Research Article **Open Access**

Landmark Based Shortest Path Detection in Alarm System

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ArticleInfo

Submitted
14/10/2017

Accepted
19/12/2017

Abstract
In this paper, an alarm system for four types of emergency states (explosion, car accident, earthquake and fire) is built. The proposed system divided in to two parts: transmitted part (Arduino, sensors, GSM and GPS), and emergency part (central site and sub center sites). Central site consists of (Android phone, Server while Sub center sites (helping centers) contain the mobile phones of competent authorities like police center or hospital. The alerting as a SMS message is sent by GSM. The system used Haversine formula to determine the nearest sub center from emergency state that receives the SMS alarm message from transmitted part. Also the path is tracked using Google map application.

Keywords: Arduino, GSM, GPS, Proteus, Google map, Haversine.

الخلاصة
في هذا البحث، تم بناء نظام إنذار لأربعة أنواع من حالات الطوارئ (الانفجار، حادث سيارة، الزلزال و الحريق). وينقسم هذا النظام إلى جزأين: الجزء المتنقل (اردوينو، وأجهزة الاستشعار، النظام العالمي للاتصالات المتنقله ، نظام المواقع العالمي)، وجزء الطوارئ (الموقع المركزي، المواقع فرعيه). الموقع المركزي يتضمن (هاتف الاندرويد,الخادم)، المراكز الفرعية (مركز مساعدة) تمثل الهواتف النقالة للسلطات المختصة مثل مركز الشرطة أو المستشفى. يتم إرسال التنبيه في هذا النظام كرساله قصيره بواسطة النظام العالمي للاتصالات المتنقله. استخدم النظام صيغة هافرسين لتحديد أقرب مركز فرعي من حالة الطوارئ التي تتلقى رسالة التنبيه القصيره من الجزء المتنقل. كما يتم تتبع المسار باستخدام تطبيق خريطة جوجل.

Introduction

Recently, the accidents and emergency situations are frequently occurred and no one can prevent the accident .These accidents are either natural events such as earthquakes and floods or those that are caused by someone, such as explosions and car accidents. All these situations need rapid intervention by competent authority to reduce the resulting losses in human life. Reducing as possible the time between the moment of problem occurrence and the moment of arrival the competent authority plays an important assistant for this goal.

The most important parameter of any alarm system is its reliability in performing its designated task, in addition to all such systems must be difficult to disable, easy to use and have good immunity against malfunctioning. In this paper, we design and implement a system that alert automatically when an accident is occurred. To make the system works in real time and accurate, it needs to include the supporting technologies like Global Positioning System (GPS) and Global System for Mobile Communications (GSM) technologies. GPS is used to retrieve the position of the vehicle in form of latitude and longitude coordinates, and GSM as a medium of data communication between the transmitted part and emergency part. This system suggested an important way to reduce as possible the losses by inform the nearest center to the problem by using haversine formula.

Literature Survey

Several researchers applied haversine formula in different purposes. Ganesh and Vijaya Kumar used haversine to find the distance between two points and find the location of object inside the building with better accuracy [1]. Arup Kumar Bhattacharjee and Soumen

Mukherjee used haversine to calculate distance between a customer and a store as well as compare distance with nearest store's geographical area [2]. Rajib Chandra Das and Tauhidul Alam are applied haversine to calculate the distance between current location of the user and location of nearest healthcare center in a system [3].

Materials and Methodologies

Platform Requirements

The requirements that the system needed to achieve their goal are abstracted in Table1 as hardware, software and tool requirement.

a- H.W Requirements	b- S.W Requirements
1. Microcontroller Arduino UNO	1- Arduino C language
2. GSM (Global System for Mobile)	2- Microsoft visual studio 2012
3. GPS (global positioning system)	3- Microsoft SQL server 2012
4. Sound sensor	4- Mymobikit (android application which turn)
5. Fire detector	
6. Shock sensor	**c- Tool Requirement**
7. ADXL335 Accelerometer	1- Wi-Fi service
8. Pc	2- Google map application
9. Android mobile	

Table 1: System Requirements

Arduino microcontroller

A micro-controller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/ output peripherals .Arduino Uno is an open-source single-board microcontroller, designed to connect to electronics and control them. It is able to make decisions of what to do base off of input from the outside world. Open source Arduino software is Integrated Development Environment (IDE). One of the best parts about Arduino is needed to program the boards [4] [5].

