Vehicle Accident Detection, Reporting and Navigation by using IoT Method

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***Abstract*—** One specific worry that Public Safety Organizations (PSO) must record for while taking part in numerous exercises is diminishing the impact of vehicle mischance's, supporting whatever number harmed individuals as could reasonably be expected and giving every minute of every day on the spot protect. The Red Cross compassionate association is a standout amongst the most known PSOs to be available on location at whatever point a mischance or a debacle happens. Be that as it may, a portion of the protect groups confront trouble in contacting the harmed individuals to due late alarms and inadequate data of the particular mishap area. The coming of the cell phone and Internet of Things (IoT) ventures reshaped the way individuals convey and conveyed a change in perspective to open and private administrations [1]. This consistently developing innovation denoted the start of new time influencing the lives of individuals and different organizations. This paper passes on a savvy and dependable IoT framework arrangement which right away tells the PSO headquarter at whatever point a mishap happens and pinpoints its geographic facilitates on the guide.

At the point when a mishap happens, a stun sensor distinguishes it. At that point, a calculation is connected to process the sensor flag and send the geographic area alongside some subordinate data to the PSO headquarter, demonstrating mischance event. This is a promising framework anticipated that would help in the monotonous saving procedure by detailing in a matter of seconds the area of a mischance, the travelers harmed, blood classifications, in this manner bringing down death's rates. The topographical information gathered from this framework could be depended upon as allowable confirmation or pointer of the street state and conditions.

Keywords— Public safety organization, accident, rescue, IoT, sensor, geographical coordinates.

I. INTRODUCTION

According to the Association for Safe International Road Travel (ASIRT), nearly 1.3 million people die in road crashes every year, 20-50 million are injured or disabled. Road crashes cost USD $518 billion globally, costing individual countries from 1-2% of their annual GDP. Currently, Road traffic crashes rank as the 9th leading cause of death and account for 2.2% of all deaths globally. Unless movement is taken, road traffic injuries are anticipated to become the fifth leading cause of death by 2030.

The challenges imposed to local PSOs in saving human lives resulting from vehicles accidents have become a crucial concern due to the huge aforementioned number of departed people. As far as many injured could lose their lives, and since no on-site medical assistance has been provided promptly as a result of: (1) late accident reporting, (2) inaccurate geographic location, and (3) lack of injured medical information, the need for automated and intelligent mobile solution tackling this burden becomes a must.

The contemporary current answers that offer assistance to passengers in case of car coincidence occurrence are particularly worried with consumer interaction after the incident happened. those cellular solutions require that the injured should release the app and request help manually and that would not be feasible if he/she is underneath critical or serious non-essential situation. The situation becomes even worse if passengers went under unconscious nation.

Our proposed solution is a smart IoT system consisting of architecture, design, and implementation. This device requires no user interaction at some stage in or after the accident; therefore, it offers immediate automatic automobile coincidence detection and reporting. This technique is applicable for any automobile used in transportation and mainly for cars accidents. The primary customers of this answer are the public protection organizations rescue teams (like pink go, Emergency management groups, law Enforcement corporations, fire Departments, Rescue Squads, and Emergency scientific services, and so on…). The main contributions of this paper are: (a) Developing a new smart IoT solution which helps the community in reducing the death rate resulting from vehicle accidents. (b) Ensuring that no passenger (injured) intervention is required during or after the accident. (c) Transmitting automatically the basic medical information needed by the rescue teams to the PSO headquarter. (d) Collecting geographical data which can be fed to a data mining engine to extract roads conditions, and to generate descriptive statistics reports about vehicle accidents. (e) Implementing a navigation system to find the closest rescue team to the crash.

This project starts with descriptive statistics about car accidents delivered by ASIRT, the challenges imposed to local PSOs in saving human lives resulting from car accidents. Sections II, III, IV, and V describe the related work, the proposed method, design and architecture, and implementation consecutively. Sections VI and VII expose results, conclusions, and future work.

