ISSN 2229-5518

Dynamic Thresholding of Vehicle Activated Signs

Hussain Saleem[1]*, Sadia Imam[1], Narmeen Shah[1], Samina Saleem[2], Ali Muhammad Aslam[3]

Abstract— This research presents a systematic analysis and proposed development on traffic management schemes based on Vehicle Activated Signs (VAS) using computing techniques. The literature revealed that the previous dynamic solutions provide results based on traffic congestion. However, they lacked to address weather conditions. Traffic management schemes and their limitations were analyzed. Different methods were found to effectively handle traffic load. An algorithm scheme has been proposed after analyzing past implemented systems, integrated the weather API with the system to make decisions based on both weather situation and traffic condition. The proposed solution makes decision based-on the current and average of previously gathered data i.e. previous traffic situation data and data gathered by a sensor network. It is concluded that an enhanced system based on star topology network integrated with the sensor networks may provide a more efficient solution to this problem.

Index Terms—Data Transmission, Internet of Things, Road Accidents, Sensor Networks, Threshold, Traffic, Vehicle Activated Signs.

---

1 Introduction

The controlling and monitoring of the traffic is becoming cumbersome every day. It is observed that the high density of vehicles in traffic usually in big cities is the main reason and a source of road congestion every day. The main reason is bulk manufacturing and import of vehicles making capacity overloaded. Many problems have arisen because of this traffic condition and many solutions have also been provided in past. Some of them are construction and usage of the Flyover Bridge or the development of the underground roads and underpasses, restriction on transportation of heavy vehicle through busy and loaded roads of the city during the working hours, implementation of the intelligent agent for the monitoring of the traffic, usage of the Vehicle Activated Sign (VAS) along with the Vehicle Message Sign (VMS) [1] [2] [3] [4]. In order to make the traffic system more feasible and comfortable, more techniques are needed to be evaluated and adopted. Road safety is one of the important aspects to consider and as it has been observed that most of the traffic accidents occur because of heavy vehicles, reckless driving and bad weather. In order to minimize these incidents, Vehicle Activated Signs (VAS) are being used to warn the driver about the traffic hazard or for the enforcement of speed. VAS consists of a radar embedded into the panel of the traffic signal sign unit module, which notices the vehicle speed from far remotely. It should be noted that VASs belong to a much bigger class of signs known as VMSs. VMS is a digital board that shows the warning message or some other information to the driver of the vehicle from far approaching about the situation of the traffic condition, construction activities or any other possibilities for both the traffic and road. A similar DMB i.e. Dynamic Message Board with the size of the Mobile phone LCD screen could be installed near the dashboard of the vehicle to watch the messages directly from a distance of one foot from the unit to the driver's eyes. The DMB is operated remotely using WiFi, RFID or other communication channel linked at Traffic Control Office (TCO) located near roads and highways [5] [1] [6] [2] [7]. Since then, many solutions have been proposed but there is still some capacity to make this process more feasible. The main focus of this paper is on VMS (Vehicle Message Sign) related work. In order to make the VMS a more intelligent and efficient decision-making system, it is necessary to get all the correct relevant information about it. The factor that makes this analysis difficult for making the right decision is that different locations at different times at different sites will provide different threshold values. Many researcher and engineers have worked on this approach and some were reached to provide the related results including Sara Nygårdhs et al. They emphasized on the usages of VMS and compared the scenario and conditions where it was helpful [8]. After that, Diala Jomaa came with a review of the Effectiveness of Vehicle Activated Signs (VAS).

Acronyms Used

API	Application Program Interface
DMB	Dynamic Message Board
FCW	Forward Collision Warning
GPRS	General Packet Radio Service
GPS	Global Positioning System
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
LAN	Local Area Network
LED	Light Emitting Diode
Lifi	Light fidelity
LOS	Line Of Sight
NRTA	Non Real-Time Applicable
RTA	Real-Time Applicable
SID	Speed Indicator Device
TCO	Traffic Control Office
V2V	Vehicle to Vehicle
VAS	Vehicle Activated Sign
VMS	Vehicle Message Sign
Wifi	Wireless Fidelity

