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An IoT Enabled Assistant for Vehicular Emergency

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Abstract: Internet of things (IoT) deals with billions of intelligent objects which can be connected to sense and collect the data and also communicate with surrounding people using mobile, wireless and sensor technologies. We present a vehicular emergency service based on cloud computing. In a situation, unfortunately if a car meets with an accident, the device implemented in the car will immediately notify the cloud database. It will send information such as car details, location and type of emergency to the cloud server. The server then based on the location of the car will find the nearest help centre and will notify about the emergency occurred along with its location. An interactive communication and real-time location tracking system prototype has been designed with Raspberry Pi Model B along with GPS and GSM technology.

Keywords: Internet of Things, Vehicle Emergency System, Raspberry Pi, Emergency Location Tracking, GPS, Cloud Computing.

I.INTRODUCTION

We are living into the world of technology and internet and are moving very fast towards making the planet smart enough where each and every device will be connected to each other. Internet of things [1] is the technology which is helping the mankind to achieve the goal of making the smarter planet. IoT change the view of human towards the way of living. All developing countries are taking efforts to transform themselves into smart country by making their cities smart [2]. The Government of India has also taken the initiative called the Digital India [3] to connect the nation to the internet and making it digitalized in every aspect.

A. *Necessity of Vehicle Emergency System*

In smart city every device is connected to the Ubiquitous network [4] continuously. They can be communicated anytime regardless of the hardware and software infrastructure. Machine to Machine communication (M2M) [5] is growing in very fast phase to make the machines more intelligent and shared in nature. In today's world machines are made smart enough to get the surrounding details and get adjusted themselves according the need and work in any condition on their own. In this paper considering the need of the smart city we have stated the life savior system for any smart vehicle which is in any kind of emergency situation that can occur on road. Most of the modern cars are equipped with all the necessary rescue system which activates on collisions or crashes. All the cars are connected with several sensors, mechanical devices, software, embedded systems, etc. to save the car from the accident. All car manufacturers consider 'Safety' and 'Security' as the major criteria for any vehicle. These modern safety systems are very much useful to the driver and the passengers on the road to avoid them from accidents. But these safety systems have a limitation of that these systems can only avoid them. But unfortunately if the system fails to avoid the accident or there is another situation other than accident then those systems have no provision to tackle them or deal with them. Consider if there is mechanical problem in the car then the existing safety system cannot deal with this situation. A study revealed the in India 141,256 people were killed by different road accidents [6] in 2014. Many were killed due to the late arrival of the emergency services. So if the accident information and location is sent immediately to the nearest emergency service provider then there is a hope that many lives can be saved.

B. Novelties of Proposed System

In this paper, we have proposed an emergency system which can track location of any vehicle when it is in emergency situation and can communicate with the help centers. This system works by aiming to minimize the damages after the vehicle meets any unfortunate situation like accident by sending an emergency message to the nearest hospital in case of medical emergency situation. It is also useful for other emergency situations such as criminal problem, civil emergency and also for the mechanical problem in the vehicle. When the vehicle meets with any situation then the system can

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be triggered by pressing the right emergency button and send the details to the server. Server then finds the nearest help center as per the emergency stated and forwards the message to them. To find the nearest help center we have used Haversine formula [7] to calculate the distance by coordinates.

II.EXISTING WORKS AND RESEARCH MOTIVATION

Internet of Things and Smart City are emerging research topics and are gaining much attention of the researchers on the global level. The exponential growth in this field is taking us rapidly towards the smart planet. This is not only a theory but Padova smart city [8] has actually proved that a fully IoT enabled city can be achieved in reality. In [9] the authors have proposed a GPS based location tracking system able to collect location information and send it through SMS. But the drawback of this system is that it is totally manual system.

In [10] the authors have discussed the impact of Intelligent Transport System for future intelligent systems. They have also discussed the emergency services that can be used in the ITS in future. In [11] the authors have introduced a system that can detect car accidents and provide situational awareness to the emergency responders using smartphones and wireless mobile sensor network. But the system in not integrated in the vehicle and is manual system and sometimes need third person to send the complete emergency information.

Ford also provides similar types of facilities by their Ford Sync [12] app in their cars. This system shows the list of all the emergency contacts on the smartphone. This system is completely dependent on user's smartphone. Authors of [13] introduce ARRS that detect the accident and report it. It uses image processing to detect vehicle crash from camera videos.

General Motor's project OnStar [14] is designed to provide smart assistance to their vehicles. It facilitates driving assistance, route direction and navigation service to its customers. Along with this it also provides emergency communication services, but unfortunately the drivers can only contact the vehicle's manufacturer or emergency numbers (e.g. 911). Contact to the local emergency service provider is not possible which can cause delay in rescue operation. Similarly, many vehicle manufacturers provide only the roadside assistance to the emergency situation. They lack in providing a particular emergency service such as medical, civil and/or criminal emergencies. The following table gives the list of emergency services provided by the manufacturer.

