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IoT based Message Alert System for Emergency Situations

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Abstract: An alarm is an audio or visual signal to alert people of a problem, danger or something undesirable. Some alarm systems are used for security purposes during producing warning signal in form of sound, light or send alarm message to warn people of a particular danger. In this research a framework of mobile emergency alarm system (MEAS) is proposed. The system consists of two parts: Transmitted and Central emergency. The aim of the first part is to detect the event, its type and trace the location using global position system (GPS) receiver device, furthermore it sends all these gathered information's as SMS message to central emergency part using Global system for mobile communication (GSM). The aim of the second part is monitoring and analyzing the alarm message and finding the nearest helping center. The system uses Arduino microcontroller R3, sound sensor and three push buttons for (fire, car accident and earthquake). Internet of thing (IOT) is used in this system to send and receive the alarms between the transmitted part and central emergency part. The proposed system follows the object-oriented software engineering (OOSE) approach using unified modeling language (UML).

Keywords: Alarm System, Arduino, GSM, GPS, IOT, Use Case Diagram, Sequence Diagram, Activity Diagram, UML, Haversine Formula

1. INTRODUCTION

When talking about the Internet of Things (IoT), it is worthy to talk first about the Internet itself. The Internet was invented in 1973 by Vinton Cerf in 1973 and used Commercially in 1980s [1][2]. The first mobile connected with Internet is Nokia 9000 Communicator, launched in Finland in 1996 [3]. In 2000, Friends Reunited in Britain launched the first online social network [4]. By emerging social networks, people's' identities are added to the Internet to make the communication between people through Internet is very interesting. For example, In Facebook, about 350 million of images are downloaded and 250 billion of images are uploaded everyday [5]. IoT, can be considered as next stage of Internet, allows objects to be connected and communicated with each other. It has not unique definition but semantically it means a worldwide network of interconnected objects uniquely addressable, based on Transmission Control Protocol (TCP) and Internet Protocol (IP) [6]. Generally, IoT defined as a connection of people and things and /or between things without time and place constrains. Thus, the concept of IoT is extended to be as huge dynamic global network infrastructure that contains all types of information devices such as global positioning system (GPS), infrared devices, scanners, radio frequency identification (RFID) tags/devices, sensors, and smartphones [6] [7][8].

The increasing crime rates and accidents in the last decade require to be attentive with our life safety. No one can prevent the accident but can reduce the losses caused by it. Some of these accidents are natural like earthquake, flooding and some done by someone like fire, explosion, car accident, burglar, etc. Many countries have been seeking to develop alarm systems that have the ability to send early audio or visual signal to alert the individuals involved that there is an emergency state. Alarm system become primary concerned with our life and is widely used in various places to secure their properties and also their safety at full time surveillance [9,10]. Electronic alarm systems are systems that operate without any human effort. Once it senses a particular signal, it gives an indication in form of audio or visual signal depending on

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its design. With the advancement in science and technology, some systems are developed to protect our buildings and properties with adequate safety devices with an increased level of sophistication. These safety devices are called the modern electronic alarm system, All modern electronic alarm systems consist of basic component, which represents in input and output devices, processing unit (control panel) and their connection wiring. Their purpose is to minimize loss from burglary, fire, explosion, accident, etc, and to warning of a potentially hazardous situation [11,12].

1.1 Problem Statement

Many environmental accidents or terrorists are causing death of many human casualties and considerable materials' losses. There is a satisfaction that if these accidents discovered early, many lives would save. So the need to design and implements real-time alarm system to minimize losses in human life and economic damages is crucial. The challenge of alarm system in general is to translate the emergency event to a signal. transferred as SMS (short message service) from machine to machine without human entrance and inform the respective authority through wireless technologies with minimum time as possible.

