Development of a Real Time Road Accident Location and Emergency Alert System

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Development of a Real Time Road Accident Location and Emergency Alert System

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Abstract

The fatality rate as a result of road accidents will be greatly reduced if the relevant response agencies are alerted as soon as these accidents occur and also given the location of these accidents. Interstate trips often include several hours of continuous driving on long and lonely roads and often times, accidents are only responded to by other road users who are not equipped to provide the required emergency assistance. This is further compounded by trips undertaken during the night as the number of other road users is much fewer and the chances of any other road user stopping to offer assistance to the accident victims is almost nonexistent. This work presents the design and development of a system to be installed in the car for generating automatic alerts in the event of a road accident. The system is designed to automatically transmit the GPS location of the vehicle to the controller station in the event of an accident. The controller collates this information and transfers the location, date, the phone number and other details of the registered uses to the emergency response teams. To facilitate a rapid response, the city is grouped into cells with dedicated emergency response teams and trauma hospitals for each cell. The controller sends the accident alerts to the emergency response teams and the trauma hospitals covering that area. In the event that the ambulance is unavailable, the ambulance of the nearest cell receives the message and moves to locate the accident victims. This system provides an opportunity to minimize the fatalities of road transport accidents due to the late deployment of emergency response teams and lack of information on the accident location

Keywords: Road Traffic Accidents, GPS, GSM, Emergency Response

INTRODUCTION

The fatality rates of road transport accidents are increased by a delay in the deployment of the emergency response teams to the locations of the accident. This is reinforced by the Golden hour Philosophy which recognizes that casualties have a much poorer chance of survival if they are not delivered to the right emergency medical care within one hour from the time of the accident. [1]. the golden hour estimates are represented in figure 1

Golden hour		
Cumulative Time	**Action**	**Time Taken**
0 minutes	Accident Occurs	0 minutes
5 minutes	Call to Emergency Services	5 minutes
15 minutes	Turnout & Travel to incident	10 minutes
30 minutes	Extrication	15 minutes
35 minutes	Package and transfer to Ambulance	5 minutes
60 minutes	Transport to Hospital	25 minutes

Figure 1. Golden hour time estimates [1]

From these data ,the call to the emergency services is the most critical activity as without it, the emergency response cannot be deployed. The lack of accurate location of the accidents especially on interstate routes and during night time travels is a major impediment to the deployment of emergency services. Emergency response teams have been located at selected points on highways and several countries have setup specialized agencies for monitoring the roads and the road users but the efficiencies of these agencies will be greatly enhanced if they are notified in real time whenever an accident occurs and if they are also notified of the location of these accidents [2] [3] [4]. This work presents the design of a system to be installed in cars and vehicles such that in the event of an accident, the system automatically sends the vehicle coordinates to a central controller which in turn notifies the relevant agency of both the accident and the location. The city is grouped into areas and each area is assigned an emergency response team comprising of an ambulance and the required personnel.

Table 1. List of selected countries with road traffic death rate between 0-10 deaths per 100,000 [5]

	Estimated number of road traffic deaths	Estimated road traffic death rate (per 100 000 population)
Country	**2010**	**2010**
Hungary	908	9.1
New Zealand	398	9.1
Italy	4 371	7.2
Brunei Darussalam	27	6.8
Canada	2 296	6.8
France	3 992	6.4
Australia	1 363	6.1
Spain	2 478	5.4
Finland	272	5.1
Singapore	259	5.1
Germany	3 830	4.7
Ireland	212	4.7
Israel	352	4.7
Switzerland	327	4.3
Netherlands	640	3.9
United Kingdom of Great Britain and Northern Ireland	2 278	3.7

Table 2. List of selected countries with road traffic death rate between 10-20 deaths per 100,000[5]

	Estimated number of road traffic deaths	Estimated road traffic death rate (per 100 000 population)
Country	**2010**	**2010**
China	275 983	20.5
Rwanda	2 118	19.9
Afghanistan	**6 209**	**19.8**
India	231 027	18.9
Gambia	325	18.8
Russian Federation	**26 567**	**18.6**
Kuwait	**452**	**16.5**
Republic of Korea	6 784	14.1
Qatar	**247**	**14**
United Arab Emirates	**956**	**12.7**
Argentina	5 094	12.6
United States of America	**35 490**	**11.4**
Democratic People's Republic of Korea	2 614	10.7
Bahrain	**132**	**10.5**

Table 3. List of selected countries with road traffic death rate from 20 deaths per 100,000 [5]

	Estimated number of road traffic deaths	Estimated road traffic death rate (per 100 000 population)
Country	**2010**	**2010**
Dominican Republic	4 143	41.7
Thailand	26 312	38.1
Venezuela (Bolivarian Republic of)	10 791	37.2
Iran (Islamic Republic of)	**25 224**	**34.1**
Nigeria	53 339	33.7
South Africa	15 995	31.9
Iraq	**9 962**	**31.5**
Guinea-Bissau	472	31.2
Oman	**845**	**30.4**
Malaysia	7 085	25
Namibia	571	25
Saudi Arabia	**6 800**	**24.8**
Kazakhstan	3 514	21.9

From the data, the countries listed in Table 1 have the lowest death rates per 100,000. This list is populated more by European countries. Table 2 contains a list of countries with a death rate in road traffic accidents of between 10 and 20. Table 3 comprises of a number of African and the Middle East countries. Among the Middle East countries, Iran has the highest death rates of 34.1 followed by Iraq with 31.5 and Oman with 30.4 while Saudi Arabia has 24.8. Other Middle East countries such as the UAE, Qatar, Kuwait and Bahrain are listed in Table 2. The high death rates recorded in these Middle East countries cannot be associated with poor state of roads as can be argued for some of the African Countries [6][7] because most of the roads in these countries are in excellent state. However, the development of an automatic system for localizing and aiding the rapid deployment of emergency response teams will greatly reduce the death rates in these countries

SYSTEM DESIGN

The system comprises of the vehicle unit and the controller units.