The vehicles mentioned in the table provide only the roadside assistance but not the emergency service which is required at that time. The concerned authorities are not informed at proper time this drawback can be avoided by implementing the proposed system in these vehicle's which will provide the exact emergency service to the location automatically in less time.

Table 1: Various Emergency Services Provided by Cars

Sr. No.	Car Name	Emergency Services provided	Price (in Lakh)
1	Mahindra XUV 500	Android Auto, Connected apps, Eco Sense and Emergency call facility	14.87
2	Hyundai Creta	Roadside Assistance	14.55
3	Renault Duster	Renault Assistance / Roadside Assistance via phone call	13.61
4	Honda City	Roadside Assistance	13.68
5	Volksvagen Vento	Roadside Assistance	13.87
6	Skoda Rapid	Roadside Assistance	13.77
7	Jeep Compass	Security Alarm, Hands free connectivity and control &SiriusXM guardian	14.95
8	Chevrolet Tavera	Roadside Assistance	10.74
9	Nissan Terrano	Roadside Assistance	14.32
10	CheveroletCruze	Roadside Assistance	14.20

III. PROPOSED SYSTEM AND DESIGN DOCUMENT

The proposed system is divided into three modules, the device installed in the vehicle, cloud server and the rescue center. The emergency situations are classified into five different types depending on the characteristics. Each module is discussed in detail in the below sections.

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A. General System Architecture

This proposed system is highly necessary and it is the integral part of any smart city for proper safety and security. The most important part of this system is that is has five buttons for eachof the emergency situation located on the dashboard of the vehicle. The user presses any of the button when met with any situation and then the location and details are sent to the nearest rescue center. The cloud server automatically finds the nearest rescue center and forwards this message to them. Then the concerned authorities send the proper rescue teams to the emergency location. The table gives the description of the five types of emergencies with the authorities to be contacted during emergency.

Table 2: Emergency Type and Authorities

Emergency Type	**Emergency Name**	**Contact Authorities**
Type 1	Accident	Police Station, Hospital
Type 2	Medical	Hospital
Type 3	Criminal	Police Station
Type 4	Civil	Govt. Office
Type 5	Mechanical	Car Workshop

To store all the necessary and emergency information in vehicle, server and rescue center we need well structured databases. There should not be communication delay as that can be dangerous for the person who is in need of help. The database on the car will contain information about the car and the owner of the vehicle. Also the contact number will be stored on the database. For providing immediate service the cloud server will have database consisting information about all the rescue centers with the location of them. In the rescue center database, the information about the emergency service provided to the location is stored for future references.

B. Emergency Situation Node

In this system, the vehicle needs to be equipped with some hardware that can detect the emergency. For tracking the location of vehicle we need GPS device which will return us the location coordinates. But if GPS is not available then we can get the location by using other services like Google's Geolocation service [15]. Here in this system we have used Google's Geolocation service to get the latitude and longitude of the emergency situation place in real-time. This service must have a platform to get implemented so we are using Raspberry Pi 3 Model B hardware in the car for the development. A USB 4G modem is required to keep the device continuously connected to network and can be used to send data to the server.

Table 3: Emergency Message Structure from Vehicle

Emergency Message		
Emergency Type	Location (Latitude, Longitude)	Car Info.

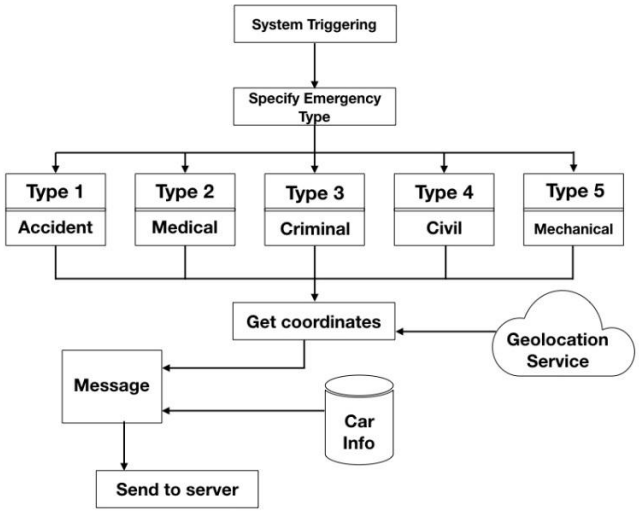

Fig. 1. Vehicle Architecture

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The system need manual triggering to send the information to the rescue center. The message is generated with all the required information. The emergency message contains emergency type, location and information of the car with emergency contact numbers. The structure of the message is shown in the figure. The entire architecture for vehicle is shown in figure.

C. Cloud Server

The server is the central point which has all the information stored about the rescue centers and vehicular emergencies on the road. The main task of the server is to receive the emergency message form the vehicle and locate the nearest rescue center according to the type of emergency and send them the notification. So when any emergency message come to the server it immediately starts finding the nearest rescue center from its own database. To calculate the distance for rescue center we have used Haversine formula. The structure of server is shown in figure.