1.2 Related Work

There are many researches that dealt with designing alarm systems. Some of these working are referred:

Salim and Humaid alfars designed accident notification system. They used hardware components of sensor (temperature sensor Linear Monolithic35 (LM35)), microcontroller, GSM and Global Positioning System (GPS). In case of an accident, GPS recording the coordinates of the event and sends SMS to the police through GSM [13]. **Jazim Baramy and et al** suggested an accident detection system. The hardware devices are sensors (shock sensor), microcontroller, GSM, GPS, Liquid Crystal Display (LCD) and buzzer. When the sensor gives a signal on any impact, GPS retrieves a location from satellites and the information as SMS message to the family member of the driver, also the SMS message displayed on LCD. [14]. The aim of paper **of Priya H. Pande and et al** are designing a home security and monitoring system. The hardware equipment's are sensors (Passive infrared sensor (PIR), Magnetic and LM35 sensor), microcontroller unit, relay and cell phone. When any sensor is triggered, the SMS alarm message will be sending to the home owner [15]. The authors **Karami M. and et al** described a gas leakage detection system for home users. They used sensors Liquid Petroleum Gas (LPG) for detecting gas leak, microcontroller, GSM and LCD to display the gas sensor value. This microcontroller gives an alert whenever a gas leakage is detected. It even displays a warning information using LCD, and sends a modifying SMS to the user for notification [16].

Finally, **Ihsan Jabbar Hasan and et al** suggested a to monitor the state of weather that can be established in any place. Hardware equipment's are sensor (DHT-22 and Anemometer) and microcontroller unit Bluetooth. In this system the DHT 11 and wind speed sensors are connected to Arduino to read the data sensors and to be sent using Bluetooth to an Android smart phone [17]. The summary of all previous work is listed in Table 1.

TABE 1. Summary of Literature Review Table

Author and Publishing Year	***approach***	***Notes***
Hajer Salim and Humaid ALFars (2015).	Structural	Threshold is used. The alarm message is sent with the location of accident. A simulation software is used to test their result.
Jazim Baramy and et al (2016).	Structural	The alarm message is sent with the location of accident to the family member of the driver when abnormal accident occurs. Displaying SMS on LCD display.
Priya H. Pande and et al (2017)	Structural	Threshold is used. The alarm message is sent to Mobile user.
Karami M. and et al(2018)	Structural	Threshold is used. The alarm message is sent to a mobile user. Displaying gas sensor value on LCD
Ihsan Jabbar Hasan and et al(2019)	Structural	The message contains data weather is sent to Android mobile by Bluetooth.
The proposed System	Object Oriented	Threshold is used. The alarm text message contains location of the event is sent to helping center in time between (11.5-20.5) seconds. The system can determine the nearest helping center. View the path on Google map application. Furthermore, simulation software is used to test the result.

proposed system

The proposed mobile emergency alarm system (MEAS) consists of two parts: the transmitted parts (Sub-EAS) and Central emergency part. Fig (1–a) and Fig (1-b) depicts the block diagram of first part and its hardware components All the components are managed and controlled under microcontroller.

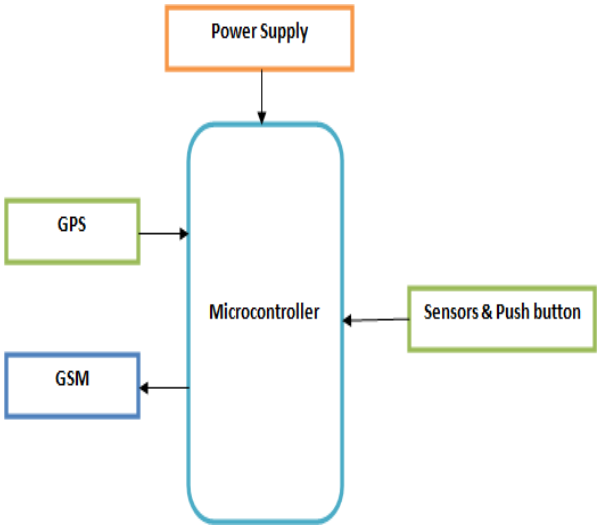

Figure (1-a). Block diagram of the first part.