II RELATED WORK

This section overlooks similar existing solutions and examines their advantages and disadvantages. Auto Accident App**,** developed by Platinum Peak LLC [3], is a mobile phone application to offer free, assistance to accident victims. It provides one-button access to emergency personnel and step-by-step guidance through the information gathering process to ensure that no critical information or evidence is missed. The main disadvantage is that it serves only as a form of manual reporting about the accident after it is being taken place. Hence, it doesn't really provide any form of rescue for the passengers.

Auto Accident App, developed by the Murphy Battista [4], is a useful application for individuals who commonly or even occasionally find themselves behind the wheel of a vehicle. It features time saving forms that allow users to clearly collect accident information. Not being automated is considered a drawback of this application.

Accident Report, lets you create an accident report (a PDF file) in a simple and organized way, as required by insurance companies and the police, without missing important details during an accident situation. The main disadvantage of this app is that it focuses on reporting and doesn't provide any sense of rescue. All the solutions lack an automated smart approach to accident detection, reporting and navigation. This paper proposes a new method which overcomes the above stated applications' weaknesses.

III METHOD

In this section, we elucidate our proposed system at a high level scope. The system is composed of the following phases:

(a) Vehicle registration and preparation,

(b) Passengers' registration,

(c) Monitoring accidents through a web interface located in the PSO headquarter.

Vehicle Registration and Preparation:

This phase deals with the process of vehicle registration. The vehicle's owner must prepare the vehicle for this system by installing the IoT device. After installing the device, the owner gives the Vehicle ID to the operator responsible for vehicles registration in the head quarter's database. This would lead the PSO to recognize that the registered car satisfies the pre-situations to be integrated in the system.

The IoT device encompasses four modular components: shock sensor, GPS, NFC reader, and cellular IoT. Those combined modules altogether spontaneously notify the rescue organization headquarter whenever an accident takes place, pinpoint the exact location, and recognize the passengers inside the vehicle on the headquarter map. The triggered sensor signal reports the vehicle's identifier along with the accident's location which appear on a web-based interface in the rescue center. This enables the rescue teams to respond immediately. The whole record of passenger's information is uploaded to the head quarter's database once the registration process is complete

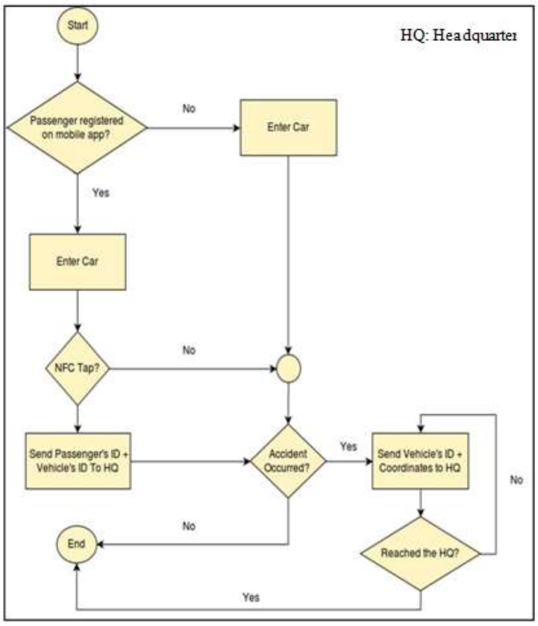

Fig. 1 – System Flowchart

Passengers' Registration:

The mobile application aims at providing a one-time only registration form for passengers' personal data. The personal data include: (a) Full name, (b) Blood type, (c) Phone number, (d) Email, (e) Medical history, (f) Date of birth, (g) Reference phone number.

Monitoring Accidents: When a passenger gets in the car and taps the Near Field Communication (NFC) handheld device (mobile phone), the passenger's ID and the vehicle's ID are transmitted and stored into the head quarter's database (see Fig. 1). Consequently, the database server establishes the mapping between the pre-registered personal information and the passenger's ID. As a result, the head quarter can recognize exactly the information of the passenger inside the vehicle.

This process can be applied to all passengers in the car. The IoT Bluetooth Low Energy (BLE) communication protocol can be used as an alternative to NFC, to signal the presence of the passenger inside the vehicle. In case of vehicle's accident, the airbag, or any shock detection mechanism triggers the shock sensor and consequently a Hypertext Transfer Protocol (HTTP) request alerting the occurrence of an accident and its geographical location is sent to the server. Since the server has previously recognized the passengers inside the vehicle, it can now spot the passengers that are in danger.

