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VANET Based Vehicle Tracking Module for Safe and Efficient Road Transportation System

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Abstract

Vehicular ad-hoc networks (VANETs) include vehicle-to-vehicle and vehicle-to infrastructure communication. This paper describes a project for implementing major applications of VANETs. In this, a novel smartphone integrated driving safety application along with a traffic signal priority control method in an effort to clear the path for emergency vehicles is modeled. The system consists of an On Board Unit (OBU), an android app titled SMaRTDRIVE (Systematic Management of Road Traffic through Data Retrieval In VANET Environment),a server and Road Side Units (RSUs). The OBU is placed inside the vehicle. RSU is to be placed at the road intersections. The server constitutes a hosted database and a web application.

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Keywords: Ad-hoc;Android; SMaRTDRIVE;VANET;Wi-Fi Direct.

1. Introduction

Road safety is one issue that needs unique attention as there's one death reported every four minutes on the streets of India[1]. India holds the most noteworthy number of deaths caused by road accidents. About five lakh street mishaps were accounted for in 2013 in which more than five lakh individuals lost their lives. A substantial amount of the victimized people were somewhere around 30 and 44 years old. Reliable with a web article revealed in

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Deutsche Welle[2] by Murali Krishnan dated 29.04.2010, The record in deaths due to accidents in India has touched a new squat, as toll rose to at least 14 deaths per hour in 2009 against 13 the past year. According to another article in the Times of India, by Dipak Kumar Dash, dated Aug 17, 2009, our nation leads the globe in accident deaths on roads. Our Government and Automotive industries nowadays pay more attention towards traffic management and regulation of safe and efficient traffic measures. They are now investing many resources to prevent the adverse impact of dangerous traffic situations on human beings, thereby increasing traffic efficiency and road safety. The advancements in technology have opened more opportunities in this context. One among the foremost promising areas is that the study of the communication between vehicles and between vehicles and Road Side Units (RSUs), that result in the emergence of the Vehicular ad hoc network (VANET)[4].

Application related to emergency vehicles is a typically cited use case of VANET. The main traffic problems that we are facing these days are traffic congestion and undetected accidents that occur at the spare time. There are many cases of death reported due to the delay in arrival of ambulance to the hospital at the right time. The crucial time between an accident and getting medical attention for the victim can often be the difference between life and death. Regrettably, very few worth that precious time on the grounds that most are afraid of legal complications. Also, this delay can be caused by the congested traffic and waiting for the ambulance at the traffic signals or due to the negligence of the bystanders. It would be great if the emergency vehicle gets information about the accident location details at the right time and its routes to the hospital are cleared provided the signals in its direction of travel are ON without causing a delay. In addition to the normal method of siren, emergency vehicle can use radio communication to pre-empt traffic lights. Such an application can cut back accident risks throughout the emergency response journey and facilitates saving of valuable time.

In this concern, here we designed a VANET based system that disseminates traffic related messages in a vehicular network. The project's objective is to develop a system that can facilitate reporting and hence alerting the drivers about things happening in their surrounding region thereby extending the range of emergency warnings. It also describes a traffic signaling method to complement the existing traffic signalling for pre-empting the traffic lights in case of emergency. Other drivers can be warned earlier and are provided with detailed information about the route of the approaching emergency vehicle. This enables them to react timely and appropriately so that they do not block the emergency vehicle. Also a pedestrian carrying a Smartphone installed with SMaRTDRIVE app can report about road accidents, hazards and congestion that come across his journey directly to the authority on click of a button and avail emergency service to the injured without involving into its legal side. In case if the user is driving, facilities are provided such that the OBU kept inside the vehicle detects the accident automatically and reports it to the authority. The paper is organized as follows. Section 2 presents the related work and background. In section 3, the architecture of the proposed system is presented. Conclusions are presented in section 4.

2. State of the Art

In the past years we have been watching a surging enthusiasm toward enhancing the applications for traffic management and road safety, to decrease the road hazards, congestion and accidents. In this manner, gathering road traffic information routines have been developed impressively. Strategies focused around the vehicle's location, in the same way as the Floating Car Data (FCD) [5], are a guaranteeing savvy answer for surmount the constraints of preset street side detectors. The guideline of FCD is to gather ongoing activity information by placing vehicles through Global Positioning System (GPS) or cell telephones. However, recovered information couldn't be so correct to gauge go times. A few upgrades to the FCD procedure have been proposed by G. Remy et al. [6], chiefly focused around a decentralized methodology, as indicated by which every vehicle expressly creates its own particular information before transmitting it over the system. In the decentralized FCD construction modeling [6] the creators propose the Long Term Evolution (LTE) innovation to remotely exchange position and kinematics data. In this General Packet Radio Service (GPRS) and Universal Mobile Telecommunications System (UMTS) are utilized to unite every vehicle with the remote server.