[1]*Department of Computer Science, UBIT, University of Karachi, Pakistan.*
[2]*Karachi University Business School, KUBS, University of Karachi, Pakistan.*
[3]*Institute of Business Management, IoBM, Karachi, Pakistan.*

**Corresponding Author: hussainsaleem@uok.edu.pk*

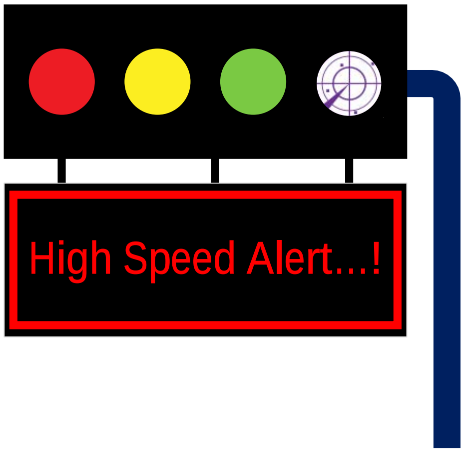

Fig.1. Vehicle Activated Signs (VAS) with Radar embedded, and Vehicle Message System (VMS) message board.

The previous studies have given the solution to these situations but all with the exclusion of the weather condition i.e. none have provided. We all know that weather plays an important role in traffic management like in condition of rain, fog, snow etc. In order to provide the best threshold value and to have the right algorithm for the VMS, it is necessary to include weather situation as well. The algorithm should consider the dynamic data and make the right decision for the driver, taking traffic and weather conditions, road slip (or road grip), and weekday or holiday load of traffic. Examining these conditions, the VMS should tell the driver the appropriate speed limit that has to be maintained to go with and also the best lane should be selected while driving. Fig.1 shows the Vehicle Activated Signs (VAS) with Radar embedded inside the module. A separate Vehicle Message System (VMS) message board is also attached to show text messages with the colour of sensitivity to drivers remotely [9].

In order to solve the traffic problem with the help of the VMSs, it is proposed that first to predict the threshold value by fetching the weather condition and traffic situation of current time i.e. load at a current specific instant of temporal that time [10]. This technique is used in this paper.

The fetching of the speed of the vehicle is determined through the two sources: (1) Speed Indicator Device (SID) that displays the speed of the vehicle passing the device, (2) Radar system module used to determine the speed of vehicles on approaching remotely as shown by illustration in Fig.2.

Fig.2. Radar System Module used to determine the speed of vehicles.

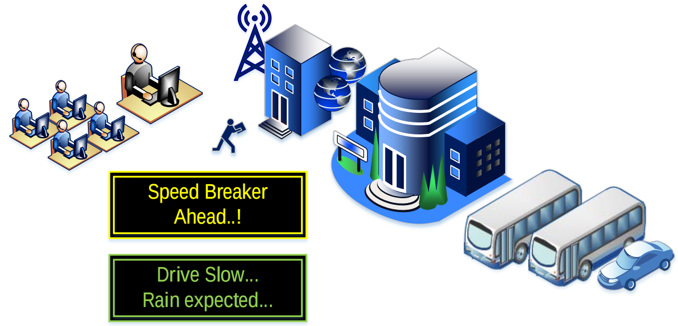

Fig.3. Vehicle Activated Signs (VAS) with Radar embedded, and Vehicle Message System (VMS) message board.

The messages and alerts are generated and communicated through "Traffic Control Office" (TCO), where staff are engaged to watch and monitor the data received through sensor devices like SID and Radar. The "Warning or Alert" message is communicated via the "Traffic Control Office" located near roads and highways as shown in Fig. 3, in two forms: (1) VMS message board hanged along with Traffic Signal panel, and (2) DMB i.e. Dynamic Message Board having the size of the Mobile phone LCD screen could be installed near the dashboard of the vehicle to watch the messages directly from a distance of one foot from the unit to the driver's eyes. The messages are communicated in one of the three colours of sensitivity (1) Red, for a highly important message, with alert tone; (2) Yellow, for moderately important message with normal tone; and (3) Green, for the normal messages with relevant voice. Fig. 4 illustrates the message board DMB with different situational "Messages" and "Alerts". Different data values are observed and placed in tables of the VMS software database. The logic as per algorithms has been applied through the program. VMS performs the data calculations and provides the result at the runtime [1] [11]. Sara Nygårdhs and Gabriel Helmers in [8] have observed that only sending the information for the speed enforcement to the driver and telling about the alternate route is not always enough because sometimes, a person needs a solid reason to alternate the planned path or decision. In order to do this, we need to present some special signs to the driver so that the reason of warning is understood in the split of a second [12].

