International Journal of Emerging Technologies in Engineering Research (IJETER)
Volume 6, Issue 5, May (2018) www.ijeter.everscience.org

Obstacle Detection and Alert System for Vehicles Based on Internet-of-Things

D.Umakirthika
Post-Graduate Scholar, Department of Electrical and Electronics Engineering, Gnanamani College of Technology, Namakkal, Tamilnadu, India

P.Pushparani
Assistant Professor, Department of Electrical and Electronics Engineering, Gnanamani College of Technology, Namakkal, Tamilnadu, India

J.Chandramohan
Professor, Department of Electrical and Electronics Engineering, Gnanamani College of Technology, Namakkal, Tamilnadu, India

M.Valan Rajkumar
Professor, Department of Electrical and Electronics Engineering, Gnanamani College of Technology, Namakkal, Tamilnadu, India

Abstract – Recent development of the Internet of Things (IoT) and Smart Things provides an opportunity for the informationization for the automotive industry. This article describes Obstacle Detection and Alert System (ODAS) both incorporated as a single system for the obstacles such as speed breakers, barricades on the road using Internet of Things. Obstacle detection system uses in-built algorithm to detect an obstacle on the road using minimal vehicle parameters such as vehicle speed, steering angle. Obstacles locations thus marked by the detection system are stored locally and uploaded to cloud from time-to-time. Cloud server processes data from different vehicles and finalizes that there is a real obstacle at the particular location based on its own algorithm. Obstacles locations thus confirmed by the cloud server are downloaded to obstacle alert system from time-to-time, which alerts the driver about the obstacle on the road when the driver is nearing the location of the obstacle. This system also provides option to see obstacles location super-imposed on google maps so that user can plan his efficient route in advance. Existing systems only have road sign indications for obstacles such as speed breakers, barricades which the driver might not notice during driving, especially at night times. Existing google maps data do not have option to find road obstacles such as speed breakers, barricades information on it. The system aims to overcome these short-comings by a dedicated system which provides audible and visual alert about road obstacles.

1. INTRODUCTION

The Internet of Things (IOT) is the network of physical devices, vehicles and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

The IOT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IOT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities. These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. The quick expansion of Internet-connected objects is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. The ability to network embedded devices with limited CPU, memory and power resources means that IOT finds applications in nearly every field.

2. RELATED WORK

2.1. Internet of Things based vehicle monitoring system

Mayuresh Desai and Arati Phadke

Advances in technologies and availability of economical open source hardware systems are setting a new trend in system designing. Use of technologies like Internet of Things (IoT) can ease the process of data collection and analysis. The main objective of the paper is to describe a system which can monitor or track the location and vehicle parameters of different test vehicles from a centralized place for research and development purposes and to store data of testing parameters of those vehicles on the server for further analysis and records. System design will be generalized for monitoring different parameters like Location, Vehicle speed, Engine compartment temperature, Fuel consumption and many more. Proposed system uses Open source controller and GPS/GSM/GPRS module for data transfer application.

2.2. Real time detection of speed breakers and warning system for on-road drivers

Mahbuba Afrin , Md. Redowan Mahmud and Md. Abdur Razzaque

The excessive use of speed breakers on national highways distracts vehicle drivers. In addition to that, drivers often can't recognize the appearance of unmarked speed breakers and loose control of the vehicle, causing serious accidents and loss of lives. In the literature, there exist a few methods to warn on-road drivers about the upcoming speed breakers which are highly error-prone and time consuming. Moreover, none of them pay any heed to track the information of infringing speed breakers. In this paper, we come forward with a system that facilitates autonomous speed breaker data collection, dynamic speed breaker detection and warning generation for the on-road drivers. Our system also incorporates real-time tracking of driver, vehicle and timing information for speed breaker rule violations. The proposed system outperforms the state-of-the-art works with which it is compared to in terms of response time and accuracy.

