

Social Internet of Vehicles for Cyber-Physical Applications

Riya John¹, Dr. S. Swapna Kumar², Divya Unni³

M.Tech Student, Department of ECE, Vidya Academy of Science and Technology, Thrissur, Kerala, India¹

Head of the Department, Department of ECE, Vidya Academy of Science and Technology, Thrissur, Kerala, India²

Assistant Professor, Department of ECE, Vidya Academy of Science and Technology, Thrissur, Kerala, India³

ABSTRACT: The Social Internet of Vehicles (SIoV) will play superior role in future vehicular systems. The unique characteristic of the vehicular networks is they are highly dynamic in nature and may change their topology very frequently. The proposed system introduces a holistic approach of social internet of vehicles which fuses the results of the Vehicle to Vehicle (V2V), Vehicle to Infrastructure (V2I) and Vehicle to Business (V2B) communications. The system proposed to provide Vehicular Social Networking (VSN) which is a class of social networking that occurs in a virtual community of vehicles, their drivers and passengers. Similar to human social network, vehicular social network will allow the vehicles to share their sensory data to the cloud and have the capability to interact with each other. The proposed system is introducing a black box concept to analyze the cause of accidents in the vehicles, which will continuously record all the operating stages of accelerator, brakes, indicators etc. In case any accident occurs the system will send the picture of the accident plot along with the current location to the respective authorities and police would be able to collect the recorded data from the SD card in the vehicle. The V2V concept is implemented by exchanging speed between the vehicles and to avoid tailgating the distance between the leading and following vehicles are monitored and notifications are provided. The proposed system is also providing V2I communication, which allows a communication between sign boards so as to alert speed controls in specific zones like school, hospital etc. So the proposed system provides convenient travel and improved safety to the vehicle users as well as to the transport authorities.

KEYWORDS: Social Internet of Vehicles (SIoV), V2V Communication, V2I Communication, Vehicular Social Networking (VSN).

I. INTRODUCTION

Vehicles play an important role to provide safe and efficient travel in day to day life. In the current scenario, there is a tremendous increase in number of vehicles which results an increase in accident rate. As per the news reports more than 10,000 accidents take place every day on roads. According to a report of the World Health Organization (WHO), the total number of road traffic deaths all over the world due to the various traffic accidents on road is 1.35 million per year. The average number of deaths per day is nearly 32876 [2]. The reports suggest that there is an emergent need to reduce traffic casualties on road using more reliable vehicular communication based safety applications. The unexpected accidents on road and road maintenance works are the relevant cause for traffic jams. An intelligent way to overcome this problem is to provide appropriate safety measures and warnings to each vehicle users, so as to keep them alert during driving. If the preventive measures to overcome the current problem have not taken, India would be one of the leading countries in the road deaths and accidents by 2020. In this scenario Internet of Vehicles (IoV) would provide more reliable framework for vehicular communications based Vehicular Ad-hoc network (VANET) for smart Intelligent Transport System (ITS) applications [7].

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

The proposed system of Social Internet of Vehicles (SIoV) intended to provide technological advancements in the field of transportation which is still an underdeveloped field [9]. The IoV is a key member or an extension of Internet of Things (IoT). A key objective of IOV is to develop next generation vehicles that incorporate new sensing, communication and social capabilities as part of the extended IOT concept [10].

The proposed system introduces SIoV that fuses the result from V2V, V2I and V2B for cyber-physical real time applications. The system allows the user to communicate with adjacent vehicles and road side sign boards for efficient driving. The system is equipped with information like owner code, vehicle type, speed, operating stages of brakes, left and right blinkers, sensory results like accident, road block, construction etc, that are exchanged between vehicles and finally to cloud. The data on cloud can be utilized by transport authorities for effective remote traffic control and monitoring. User can set the data whether it is private or public. The system also incorporates security facility to identify the particular vehicle and has a feature to freeze the intended vehicle remotely as a part of crime investigation.