Sound sensor

Sound Sensor is used to detect the sound intensity of the environment. The main component of the module is a simple microphone, which is supplied the input to an amplifier. It uses a microphone, peak detector and buffer. When the sensor detects a sound, it processes an output signal voltage which is sent to a microcontroller then performs necessary processing. This module can be used for security, switch, and monitoring applications. It has three pins: Power, Ground and Output.

Shock Sensor

This sensor also known as vibration sensor used to detect car accident. It detects any hard impact acted on it. These sensors are distributed on all sides of the car to detect the impact. The output values of all sensors are sending into OR gate to detect at least one impact [6].

Temperature sensor

Sensor LM35 will constantly send the temperature values to Arduino. It checks the temperature value, if it is above a certain level; Arduino unit will trigger an alarm and sends a warning message to fixed center through GSM [7].

ADXL335 Accelerometer

The ADXL335 is a complete 3-axis acceleration measurement system. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration [8]. In this system used to detect the earthquake state.

GSM (Global System for Mobile)

Global system for mobile communication is digital mobile telephony system and completely optimized for full duplex voice telephony. GSM modem is a specialized type of modem requires a SIM card provided by a network operator to interface with the cellular network [9]. Arduino GSM shield is used in this system.

GPS (global positioning system)

Global Positioning System (GPS) is a satellite based, medium earth orbit (MEO), navigation technology. GPS provide location, speed and direction information to its users this information collected by at least 24 satellites. GPS have very low accuracy in the cities which have high buildings and narrow streets because the limited number of satellites that found [10]. In this system used GPS in transmitted part to get the coordinate of the vehicle.

Proposed System

The general idea of the proposed system is depicted in figure 1.The system consist of two parts Transmitted part and emergency part.

The aim of the paper is to find out the shortest path between event place and helping center site (hospital, police center) using GPS technology. The mechanism of the work is started from transmitted part. When the sensors sense the problem, GPS get the location from satellite. GSM will send SMS message to emergency part. Arduino microcontroller is controlled on all these modules (Sensors, GPS, and GSM). These modules need embedded language to give its designed goal. Assembly C language is implemented as powerful tool for supporting these modules to work efficiently. The task of Emergency part is receiving the SMS.

Figure 2 illustrates the type of alarm messages which sent to mobile .The message is started with alarm word then type of event (explosion, car accident, earthquake, fire) and the location of event as (latitude and longitude). The SMS is sent to server by using web services technologies. All the real location (latitude, longitude) of helping center site and its phone number are stored in specific Data Base. Haversine formula is used to find the shortest path between locations that taken by GPS and locations in database. The alarm message will be sent to nearest helping center and the shortest path will be view in Google map application.

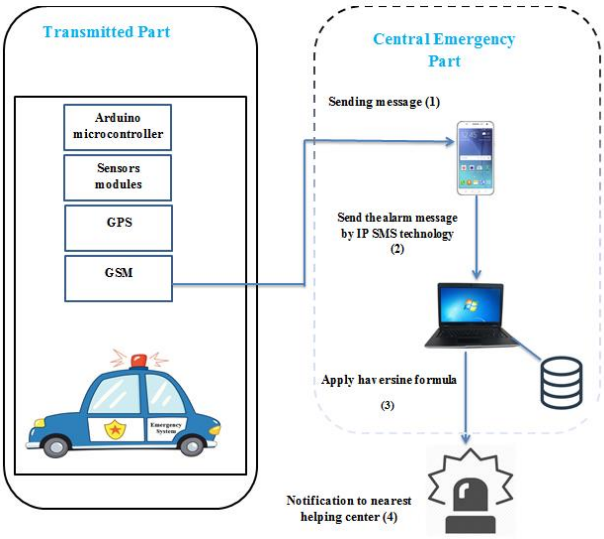

Figure 1: Overview on the proposed system

Figure 2: Alarm Messages Types.