A rescue team can then be sent immediately to the acknowledged location carrying out appropriate medical support since pre-medical info have already been identified by head quarter's operator.

IV DESIGN AND ARCHITECTURE

The below system architecture is the conceptual model that defines the structure, behavior, and more views of our proposed system.

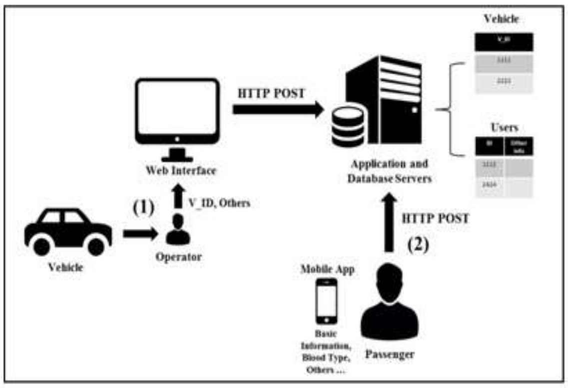

Fig. 2 – Registration Phase Architectural Diagram

On the other hand, the passenger registers himself/herself on the server through the corresponding mobile interface. This would make a passenger eligible to get into any equipped vehicle and benefit from the rescue facilities provided by the system.

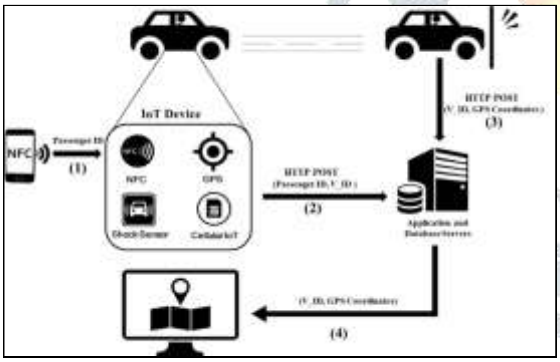

Fig. 3 – Monitoring Phase Architectural Diagram

The monitoring phase discussed in section III is illustrated in Fig 3. When the user taps the NFC enabled device (mobile phone) to the IoT node, an HTTP request holding the passenger's ID and the vehicle's ID, is sent through the IoT cellular network to the application/database servers. If a passenger decides to leave the car, he must tap again the NFC enabled device for the record to be removed from the database. Another alternative could be to store the information The preparation/registration phase discussed earlier is illustrated in detail in Fig 2. The operator registers the vehicle using its vehicle ID through a web interface connected to the database server. As a result, the Vehicle table in the database now comprises records pertaining to all registered vehicles. Locally in a memory, thus reducing the number of transactions are on the server.

On the server side, a table containing the current trips is maintained. Each trip consists of its passengers and the vehicle's ID. In case of accident, another HTTP request containing the vehicle's ID and the GPS coordinates (longitude and latitude) is sent to the server in which all records' attributes are stored in the database and inserted to an XML file simultaneously (see Fig. 4).

```
<markers>
  <marker status="Pending" car_id="263463_0" lat="33.88497" lng="35.52343"/>
</markers>
```

Fig. 4 – XML File Containing Current Accidents

Technically, the webpage is reading asynchronously from the XML file the child entries "marker", and updating the map without having to refresh the page repetitively. While reading the XML file, a pin pops up on the map indicating the location of the accident.

When the operator browses the map, locates and clicks on the pin, a popup window is displayed, showing all passengers' information. This allows the rescue team to prepare the required medication, treatments, and toolkits beforehand.

V IMPLEMENTATION

Hardware Components

In our implementation we have used an IoT device containing different components and modules as well as communications capability. The main components of this device are:

1 Shock sensor

Shock sensor can be integrated in various ways to match the vehicle requirements.

It could be activated by vibration or triggered by highly effective safety system airbag. This airbag system contains several components and mechanism which all work together to ensure the physical integrity of the passengers to the highest degree [6]. The sensitivity of the employed sensor is adjusted to meet the standards adopted in safety airbag systems.

