if someone has been kidnapped, there is a possibility that he is unable to request help as it is not possible for normal people to track phone calls to know where the caller is.

One more situation of the need of this system in our life is' Reply via SMS' function, for instance, the majority of teenagers are that they may not care to answer their parents calls especially when they are with friends, so, parents cannot know whether their son is okay or just acting as a normal teenager.

Now we come to the brighter side, imagine how easy it is when you make an accident but you can press a single button and your phone will send your exact location immediately to someone who can help you.

Or imagine how the victim who got kidnapped can easily press one button (power button) and the phone will send his location to someone who can help him and keep on sending the current location as the car moves so it works as a tracker.

When the parents send an SMS containing a secret keyword to their son's phone, the proposed system will reply with the current location of their son without even notifying him about it.

Emergency& Anti-Theft software system can easily and effectively work for all of the above situations.

Last function to mention is the Anti-Theft. If your phone has been stolen, there is two ways to get it back, either by sending a secret keyword to enable the Reply with SMS function, or if the thief changed the SIM card, then the system will automatically send the phone number of the new inserted SIM card & current location of the device to the predefined phone number and/or emails.

2- Related Work

In 2009, Kumar , Arunachalam , and Sandhya [Kumar,2009], design a biometric Anti-theft and tracking system. The outcome is the prevention of mobile theft and high information security When the Fingerprint reader senses the illegitimate fingerprint through image processing, it immediately sends alert to the person whose contact number has been registered in the mobile security name field, at regular intervals. The alert contains the information of time and place the mobile has been used.

In 2012, Ramada n, and Al-Khedher, [Ramadan, 2012], design a security system which is
implemented for anti-theft using an embedded system occupied with a Global Positioning System (GPS) and a Global System of Mobile (GSM). The client interacts through this system with vehicles and determines their current locations and status using Google Earth.

In 2013, Tekawade [Tekawade et al,2012],design mobile tracking application for locating friends using Location Based Service LBS, which uses the GPS as location provider through geographic location for mobile network. It helps the user to locate and track their friends, and receive the alert message when nearby, basing on radius set by administrator.

Also, in 2013, Alsadi [Alsadi,2012] ,desidn a system for the purpose of tracking it to determine its current GPS location in the real time, the system use Global System for Mobile communication (GSM) network as a medium to send the information to a monitoring station in two way: the first way by using Short Messaging Service (SMS) while the second way use General Packet Radio Service (GPRS).

Also, there are some software systems for Android that deals with the emergency cases and phone theft:

Lookout Security & Anti-virus. The free version of this system works as an Anti-Virus and has a scheduled scanning, also it locates the location of the stolen device. The drawback with this system is that the user must access Lookout Website to track his lost phone (real time process).We have dealt with this problem by allowing the user just to enter phone number and/or emails in the settings of Anti-Theft in our system, and when the SIM card is changed, from the new SIM card, the system will send to the phone number and emails stored in the settings, the new SIM card number and the location of the device.

Kaspersky This system has been developed by the big name security software brands, Kaspersky. As this system is Anti-Virus, it works as an Anti-Theft system, but the main usage for this system is as an Anti-Virus because that was the main function this

system has been designed for. The drawbacks for this system are; the application must be installed on the device's memory and the user can only wipe his device's data without locating its location.

Nike+ running, Waze, Glympse, Locale, Where, Topo Maps, CoPilot GPS, NeverLate [Cassavoy,2012]. Each of these application has a drawbacks, like some of them require an internet connection like **Waze**, others can locate the current location only using GPS like **Nike+ running**, another drawback is the application may not work everywhere, like **CoPilot**, it only work in some countries and not worldwide.

After determining all the drawbacks, **Emergency & Anti-Theft** System came on dealing with all of them in order to get a fully functional system that works without any of the previous drawbacks.

3- Challenges in Determining User Location

There are several reasons why a location reading (regardless of the source) can contain errors and be inaccurate. Some sources of error in determining user location include [Rani et.al.,2012]:

- **Multitude of location sources.** GPS, Cell-ID, and Wi-Fi can each provide a clue to users location. Determining which to use and trust is a matter of trade-offs in accuracy, speed, and battery-efficiency.
- **User movement.** Because the user location changes, you must account for movement by re-estimating user location every so often.
- **Varying accuracy.** Location estimates coming from each location source are not consistent in their accuracy. A location obtained 10 seconds ago from one source might be more accurate than the newest location from another or same source.

