JOURNAL OF NORTHEASTERN UNIVERSITY

Volume 25 Issue 04, 2022 ISSN: 1005-3026 https://dbdxxb.cn/ Original Research Paper

ENHANCING THE QOS FOR SPEED VIOLATION DETECTION AND REPORTING IN CLOUD BASED VANET

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Abstract:

Every year, car accidents claim millions of lives. Accidents frequently happen as a result of drunk driving or a vehicle travelling at a fast speed. Traditional speed-limit detection and reporting technologies are unsuitable for modern cities. Among the most advanced existingnetwork model that automate speed limit infractions with cameras or RFIDs have a number of shortcomings, including cost, difficulty, dependability, and verification. In this research, we proposed a system rely on the Internet of Vehicles (IoV) that may autonomously report speed limit infractions to the relevant authorities after being automatically alerted to them. Our systems do not necessitate any additional hardware or equipment; all that needs to be upgraded to have a completely operational system provided withIoVarchitecture is installed are the On-Board Unit (OBU), the Road Side Unit (RSU), and the Cloud Server. On the OBU, one of the systems will be implemented. Using Cloud Servers (CSs) and the IoVsignals that are transmitted by the vehicle is a second alternative system design. Additionally, highways and all roadways in modern cities would be completely surveyed, unlike the current systems put in specific locations.The developed method is analysed with traditional systemin terms of Average volume, Travel time,and Traffic congestion.

Introduction:

In cities, a major issue is vehicle traffic congestion. Accidents are a constant risk due to the problem of traffic and car accumulation. A number of priceless lives are lost due to poor road safety and an increase in the number of fast moving vehicles, and our environment is also seriously threatened. Environmental harm and energy waste are two more effects. According to the National Highway Road Safety Administration, police claimed 6.1billion traffic accidents, with 42,000 persons died. More than $230 billion was lost in the economy as a result of these incidents, and millions of people suffered injuries [1]. Although airbags and seat belts are utilised as preventative measures, drivers' inability to anticipate situations in advance makes them ineffective. A vehicle is unable to predict the present speed of opposite vehicles on the road or at a turning point. However, the danger of future mishaps could be reduced by using

Submitted: 21/10/2022 **Accepted**: 24/11/2022

wireless communication technology to estimate sensor and computer speed and send alert messages every 0.5 seconds [2].

The issue of speed limit infringement detection has been thoroughly researched for many years. Speed radars and traffic patrols are the traditional methods. Radar signals are ineffective because they can be jammed or picked up by radar detectors. For automatic identification of car plate numbers and transmission of information to the traffic authorities for the purpose of collecting fines, Radars that measure speed are traditional examples of advanced systems. using numerous RFID scanners and RFID tags on each vehicle to determine each vehicle's speed are more sophisticated older ways. The camera-based method has the similar drawbacks as the radar-based one. Furtherly, they cost a lot of money, are incorrect, and involve computer vision.

In this article, we propose the development of two intelligent, precise, and effective speed-limit violation detection systems using the Internet of Vehicles (IoV) and Intelligent Transportation Systems (ITSs). Additionally, we offer a system for automatically and autonomously reporting speed limit infractions. Those devices would be implemented on roads and modern cities to reduce speeding and help the Sustainable Development goals set by the WHO.

Figure 1. Architecture of IOV

Once in use, IoV would make it possible to create a variety of beneficial applications for infotainment,controlling and observing the lighting on roads [3], traffic management and optimization [4], and safety. The smart car with an On-board Unit is a crucial element of IoV. (OBU). OBU can be considered about an automobile connected with additional IoV abilities and capability (software and hardware). (By constructing the OBU and placing it in the vehicle, the traditional vehicle may be quickly and easily converted to be IoV functional. Vehicle-to-Vehicle (V2V) communication allows moving vehicles to talk with each other on the road.

This work provides a speed limit violation detection system based on IoV that operates automatically and effectively. We also give the traffic authorities a means for reporting traffic violations.