Calculate distance between geographical points

There are four different methods to calculate distance between any two geographical points. These are, the 'Spherical law of cosines', 'Haversine', 'Vincenty Sphere' and ' Vincenty Ellipsoid'. The 'Vincenty Ellipsoid' assumed the earth to be an ellipsoid while others assume it is a Sphere [11] .Haversine Formula gives minimum distance between any two points on a sphere. It is an important equation in

navigation, giving great-circle distances between any two points from their longitudes and latitudes [12]. Haversine formula is employed in our system for calculating the distances between event location and the nearest sub-center. This is described in equation (1) to (3):

$$d = R.C \quad (1)$$

Here, R = earth's radius (mean radius = 6,371km)
Where "d" is the distance between two places:

$$C = 2.atan^2(\sqrt{a}\ ,\sqrt{(1-a)}) \quad (2)$$

$$\Delta latitude = latitude2 - latitude1$$

$$\Delta longitude = longitude2 - longitude1$$

$$a = sin^2\left(\frac{\Delta latitude}{2}\right) + cos(latitude1) \cdot cos(latitude2) \cdot sin^2\left(\frac{\Delta longitude}{2}\right) \quad (3)$$

Consider two points. "*latitude1*", "*latitude2*" stand for latitudes, "*longitude1*", "*longitude2*" stand for longitudes of two points and "$\Delta latitude$" stands for difference in latitude of two points and "$\Delta longitude$" stands for difference in longitude of two points. Figure 3 describes the pseudo-code to compute the distance between two locations p1 and p2 using Haversine. Each p1 and p2 is given as latitude and longitude.

Pseudo coding1: Preform Haversine formula

Input: *point P1 (lat1, lon1), point P2 (lat2, lon2)*
R=637, 1 km// radius
Output: *d // the distance between p1 and p2*
Begin
$\Delta lat = lat2 - lat1$
$\Delta lon = lon2 - lon1$
$a = sin^2\left(\frac{\Delta lat}{2}\right) + cos(lat1).cos(lat2).sin^2\left(\frac{\Delta lon}{2}\right)$
$C = 2.atan^2(\sqrt{a}\ ,\sqrt{(1-a)})$
$d = R.C$
End

Figure 3: Psuedo code of Haversine distance.

Finally the proposed system perform Algorithm 1to find the nearest helping center.

Algorithm 1: Determine Optimal SubCenter

Input: eventlocation // location of event (latitude, longitude).
Helpcenters// array of all locations of helping centers in Data base
Output: pos // location of nearest helping center
Begin
Step 1:
For i= 1 to no. of helping centers in database
D(i)=heversine(helpentecnter(i) , evenlocation)
EndFor
Step2: pos = minimum (D)
End.

Simulations Results

Proteus software is one of the important software that used in simulation and especially in microcontroller simulation, schematic capture, and printed circuit board (PCB).It is used to get the beginning result for any project and for testing the circuit and check if a system is working successfully. The sensor that used in the proposed system is checked using **Proteus** software. Figure 4 shows the circuit with description for each component.