The system uses a black box concept to identify the cause of accident. The black box concept introduced in the proposed system is inspired from the black box in aircrafts [8]. Black box will record the speed, time, images etc of the vehicle and required authority can collect the data from USB port. The system automatically communicates with road side sign boards and alerts the driver in accordance with speed zones like hospitals, schools etc. The proposed system uses On Board Unit (OBU) to identify road blockage and accident events. The OBU placed inside the vehicle is connected to internet. It is possible to track vehicles which try to escape without stopping, immediately after an accident. Once accident occurs the vehicular system itself message to transport authorities with GPS location and picture of the spot indicated. The data and picture can be used by the police by incorporating vehicle to business communication.

Paper is organized as follows: Section II describes about the literature survey which gives information about the related works. The proposed methodology which describes about an overview of the proposed system, including the flow diagram of the entire system, block diagram and explanations are described in Section III. Section IV presents experimental results showing results of hardware and software implementations. Finally, Section V includes the conclusion of the proposed system.

II. LITERATURE SURVEY

The proposed system uses SIoV which is an emerging technology in the field of VANETs. The study of current VANET technologies has played an important role for the development of the proposed system. The referred key points from various related works are discussed below:

Saini et al. [1], discussed about the idea of incorporating social connectivity between the vehicles which uses traditional method for vehicular networking called VANET. The paper pointed out some of the drawbacks of VANET while using it alone in vehicular networks. The framework of VANETs could not guarantee the global and sustainable services by ITS applications. Intelligent decisions based on the big data mining driven computations were not possible in traditional VANETs architecture. This was due to the pure ad-hoc network architecture.

Abid et al. [3], proposed a novel multi-layered vehicular data cloud platform by using cloud computing and IoT technologies. The concept generally incorporates various services like Infrastructure As A Service (IAAS), Platform As A Service (PAAS), Software As A Service (SAAS). A new vehicular cloud architecture called ITS-Cloud was proposed to improve V2V communication and road safety.

Dominique et al. [4], proposed a platform that enables people to share the data from web enabled devices so that others can use them. It described the method which relies on existing social networks and their open Application Programming Interface (APIs). Representational State Transfer (REST) architecture is the core of described web system and it focuses on creating loosely coupled services so that they can be easily reused.

Xiping et al. [5], proposed a service oriented vehicular social networking platform called VSSA for transportation efficiency. VSSA consists of two layers: service layer and application layer. The application layer was oriented to end users who can directly use the VSSA system in the mobile devices through VSSAs user interface, whereas service layer was for supporting efficient development of applications for the improvement of transportation efficiency. Although

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

VSSA described many types of services but it does not detail how social network of vehicles will be realized and what are the types of interactions, message exchanges occur among different vehicular network nodes.

Yunxin et al. [6], provided a high level overview of the current Dedicated Short Range Communication/Wireless Access in Vehicular Environment (DSRC/WAVE) communication and to identify its strength and weakness. DSRC/WAVE is the only wireless technology that can potentially meet the extremely short latency requirement for road safety messaging and control. According to the paper the WAVE communication is based on the IEEE 1609 family and IEEE802.11p standards.

III. PROPOSED METHODOLOGY

The proposed system introduces vehicle to internet communication which fuses the results from vehicle to vehicle communication and vehicle to infrastructure communication for cyber-physical real time applications. The system collects information from its surroundings using various sensors deployed in the OBU of the vehicle. The information includes operating stages of brakes, accelerator, left & right indicators etc. The speed of the vehicle and the inter-vehicular distance measured are exchanged between the surrounding vehicles to avoid collision and for the improved safety. The accident data logger system performed by the black box placed inside the OBU can be used to analyse the cause of accident. It will record the time along with the operating stages of accelerator, brakes, indicators etc and also record the data from GPS receiver to track the location of the vehicle.

It is possible to freeze or control a particular vehicle by using its unique ID provided during registering on social network app, by the transport authorities as a part of crime investigation. In case any accident occurs the web camera deployed in the vehicle will automatically send the picture along with the location to the respective authorities.

The vehicle can communicate with road sign boards that transfer the speed limit data along with a warning to driver. The OBU in the vehicle compares the speeds & if any violation is detected it automatically sends the vehicle ID to authorities. A simulation of social graph representing the vehicles as nodes are also implemented using Java script. The flow diagram describes about the various stages involved in the proposed process. It shows the connections and inter-relationships between each stage. The output and input stages of each section can be analysed by the flow diagram. Thus flow diagram provides a simplified representation of working of the entire proposed system. Fig. 1 shows the flow diagram for the proposed system which describes the flow of various stages involved in the system. It also helps to analyse the data flow from input to output stage.