These problems can make it difficult to obtain a reliable user location reading. This paper provides information to help you meet these challenges to obtain a reliable location reading. It also provides ideas that you can use in your application to provide the user with an accurate and responsive geo-location experience.

4- Design & Implementation of the Proposed System

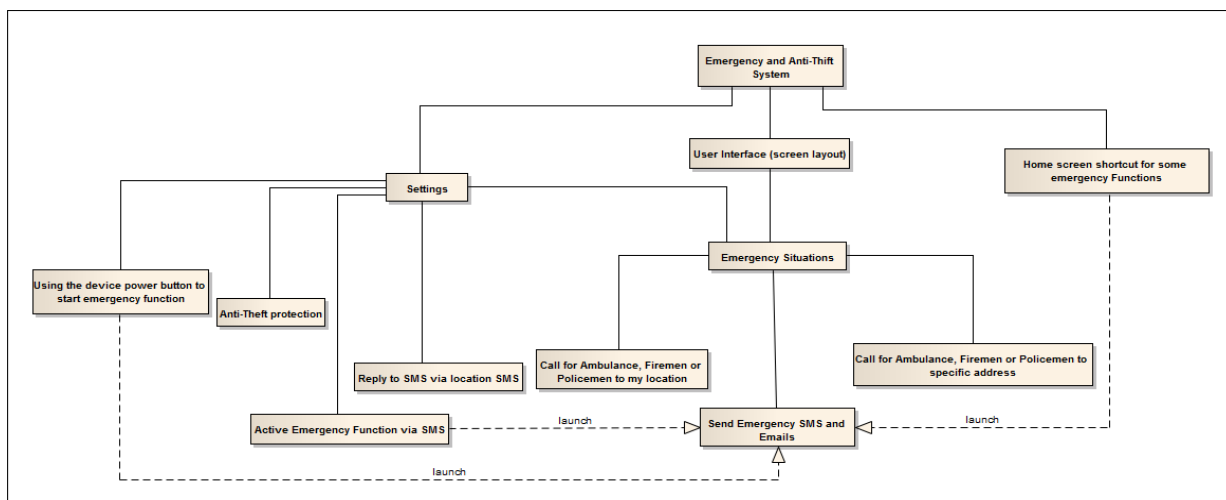Figure (5.1) shows the structure of the proposed system.

Figure (5.1) Structure of Emergency and Anti-Theft System.

The main screen of the system (As shown in figure 5.2) has a specific button and/or image-icon (our system uses both) for each emergency function and it is not exceed two-level hierarchy of sub-menus.

First of all, the user has to set some settings in order to make the system ready to work, and that will be done only once. The most important field to set in settings (As shown in figure 5.3) are the phone numbers, emails and addresses, because there are no default values for those fields.

The system is capable of getting the current location from GPS, Wi-Fi, GPRS, or even from the nearest service provider towers and get the location, so no matter where you are, there must be a way to get your location.

If someone can coordinate with the Policemen, Firefighters, or Hospitals, then there is an option that you can enter the Policemen, Firefighters, or Hospital's number, so instead of sending the location to some friend, you can send it to the Policemen for example, and they will reach you faster.