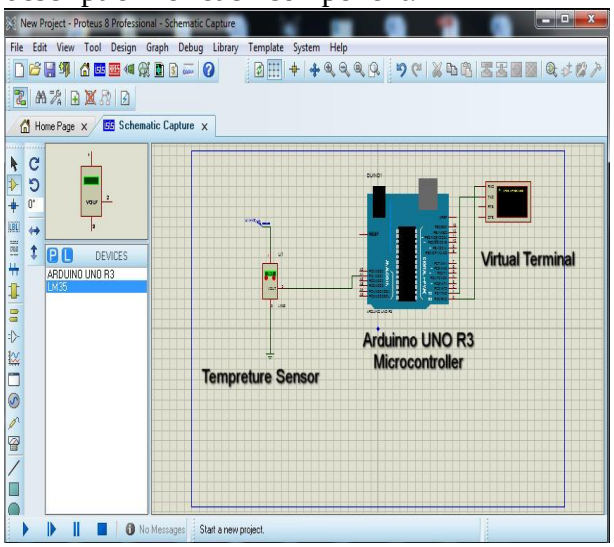

Figure 4: Temperature sensor simulation

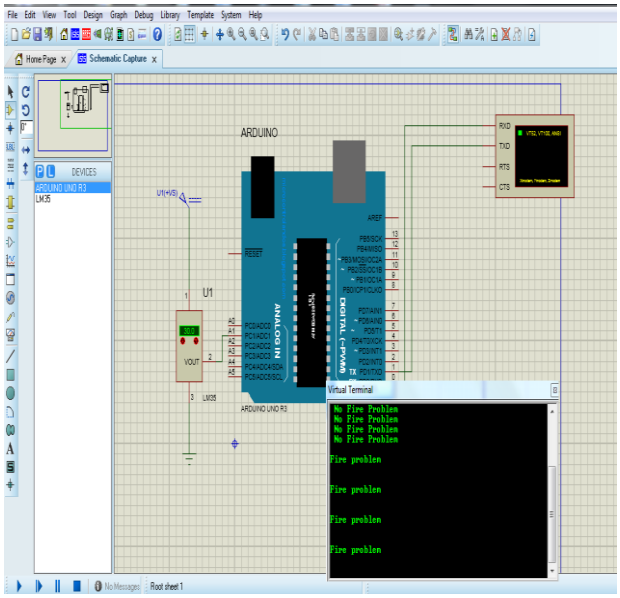

Figure 5: Runing of the project.

If the tempruture degree >= some threeshold as example 55°C (assumption value) then the sensor will give a signal to arduino and a worning message will apper, othorwise if the tempruture degree < 55°C then no thing occurs. Figure 5 shows the runing of project.

Results and Discussion

In this system, haversine solves a big problem by quickly response from nearest sub center and thus decrease the number of victims and the value of losses. Table 2 shows an illustration example of the algorithm of five police centers in database and an accident location is 33.374436, 44.384382. Both latitude and longitude are measured in decimal degrees. The nearest center is the Cairo Police Station.

The proposed system used Google map application to show the nearest path between the place of event and the place of helping center.

Figure 6 depicted the nearest path with alterative paths which offer by Google map.

Our objective have been achieved and the maximum time that need from the moment of accident occurrence and the moment of intervene in worst case is 20.5 second, and minimum time is 11.5 second in best case. This time is very optimal for alarm systems to decrease the casualties and for fast response.

Table 2: Example of Haversine Distance

Helping center Name	Lat. Coordinate Lat (i)	Lon. Coordinate Lon(i)	Haversine distance (km)
Bab Al-Mu'adh Police Station	33.352610	44.388478	5910,47
Al-Kana Police Station	33.362848	44.423145	5908.916
Al-karadah Police Station	33.294581	44.437466	5916.267
Cairo Police Station	33.386373	44.387146	5906.267
Al-Sulaikh Police Station	33.391616	44.362891	5906.483

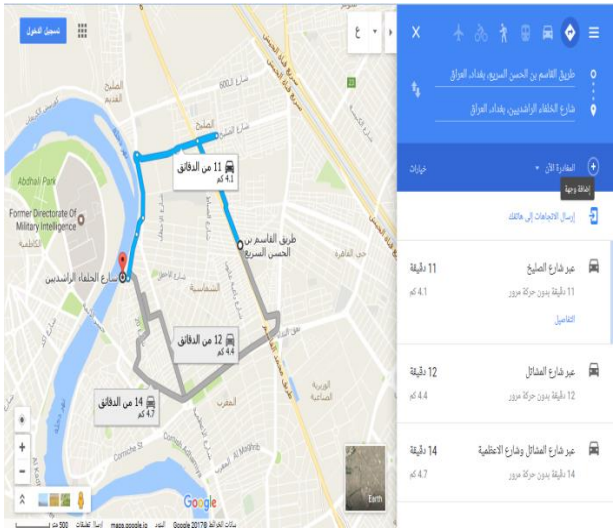

Figure 6: Optimal and alterative paths

Conclusion

Hence, Haversine formula is used to determine the nearest sub center from accident place using GPS technology. Also, Microcontroller will be used to develop a smart emergency system that alert emergency center remotely. The system sends SMS alarm to emergency center that analysis and monitoring the events also send the alarm to nearest helping center and display the path on Google map application. Proteus software is used to test the system and check the result. Decrease the

victims and loss is the main constraint of this work. The system can be easily implemented with high reliability, high security and low cost.

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