2.3. Detection and analysis of holes and bumps on road surface

Mujdat Soyturk, Fatih Dogan, Esma Sasmaz and Saban Boyuk

In this study, the road surface irregularities (pits, bumps, holes, speed breakers, etc.) is intended to be detected and identified with a system to be placed on the vehicles. For this purpose; a vibration-sensitive system is designed consisting of sensors, processor, and GPS receiver as hardware and the algorithms to be used for analyzing the obtained data. With the use of 3-dimensional acceleration sensors in the system, the measurements at the vehicles (vehicle speed/acceleration, the severity of the concussion and location information) are transferred to a database and then the resulting data are analyzed. Exact locations of pits and bumps are determined and their magnitudes are estimated.

3. PROPOSED MODELLING

Obstacle detection and alert system is a combined embedded system having algorithms to detect obstacles and also alert the driver with pre-stored obstacle data. ODAS is an additional system that will be fitted in the vehicle.

ODAS in vehicle consists of following components:

- Controller
- CAN Transceiver
- LCD Display
- Buzzer
- GPS Module
- GPRS Module

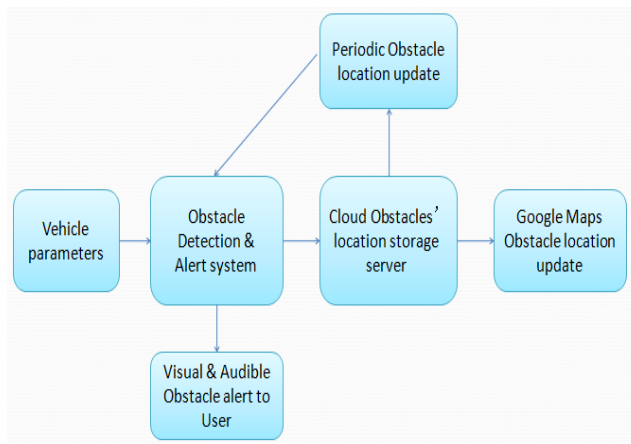

Figure 3.1: Overview of ODAS

3.1 ODAS – Detection System

3.1.1 Probable obstacle detection

ODAS Detection system has the responsibility to detect obstacles such as speed breakers, barricades, and potholes on the road by pre-defined algorithm. It detects probable obstacle locations by using vehicle parameters as input and by using in-built detection algorithm. It uses two vehicle parameters as major inputs

- Vehicle Speed
- Steering Angle

Conditions for Obstacle detection (speed breakers, potholes) are as follows:

- Vehicle speed falls from above 40km/h to below 20km/h within definite time (say 10seconds)
- Vehicle speed rises above 40km/h from below 20km/h within definite time (say 20seconds)

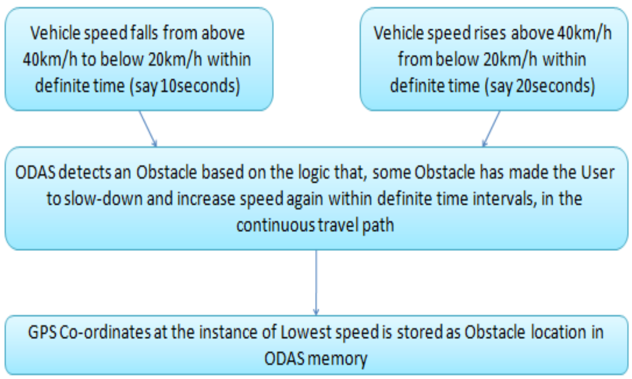

Figure 3.2: ODAS speed breaker detection method

If the above conditions of detection algorithm satisfy, then ODAS detection system concludes that there was speed breaker/pothole in the path, based on the logic that, speed breaker/pothole has made the user to slow-down and increase speed again within definite time intervals, in the continuous travel path.

GPS Co-ordinates from GPS Module at the instance of lowest speed is stored as speed breaker/pothole location in ODAS memory.

Conditions for obstacle detection (Barricades) are as follows:

- Vehicle speed falls from above 40km/h to below 20km/h within definite time (say 10 seconds)
- Steering angle changes from Center -> Positive -> Center -> Negative or vice versa
- Vehicle speed rises above 40km/h from below 20km/h within definite time (say 20 seconds)