2 Global Positioning System (GPS)

GPS navigation is a component that accurately calculates geographical location by receiving information from GPS satellites. [7] The SKM53 GPS module device is used to send to server the exact vehicle location.

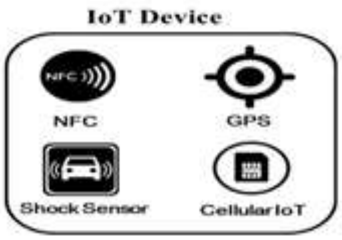

Fig. 5 – IoT Device Components

1. NFC Reader

Near field communication (NFC) is a set of communication protocols that enable two electronic devices, one of which is usually a portable device such as a smartphone, to establish communication by bringing them within 4 cm (2 in) of each other (tapping) [8].

An NFC reader is used to identify each passenger by detecting his/her ID. Then the IoT device sends and matches this ID with the corresponding remote database entry.

2 Cellular IoT

It is required to implement cellular IoT 3rd Generation Partnership Project (3GPP) technologies: Extended coverage Global System for Mobile communication (ECGSM), Long Term Evolution (LTE), Long Term Evolution Machine to Machine LTE-M, and the new radio access technology Narrowband IoT (NB-IoT) specifically tailored to form an

Software Components

The mobile application is built using Android Operating System. Hypertext Preprocessor (PHP) is used for server-side scripting, Raspberry Pi open-source prototyping platform for data and signal processing. In addition, a near field communication (NFC) component is used to read the user's data from the mobile. The Raspberry Pi board was programmed using the Python programming language. A GPS component is used to send the exact location of the vehicle that had the accident. Finally, MySQL is used as the Database Management System (DBMS).

Navigation

In our proposed system, a navigation mechanism is implemented using the Haversine function to determine all distances between the accident location and all widespread rescue teams. The Haversine formula is an equation important in navigation, giving great-circle distances between two points on a sphere from their longitudes and latitudes. [10]

```
Require: Points – A list of points identifying the location of rescue teams
Require: AccPoint – A point representing the accident's location
Output: Sorted list of distances in ascending order
  DistanceList← empty
  i ← 0
  for CurPoint in Points do
    DistanceList { i++} ← Haversine (AccPoint, CurPoint )
  end for
  Sort (DistanceList)
  return DistanceList
```

Fig. 6 - Pseudo code for Determining the Nearest Point

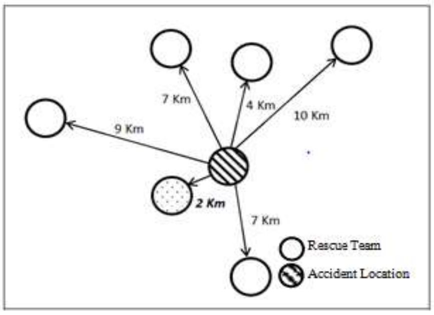

Fig. 7 – Points Distribution Example Scenario

The list of all calculated distances is sorted in ascending order to determine the second nearest rescue team whenever the former team is not available. (see Fig. 6) A push notification of the accident's location is sent to the closest available rescue team which can now use the Google Map service to determine the shortest route to destination.

V RESULTS

This section shows a simulation of some important features implemented in our system. (1) On the headquarter side, Fig.6 illustrates a pin instructing the occurrence of an accident.

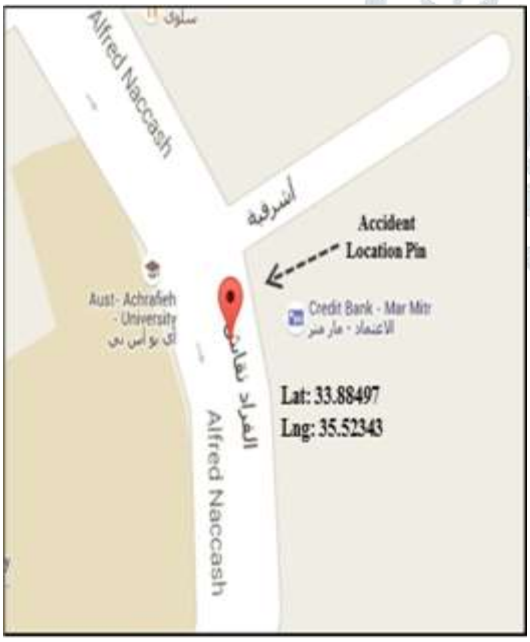

Fig. 8 – Detecting Accident

The guide likewise demonstrates the geological directions (longitude, scope) of the mishap area. (2) When the administrator taps on the stick, a popup window is shown, demonstrating all travelers' data. This permits the safeguard group to set up the required medicine, medications, and toolboxs heretofore as appeared in Fig. 9.