Literature survey:

The advancement of location techniques, traffic violation detection network, ad hoc system, the vehicular ad hoc network, and protection approaches to safeguard all communications are all pertinent to this article.Using wireless connections between roadside equipment and vehicles, the [5] study suggests a way for measuring the volume and speed of moving vehicles. In order to determine their precise location and to establish an ad hoc network connection using the roadside device, vehicles are outfitted with GPS receivers and wireless communication equipment.A unique RF-based vehicle Identification and speed prediction model is proposed by the authors in [6]. (ReVISE). It takes advantage of the fact that the presence and mobility of things alter the wireless signal intensity in an RF environment, causing the wireless signals to be able to be interpreted the environment's state and Identify things solely in the field of interest, not across the entire country. Therefore, a vehicle can travel at any speed in a given locationwithout an RF signal.

A variety of tools for automatically identifying traffic offences evaluate the vehicle's speed in various ways. In [7], the projection displacement difference is taken into account when estimating the vehicle speed utilising a motion plane-based method (PDD). By mapping the plate location to the motion plane, the displacement is computed.Using specialised gear, another study attempts to measure thespeed is [8], which makes use of a number of active infrared sensors to inform the data centre of information on violations.Road Side Units (RSUs) in a Vehicular Ad Hoc Network (VANET) are used in the approach in [9] to calculate vehicle speed. On the basis of data from a number of adjacent RSUs, one may estimate the vehicle's speed. In [10], a similar research plan for VANET-based speed limit detection is laid forth.

Requires specialised technology to estimate the vehicle's speed in [11]. The vehicle's speed is recorded using an XBee speedometer in so that it may be compared to the network of Master XBees.The research in [12] examines how machine learning (ML) can be used to address the next-generation (6G) network's IoV needs for ultralow latency, high dependability, high security, and huge connections. Here, we want to help the development of intelligent radio (IR), which combines proactive exploration with self-learning.

IoV applications require increased data speed, reduced latency, higher security, and huge connection due to the nature of their industry [13]. IoV applications that are now in development need edge, fog, software-defined, and named data networks [14].IoV applications require extensive data sensing, gathering, processing, and storage when used in smart cities [15]. The security of the data sent to and from cars is a major issue in IoV and VANET.

Proposed Architecture:

We outline the general system framework of the suggested model for speed-limit violation and reporting using IoV technology. The fundamental functional layers of IoV make up the architecture. However, it is necessary to upgrade the On-Board Unit (OBU), Road Side Unit (RSU), and Cloud Servers (CSs) (software only).

On-Board Unit:

The On-Board Unit (OBU) that must be placed in every vehicle, is the simplest IoV module. The IoV operations can be carried out within the vehicle with the help of the (the OBU and other IoV components. Figure 2 shows the fundamental OBU as well as the additional modules needed to carry out independent and automated of speed limit violations identification and reporting.

Road Side Units:

The infrastructure, which comprises of Road Side Units (RSUs) that are linked to a special network, is a crucial part of IoV. Its network is linked to traffic control systems and CSs. RSUs are positioned next to roads. In this manner, V2I communication between vehicles and RSUs is possible. Additionally, utilising RSU as the gateway, vehicles can connect with CSs.

Cloud Servers:

The Cloud is one crucial element of IoV that is absent from VANET. It is made up of numerous clustered servers operating in the Cloud and giving IoV the necessary services.

Digital Map Service:

The operators of the Digital Map Service and Speed-Limit Service are another crucial part of the suggested systems. It makes it possible for systems and drivers to be aware of the permitted speed limits for each place and lane on the road. The type of vehicle affects the speed limitations. Additionally, global speed limits may be modified in response to certain circumstances, such as the state of the weather. For instance, if the IoV infrastructure detects that it is now foggy, RSU can transmit to all automobiles to minimize the maximum speed restriction for smart cars for a certain strip of road to 60 km/h.