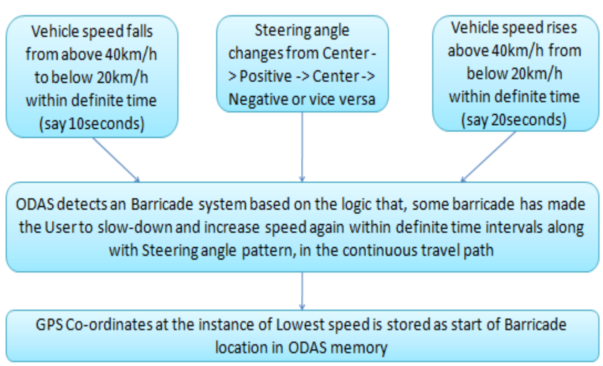

Figure 3.3: ODAS barricade detection method

If the above conditions of detection algorithm satisfy, then ODAS detection system concludes that there was barricade in the path, based on the logic that, barricade has made the user to slow-down, steer opposite sides and increase speed again within definite time intervals, in the continuous travel path. GPS co-ordinates from GPS Module at the instance of lowest speed is stored as barricade location in ODAS memory.

3.1.2 Upload to Cloud Server

Obstacle locations that are GPS co-ordinates that are stored in ODAS memory are uploaded to cloud server from time-to-time using IOT infrastructure.

3.1.3 Obstacle Detection Cloud Server

Obstacle detection cloud server forms a important part of ODAS system. It receives all the obstacles locations that are detected by individual ODAS systems installed in vehicles via IOT infrastructure.

The cloud server has the following functions

- Receive and store obstacles location from individual ODAS
- Consolidate and group closer GPS co-ordinates of obstacles

The cloud server determines that there is actually an obstacle on the road using the GPS co-ordinates with difference of 0.001 differences exceeds 10 instances. If the condition is satisfied, then the average of the 10 GPS co-ordinates is stored as obstacle location in cloud server.

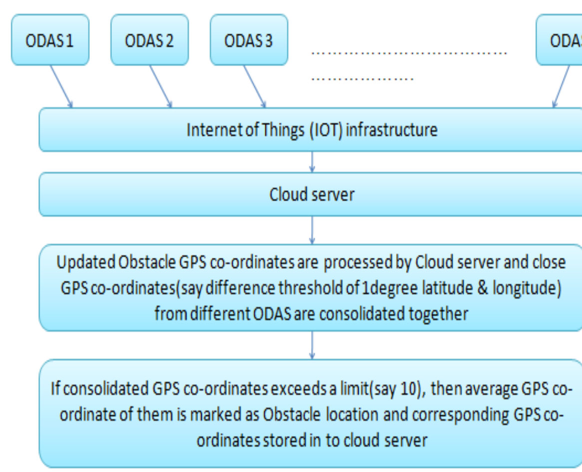

Figure 3.4: Cloud server

3.2 ODAS - Alert System

3.2.1 Download from cloud server

Obstacle locations thus consolidated in the cloud server are updated to ODAS in individual vehicles by means of Internet-of-Things (IOT) infrastructure from time-to-time.

Obstacles location GPS co-ordinates are pushed to individual ODAS upon request which happens periodically. GPS co-ordinates thus received are stored in ODAS memory as obstacles locations, which are used to alert the driver about the obstacles.

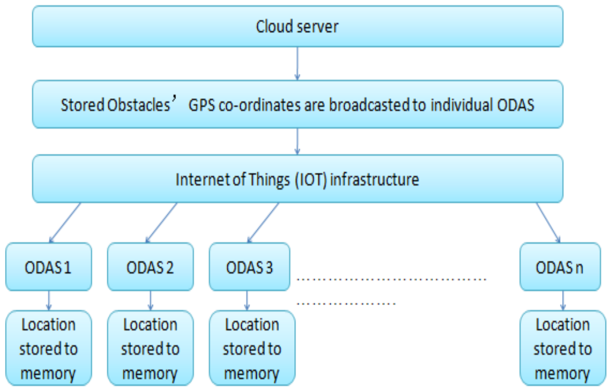

Figure 3.5: Obstacles location download

3.2.2 Obstacle Alert

Obstacles locations received from cloud server are used to alert the driver about nearby obstacles on his path. Current GPS co-ordinates from GPS module are compared continuously with obstacles GPS co-ordinates when the vehicle is in travel.

If the current GPS co-ordinates are closer to any of the pre-stored obstacles GPS co-ordinates in ODAS Memory, then an alert is given to the user.