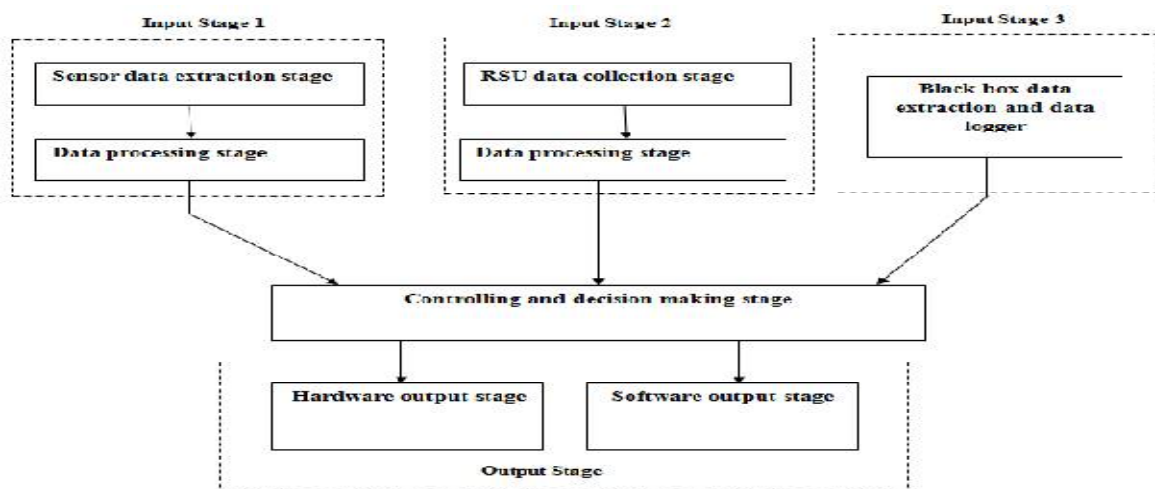


Fig. 1Flow diagram of the system

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

According to the flow diagram the entire input stage is divided in to three stages:

1. The first input stage deals with the extraction of various sensor results. It includes collection of information such as owner code, vehicle type, speed, operating stages of brakes, accelerator, left and right blinkers and distance between the leading and following vehicle. The different sensors are deployed in the vehicle to collect sensory results like accidents and to avail the current location of vehicle. Thus the sensory data extraction stage will extract various sensory results with the help of sensors.
2. Second input stage is to collect data from Road Sign Boards (RSU). The RSU may be road traffic signals or road sign boards. The proposed system uses road sign boards as RSU which is occupied with a controller. The controller inside the RSU will sent the necessary information to the vehicles within its radio coverage region. Thus the second stage of the flow diagram performs transferring of speed control data from RSU to the all the vehicles.
3. The third input stage is the extraction of data from black box and to create a data logger file. This records the operating stages of accelerator, brakes, indicator along with its time. These recorded data is useful for the authorities as well as the vehicle owner to analyse the cause of accident and for further insurance claims.

The output of all three input stages is given to a data processing stage, which in turn perform signal conditioning process. In this stage the data is filtered out and fed to the controller for further processing. The output from the data processing stage is given to a controlling and decision making stage, where the controller will make appropriate actions according to the sensory results. The controlling and decision making stage act as the heart of the proposed system. The output section can be divided in to software and hardware output section. All the warnings and remote operations are under the hardware output stage whereas the generation of social networking app and exchange of messages are under the software output stage. The social networking app used in this proposed system is the telegram social networking application. By using JSON script in Python programming language the social networking pages with required keypad options are created. The hardware output includes the prototype models of both vehicle and RSU sign boards. Thus the proposed system helps to improve the road safety and to reduce the number accidents by providing warnings to driver. Fig.2. shows the block diagram of the proposed system which is composed of both OBU and RSU, incorporated with various sensors used in the system, controlled by a sensor control module and other required hardware.