A. Vehicle Unit

The vehicle unit is designed to be installed in the car and it serves as the system for detecting the occurrence of an accident and also notifying the controller of the location of the accident. Figure 2 shows the block diagram of the vehicle unit

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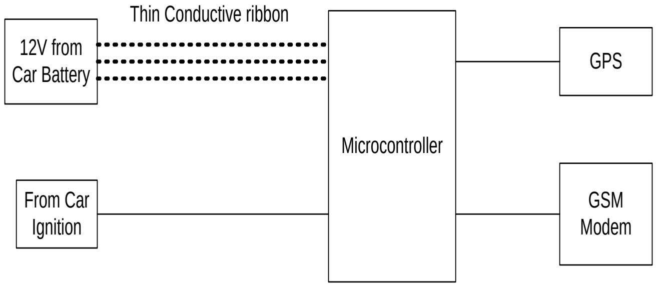

Figure 2. Vehicle Unit

The Vehicle Unit which is dedicated to the vehicle and the registered owner comprises of a microcontroller, a GPS receiver and a GSM Modem. The system utilizes a thin conductive strip which is to be strapped across the steering wheel for vehicles with airbags and connected to a 12V source. This can be the car cigarette lighter port. The system is activated by the ignition system of the vehicle and it stays on for as long as the ignition is on. In the event of an accident, the deployment of the airbags breaks the conductive ribbon and this is interpreted by the Microcontroller as the occurrence of an accident. The GPS receiver is configured to take its location readings at regular intervals and also store the last 5 locations. In the event of an accident, these location data is sent to the system controller.

B. Vehicle Unit Algorithm

The algorithm which controls the vehicle units operations is listed below

i. With car ignition on, the GPS reads its location every 10 seconds and stores up to the latest 5 location data
ii. The microcontroller monitors the port connected to the ribbon continuously.
iii. If the conductive ribbon breaks while the ignition is ON, this is interpreted as an accident and the microcontroller sends the message *(_Vehicle number_ just had an accident at _GPS Location_)* to the system controller

C. Controller Unit

The controller unit coordinates the communication between the vehicle units and the Emergency Response Teams (ERT). The city or region to be covered is broken down into cells with emergency response teams and ambulances assigned to each cell. The cell areas are selected such that the response teams will require minimal time to get to any location within their cell. The block diagram of the controller systems, the cells and the ERT are shown in Figure 3

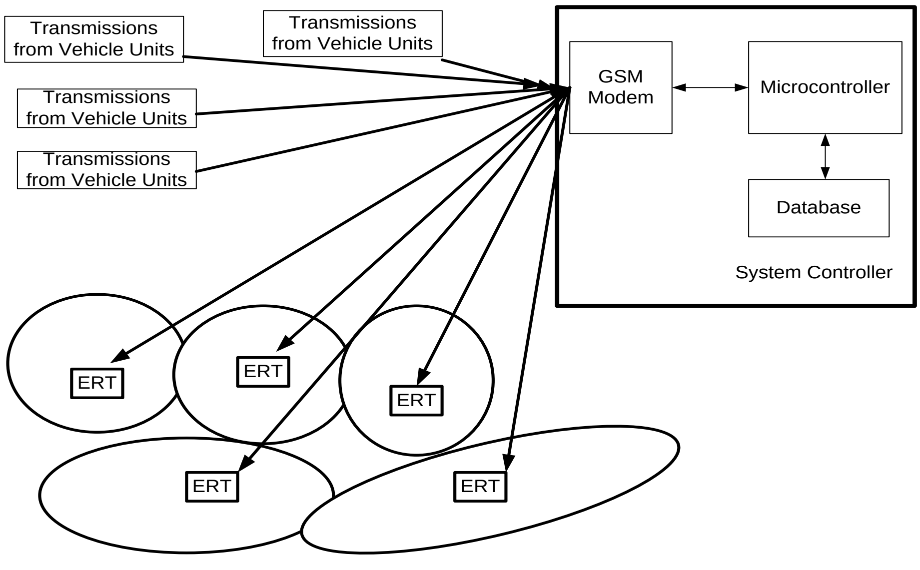

Figure 3. System block diagram for the Controller Units

The controller station maintains a database shown in table 1 comprising of the GPS range of the different cells and the phone number of the ERT covering the cells.

Table 4: Controller database

ERT Phone number	Cell coverage	GPS range of the cell	Police Station

D. Controller algorithm

The algorithm that controls the operation of the controller is listed below

i. The controller receives transmission from the vehicle units
ii. The controller compares the GPS location in the received message and determines the cells that the GPS coordinates fall within.
iii. The Controller send a predefined message (Accident *at location ___GPS Location___*) to the ERT team covering that location and as an optional feature, the

system sends the same message to the police station so they can provide traffic control or security cover for the emergency team to function especially during the night.

CONCLUSION

The system provides a low cost solution to the challenges associated with accurate location of accidents especially on interstate routes and during night time. The system is capable of reducing the rate of fatalities associated with road transport accidents especially as it relates with those fatalities caused by delays in the arrival of emergency response. The system is capable of providing national coverage due to the use of the GSM technology. The key challenge with the system is in the lack of network coverage in remote regions of the roads. This challenge is however very minimal as most regions and most highways are covered by the GSM technology. The vehicle units system can also be programed to utilize multiple SIM based Modems where the system switches between the different networks as the vehicle moves across the coverage areas of the different network providers.

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