Alert from ODAS is of two types

- Audible alert
- Visual alert

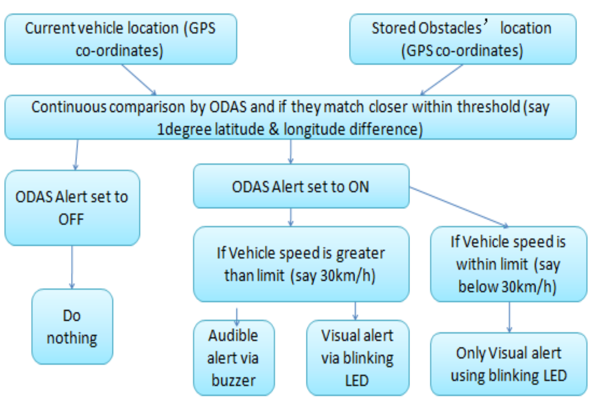

Figure 3.6: ODAS Alert system

If the vehicle speed is within lowest set limit, then ODAS understands that user has already noticed the obstacle and is going slow. Only visual alert is given to the user in that case. If the vehicle speed is above the lowest limit, then ODAS alert the user about obstacle with audible as well as visual alerts. ODAS can be switched off from giving alerts as and when needed.

3.2.2.1 Audible Alert

ODAS provides audible alert to the user by means of buzzer connected to ODAS. Buzzer frequency depends upon the current speed of the vehicle above the threshold limit on nearing the obstacle location.

- If the vehicle speed is much higher than the threshold limit, then frequency of buzzer is set high so that user understands that he needs to slow down immediately.
- If the vehicle speed is only slightly higher than threshold limit, then frequency of buzzer is kept less, because user may already be slowing down seeing obstacle.

3.2.2.2 Visual Alert

ODAS provides visual alert to the user by means blinking LED lights. Similar to audible alert, the frequency of blinking depends upon vehicle speed above threshold limit.

- If the vehicle speed is much higher than the threshold limit, then frequency of blinking LED is set high
- If the vehicle speed is only slightly higher than threshold limit, then frequency of LED blinking is kept less.

3.3 Obstacles update to Google maps

Obstacles locations, basically GPS co-ordinates available in cloud server are not just sent to individual ODAS in vehicles. They are also used to show the obstacles location on top of Google Maps of the end user. This is achieved by making use of in-built Google Maps feature called "Places List".

3.3.1 Google Maps Places List

Google Maps has an in-built feature called "Places List". It allows the user to store desired locations (GPS co-ordinates) of the map in to memory as a list. This stored list of Places is available on top of Google Maps for the user, which can be revisited by a single click. User has the option to add, delete, and edit the stored places. In the Google Maps app, you can create a list of places, like your favorite places or places you want to visit.

3.3.2 Google Maps places list sharing

Google Maps allow the places list to be shared with other users via a link. The other users on receiving the link can follow them and updates in the list will be visible to all users who follow the list. As "Places List" can be shared and followed, we make use of the option to share obstacles locations to users who have installed ODAS in their vehicles. Google Maps "Places list" are associated to a Google account.

Since “Places List” is associated to Google account, cloud server shall have a Google account and “Places List” created for storing obstacles locations on the list. Users who have ODAS installed are shared the “Places List” link. Users can follow the “Places List” that is shared to them to get updates on the obstacles location on top of their Google Maps.

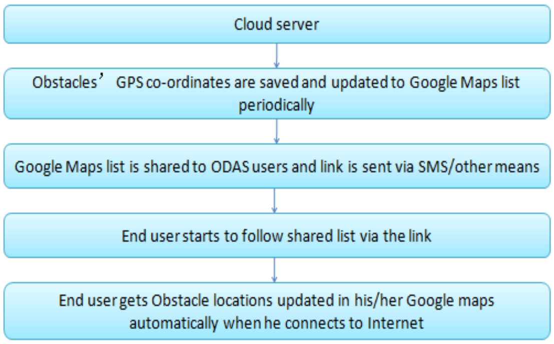

Figure 3.7: Obstacles location update to Google Maps

Cloud server will update obstacles location list periodically based on the data it receives from individual ODAS. Cloud server can have multiple lists for each obstacle and also separate lists for each region which the user can follow in his own device using his Google account.