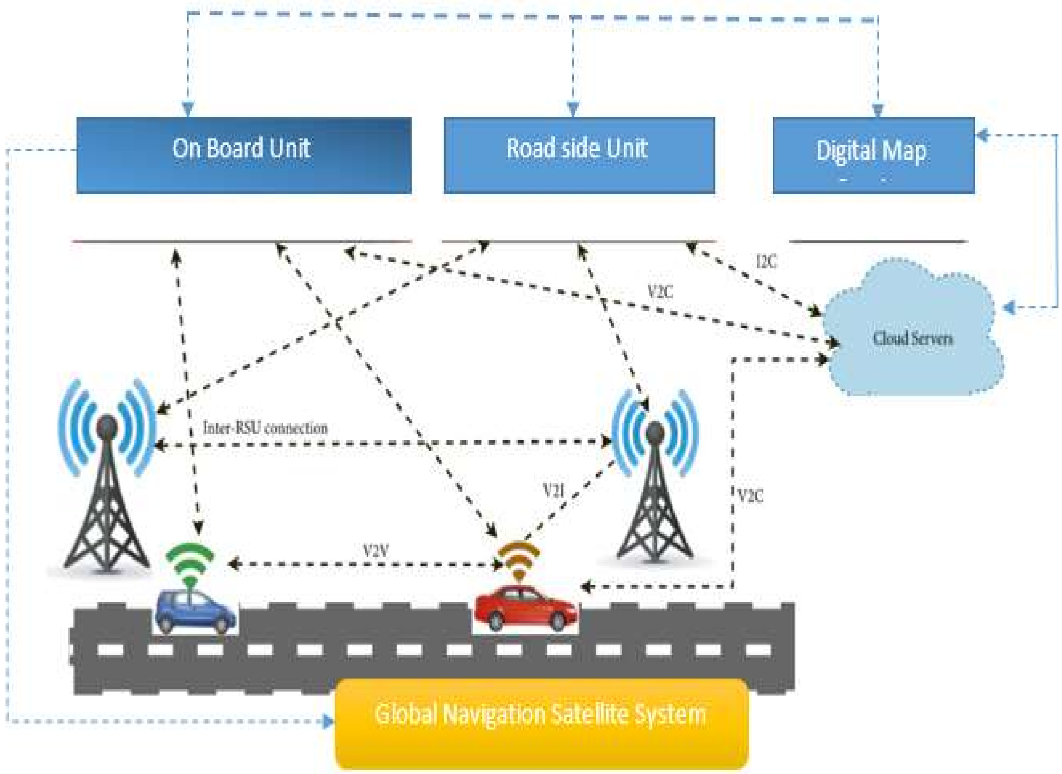

Figure 2: Architecture of IoT based VANET

Global Navigation Satellite System:

The vehicle should constantly be aware of its potential in IoV. If accessibility to the CAN bus is truly impossible, the vehicle's speed is also determined from the time variation in the location of the vehicle. In addition, the changes in location can be used to determine the bearing angle, or direction, of the moving object. However, location service is necessary for IoV to function properly. With IoV, there are numerous location services. The six most typical ones will be explained in this portion of the article. The most popular one is GPS, but its precision is insufficient to let the car know which lane it is travelling in.

Security Considerations:

The security concerns, which may include information security, software manipulation, and hardware tampering, are a major problem regarding the application of the suggested solutions. The literature has extensively researched IoV security issues. The systems we suggest employ the same IoV security strategies. Here, we will concentrate solely on security concerns relating to the detection and reporting of speed limit violations.

The Root of Trust strategy is particularly effective at protecting the hardware of every system component. The vehicle system can be configured to not operate whether any infraction of the hardware or software integrity is discovered, and it can be utilised to safely prevent OBU from hardware tampering.

For such systems, it is essential to design secure software, which must be signed by a trustworthy authority using a digital certificate. As a result, any software manipulation can be discovered and the vehicle's engine shut off. The OBU, RSU, and CS software can only be updated or upgraded by these software authorities. When traffic violations are detected and reported by OBU, (the users/drivers cannot access the RSU to update the software, which prevents them from preventing the detection or reporting of violations. There is no security risk when RSU and CS are utilized to track down and report speed limit infractions because only the traffic authority will be responsible for maintaining them.

Proposed Methodology:

In this section, we describe an intelligent system that uses IoV technology to efficiently automated detection of speed limit violations notify them. The initial one will make use of the vehicle's OBU. The second system is centralised, employedtransmit messages from moving vehicles, and effective of RSU and CSs to identify any vehicle's infringement anywhere in the city.