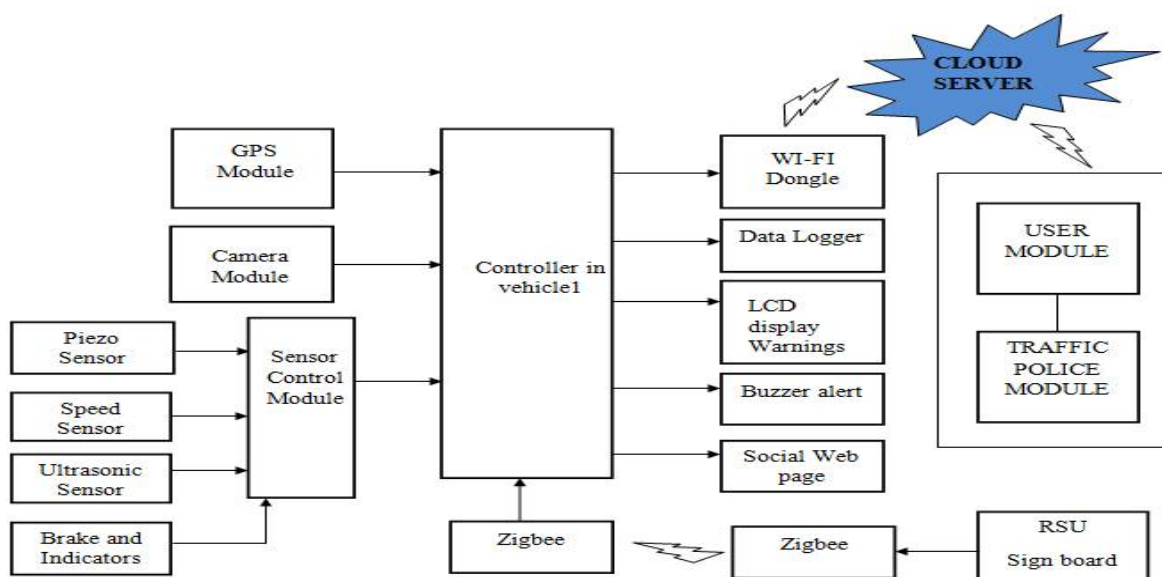


Fig. 2Block diagram of the system

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

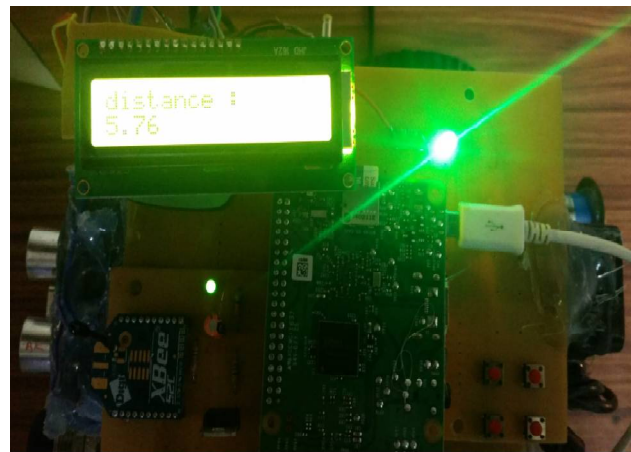
According to the block diagram, all the vehicles are required to register in a telegram social networking app with their unique number plate as vehicle ID. The OBU of vehicle consist the sensor control module which extract various input from different sensors connected to it. Different sensors include piezo sensor, speed (proximity) sensor, ultrasonic sensor, brakes and left-right indicators as switches. The GPS module and camera module is placed in black box system are also connected as the controller input. RSU sign board will contain another controller to transmit speed regulation data which is transmitted wireless via zig-bee. All these input are processed by the controller in the vehicle and take appropriate actions according to applications. LCD display and buzzer warnings are produced according to alert the driver in order to keep a safe distance between the vehicles and to notice the speed regulatory information from sign boards respectively. By using a WI-FI dongle the vehicle can be connected to a cloud server. The data recorded from speed, vibration, distance and brake indicators are used to create data logger file. The V2V communication is employed by the exchange of speed and distance to the android mobile phone which is considered as the following vehicle. The collected data can also possible to shared in social networking page. The data can be make use of vehicle owners and as well as traffic police module.