3.4 Circuit diagram for ODAS in vehicle

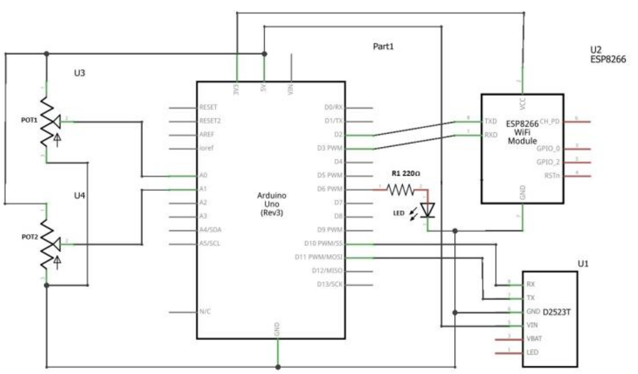

Figure 3.7: ODAS circuit diagram

3.5. ODAS Hardware

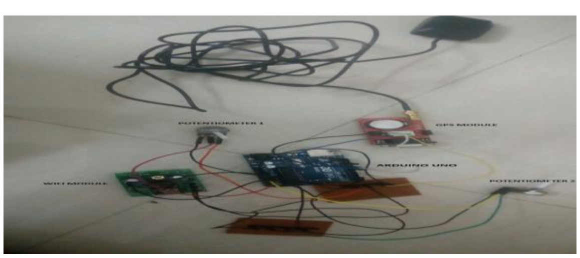

Figure 3.8: ODAS Hardware

4. RESULTS AND DISCUSSIONS

4.1 Travel path of vehicles

Below figure show Google Maps path from Erode to Salem

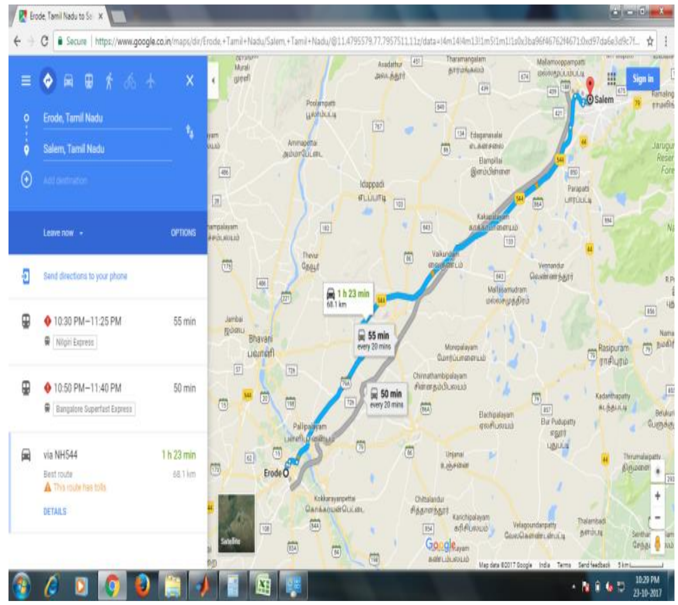

Figure 4.1 Google Maps – Erode to Salem

Below graph shows the Latitude and Longitude co-ordinates extracted from Google.

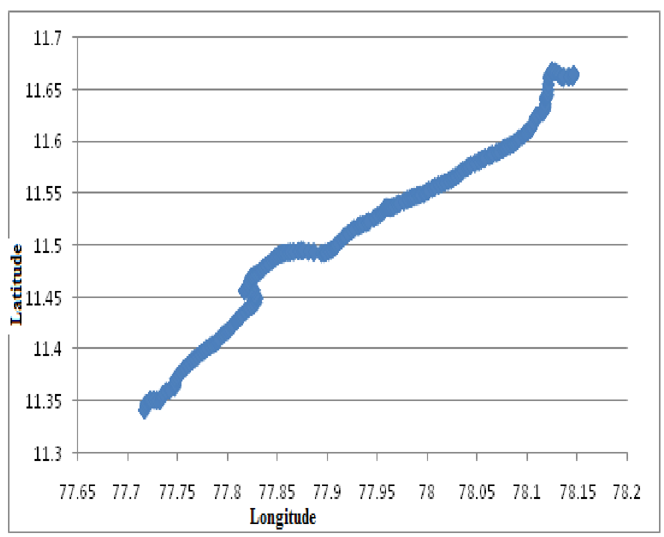

Figure 4.2 Extracted Latitude Longitude co-ordinates

4.2 Obstacle detection data from multiple vehicles

Below graph shows the time duration, in which the mentioned vehicle (shown in y-axis), takes the route from Erode to Salem.