Smartphone support many radio interfaces, for instance, both Wi-Fi and 3G technologies, which can be used to enhance data retrieval in VANET. Jorge Zaldivar et al. [7] proposed an Android based application that screens the vehicle through an On Board Diagnostics (OBD-II) interface, having the capacity to identify accidents. The application responds to positive discovery by sending insights about the accident through either email or SMS to predefined targets, promptly took after by a programmed telephone call to the crisis administrations An Android application is proposed by K. Athavan[8] to locate and notify mishaps. The Smartphone peruses Controller Area Network (CAN) transport information through the setup of a Bluetooth association with an On-board Diagnostics (OBD) interface. The application scans the vehicle speed, the airbag sensor status, and accelerometer data; if a mishap happens then it is speedily informed, by sending SMS or an email or a telephone call to the crisis administration. In another article[9] the utilization of Smartphone is recommended to revise awful driving propensities and the outlined smartphone application coupled with sensors can discover the driving example and propose new practices to diminish the fuel utilization. A context-aware embedded system was designed and implemented by S. Cai et al. [10] to deploy context-aware applications.

This project is further influenced by the expansive business accessibility of low-cost gadgets that permit private clients, even credulous, to effectively get access to their vehicle's parameters. For a discrete information gathering to be effective, the client cooperation is a key necessity. From one perspective, many people may be hesitant to join this sort of initiative, since they are compelled to purchase the hardware and to manage the cost of correspondence expenses to transmit gathered information via the Smartphone. Even then, a developing number of drivers are ready to pay to have admittance to use this facility. The boundless accessibility of Internet integration empowered by level rate memberships can fortify nationals' contributions in the information gathering. Likewise, the quick development of social networking could further propel clients to furnish their vehicles with a SMaRTDRIVE like app for actualize 'Social IoT' (Social Internet of Things) applications.

3. Proposed System

This project is a novel Smartphone integrated driving safety application that makes use of a dedicated hardware equipped within the vehicle to interact with the vehicle and its surroundings. Unlike existing solutions, the software is designed also to perform the selection Wi-Fi Direct technology for data transmission between vehicles. The Hardware units so designed is a different approach implemented in real-time. It is a simple to-utilize arrangement, which just requires the client to interface the Smartphone empowered with SMaRTDRIVE, to the OBU platform. It anticipates an android application module in the Smartphone responsible for user interaction with the server and other users.

1.1. Proposed System architecture

The system consists of an On Board Unit, an android app in the Smartphone, a server and Road Side Units (RSUs). The OBU is placed inside the vehicle. RSU is designed to place at the road intersections. The server constitutes a hosted database and a web application. The android application so developed is titled SMaRTDRIVE (Systematic Management of Road Traffic through Data Retrieval In VANET Environment). It is integrated into a navigation system that permits access road maps, current location and route information through an interface. The app is so developed that a pedestrian carrying a Smartphone installed with SMaRTDRIVE also can report any accidents or road hazards directly to the authority on click of a button and avail emergency service to the injured without involving into its legal side. In case if the user is driving, facilities are provided such that the OBU kept inside the vehicle detects the accident automatically and reports it to the authority. Connectivity between OBU and Smartphone is achieved through the Bluetooth technology. The communication between the RSUs is established with the RF transceiver. Vehicles can communicate with themselves through Wi-Fi Direct.

Depending upon various events such as accident, medical emergency, sudden breakdown and congestion, the Smartphone will send messages indicating the relevant data along with the location of the vehicle to the main server. The server keeps track of each vehicle and real-time traffic data. The server communicates with each vehicle and will further facilitate relevant service. The architecture of this system is shown in the Fig.1.The system components and their functions are:

- The OBU: It gathers the sensed data from vehicles. It is thus responsible for data acquisition and collection from different sensors equipped in the vehicle.
- RSU: Controls the traffic signal.
- A hosted database: to store user accounts, vehicle details, hospital details and emergency vehicle details.
- A web application:

- Website -Provides an interface to create, manage and monitor vehicle and hospital registration.
- HTTP Service- To facilitate requests from the mobile client to the database server where the data is stored it will also facilitate the communication between the client mobile devices and the database server.

- Android application-client that will allow users to participate in the SMaRTDRIVE Android application.