The first object to know its speed in real-time at all times is a vehicle. The CAN bus can be used to determine its speed. Additionally, the OBU of the car can access the GNSS or any other trustworthy location service to determine how the vehicle's location has changed over time. The OBU of the car can determine the speed of the car in real time. The "Digital Map Service and the Speed Limits" device of IoV can inform the vehicle of the permitted speed limits based on its present location, type, and lane on the road. These are the only details required to determine whether the vehicle is travelling within the speed limits or exceeding them. However, instead of providing new hardware to the IoV framework, why shouldn't modify the OBU software of the car to recognize any speed limit infringement whenever and wherever it happens? Furthermore, why just not declare these speed limit infractions that were committed through the vehicle's OBU to the traffic officers, so that they can collect fines or take legal action in accordance with the applicable traffic laws.

In this concept, the road-side units (RSUs), cloud servers, and the vehicle's OBU are responsible for identification and reporting (CSs). The following are the explanations for this strategy. Through the use of Vehicle-to-Infrastructure (V2I) communications, each vehicle retransmits to the infrastructure its present location. A distant RSU receives these messages. These messages include the timestamp, the location of the vehicle as it is at the moment, and some other data. When CSs rather than only vehicles are to be employed for detection and reporting.

These messages will reach RSUs if an automobile broadcasts its real-time speed. Each RSU will package the messages it receives and deliver them towards the CSs. The RSU ID is present in the enclosed communications. As a result, CSs can be aware of the authorized speed limitations for the region that RSU serves. The speed of the vehicle and the permitted speed restrictions as a function of time will be displayed on the CSs for every vehicle. To determine whether a vehicle is exceeding the speed limit or not, CSs evaluate the permitted speed limits with each individual vehicle. Determining the duration of the over- or under speeding as well as the top/bottom speeds achieved presents a hurdle in this situation. CSs can quickly assess whether a car is breaking the law or not. When a violation occurs, CSs can use the data at their disposal to determine all the specifics of the violation (starting time, duration, peak speed, locality, etc.).

Calculating the temporal speed from the temporal location:

The temporal location of the automobile is the minimally acceptable data that must be transmitted from a vehicle to RSU. The temporaryposition of the vehicle is sufficient to determine the velocity as a function of time in the absence of a vehicle transmitting its real-time speed. When a vehicle broadcasts a message, an RSU collects the message, packages it, and sends it again to CSs. From the temporal locations of the vehicle, CSs determine the temporal speed for the vehicle and proceed with the processing in the manner previously described.

For two subsequent data transmission m_{i-1}, m_i, a particular vehicle was at position R_i at time t_{i-1}, then travelled to position P_i at time t_i. Pi and R_i are denoted by latitude (α in degrees) and longitude (β in degrees) respectively. Haversine's formula can be used to calculate the separation between the two points, $d_{(p_i, p_{i-1})}$. It is applied as follows to determine the path between two points above the surface of the Earth:

$$d_{(R_i, R_{i-1})=R*c,}$$

Wherr R is the radius of the earth (mean radius of 6731km), where $c = 2 * a \tan 2\left(\sqrt{a}, \sqrt{1} - a\right)$, where $a = sin^2(\frac{\pi(\alpha_i - \alpha_{i-1})}{360}) + \cos(\pi\alpha_i /180) * \cos(\pi\alpha_{i-1}/180) * sin^2 (\pi(\beta_i - \beta_{i-1})/ 360)$.

As seen below, we can determine the vehicle's temporal speed:

$$v_i = \frac{d(R_i, R_{i-1})}{t_i - t_{i-1}}$$

Based on the contextual speed information and procedure 1, the CS can identify the beginning, end, fast/low speed, and area of every violation of a posted speed restriction by any vehicle.

Generally, it has not made sense for the vehicle to be able to detect and inform the violations it makes. However, with IoV, this might be achievable and would have several benefits over the current methods.

Algorithm for OBU:

Listing Algorithm is a detailed presentation of the algorithm. The algorithm can be summed up simply as follows: The OBU first determines its present position, then calculates or determines its current speed, then retrieves the permitted speed restrictions, compares the current speed to the permitted speed, notes any infractions that may have happened, and then reports the violations.