Another option is, the user can send the SMS containing his house, work, or other location. And that makes the application more feasible for being able to send the current location as well as any other location which can be set manually.
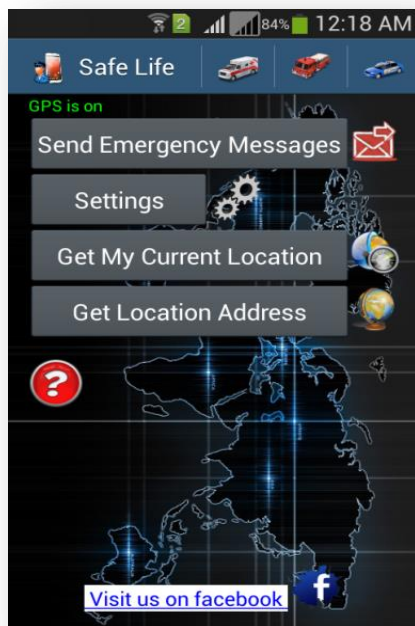
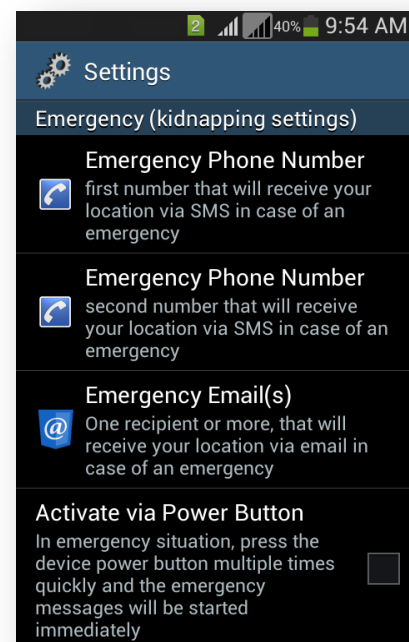|	
Figure (5.2) The main screen of the system	Figure (5.3) Settingsof 'Send Emergency Messages'

Referring to Figure (5.2), there are two more features:

"**Get My Current Location**", which helps the user to know his current location, which in turn may work as a tracker as it provides a real time location if he is moving, and he can see his speed with KM/H or MPH as well as providing him with an option whether he wants to share (e.g. via Facebook, Twitter, or other social media)his current location or not as in figure (5.4).

The second feature is, "**Get Location Address**", which include two fields, where theuser can enter a longitude and latitude and the system will inform him where does these coordinates are. The location can be shown as a point on Google Maps and by text (Human readable form).

For instance, if the user enters these two coordinates:

Latitude (50.0) & Longitude (-100.0)

The system will show this location, figure (5.5):

Forrest, MB R0K 0W0, Manitoba, Canada.

The last feature to explain is the Anti-Theft feature, if the user enables this option,he has to enter a phone number or email, so that if his phone got stolen and the thief changes the SIM card, the system will work immediately and send the location of the device without notifying the thief and without any further thing to do, which means that everything will be done automatically just by inserting new SIM card.

The following sections describe in details each of the main menu functions.
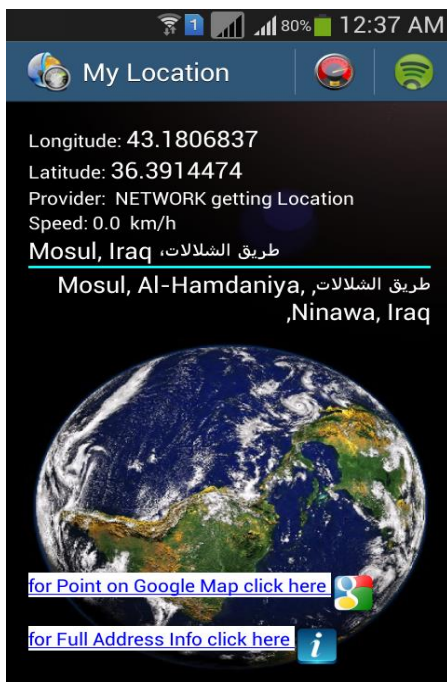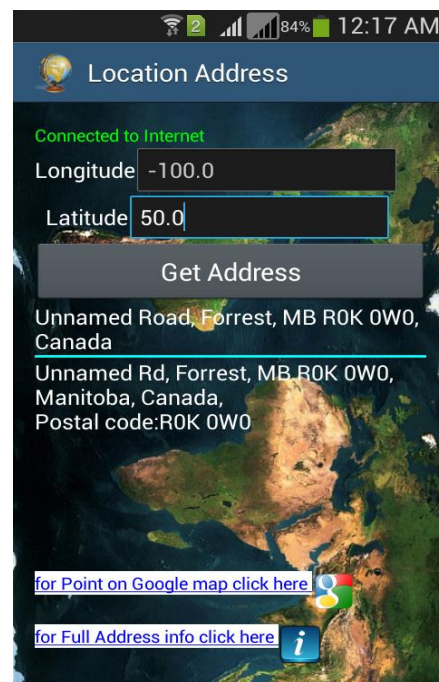

Figure (5.4) Get My Current Location   Figure (5.5) Get Location Address.