Fig.4. Message board DMB with different situational "Messages" and "Alerts" indicated with colours.

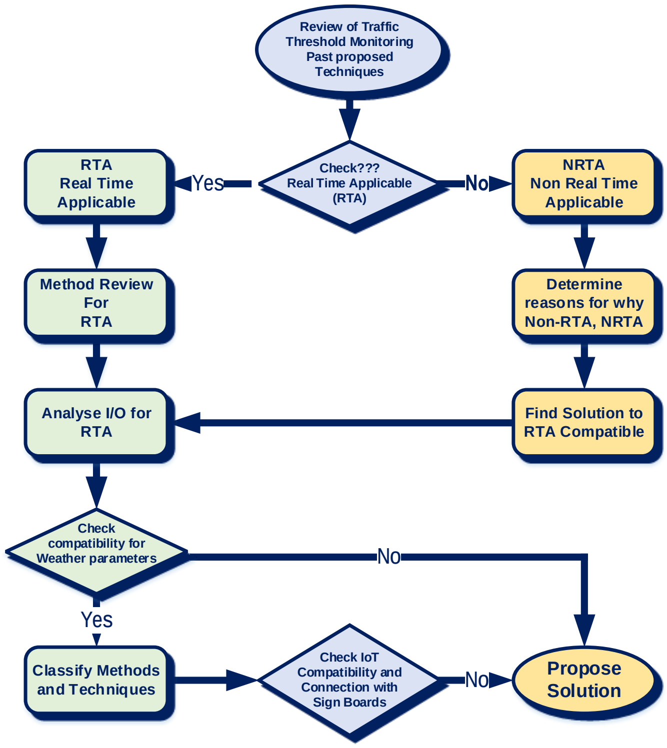

Fig.5. System architecture flow of methodology.

2 Discussion

The purpose of this study is to review the previous methods and researches already done in the field of traffic management using the VMS and VAS based approaches [13]. And so the goal of this study is to review the previous solutions, analyze them, find problems with those solutions and then propose a better feature that could work in the situations where the previous methodologies of VMS failed [11] [14] [15] [16] [17].

Previous records or data is used in order to generate results that are more efficient. An algorithm is required to be made for the processing of the result taking weather and traffic conditions into consideration for the warning or suggestion.

This should be an intelligent system, which makes decisions based on both, the previously recorded data and the data about the current weather conditions. Fig. 5 provide the skeleton of flow of methodology determination for proposing a solution.

3 Analysis of VAS & VMS

In this section, the identification of the characteristics of VAS and VMS such as power source, control logic, information architecture and application scope is compared with the previous works [18].

These comparisons have been covered for identifying the best proposal for achieving dynamic thresholding for VAS and VMS that can incorporate dynamic weather patterns, real-time feedback and information retrieval system, offline operational support, and lower power consumption and maintenance cost.

3.1 Power Consumption

The electronics used in VAS/VMS is very sophisticated as these include radars, modems, LED controller, weather sensors etc. And these electronics are required to be active most of the time for regular scanning of vehicles that drives constant power from the power source. The decision of choosing a viable power source is vital, not only for the environment but also for the infrastructure budget. If a regular energy grid is used, then an average maintenance cost, as well as power failure risk, is convinced. A battery-powered system incurs a higher maintenance cost. According to reference [19], it is recommended to choose a hybrid system that would mitigate the power failure issue. If a solar system backed up by battery power is used, that can support dynamic speed thresholding by identifying an optimal trigger speed for displaying sign messages, it can greatly reduce the overall power consumption.

3.2 Feedback and Data Transmission

The feedback system constitutes of all the sensors that may include radars, cameras, infrared detectors, loop sensors, weather sensors etc. These devices gather valuable data and transport that data to the feedback system via a network link. Processing of the collected data needs to be performed at central authority. The decisions of how to process data are proportional to what outcomes are desired by the system. The data processing objectives are formulated in this study by comparing previous studies in this section. The comparisons are limited to identifying dynamic thresholding value, dynamic triggering of messages to the display units and integration of weather analysis to the outcome [17].