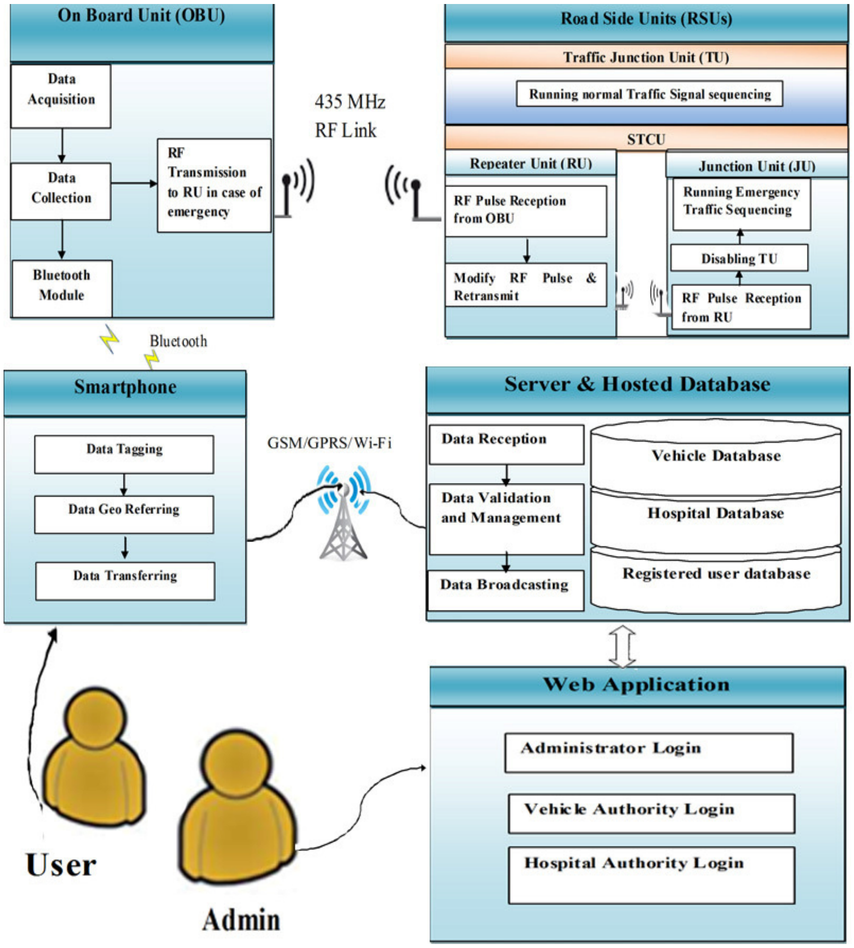


Fig.1.Proposed system architecture

The system thus is an integration of embedded, Android and .Net platforms. Fig.2 shows how the components are connected to one another. The web application is built based on the client/server model. The web application and database are on the server-side, and the mobile application is the client. Both the web application and mobile application will also make use of a 3-tier approach where each tier is developed and maintained as independent modules. Three-tier architecture has the following three tiers, as illustrated below:

- Presentation tier: This is the topmost level of the application which displays the information which the users can directly access.
- Application tier (Controllers): The application tier is also known as the business logic or logic tier. It is the middle layer, and controls application functionality by performing detailed processing.
- Data tier: This tier consists of the database server. Information is stored and retrieved here.

The data tier will implement the data model, and will exist on the server alongside the web application. The web application will provide the presentation and application tier required to allow the creation, management and monitoring of the application, but it will also facilitate the communication between the client mobile devices and the database server.

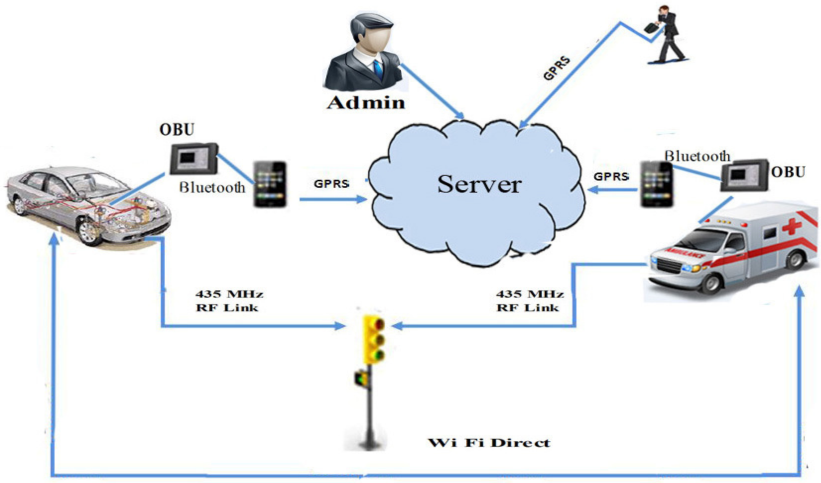


Fig.2.Network Diagram.