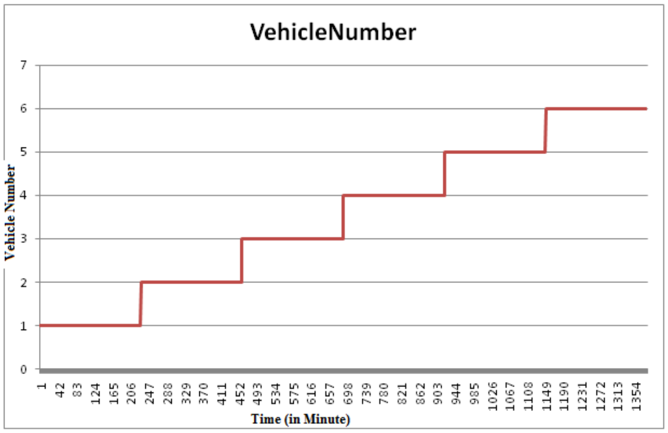

Figure 4.3 Vehicle and time of travel in the path

Below figure shows the time to travel of each vehicle (in relation to Figure 4.3) and the speed of the vehicles in y-axis.

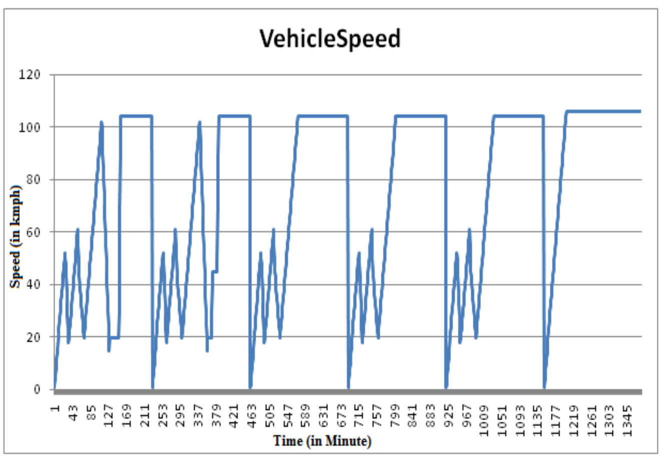

Figure 4.4 Vehicles speed against time of travel in path

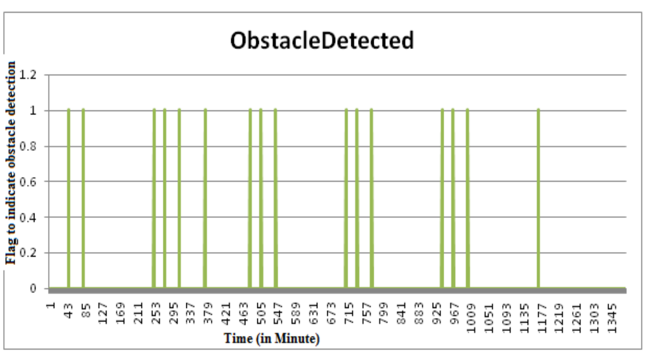

Figure 4.5 Obstacle detection flag and time of travel of all vehicles in the mentioned path

For e.g., As seen in figure, for initial 226 min, vehicle 1 travels in the considered path. From figure 4.4, the change in speed of vehicle 1 is observed during the defined time period.

Vehicle 1 picks up speed from standstill and it goes to maximum of 105 km/h, and the change in its speed also shown in figure 4.4.

As seen in below figures, from the time of travel, it's shown that how many times vehicle1 to vehicle 6 reported the obstacle presence in the considered route.