IV. EXPERIMENTAL RESULTS

The hardware of the system consists of an On Board Unit (OBU) section and a Road Side Unit (RSU) section. The OBU with a computing unit is placed inside the vehicle and RSU is a road sign board which is taken as the road infrastructure in the proposed system is also occupied with a controller. Various sensor modules to collect sensory data from the surroundings are incorporated in the OBU of vehicle unit. The data is shared between vehicles to employ V2V communication and also with cloud platforms. To deploy the V2I communication the road side units are responsible to send speed regulatory information continuously to every vehicle in its range. The vehicle that receives the speed regulatory data compares with its own measured speed and takes appropriate actions. The different sensors embedded in the OBU are piezo-electric sensor, proximity sensor and ultrasonic sensor. Among these, ultrasonic sensor is used to measure the inter-vehicular distance between the vehicles, whereas piezo-electric sensor is used to detect the accidents and proximity sensor is used to measure the speed of the vehicle. In the prototype model the threshold value for the distance is set as 5cm. Thus if the distance is less than the 5cm the system shows an alert message in the LCD and also transfer this distance alert message to the following vehicle as a warning to keep distance. Fig. 3(a) shows image of the hardware prototype of entire system which consist of both OBU & RSU units with their own computing units and Fig. 3(b) shows the LCD display of inter vehicle distance measurement by using ultrasonic sensors placed in front of OBU unit of the vehicle.



(a)



(b)

Fig. 3Hardware output images (a) Image of the entire system consist of OBU & RSU (b) LCD display of inter vehicle distance.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

In the proposed system for employing V2V communication the following vehicle is demonstrated using an android phone. Twilio cloud platform is used to transfer message between the vehicle prototype model and the android phone which represents the following vehicle. Twilio cloud server will grant an authentication token and user ID to each user while registering to the platform. By using these credentials the system is designed to send the distance alert message to the particular android phone. The ultrasonic sensor continuously measure the inter-vehicular distance and compares it with the predefined value which is 5cm and exchange safety messages between the vehicles to employ V2V communication. Similarly speed of the vehicle which is measured using the proximity sensor, is also exchanged between the vehicles. The data measured from both proximity and ultrasonic sensors are entered in to a data logger file for further applications.

V2B communication is incorporated in the proposed system to provide a data exchange between police units, which is also represented as an android phone with cloud Twilio platform. Police authorities have to register in Twilio cloud platform with a particular phone number. When the piezo-electric sensor mounted on the OBU detects an accident, the vehicle unit is programmed to send an accident alert along with the current location which can be extracted using the GPS module to the police authorities. With the help of Google map the current exact location can be identified by clicking on the link of location sent from the vehicle module itself. Thus the immediate recovery action can be made very fast and accident victims can be provided fast emergency ambulance services.

In V2I communication, the controller in the RSU will sent the data to all vehicles in its range. The OBU of the vehicle unit will receive the data and compares with the measured speed. If the speed is greater than the allowed range the driver gets a buzzer alert and speed is not reduced by the driver, a speed violation message is transmitted to the traffic authorities. The allowed speed limit in the proposed system is 30 km/h. The proposed system is designed to give alert and violation messages if the vehicle speed is greater than the 30 km/h.

The V2V, V2B and V2I results are shown in Fig. 4(a), (b) and (c) respectively. Fig. 4(a) shows the screen shot of warning message sent to the following vehicle represented by an android phone, when the inter-vehicular distance become less than the predefined threshold of 5cm. It represents the V2V communication employed in the proposed system. Fig. 4(b) shows screen shot of the accident alert sent to the transport authorities, when the piezo electric sensor mounted on the OBU detects vibration. The current location of the accident plot is also sent with the help of GPS module in the vehicle. This represents V2B communication employed in the proposed system. Fig. 4(c) shows the screen shot of speed violation message sent to the traffic authorities. Speed violation in each zone is determined by comparing the speed regulatory data send from the RSU road sign boards with the current speed of the vehicle. This represents V2I communication in the proposed system.