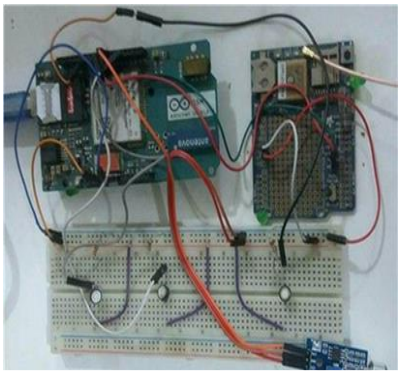

Figure (1.b). Hardware components of the first part.

This needs and embedded language to work correctly and give their result. Arduino C language is used for programming microcontroller.

When an event is occurred, part1 sends SMS message to android mobile by GSM. Part2 uses haversine formula to determine nearest helping center. Google map application is used to accident loacation. Mymobkit application based IOT technique is also used to exchange the messages between the parts. Fig 2 illustrates the center emergency part of the system.

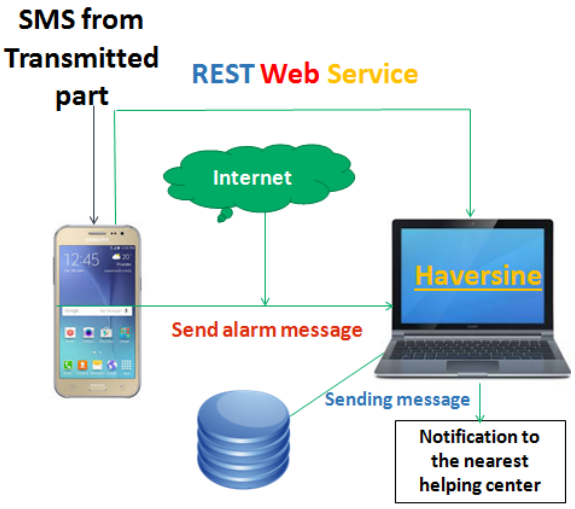

Figure 2. Central Emergency part.

2. REQUIREMENTS SPECIFICATIONS

Before The functions or the services of the proposed system are presented as high-level abstract statements through the following classification:

A. Functional Requirements

1) The Location (latitude, longitude) and the type of events (explosion, earthquake, accident, and fire) are automatically detected.

2) Provide facilities for rapid alarm and immediate response.

a) The system should send an alarm message SMS (containing location and event emergency type) to central emergency monitoring part and then to specialize helping center.

b) The system must be able to determine the nearest helping center from emergency event.

3) Database of emergency state is provided for reviewing and analysis.

4) Monitoring and tracing the path should be providing.

A. Nonfunctional Requirement

B. Three types of nonfunctional requirements are considered: Quality, platform and methodology requirement.

1) QUALITY REQUIREMENTS

- *Response time:* - The system must be designed in a fast response time because any delay may cause a casualty. The average time of EAS from detect to intervene must be less than 30 second in worst case.
- *Reliability:* - The system must be reliable enough to get their goal, EAS should be continuously running.
- *Availability:* -The system should be useable all the time to perform their goals
- *Allowances for maintainability and enhancement:* - The system allows to add some new hardware or software to increase the efficiently.

2) PLATFORM REQUIREMENTS

This type of requirement includes the environment and technology of the system:

a) Computing platform:- the system works on windows 7 operating system /64 bit with 4GB RAM / 1.80GH processor, Arduino Uno microcontroller R3 ,Sound sensor, three push button which express on three emergency states(earthquake, fire, car accident), GSM, GPS and external antenna, Android phone, Bread board, Led, ,Resistance, Jumper wires, SIM, PC, power supply and Cable.

b) Technology used:- The system uses Arduino C language, Microsoft visual studio .net 2012, Microsoft SQL server 2012, proutes software, also many another tools and libraries includes (.NET Framework 4.0, Adafruit , Attsoftserial, and GSM libraries) , (Mymobikit IOT application , StarUML, and Google map application) and (Internet service(Wi-Fi)).