4.1 Send Emergency Messages:

The Send Emergency Messages function has been designed for kidnapping situations at the first place and for other emergency situations at the second place. It must have quick access by user and more than one way to start (launch) it; in our system we made four different ways to launch it. The first way is the traditional way by simply start the system and then click on emergency button, the second way is by a shortcut(e.g. widget in android) in the device home screen, the third way is via receiving specific keyword(Activation key) via SMS and the last and the most important way is by pressing the device power button multiple times quickly (like 3-4 times in two seconds).We regard the last way is the most important, because the user might not be able to open his device and use emergency function.

Figure (5.6) shows the algorithm of this function, the function is called with arguments passed to it (from settings that should be filled previously by the user) are: the emergency phone numbers, emergency user-emails, time intervals between messages and the password(user authentication) to abort the operation, for each location provider(for instance android location providers are GPS, Network and Passive providers) available on that system(device) use a separate process to get geo-location coordinates. If there is at least one emergency number or user-email, continue the operation. If there is neither an emergency phone number, nor a user-email, show dialog message and ask the user to enter phone number to be able to continue the operation or it will be aborted. It is necessary to get(activate) access to internet if there is no emergency phone number and there is one or more user-emails. Schedule a timer to run after 3-5 seconds (to give GPS and other slow providers enough time to get geo-location coordinates) and repeat every time unit (time intervals between messages) to execute the following: Starting from most accurate location provider, check whether it has got geo-location coordinates. If yes, send SMS to the phone numbers and emails to user-emails, if not, move to the second most accurate and so on, repeat checking them(location providers) until one of them get geo-location coordinates and then wait for the next interval. This operation should continue until the user write the correct password and exit.

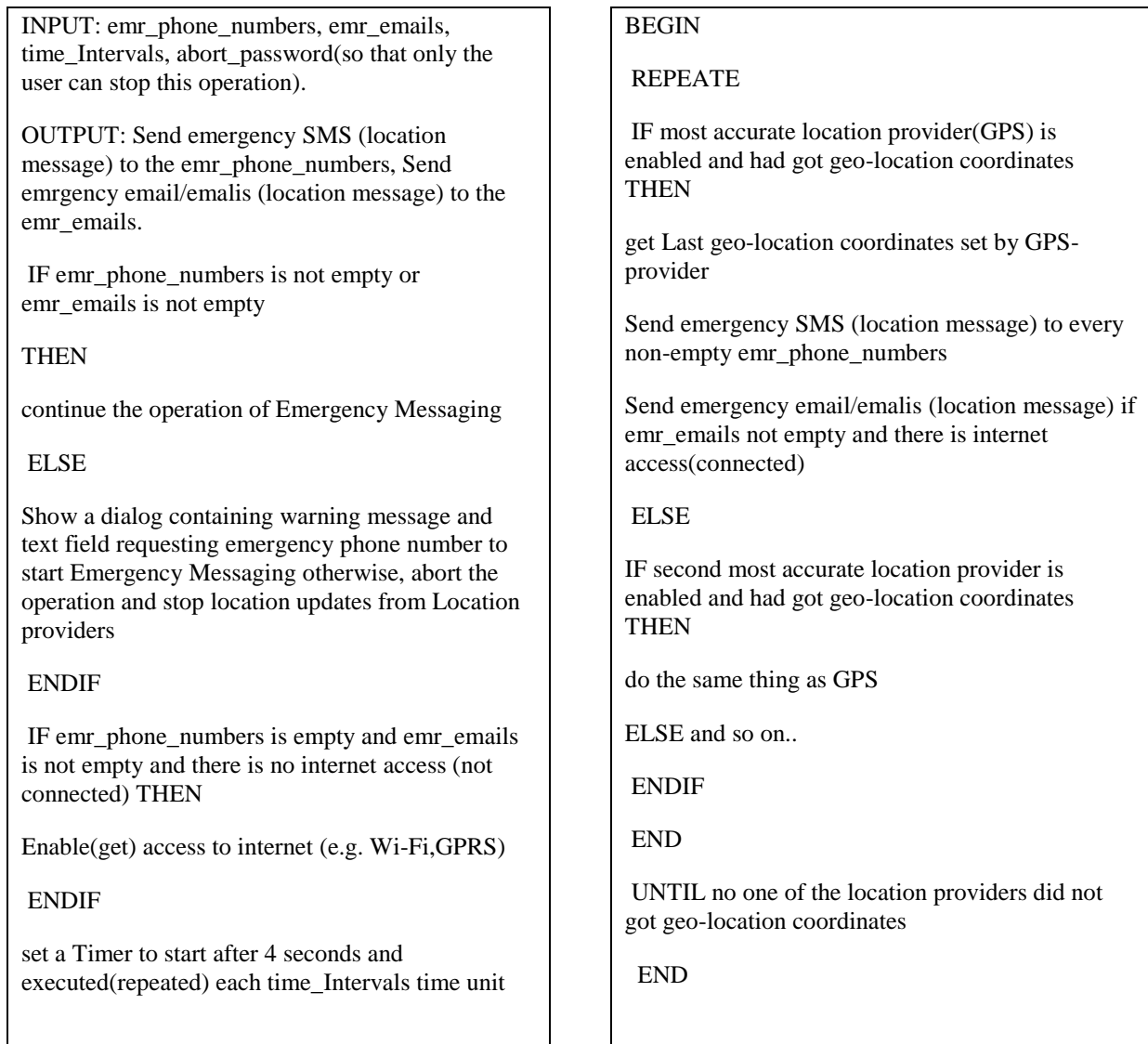Following sections explain these different methods of lunching the 'Send Emergency Messages' function.