3.3 Weather Detection & Analysis

In a study performed by Jess Christopher, B. Lopez and Harreez M. Villaruz, [20], they discussed using Arduino, an open source-computing platform to interact sensors to the device. These sensors can achieve data from analysis of rainfall, wind speed, temperature, humidity and other factors. However, in this study, the transmission is carried out using Ethernet interfaces, which can lead to an increase in deployment and maintenance cost but it is real-time applicable (RTA). In another study, General Packet Radio Service (GPRS) is used to achieve these transmissions. Transmissions speed offered by GPRS is adequate only if the size of the gathered data is lowered and can easily be transmitted [21]. The higher speed rate is not desirable since the modems that support higher speeds are not energy efficient [19] [21]. If a video source is used, then it would require higher data transfer rate capability devices but it will add much cost. A weather monitoring experiment was performed by Yawut et. al. [22] recently. It used a wireless sensor network based on the ZigBee/IEEE802.15.4 standard that transmits weather data and disaster alerts. However, this system would be expanded to include delivering VAS/VMS services.

3.4 Global Positioning System Based Techniques

Global Positioning System (GPS) based techniques have been deployed to prevent traffic congestion and to avoid collisions with objects. GPS based techniques can give an accuracy of fewer than three meters as discussed by Zahrani, Ragab and Asrar [23]. This technique can be used to detect animals on highways and avoid collisions. Zahrani also proposed a system named Camel-Vehicle Accident Avoidance system to detect animals and their movement and positions. However, this system also lacks consideration of weather conditions. GPS signals travel from the satellite to receiver through the atmosphere where different layers refract in different ways [24], which causes delays in receiving messages. It was compensating but not able to provide actual real-time replies.

3.5 Internet of Things (IoT) Based Techniques

According to the San Francisco Municipal Transportation Agency, the drivers looking for a parking space cause 30 per cent of the city's traffic congestion. An IoT based technique was proposed to resolve this problem [25]. A sensor is placed in each parking space. These sensors are energy efficient since they do not need much power because they only need to transmit when there is a change found in parking space. These sensors work on small lithium batteries which are needed to be replaced after a year of service. An IEEE 802.15.4e mesh network is enough to provide communication between the sensors. All the data from sensors is pushed to a cloud application on the internet and the drivers can access the data pushed from sensors in real time. This saves the problem of seeking a parking space that is also a common cause of traffic congestion. This problem solved the problem of traffic management in San Francisco but it was applied on a very small scale and also it was just based on a single variable, which is the parking problem. It does not consider other important variables in traffic management. Vehicles are also getting this technology as they are adopting IoT. They are aware of their surroundings and they communicate data with each other knows as Vehicle to Vehicle Communication (V2V Communication) [26]. But not all vehicles are smart, which is a downside for this technology. But we can use their data to enhance VAS/VMS decisions more accurately as if a person identifies a car collision and its location then this technique can be used for notifying emergency services with the help of "Forward Collision Warning" system (FCW) [5]. Above synthesis has stated different strategies given for controlling traffic management. Different algorithms and strategies are developed using these strategies. The synthesis states that with proposed processes, traffic can be more effectively controlled.

4 Proposed Methodology

The biggest drawback with all the previous researches was that they proposed for specific conditions or did not cover several parameters that effects speed limitations. One of the factors was weather condition that was not in consideration of the previous researches or, the researchers could not come up with a suitable solution. The main purpose of this study was to propose a method that could provide a complete solution considering real-time weather analysis and suggesting driving style based on these conditions and the data gathered from databases.

4.1 Weather Component API

In order to analyze the current weather condition, there are two choices; either to choose the previous algorithm or to propose a new algorithm. After reviewing the proposed algorithms, we came to the mutual decision that choosing Google weather API (Application Program Interface) would be better because it gives the best result if compared to other API's or algorithms. However, for more effective weather condition calculation there should also be local area weather condition identification equipment that could provide weather conditions to nearby VAS/VMS nodes.