1. **Acquire** the present speed, $Present\_Speed$
   If the current speed when there is bus protocol connection to the vehicle's on-board computer.
   Else ifuse the OBU's GNSS transceiver to determine the present speed.
   If no error-correcting server is unavailable, reduce the speed by a safety factor to account for GNSS faults.
   Else If the GNSS signal is very weak and cannot be received by the satellite system, which renders the present speed invalid and makes it impossible to determine any traffic violations.
2. **Obtain** the present location coordinate (*Present_Location*) using GNSS and OBU.
3. **Obtain** the maximal allowed speed limit, $Maximum\_Allowed\_Speed\_Limit$ for this present location.
   If the data is taken from OBU's memory, then utilise the already stored maximum allowable speed limit.
   Else ifthere is indeed a highway unit nearby, advise it for the maximum speed limit which save it to the system storage
   Alternatively, contact the CS directly via the Internet access. The "Digital Map-Speed Limit" service execute follows:
   If the location is saved in database, respond with the maximum speed limit.
   Otherwise, do a REST request to "Digital Map Service Provider"
4. If the Present_Speed>Maximum_Allowed_Speed_Limit
   a. **Alert** (vocally and visually) the driver
   b. **Record** in the internal memory
   c. **Record** the Current_Location
   d. **Determine the maximum speed and duration.**
      Set the Maximum_Excess_Speed
      While Maximum_Allowed_Speed_Limit<Present_Speed
      Wait
      Recalculate
5. **Inform the violation that was occurred as follows:**

Convey the violating information to a neighbouring RSU if there is connectivity.

Otherwise, convey the specifics of the offence to the CSs individually if they have access to the Internet.

An "Acknowledgment message" is required to be returned from Cloud Server to OBU.

6. Continue the procedure to check the speed violation.

Performance Analysis:

The analysis of the proposed performances with VSL and Non-VSL techniques is a component of the evaluation of this work.Travel time, traffic flow, and occupancy are primarily taken into account in the evaluation methods while analysing various traffic situations like light, moderate, and heavy congestion.

Figure 3 depicts the effects of IOV, VSL, and Non-VSL methods on travel time. This graph specifically shows the duration of each method's vehicular travel on average at the subsequent 1000-meter intervals of the specified highway. The outcomes showed that the suggested approach significantly exceeded VSL in terms of a decrease in average travel time, with a reduction of 9.3%.

Table 1. Comparison of average travel time with other techniques

Distance (m)	proposed time (s)	VDL Time (s)	Non VDL Time (s)
1000	200	180	190
2000	220	195	210
3000	310	259	270
4000	420	409	415
5000	542	512	532
6000	586	520	558

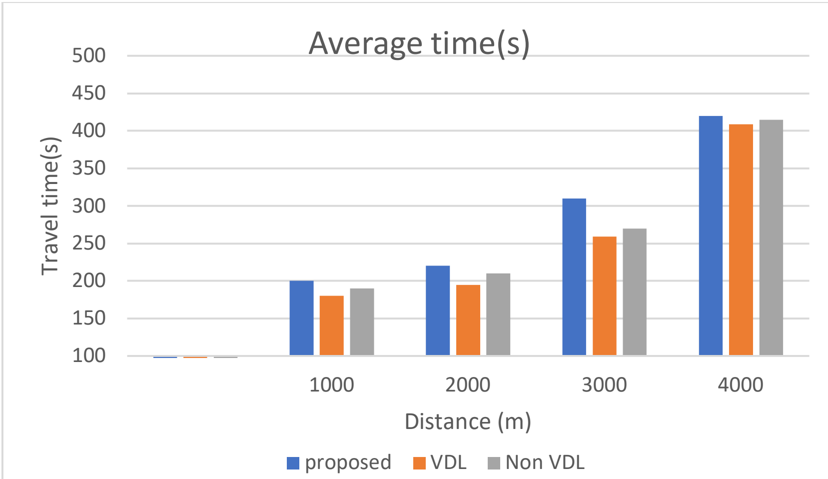

Figure 3. Comparison of average travel time with other techniques

Figure 4 describes the effects of the suggested, VSL and non-VSL techniques on average volume.The chart shows the average amount of traffic that was seen during the whole sampling period at various points along the highway.According to the observations, the non-VSL, VSL, and proposed methods' comparative average vehicle volumes in dry conditions were 1304.89, 1320.92, and 1356.01 correspondingly.