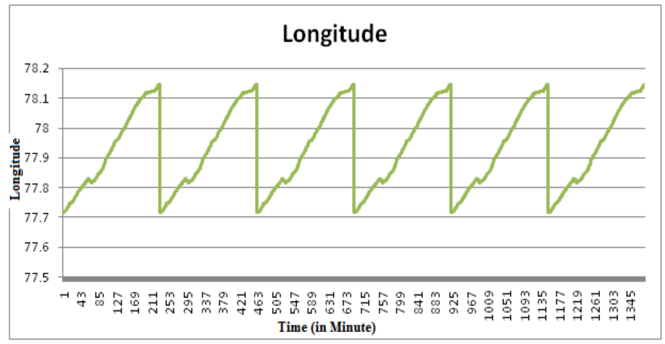

Figure 4.6 Longitude and time of travel of all vehicles in the mentioned path

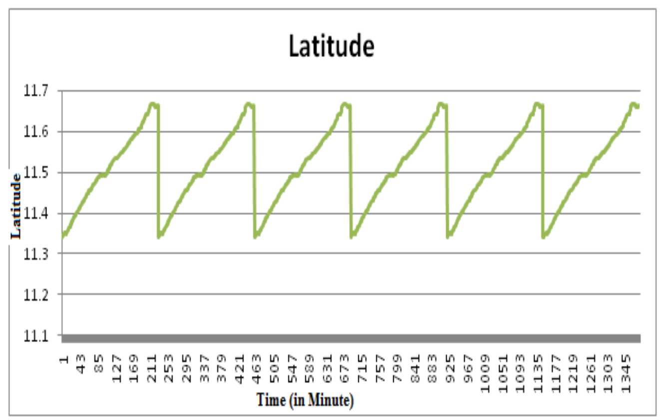

Figure 4.7 Latitude and time of travel of all vehicles in the mentioned path

By relating Figure 4.6, 4.7 with figure 4.5, the location (latitude, longitude) at which the obstacle detected by vehicles 1 to 6 is observed.

Vehicle 1 ODAS:

Obstacle 1 - 77.77752, 11.39853

Obstacle 2 - 77.82038, 11.46017

Vehicle 2 ODAS:

Obstacle 1 - 77.71724, 11.34111

Obstacle 2 - 77.77752, 11.39853

Obstacle 3 - 77.82038, 11.46017

Obstacle 4 - 77.98474, 11.54566

Vehicle 3 ODAS:

Obstacle 1 - 77.71724, 11.34111

Obstacle 2 - 77.77752, 11.39853

Obstacle 3 - 77.82038, 11.46017

Vehicle 4 ODAS:

Obstacle 1 - 77.71724, 11.34111

Obstacle 2 - 77.77752, 11.39853

Obstacle 3 - 77.82038, 11.46017

Vehicle 5 ODAS:

Obstacle 1 - 77.71724, 11.34111

Obstacle 2 – 77.77752, 11.39853

Obstacle 3 - 77.82038, 11.46017

Vehicle 6 ODAS:

Obstacle 1 - 77.71724, 11.34111

Uploaded Obstacles' GPS co-ordinates are uploaded to Cloud server. Cloud server algorithm marks an Obstacle location as valid Obstacle, only if it is reported by minimum five ODAS.

From above data, only three locations shown below are marked as valid Obstacles' location by Cloud server.

Obstacle 1 - 77.77752, 11.39853

Obstacle 2 - 77.82038, 11.46017

Obstacle 3 - 77.71724, 11.34111

Thus Cloud server acts as the administrator and marks the validity of the Obstacles' location by making use of ODAS data from multiple vehicles.

5. CONCLUSION

The Obstacle Detection and Alert System (ODAS) uses readily available Vehicle parameters such as Vehicle Speed, Steering angle along with GPS Module helps to detect the Obstacles on Road. By a centralized Cloud server, the actual Obstacles' GPS locations are marked by making use of data from different ODAS systems, which makes it a reliable system. ODAS alert helps in avoiding Road mishaps by alerting the driver to reduce his speed to safe Vehicle speed before encountering the Obstacles. Update of Obstacles location in End-user Google Maps helps the user to plan his/her efficient route for travel in advance.

REFERENCES

[1] M.Afrin, M.R.Mahmud and M.A.Razzaque (2015), "Real time detection of speed breakers and warning system for on-road drivers," IEEE International WIE Conference on Electrical and Computer Engineering, Dhaka , pp. 495-498.