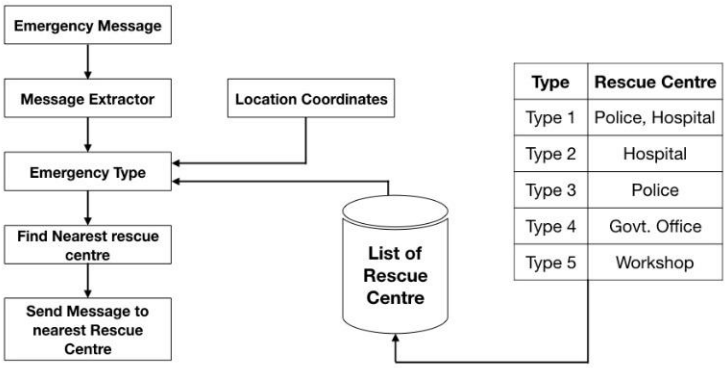

Fig. 2. Server Architecture

Distance Calculation: Distance calculation is the major part of this system. When a vehicle sends message, the location is extracted from the form the message and then distance comparison is done according to the type of emergency. The distance between two points (x1, y1) and (x2, y2) can be calculated using Equation1.

$$Distance = \sqrt{(X2 - X1)^2 + (Y2 - Y1)^2} (1)$$

But this formula is only applicable for flat surface and as earth surface is spherical we can't use this formula for calculating distance more than 20 kilometers. So we have to use Haversine formula as follows.

$$dlong = long1 - long$$
$$dlat = lat1 - lat$$
$$a = \left(\sin[\![\left(\frac{dlat}{2}\right)^2]\!] + \cos lat * \cos lat1 * \left(\sin[\![\left(\frac{dlong}{2}]\!]\right)\right)^2$$
$$c = 2 * arctan2(\sqrt{a}, \sqrt{1-a})$$
$$d = R * c$$

Where,
$lat =$ Latitude of the emergency location,
$long =$ Longitude of the emergency location,
$lat1 =$ Latitude of rescue center 1,
$long1 =$ Longitude of rescue centre 1,
$R =$ Radius of Earth (6371 km),
$d =$ Distance between emergency location and rescue centre

D. *Rescue Center*

Rescue centers are categorized with their mode of emergency services. For accident emergency, all nearby police stations and hospitals are listed with their emergency service details. Similarly, for medical emergency, all nearby hospitals are listed with their details. For civil emergency all nearby Government offices are listed and for vehicle breakdown emergency all the car workshops are listed. The primary task of this center is to whenever an emergency comes from the server on their desktop application they have to send the appropriate rescue team to the location. The emergency location is shown in the map on their

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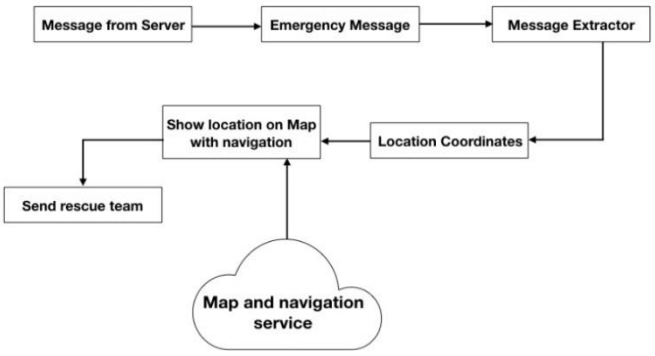

Fig. 3. Rescue Centre Architecture

desktop application with route directions and navigation service [16] provided by Google so that they can reach the emergency location at the earliest. The architecture of rescue center is shown in figure.

IV. RESULTS AND DISCUSSIONS

Proposed emergency system is able to send message automatically to the cloud server with all the relevant emergency information. The location of the situation is sent and the nearest rescue center is located using the Haversine formula so that the rescue team can reach the location at the earliest. The nearest rescue center is calculated from the database and an automatic message is sent to them on their desktop application. The message displays the location and other details of the vehicle and the situation. This system is semi-automatic and does not require any control room for detecting the nearest rescue center. Not only accident, other types of emergency options are also provided to the driver that can take place on the road.

V. ADVANTAGES AND DISADVANTAGES

The advantages of this emergency system are as follows. This system detects the emergency and sends notification to particular rescue center. The tracking of the location is done automatically. Also locating the nearest rescue center is automatic. Implementing this system can reduce the rate of deaths caused due to accident as the help is provided in very less time. The disadvantage of this system is that if the device is not connected to network then this safety system will not work. This proposed system in not offline.

VI. CONCLUSION AND FUTURE ENHANCEMENT

In this paper, we have proposed an emergency system for the vehicle which is in emergency situation on the road. This system is semi-automatic in nature that can help us to minimize accidental and other emergency damages.

This prototype is mainly designed for the smart cities and can be implemented in any vehicle. This safety system can also be used in the existing cities which are still in development phase. This proposed system sends the location and details of the vehicle to the nearby help center or the concerned authorities. This system can't avoid the emergency issues taking place. This system is dependent on several hardware and software in the vehicle to detect any accident or emergency.

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