Table 2. Comparison of average volume with other techniques

Distance (m)	proposed volume (vphpl)	VDL volume (vphpl)	Non VDL volume (vphpl)
1000	985.56	856.23	915.23
2000	1115.63	1025.23	1126.52
3000	1125.85	1051.58	1110.58
4000	1248.23	1078.54	1124.52
5000	1385.27	1185.42	1257.23
6000	1489.52	1259.65	1458.78

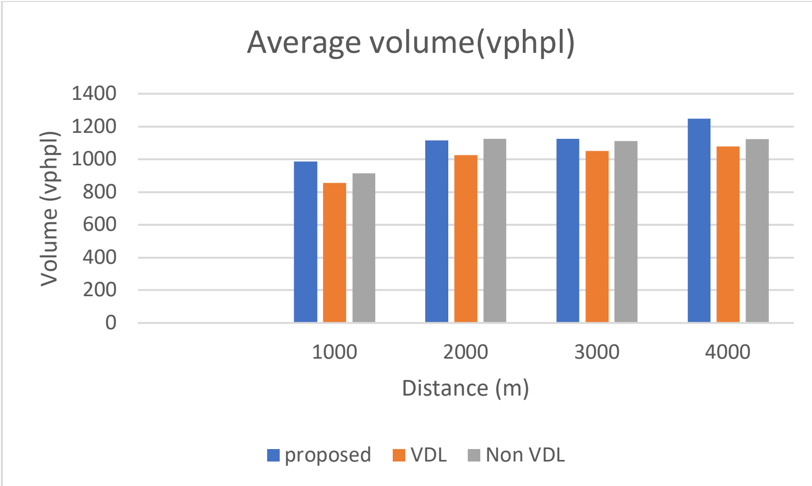

Figure 4: Comparison of average volume with other techniques

Figures 5 show the effects of using Non-VSL, VSL, and recommended techniques on the typical flow of traffic in a case of events on the highway.In comparison to the Non-VSL method, the process of employing varying speed restrictions in both the VSL and and proposed techniques improved traffic flow volume in the area surrounding the incident site by 3000 metres. On the other hand, the inclusion of a number of prohibited areasin incorporated traffic management in proposed has led to a significant rise in the amount of traffic flow. In comparison to Non-VSL and VSL strategies, the suggested technique enhanced traffic flow by 31.2% and 18.9% for a distance ranging from 2000 metres to 6000 metres, correspondingly.

Table 3. Comparison of traffic flow with other techniques

Distance(m)	proposed volume (vphpl)	VDL volume (vphpl)	Non VDL volume (vphpl)
1000	985.56	856.23	915.23
2000	1115.63	1025.23	1126.52
3000	1125.85	1051.58	1110.58
4000	1248.23	1078.54	1124.52
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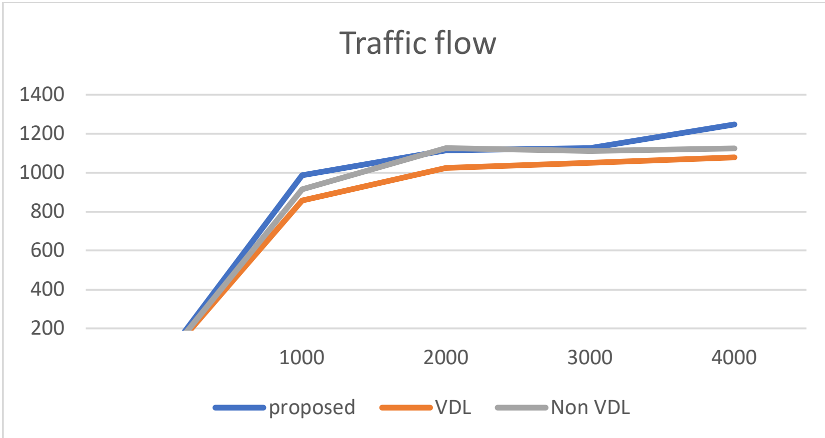

Figure 5. Comparison of traffic flow with other techniques

Conclusions:

The automatic detection and reporting of speed limit infractions utilising IoV technology without the usage of additional hardware is a new proposed model in this paper. The suggested solutions simply update the On-board Unit (OBU) of the vehicle, the Road Side Unit (RSU), and Cloud Servers, extending the current Internet of Vehicles (IoV) (CSs). In the suggested model, the vehicle's OBU detects whether vehicle is reaching the maximum allowable speed restrictions and, in this particular instance, accumulates several essential information about the committed infringement, including start time, the duration of the same violation, the peak speed during the violation, the lane, and the route details.In addition, the infractions will also be seen and reported at anytime and anyplace on the road. In contrast to previous procedures, which are deployed in a few fixed spots along the roadways, this indicates that each and every route should be heavily supervised. This indicates that each and every route should be heavily supervised. The suggested systems are quite effective and trustworthy. Hence, implementation of these devices would significantly lessen fatalities or injuries from traffic accidents.