3.2. On Board Unit & Road Side Units (OBU &RSUs)

OBU is the data collection and pre-processing module which is kept inside the vehicle. It is realized through a dedicated microcontroller board receiving inputs from sensors, inside the car itself. It is also responsible for merging and temporarily storing retrieved data. According to the proposed system, every vehicle should be equipped with OBU. The OBU consists of an accelerometer for sensing any large scale vibration in the vehicle, and in turn detects accidents, ultrasonic sensor to detect the obstacles ahead of the vehicle and hence to check if the vehicle is keeping a safe distance from other vehicles ahead of it, a microcontroller, a buzzer, a Bluetooth module, user interface switches and status LEDs.

On reception of these sensed data, the microcontroller checks them against their threshold values. If the sensed data is beyond these values, the controller turns on the buzzer alerting the driver. The accelerometer shows x, y and z coordinate values. The controller compares them with a threshold value and if it exceeds that, then the controller automatically sends a command to the android app for triggering the accident event. The app is so designed that it starts a timer display on reception of this command. In case of a minor accident, the passenger probably would not need the service of the ambulance and can therefore switch off the timer before time out, by pressing a reset switch in the OBU. Or else, on time out it would trigger the reporting event corresponding to accident and sends the vehicle id and its current location (latitude and the longitude) to the server.

Along with this reset switch there are 2 more status switches in the OBU. One of them is used as an interface for reporting medical emergency. When this switch is pressed the controller sends a command to the android app which thereafter sends a request to the server for granting the vehicle as an emergency entity. The server grants this request and sends back details of route to the hospital to the smartphone. In case if the vehicle faces a sudden breakdown or any abnormal conditions like flattened tire, user can report it by pressing the other switch. When this happens the controller sends another command to the smartphone, which will initiate vehicle to vehicle communication activity through Wi-Fi Direct. The communication between OBU and RSU is established through the RF transceiver. When the vehicle becomes an emergency entity, it will send a unique transmitter ID via the RF transmitter. The transmission frequency for the prototype is 435 MHZ.

RSU consists of two subsystems; one for the existing traffic system (Traffic Junction Unit-TU) and the other one is a Smart Traffic Control Unit (STCU) that can work in conjunction with the existing one. Traffic signal system containing STCU monitors and controls the whole traffic and gives priority to emergency vehicles so that they will not remain at intersection points for long. STCU consists of two modules; Junction Unit (JU) and Repeater Unit (RU). The RU is designed to be placed 900m away from the JU, which is kept along with the TU at signalling Junction. When an emergency vehicle equipped with an RF transmitter approaches this Repeater unit, it sends this information to the JU. On receiving this information the JU disables TU and runs its own emergency mode sequence and turns on the green signal in that direction as soon as the vehicle reaches the traffic intersection.

3.3. SMaRTDRIVE- the Android APP

The SMaRTDRIVE app is presented in an instinctive manner and provide easy to use functionalities to accept data from the OBU and from the user. Bluetooth communication is used primarily to carry out the data communication between the OBU and the Android smartphone. A Bluetooth connection to the OBU is initiated from the SMaRTDRIVE application on the Android device while the OBU is turned on. In case the user is a pedestrian, the application can be run without invoking Bluetooth service. SMaRTDRIVE App has the following main functions:

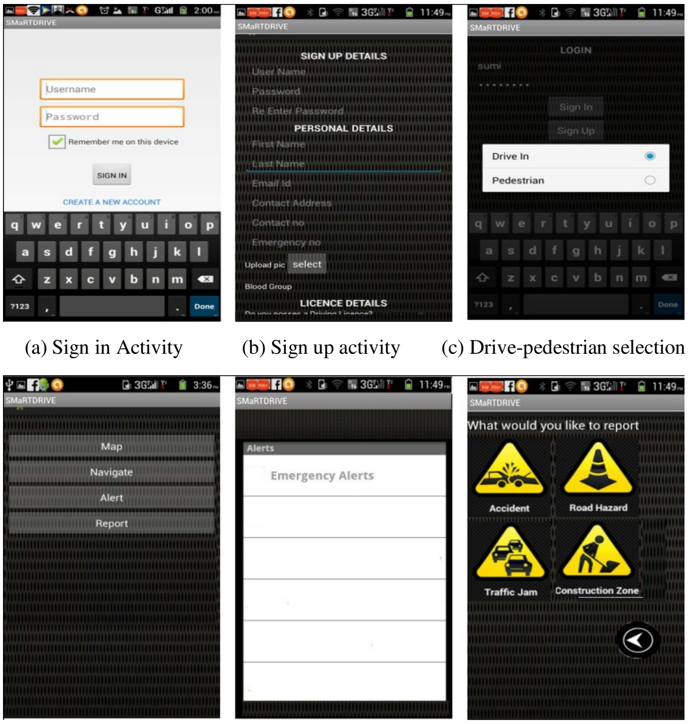
- Receiving Data from OBU.
- Setting up and maintaining connection with the hosted database and the Web Application.
- Tagging Data retrieved from OBU with the GPS information.
- Displaying information to the client through Graphical User Interfaces (GUI)
- Transmitting Data to the hosted database.
- Vehicle to vehicle communication establishment.