3) METHODOLOGY REQUIREMENTS

The system uses the object oriented methodology using Unified modeling Language (UML).

3. USE CASE DIAGRAM

The functionality of the system is modeled by use cases. Each use case is a task that stimulate by one or more actors. The system has three actors (Administrator, Sub-EAS (secondary actor), and Helping staff), also the (Association, Generalization, Inclusion and Extension) relations between use cases. Fig 3 depicts the general use case model of the system.

4. ACTIVITY DIAGRAM

Fig 4 illustrates the activity diagram that shows the sequence of activities to be held in the system. There are three parallel directions in which the system will work. The system can login, detect emergency event, trace the location, send message to second part in which in turn receive and resend the message after calculates the shortest path of two places

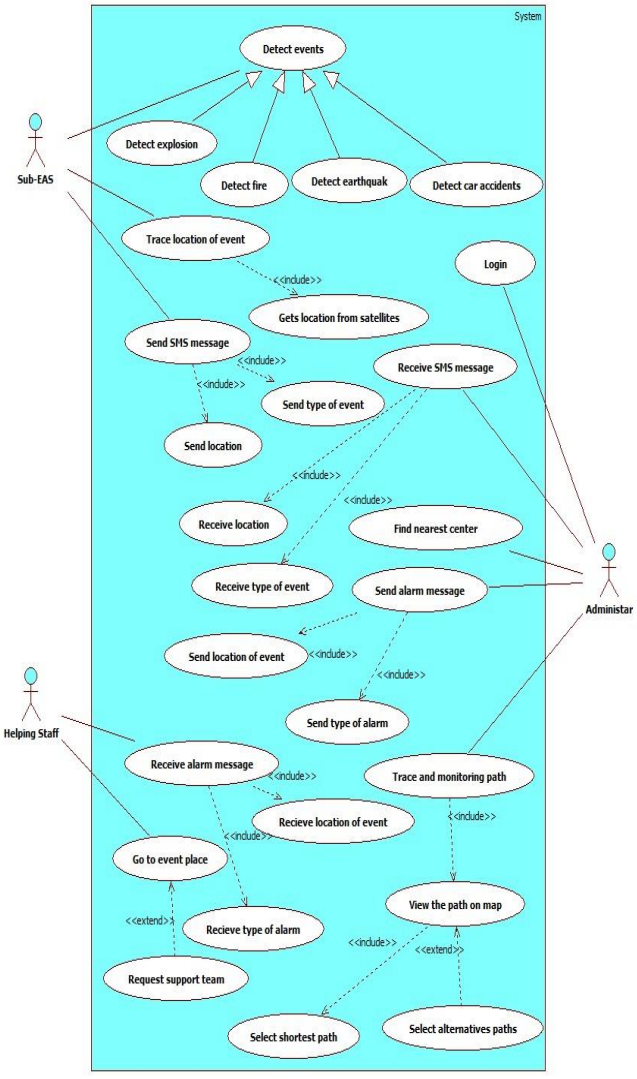

Figure 3. Use case diagram of the system.

5. SEQUENCE DIAGRAM

Fig 5 shows the sequence diagram. This sequence diagram shows the sequences of the work in the system. The Sub EAS performs its functions in transmitted part by sending message to Android mobile by GSM and transferred to PC using REST web services technology. An algorithm is used to determine the nearest helping center. The path between an accident place and nearest helping center is tracked using Google map application.