INPUT: emr_phone_numbers, emr_emails, time_Intervals, abort_password(so that only the user can stop this operation).

OUTPUT: Send emergency SMS (location message) to the emr_phone_numbers, Send emrgency email/emalis (location message) to the emr_emails.

 IF emr_phone_numbers is not empty or emr_emails is not empty

THEN

continue the operation of Emergency Messaging

 ELSE

Show a dialog containing warning message and text field requesting emergency phone number to start Emergency Messaging otherwise, abort the operation and stop location updates from Location providers

 ENDIF

 IF emr_phone_numbers is empty and emr_emails is not empty and there is no internet access (not connected) THEN

Enable(get) access to internet (e.g. Wi-Fi,GPRS)

 ENDIF

set a Timer to start after 4 seconds and executed(repeated) each time_Intervals time unit

BEGIN

 REPEAT

 IF most accurate location provider(GPS) is enabled and had got geo-location coordinates THEN

get Last geo-location coordinates set by GPS-provider

Send emergency SMS (location message) to every non-empty emr_phone_numbers

Send emergency email/emalis (location message) if emr_emails not empty and there is internet access(connected)

 ELSE

IF second most accurate location provider is enabled and had got geo-location coordinates THEN

do the same thing as GPS

ELSE and so on..

 ENDIF

 END

 UNTIL no one of the location providers did not got geo-location coordinates

 END

Figure (5.6) 'Send Emergency Messages' Algorithm

4.1.1 Click on Emergency Button in main screen

In this method, start the system and click on 'Send Emergency Messages' button in main screen (Figure 5.2).

4.1.2 Activation via SMS

The 'Activation via SMS' function used to trigger the 'Send Emergency Messages' function by SMS from any phone, by sending the Activation keyword, as in figure (5.7).

This function works as follows, the user specifies an 'Activation Keyword' in the settings and when someone sends this keyword via SMS to the user device, the system will activate the emergency (Send Emergency Messages) function.