4.2 Applying Internet of Things (IoT)

In order to communicate with other nodes at the remote destination, there should be an information and communication technological (ICT) network of some kind. Each node must have a network interface through which it could be connected to other nodes. Consider a scenario where there is too much traffic at one node, then by sharing information with other nodes through the network, it can help in reducing traffic congestion for the sender node by regulating traffic flow. By passing informing through VAS and VMS, the passengers or drivers can even choose the alternate path to reach their destination [27] [28] [29] [30] [31] [32].

4.3 Average Speed

In normal weather condition, the system will set maximum possible speed limit as per local government traffic and transportation policies but each node will have radar that will monitor surrounding congestion and vehicle's average speed to

ISSN 2229-5518

make the decision for defining current speed limit. Through the formula in Eq.(1), given below, the average speed of the vehicle moving from the specific destination could be calculated [33].

$$\overline{V_t} = \frac{1}{N}\sum_{n=1}^{N} V_n \quad , \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

Where; $N = Number\ of\ vehicles, V_n = speed\ of\ n_{th}\ vehicle.$

4.4 The Internet Medium

In order to interconnect different devices with each other, there are three different choices of internet communication that are, LAN, Wifi technology and Lifi technology. In case of LAN, it would be very complex and difficult to place wires for the interconnectivity of different nodes and to fetch results from the sensor or to implement some action or recover from any incident if occur in future.

It will be a challenging task for the authority who were assigned for this implementation. The remaining choice would be Wifi or Lifi, which are networked wireless communication technology. Due to Lifi's faster speed as compare to Wifi, it can make a difference and would be assumed as the first priority for the internet medium. According to the research, Lifi is 100 times quicker than Wifi technology and nearly reaching a speed of 224 gigabits per second [34] [35].

5 Proposed Implementation Methodology

The proposed system makes decision based on a centralized database system that keeps the data record for the past 2 years of weather, along with the previous traffic conditions for forecasting the traffic prediction. The forecasting system will be based on current weather condition and previous weather on the same date. The current weather condition will be compared with the average of previous years so that it can normalize fluctuated extreme weather conditions. Weather data of recent years has been considered because climate changes are relatively larger in recent years compared to previous years because of global warming.

The data for recent traffic is also considered because the traffic today is not the same as the traffic 10 years ago (an adjustable parameter). The sensors are placed after every fixed distance so that they can provide current traffic situation with the help of the equation provided above. The centralized database will provide messages for VMS based on the current traffic situation and previous or current weather condition.

The weather is analyzed through sensors and is uploaded to the server for acquiring the new threshold values. With the help of three parameters, which are (1) Weather, (2) Traffic, and (3) Feedback from adjacent terminals, the system will propose new threshold values.

These proposed units will be made part of the IoT to collaborate and share information and decisions. Each node will share to adjacent nodes with the help of the Lifi technology. Tree topology will be used for interconnection between terminals with one more node acting as a gateway to an external network. All the nodes will have access to the external network. This topology provides the advantages of a linear bus topology and star topology. Given below is the reference diagram of terminals connected with the single bus that share the internet connection.

The preservation of the knowledge of interconnected node in this topology will help identify adjacent nodes and eventually in making decisions based on knowledge provided by them.

6 Future Prospects

The study evaluated different traffic management systems to develop a traffic management scheme that could make decisions based on current or previous weather and traffic conditions.

After the analysis conducted based on various research papers, the proposed strategy has been finalized. The previous study assumed that the local connection would be made via Wifi or wired connection. However, usage of Lifi could replace wired and radio communication as it is cheaper and also provides much faster communication speed than wired or Wifi connection [2].

Since there are also some drawbacks on its usage, as it needs light from LEDs (Light Emitting Diodes) as a medium to deliver network, Line Of Sight (LOS) needs to be maintained and always be on power for Lifi transceivers [34]. For this purpose, different poles along with wires have to be placed near VAS and VMS systems.

Resolving network or any incident issue could be a tough task there but a worthy one in the end. It has been expected that in the future, different algorithms or strategies will be proposed for VAS and VMS that will totally remove the current issues.