Fig. 9 – List of Passengers and their Information

Passengers Information

+ Coming

Name	Age	Phone	Blood Type	Email	Allergy
Elie Kfoury	25	+961[illegible]	A+	ekfoury@aust.edu.lb	None
Elie Nasr	45	+9[illegible]54	O+	enasr@aust.edu.lb	None
David Khoury	50	[illegible]6123	B	dkhoury@aust.edu.lb	None

Fig. 10 – List of PSO's Rescue Teams

(3)In Fig. 9, when the administrator push on the "+ Coming" catch, another popup windows is shown demonstrating an arranged rundown of all save groups alongside the ascertained separations to mischance area (see Fig. 10).

Team Number	Location	Distance from Accident
Team 1	Ashrafieh	02 KM
Team 3	Hazmieh	05 KM
Team 2	Broumana	08 KM

Fig. 11 – Accident's Location Sent to the

Rescue Team Leader

(4) In Fig. 10, when the administrator select "Group 1", a message pop-up is sent educating Team 1 pioneer to course to the mishap area as appeared in Fig. 11.

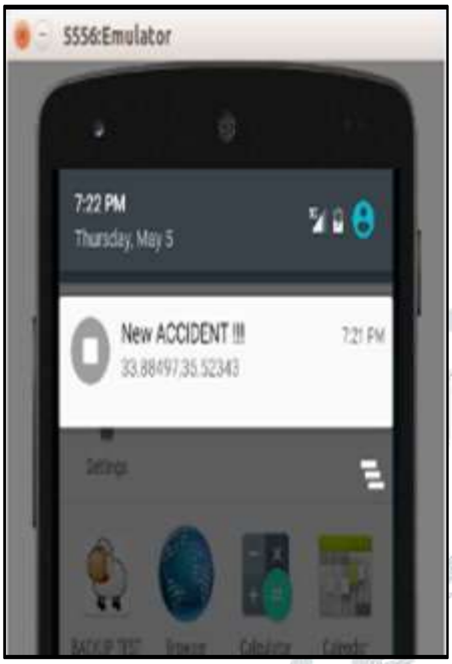

Fig. 12 – Routing from Team Location to Accident

Fig. 12 demonstrates the track that the group must cross to achieve the mischance area.

Performance

The heap on the server isn't considered as gigantic as the quantity of exchanges is constrained to the quantity of mischances amid a timeframe. Consequently, the quantity of detailing isn't colossal contrasting with any typical application in the market. In the elective where the traveler data is put away in the auto, the quantity of exchanges will be even lower.

With respect to cautions conveyed by the sensor, no less than three alerts ought to be sent to affirm the mishap. In the event that one caution is sent, at that point it is considered as flawed alert.

VI CONCLUSIONS AND FUTURE WORK

In this paper, we proposed and implemented an IoT system which may help the community lowering the death rates resulting from vehicles accidents. Results showed that this solution provided many advantages compared to standard systems, namely, minimizing injured passengers interaction, providing basic medical information to rescue teams, recognizing exact and accurate accidents locations, and facilitating the routing process.

Reliability test showed that the system is robust, that is, available and serviceable specially when the IoT device keeps sending continuous notification of crash occurrence until it makes sure its reception by the headquarter as shown in Fig. 1. additionally the records accrued from this machine can be fed to facts mining engine and as a result, can serve the PSO in producing statistical reports related to the range of injuries, number of injured, financial institution of blood donors, and avenue conditions.

Our destiny imaginative and prescient is to enhance the gadget and push ahead toward integrating it into every car at some point of the producing section. also, this gadget can be controlled to get passenger facts using a number one key just like the Social safety wide variety (SSN) from a governmental centralized database.

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