This function has been designed to enable (run) the basic emergency function from far distance and then, user can use his device as a tracker, for instance, someone stole your suitcase or your car and run a way then, you can activate the emergency function via sending SMS and use your device as a useful tracker tool (of course if your phone was in your suitcase or your car in that time).
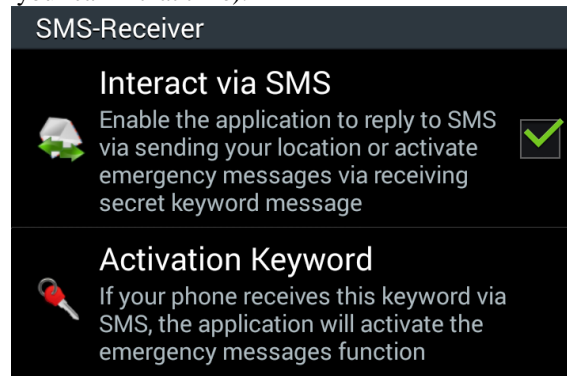

Figure (5.7) Settings of 'Activation via SMS' function

Figure (5.8) shows the algorithm of this function, for every new SMS received check whether the activation state is enabled in the settings(the user approval on this function). If enabled, read the SMS message body and compare it with the 'Activation Keyword' stored in the settings. If they matched, start the 'Send Emergency Messages' function.

INPUT: sms (new SMS Received), activation_state (the user approval on this function), activation_keyword.

OUTPUT: Start(Activate) the 'Send Emergency Messages' function.

 IF the state of activation_state is enabled THEN

read the message body of sms

   IF message body equals the activation_keyword THEN

   Start(Activate) the 'Send Emergency Messages' function

   ENDIF

 ENDIF

Figure (5.8) Activation via SMS algorithm

4.1.3 Trigger the emergency function by a widget.

The benefit of using shortcuts (e.g. widget in android) in our system is to provide the user fast access for important emergency functions, and simply it will call the related emergency function by single click on it.

4.1.4 Activation by the device 'Power Button'.

This function has been designed to allow the user to start the main emergency (Send Emergency Messages) function via quick repeatedly (e.g. 3-4 times in couple of seconds) pressing on one of the device buttons (Power Button in our system), this would be very useful in situations that the user is not capable to open his device and use the emergency function.

It was a big challenge for our system as the androidOS prevent the non-system applications from using the device buttons to launch or activate a specific functions in those applications (non-system applications), so we
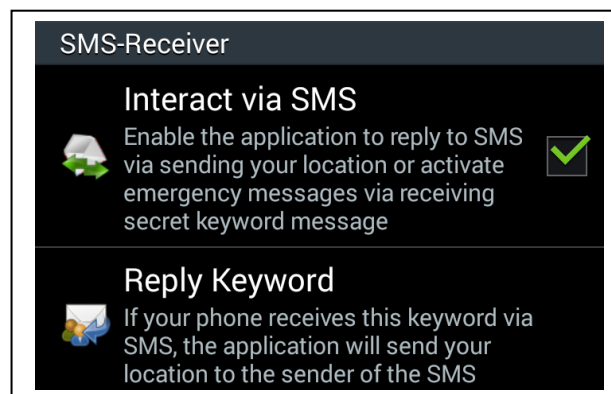

Figure (5.9) Settings of 'Reply via SMS' function

had to use some tricks to make it possible even when the app wasn't running (active) in that moment, at the same time our system will let the user to chose(from settings), whether it can uses the device 'Power Button' to start emergency function or not.

This function is simply works as follow; make a process to run 24 hour in the device background thread. If the device 'Power Button' pressed (clicked) more than or equal three times in the boundary of two seconds, then start the emergency (Send Emergency Messages) function.

4.2 Reply via SMS:

The difference between this function and the Activation via SMS functions, the 'Activation via SMS' function will activate the emergency function (Send Emergency Messages),whereas the 'Reply via SMS' function will send back the current location of the device to the same phone number that has sent the SMS with the secret keyword, figure (5.9).

The 'Reply via SMS' function work as follows, the user specify a 'Reply Keyword' in the settings and when someone send this keyword via SMS to the user device, the system will reply to that SMS via sending the current location of the device.

This function has been designed to send user location in case the user cant or not old enough to describe his location and many other cases such as with teenagers as described earlier.