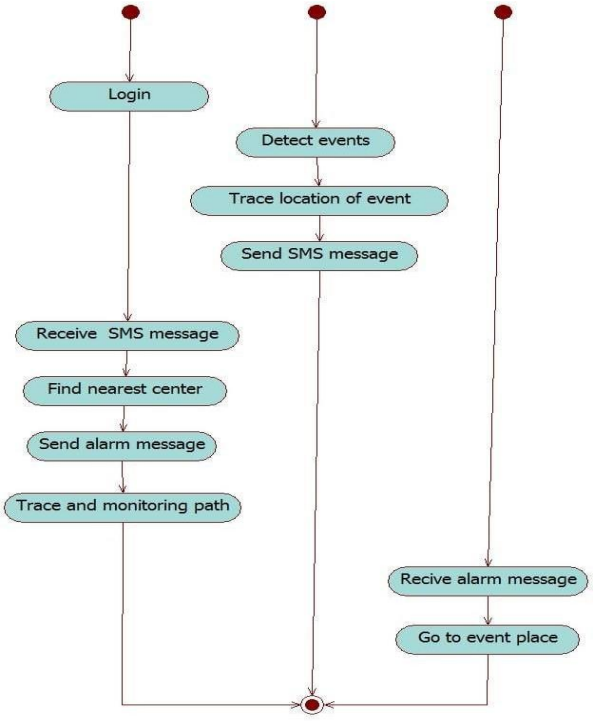

Figure 4. Activity diagram of the system.

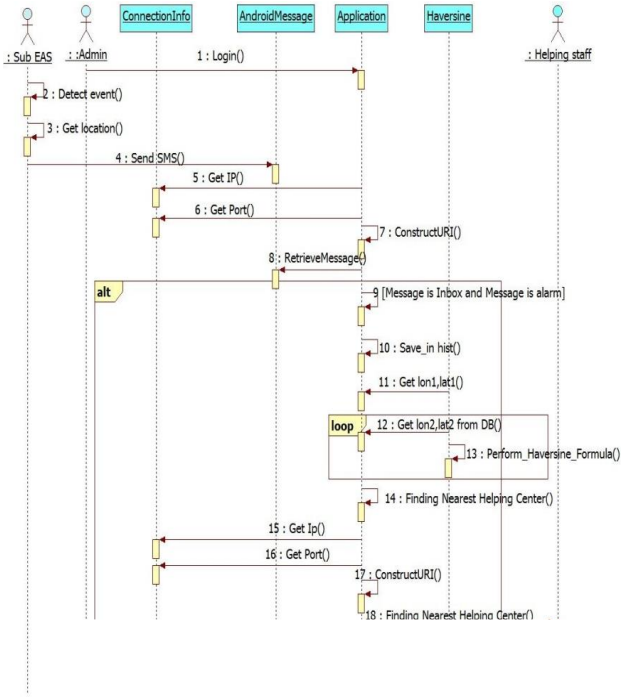

Figure 5. Sequence diagram of the system.

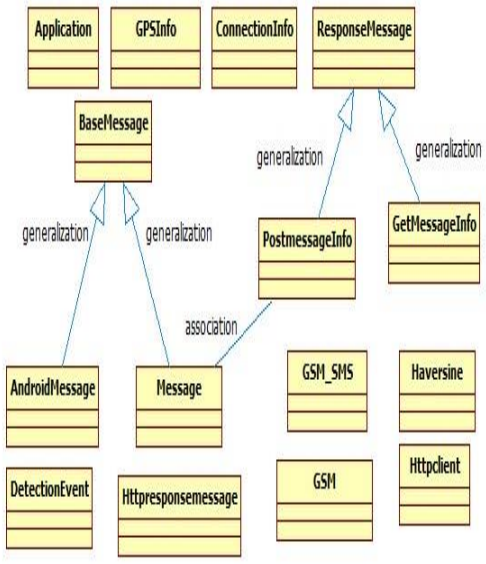

Figure 6. Class diagram of the system

6. CLASS DIAGRAM

The system is modeled by class diagram. This model includes all attributes and operations that are needed to investigate MEAS prototype. Fig. 6 above illustrates the classes and their relations (association and generalization).

7. CASE STUDY

The system is tested in many different places. Consider an accident with location (33.374436, 44.384382) and there are five police centers with locations listed in column two and three of table 2.