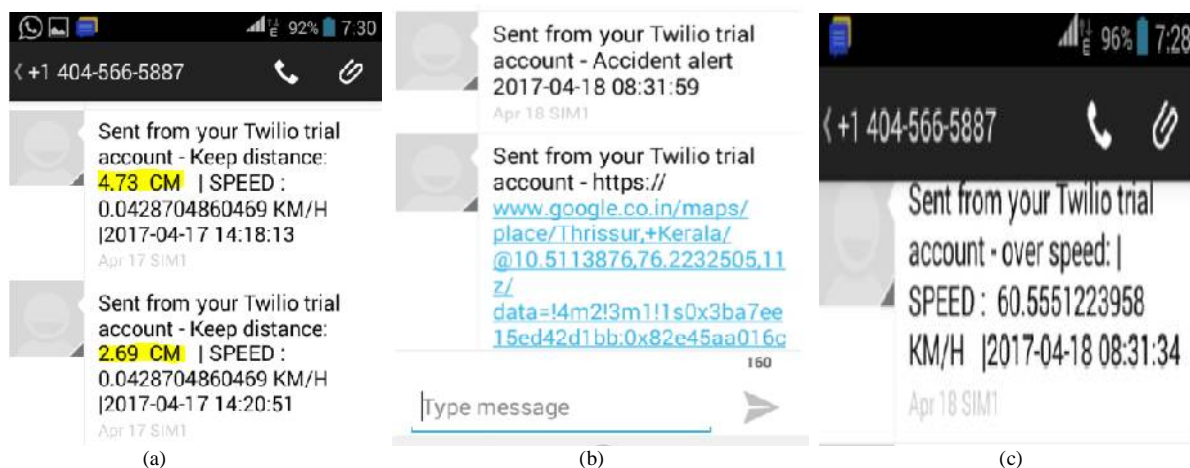


Fig. 4V2V, V2B, V2I Results (a) Screen shot of distance warning message from cloud (b) Accident alert message from cloud (c) Over speed alert.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

The black box concept implemented in the proposed system records the operational status of brakes, accelerator and horns along with the time. The speed and inter vehicular distances are also recorded to form a data logger file. This data logger file can be further used to analyse the cause of accidents. When an accident occur this data log file in the OBU will be automatically send to the social media application account. The proposed system uses Telegram social networking application which acts as a server. The vehicles have to register in the social networking app using their unique vehicle ID. The proposed system uses the vehicle number plates as their unique ID. The JSON script in the python programming language is used to create different keypads for different users. The authorities can able to freeze or control the particular vehicle from remotely as a part of their crime investigation. Black box mode & Telegram app results are shown in Fig. 5(a), (b) and(c). Fig. 5(a) shows the screen shot of the welcome window of proposed system incorporated with various mode of operation designed by using JSON script. Fig. 5(b) shows the screen shot of received vehicle data log file send from the vehicle as a part of black box mode of operation. This data log file help the authorities to analyze the cause o accident by observing the operation of accelerator, break etc. Fig. 5(c) shows the screen shot of reception of accident image from the vehicle remotely, if an accident occurs.