Figure (5.10) shows the algorithm of this function, or every new SMS received check whether the reply state is enabled in the settings(the user approval on this function). If enabled, read the SMS message body and compare it with the 'Reply Keyword' stored in the settings, if they match, for each location provider(for instance android location providers are GPS, Network and Passive provider) available on that system(device),use a separate process to get geo-location coordinates, first one of the location providers gets geo-location coordinates with accuracy less than 25 meter, then stop all location providers and send location SMS to the sender of the SMS and wait for the next new SMS received.

INPUT: sms (new SMS received), reply_state(the user approval on this function), reply_keyword.

OUTPUT: Reply to the sender of the 'Reply Keyword' by sending the device location via SMS message.

  IF the state of reply_state is enabled THEN

read the message body of sms

read the phone number of the sms sender

  IF message body equals the reply_keyword THEN

request Location Updates for each available Location provider (GPS, NETWORK,....) in a separate process to get geo-location coordinates
*

when first one of the location providers get geo-location coordinates accurate less than 25 meter

  BEGIN

stop location updates from Location providers

  Send location SMS (location message) to phone number of the sms sender

  END

  ENDIF

 ENDIF

Figure (5.10) Reply via SMS Algorithm

4.3 Request Assistants to current location:

With this function, the user can request assistance from Ambulance, Firemen or Policemen (Figure 5.11) to his current location (geo-location coordinates).It is helpful in the situations when the user wants to get assistance and doesn't know the address or even where he is (for instance, a person went for camping and got bad injury).

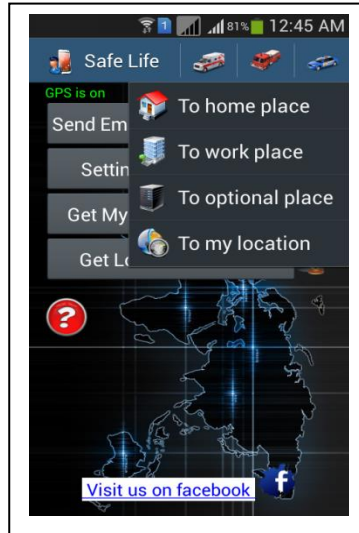Figure (5.12) shows the algorithm of this function.

Figure (5.11) Request Assistants to current location.

INPUT: phone_number, assistance_type.

OUTPUT: Send emergency SMS (location message) to phone_number(assistance phone number).

Request Location Updates of the most accurate Location provider(e.g. GPS) to get geo-location coordinates

  IF geo-location coordinates accuracy less than 20 meter THEN

Stop location updates from the location provider

setmessage_bodyacording to the assistance_type and geo-location coordinates

Send emergency SMS of the message_body to phone_number and request the status of the message(sent, delivered, failed and so on)

ENDIF

Figure(5.12)Request assistants to current location Algorithm

4.4 Request Assistance to specific address:

One more feature is getting the Ambulance, Firemen or Policemen to a specific location (not the current location) like when the user wants the Ambulance in his house while he is at work.

It is helpful in many situations and reduces the time required in describing the address to the assistance provider(Police, Firemen or Ambulance) as the address details has been already written by the user and stored in the settings.

Figure (5.13) shows the algorithm of this function

INPUT: phone_number, address, assistance_type.-

OUTPUT: Send Emergency SMS of the address to phone_number(assistance phone number).

BEGIN

Set message_body according to the assistance_type and address

Send Emergency SMS of the message_body to phone_number and request the status of the message(sent, delivered, failed and so on)

END

Figure (5.13) Request Assistance to a specific address Algorithm

4.5 Anti-Theft function:

The Anti-Theft function (Figure 5.14) has been designed to send SMS and/or emails to the user containing his stolen phone location and the number of SIM card that replaced in place of his original SIM card.