The data received from OBU is included with data accumulated by the mobile phone itself, i.e., GPS information, time and location coordinates. The information are then transmitted to the server. Cellular GPRS technologies and the Wi-Fi interface are used for this purpose. The server receiving the data can integrate the information provided with each vehicle. By following the location of a SMaRTDRIVE- equipped vehicle, a near real-time kinematics information can be provided with the server. The OBU module additionally reports about a sudden vehicle fault and the corresponding data are immediately transmitted over the most reliable and low-latency Wi-Fi direct connectivity interface. Thus the SMaRTDRIVE app handles;

- Safety applications to avoid crashes
- In conjunction with OBU reports automatically about accident.
- Alerts about accidents in nearby places in its route.
- Alerts and reports bout road hazards and serious traffic infringement
- Alerts and reports about approximation of emergency vehicles, and so forth.
- Applications for traffic management and monitoring, which allow warning and/or avoiding traffic jams.

The user interfaces of the app consist of 6 activity classes and one service class. The layout for different activities in an application can be defined using the XML based layout file. The first one is the “sign in” activity that is implemented as the welcoming screen. The user interface of this activity consists of linear layout components, two text views, a check box and a button widget that is used to sign in into the application and proceed to the next activity. If the user is a new user then, after the launching application he will have to create a new account. For this purpose after clicking “CREATE A NEW ACCOUNT” link in this activity, the user is directed to second activity which corresponds to the sign up activity.

If the user is already an existing one, after clicking the SIGN IN button he will be directed to another activity which lets the user to select either Drive-in or pedestrian options. On selection of the Drive-in option the application will invoke the Bluetooth service to get connected with the OBU. After connection establishment he is navigated to the main activity of the app. If the user is a pedestrian after selecting pedestrian options he is navigated to the main activity without invoking Bluetooth service. The main activity consists of four button views named Map, Navigate, Alert, and Report. On clicking the Map or the navigate button the user is directed to the Google map server API. The alert invokes another activity which lists out all the alerts received either from the server or other vehicles. When the report button is clicked the user can view another layout consists of five buttons accident, hazards, congestion, construction zone and a back button. By clicking these buttons corresponding events can be reported to the server. The screenshots of these activities are shown in Fig.3.



(a) Sign in Activity (b) Sign up activity (c) Drive-pedestrian selection

(d) Main Activity (e) Alert Activity (f) Report Activity

Fig.3.Screenshots of Android app activities

3.4 The Hosted Database and the Web Application.

The server communicates and controls every part of the system. The website should be accessible, ideally via any device with internet connectivity. The server must have the following databases:

- A hospital database - containing hospital name and its location (GPS coordinates) details.
- A vehicle database- containing detail of all registered vehicles.
- Registered user database -contains all the details of the registered users.

The website has the login facility for the Admin, vehicle authority and the hospital authority. When a vehicle meets with an accident, the SMaRTDRIVE app immediately sends GPS location along with the vehicle details to the server. The server then selects the nearest ambulance to the accident spot from the ambulance database containing the details of free and busy ambulances at that point of time. Thereafter the server sends the location of the accident vehicle and the hospital to the Ambulance.

4. Conclusion

In this paper, we described about our project in which we designed a VANET based system that disseminates traffic related messages in a vehicular network. The system facilitated reporting and hence alerting the drivers about things happening in their surrounding region for extending the range of emergency warnings and to complement the existing traffic signal methods for pre-empting the traffic light. An easy method of implementation of a tool for deploying VANETs with OBU and the SMaRTDRIVE app is thus presented. This application encourages the quick development of vehicular networks. Hence, its development can act as an engine for further innovative projects in ITS.

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