References

1. JosianeNzouonta, NeerajRajgure, Guiling Wang, and Cristian Borcea. Vanet routing on city roads using real-time vehicular traffic information. Vehicular Technology, IEEE Transactions on, 58(7):3609–3626, 2009.
2. Christian Lochert, Hannes Hartenstein, Jing Tian, Holger Fussler, Dagmar Hermann, and Martin Mauve. A routing strategy for vehicular ad hoc networks in city environments. In Intelligent Vehicles Symposium, 2003. Proceedings. IEEE, pages 156–161. IEEE, 2003.
3. S. A. E. Mohamed, “Smart street lighting control and monitoring system for electrical power saving by using VANET,” International Journal of Communications, Network and System Sciences, vol. 6, no. 8, pp. 351–360, 2013

4. L.-M. Ang, K. P. Seng, G. K. Ijemaru, and A. M. Zungeru, “Deployment of IoV for smart cities: applications, architecture, and challenges,” IEEE Access, vol. 7, pp. 6473–6492, 2019
5. S. Tomic, M. Beko, L. M. Camarinha-Matos, and L. B. Oliveira, “Distributed localization with complemented RSS and AOA measurements: theory and methods,” Applied Sciences, vol. 10, no. 1, p. 272, 2020
6. C. L. Nguyen and A. Khan, “WiLAD: wireless localisation through anomaly detection,” in Proceedings of the GLOBECOM 2017-2017 IEEE Global Communications Conference, Singapore, December 2017.
7. M. Famouri, Z. Azimifar, and A. Wong, “A novel motion plane-based approach to vehicle speed estimation,” IEEE Transactions on Intelligent Transportation Systems, vol. 20, no. 4, pp. 1237–1246, 2019.
8. B. J. Damascene and R. Okuda, “Low-cost speed limit monitoring system for developing countries using a series of Figure 7: Developed prototype in action. Journal of Advanced Transportation 13 active infrared sensors,” in Proceedings of the 2017 56th Annual Conference of the Society of Instrument and Control Engineers of Japan (SICE), pp. 740–744, Kanazawa, Japan, September 2017.
9. R. P. Nayak, D. S. Sethi, and D. S. K. Bhoi, “PHVA: a position based high speed vehicle detection algorithm for detecting high speed vehicles using vehicular cloud,” in Proceedings of the 2018 International Conference on Information Technology (ICIT), pp. 227–232, Bhubaneswar, India, Decemer 2018.
10. S. A. Elsagheer Mohamed, “Automatic trafc violation recording and reporting system to limit trafc accidents: based on vehicular ad-hoc networks (VANET),” in Proceedings of the 2019 International Conference on Innovative Trends in Computer Engineering (ITCE), Aswan, Egypt, February 2019
11. J. Goswami, S. Ghosh, S. Katiyar, and A. Majumder, “Development of a prototype to detect speed limit violation for better trafc management,” in Proceedings of the 2015 Eighth International Conference On Contemporary Computing (IC3), pp. 449–454, Noida, India, August 2015.
12. F. Tang, Y. Kawamoto, N. Kato, and J. Liu, “Future intelligent and secure vehicular network toward 6G: machine-learning approaches,” Proceedings of the IEEE, vol. 108, no. 2, pp. 292–307, 2020.
13. B. Ji, X. Zhang, S. Mumtaz et al., “Survey on the internet of vehicles: network architectures and applications,” IEEE Communications Standards Magazine, vol. 4, no. 1, pp. 34–41, 2020.
14. P. K. Singh, S. K. Nandi, and S. Nandi, “A tutorial survey on vehicular communication state of the art, and future research directions,” Vehicular Communications, vol. 18, Article ID 100164, 2019