[2] M.A.Al Rashed, O.A.Oumar and D.Singh (2013), "A real time GSM/GPS based tracking system based on GSM mobile phone," *Second* International Conference on Future Generation Communication Technologies, London, pp. 65-68.

[3] Ambade Shruti Dinker and S.A Shaikh (2011), "Design and Implementation Of vehicle Tracking System Using GPS", Joural of Information Engineering and Applications, Vol 1, No.3.

[4] M.Desai and A.Phadke (2017), "Internet of Things based vehicle monitoring system," Fourteenth International Conference on Wireless and Optical Communications Networks, Mumbai, India, pp. 1-3.

[5] J.Eriksson, L.Girod, B.Hull, R.Newton, S.Madden, and H.Balakrishnan (2008), "The pothole patrol: Using a mobile sensor network for road surface monitoring," in proceedings of the 6th International Conference on Mobile Systems, Applications, and Services, New York, USA, pp. 29–39.

[6] M.Jain, A.P.Singh, S.Bali, and S.Kaul (2012), "Speed-Breaker Early Warning System," in Proceedings of the 6th USENIX/ACM Workshop on Networked Systems for Developing Regions, New York, USA.

[7] M.Jalaluddin, M.Jabeen, D.Vijayalakshmi (2012), "Service-Oriented Architecture based Global Positioning System", IOSR Journal of Engineering, Volume 2, Issue 10, PP 09-13.

[8] S. Lee, G. Tewolde and J. Kwon (2014), "Design and implementation of vehicle tracking system using GPS/GSM/GPRS technology and smartphone application," IEEE World Forum on Internet of Things, Seoul, pp. 353-358.

[9] Mohammad A. Al-Khedher (2011), "Hybrid GPS-GSM Localization of Automobile Tracking System", International Journal of Computer Science & Information Technology, Vol 3, No 6, Dec 2011.

[10] Y. Musa, J. Wang (2012), "Vehicle Tracking and Anti-theft System using GPSGSM", International Journal of Engineering Research & Technology, Vol. 1 Issue 10.

[11] R.Ramani, S.Valarmathy, N.SuthanthiraVanitha, S.Selvaraju, and M.Thiruppathi (2013), "Vehicle Tracking and Locking Sytem Based on GSM and GPS", I.J. Intelligent Systems and Applications, Vol. 9, pp. 86-93.

[12] M.Soytürk, F.Doğan, E.Şaşmaz and Ş.Böyük (2014), "Detection and analysis of holes and bumps on road surfaces", 2014 22nd Signal Processing and Communications Applications Conference, Trabzon, pp. 1897-1901.

[13] Rode, S.S.ve diğerleri (2009), "Pothole Detection and Warning System: Infrastructure Support and System Design", International Conference on Electronic Computer Technology, pp.286-290.

[14] Tsai (2012), "Critical Assessment of Detecting Asphalt Pavement Cracks under Different Lighting and Low Intensity Contrast Conditions Using Emerging 3D Laser Technology". Journal of Transportation Engineering, 138(5), pp. 649–656.

[15] L. Atzori, A. Iera, and G. Morabito, ``SIoT: Giving a social structure to the Internet of Things," IEEE Commun.Lett., vol. 15, no. 11, pp. 1193-1195, Nov. 2011.

[16] L. Atzori, A. Iera, G. Morabito, and M. Nitti, ``The social Internet of Things (SIoT)-When social networks meet the Internet of Things: Concept, architecture and network characterization," Comput. Netw., vol. 56, no. 16, pp.3594-3608, Nov. 2012.

[17] E. Biddlecombe, "UN predicts 'internet of things'," July 6,2009.

[18] K. M. Alam, M. Saini, and A. El Saddik, ``tNote: A social network of vehicles under Internet of Things," in Internet of Vehicles_Technologies and Services. Berlin, Germany: Springer-Verlag, 2014, pp. 227-236.

[19] N. Abbani, M. Jomaa, T. Tarhini, H. Artail, and W. El-Hajj, ``Managing social networks in vehicular networks using trust rules," in Proc. IEEE Symp. Wireless Technol. Appl., Sep. 2011, pp. 168-173.