Figure (5.15) shows the algorithm of this function. The way in which this function work is simple and active, when the device is booted and the Anti-Theft function is enabled in the settings, the current SIM card (if there is
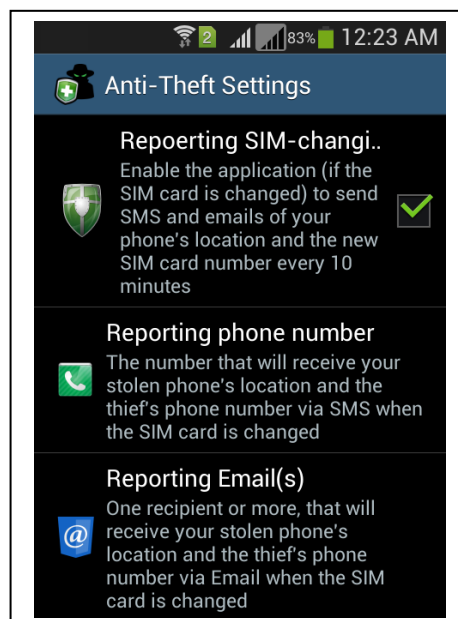

Figure (5.14) Settings of Anti-theft function

any) serial number is compared with the stored (old) serial number(the original SIM card of the user), if there is mismatch then, the reporting (recovery) phone number and emails from settings is taken in order to report SIM changing, this action is repeated every time unit (10 minute in our system) interval, for each location provider (for instance android location providers are GPS, network and passive provider) available on that system(device) use a separate process to get geo-location coordinates, first one of the location providers gets geo-location coordinates and its accuracy less than 25 meter, then stop all location providers and send report SMS to the reporting(recovery) phone number and wait for the next time interval to repeat this operation.

INPUT: sim_changing_report_state(the user approval on this function), old_serial_number(the original S.N of the user SIM-card), reporting_phone_number, reporting_emails.

OUTPUT: Send sim-changing report (the thief's phone number and the stolen phone's location) to the reporting_phone_number and reporting_emails.

When the device is booted

BEGIN

  IF the state of sim_changing_report_state is enabled THEN

read the current sim-card serial number if there is one, otherwise stop operation(there is no SIM-card in the device)

   IF current Sim-card serial number not equals the old_serial_number THEN

    REPEATE every time unit (in periodicity manner)

Request Location Updates for each available Location provider (GPS, NETWORK,....) in a separate process to get geolocation coordinates

When first one of the location providers get geolocation coordinates accurate less than 25 meter

Begin

Stop location updates from Location providers

Send sim-changing report SMS (with the phone's location) to reporting_phone_number

Send sim-changing report emails (with the phone's location) to reporting_emails

 END

UNTIL the state of sim_changing_report_state is disabled (when the user got his phone, he can stop this operation)

ENDIF

ENDIF

END

Figure (5.15) Anti-Theft Algorithm

5- Conclusions

The proposed system has been designed to overcome the drawbacks of other used Emergency and Anti-theft algorithms, which mostly rely on internet service to be enabled in the stolen phone.

The system can detect and locate the thief number and location even if the internet service in the stolen phone is not enabled. Followings are some other important features of the proposed system:

1. Trigger via the Power Button. This is a unique feature that we could add to our system, with this feature, the user can send his current location with the minimum amount of effort by repeatedly clicking on a single button (Power Button). This is the most important and the fastest way to trigger the application and send the location when the user wants to do it urgently.

2. Fast. The system execution functions can be done so fast as there's more than a way to get the current location, starting with GPS, there's a possibility that the GPS is not available at some places, so the system will automatically start searching for a Wi-Fi to get the current location, when there's no available free Wi-Fi, the system will connect to GPRS (ISP), when it's not possible to get it using GPRS, another way to get it is by connecting to the nearest Network Towers and depending on some algorithms it will calculate the distance and get the location.

So there is always a way to get the location and it's way better than other systems that keep waiting till the GPS will be available.

3. Reliable. The user can always trust the system as there is always a way to get his/her current location.

4. Tracker. This system can work as a tracker as well, and that's because it sends the current location based on an interval time and will be updated automatically if the device will be moving.

5. Reply via SMS. With this feature the user can send an SMS to the phone that has the system installed in, and the phone will send back the current location of the device to the user who sent the SMS.

6. Multi Phone Number& Email. We have limited the phone numbers used in this system to two numbers, but with emails, we allowed the user to add as many emails as he likes just by adding a comma "," after each email, and the email will be sent to all of the emails simultaneously using built-in mail client.

7. Set Address. The user can set his home, work, or an optional address and send for help to one of those location and not his current location.

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