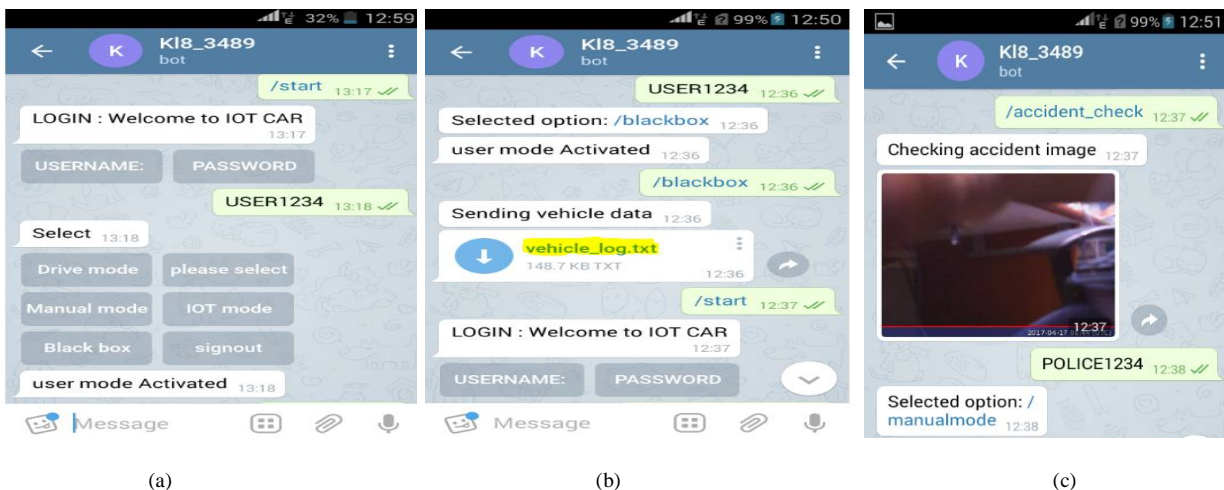


Fig. 5 Telegram app results (a) Screen shot Telegram window (b) Screen shot of received black box data log file. (c) Accident image model.

V. CONCLUSION

Vehicles play an important role to provide safe and efficient travel in day to day life. It is a real fact that the number of vehicles and the number of accidents are increasing day by day. The proposed system aims to provide technological advancements in the field of transportation which is still an underdeveloped field. This project presents a novel method for enhancing automotive safety using SIOV. The various sensory results are collected by OBU, which is placed inside each vehicle. These sensory data can be shared with cloud and can be utilized for a wide range of applications. Transport authorities can also make use of the cloud data, for remote traffic control and monitoring. The information is exchanged between the vehicles in order to employ V2V communication. The system incorporates V2I communication with road sign boards and can send speed regulatory information according to the speed limit specified for each zone. The system is designed to provide over speed alert to the driver and a violation message is also transmitted to the traffic authorities. The system also incorporates an application to avoid tailgating which is one of the major causes of accidents. The inter-vehicular distance is always monitored and warnings to maintain a safe distance are transmitted between vehicles. An accident event recorder known as black box is also implemented to identify the cause of each accident. Black box system creates a data log file that records the operational stages of brakes, accelerator, indicators

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

and also the speed & inter vehicular distance. Thus the proposed paper is intended to use for real time and efficient travel of vehicle users.

REFERENCES

- [1] Mukesh Saini, Kazi Masudul Alam, and Abdulmotaleb El Saddik, "Towards Social Internet Of Vehicles: Concept, Architecture and Applications" IEEE Journal Wireless Technol. Appl., Volume 3, April. 2015.
- [2] World Health Organisation (WHO) official website, Available : <http://www.who.int>.
- [3] H. Abid, L. T. T. Phuong, J. Wang, S. Lee, and S. Qaisar, "V-Cloud: Vehicular cyber-physical systems and cloud computing", in Proc. 4th Int. Symp. Appl. Sci. Biomed. Commun. Technol., p. 165, 2011.
- [4] Dominique Guinard, M. Fischer, and V. Trifa, "Sharing using social networks in a composable Web of Things", in Proc. IEEE Int. Conf. Pervasive Comput. Commun. Workshops, pp. 702-707, 2010.
- [5] Xiping Hu, W. Wang, and V. C. M. Leung, "VSSA: A service-oriented vehicular social-networking platform for transportation efficiency", in Proc. 2nd ACM Int. Symp. Design Anal. Intell. Veh. Netw. Appl., pp. 31-38, 2012.
- [6] Yunxin Jeff Li "Performance Analysis and Enhancement of the DSRC for VANETs Safety Applications", IEEE Trans, vehicular technology, vol. 62, no.7, 2013.
- [7] N. Kayastha, D. Niyato, P. Wang, and E. Hossain, "Applications, architectures, and protocol design issues for mobile social networks: A survey", IEEE Trans, vehicular technology, vol. 99, no. 12, 2012.
- [8] M. Ortiz, D. Hussein, S. Park, S. N. Han, and N. Crespi, "The cluster between Internet of Things and social networks: Review and research challenges", IEEE Internet Things Journal, vol. 1, no. 3, pp. 206-215, 2014.
- [9] J. Barrachina "CAOVA: A car accident ontology for VANETs", in Proc. IEEE Wireless Commun. Netw. Conf., pp. 1864-1869, 2012.
- [10] M. Schutz and K. Dietmayer, "A flexible environment perception framework for advanced driver assistance systems", in Advanced Microsystems for Automotive Applications, Berlin, Germany: Springer-Verlag, pp. 21-29, 2013.