TABLE 2. Example on haversine formula .

No	*Lat Coordinate*	*Lon Coordinate*	*Haversine distance*
1	33.352610	44.388478	2.457 km
2	33.362848	44.423145	3.825 km
3	33.294581	44.437466	10.16 km
4	**33.386373**	**44.387146**	**1.352 km**
5	33.391616	44.362891	2.763 km

Haversine formula is used to calculate the distance between the accident and the police centers according to their latitude and longitude. Column four of table 1 shows the results and refers that location number 4 is the nearest. Fig.7 illustrates the path traced by Google map from location to police station. It is important to mention that the GPS in part1 is programmed with Arduino language to determine the location of accident. Also, a database is designed in part2 to store the names of all hostpitals and police centers with their locations. This database the input to the Haversine algorithm to calculate the nearest one to the accident location and to support drawing path on Google map using C# language. The alarm message consists of: -

1) The first word (alarm) which used as a keyword to different between alarm message and others in mobile inbox.

2) The second word is (Explosion, Fire, Accident, Earthquake) which express on event type.

3) The two numbers (x, y) represent the location of event in form of (latitude, longitude).

Figure.8 illustrates alarm message that rustleed from transmitted part.

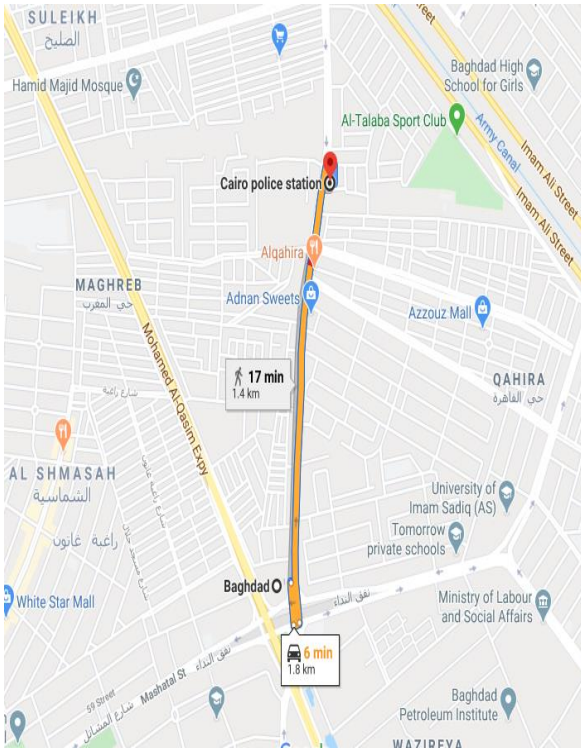

Figure 7. Shortest and alternatives paths

Figure 8. Types of alarm system

8. CONCOLOSIONS

From testing results, the following remarks are extracting: -

1) The system used cloud technology to store all SMS messages. SMS getaway service solved a problem for transmitted information from part to another using web services technology.
2) The proposed system is IOT application using IP address for transmitted information.
3) The problem of duplicate sending message has been processed successfully.
4) The proposed system dealt with critical situation, so we must take into consideration the time span between the moment of detection and the moment of intervenes. The elapsed time that needs from the moment of accident occurrence and the moment of intervening in the best case is 11.5seconds and 20.5 seconds in the worst case.

9. FUTURE WORKS

The following suggestion has been stimulated during this research.

1) Using Vincenty's formula for more accurate that based on the assumption that the figure of Earth is an ellipsoid rather than a spherical figure.
2) Adding new sensors to increase systems functionality.
3) Adding a new hardware such as camera in the vehicle to Auto-observation and surveillance, and adding some facilities that enable to implement Auto-monitoring alarm system.
4) Develop embedded system using Arduino hardware to detect the type of explosion materials.
5) Develop embedded system using Arduino to determine the type of gases that pass from the accident.

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