7 Conclusion

Previous implementations relating the study at hand had some constraints like; it did not consider the weather conditions as a factor in traffic congestion. Possible solutions to this problem in real time have been investigated.

During the study, it was concluded that a system with centralized database that keeps a record of previous years for traffic and weather conditions can be used for this. It can make decisions based on current or previous years of weather and traffic situations.

The system also contains different sensors that are placed every few miles so that they can provide current weather condition and average speed of cars to the centralized system. These sensors can be connected using the tree topology. In this way, a system can be created which will be intelligent enough to handle traffic effectively via managing VMS and VAS.

This study can be used as a foundation for any future system to be implemented that can manage traffic situation including one the most important factor in traffic congestion i.e. weather.

REFERENCES

[1] D. Jomaa, S. Yella and M. Dougherty, "Review of the Effectiveness of Vehicle Activated Signs," *Journal of Transportation Technologies,* pp. 123-130, 2013.

[2] H. Saleem, "Review of Various Aspects of Radio Frequency IDentification (RFID) Technology," *International Organization for Scientific Research - IOSR Journal of Computer Engineering (IOSR-JCE),* vol. 8, no. 1, pp. 1-6, 2012.

[3] H. Saleem, "Mobile Agents: An Intelligent Multi-Agent System for Mobile Phones," *International Organization for Scientific Research - Journal of Computer Engineering (IOSR-JCE),* vol. 6, no. 2, pp. 26-34, 2012.

[4] J. L. Adler, G. Satapathy, V. Manikonda, B. Bowles and V. Blue, "A Multi-Agent Approach to Cooperative Traffic Management and Route Guidance," *Transportation Research Part B Methodological (TRANSPORT RES B-METH), Publisher: Elsevier,* pp. 297-318, 2005.

[5] M. Eye, "Mobile Eye," Mobile Eye, 2018. [Online]. Available: https://www.mobileye.com/our-technology/. [Accessed 2019].

[6] M. S. A. Khan and H. Saleem, "Proposed Secure Protocol for Online Health System in Cellular Communication," *Karachi University Journal of Science,* vol. 36, pp. 23-26, 2008.

[7] K. K. Tan, M. Khalid and R. Yusof, "Intelligent Traffic Lights Control by Fuzzy Logic," *Malaysian Journal of Computer Science,* pp. 29-35, 1996.

[8] N. Sara and G. Helmers, VMS: Variable Message Signs. A Literature Review, Sweden: Swedish National Road and Transport Research Institute, VTI Rapport 570A, Linkö-ping, 2007.

[9] D. A. Roozemond, "Using Intelligent Agents for Dynamic Urban Traffic Control Systems," in *European Transport Conference (PTRC)*, Cambridge, 1999.

[10] A. Burney, N. Mahmood, T. Jilani and H. Saleem, "Conceptual Fuzzy Temporal Relational Model (FTRM) for Patient Data," *WSEAS Transactions on Information Science and Applications (Journal),* vol. 7, no. 5, pp. 725-734, 2010.

[11] S. M. A. Burney, H. Saleem, N. Mehmood and T. A. Jilani, "Traceability Management Framework for Patient Data in Healthcare Environment," in *3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT)*, Chengdu, China, 2010.

[12] H. Saleem, Interviewee, *Software Has Become A Driving Force.* [Interview]. 2004.

[13] S. M. A. Burney and H. Saleem, "Inductive and Deductive Research Approach," University of Karachi, Karachi, 2008.

[14] A. M. Rana and H. Saleem, "Novel Integrated Sensor Based Sleep Apnea Monitoring and Tracking System Using Soft Computing and Persuasive Technology for Healthcare Support," *International Journal of Systems Signal Control and Engineering Application (ISSN-p: 1997-5422),* pp. 43-48, 2014.

[15] H. Saleem and F. A. Zaidi, "Identification and Realization of Trace Relationships within Requirements," in *International Conference on Software Engineering (ICSE'06)*, Lahore, Pakistan, 2006.

[16] A. M. Rana and H. Saleem, "Novel Integrated Sensor based Sleep Apnea Monitoring and Tracking System using Soft Computing and Persuasive Technology for Healthcare Support," in *9th International Conference on Innovative Trends in Management, Information, Technologies, Computing and Engineering (ITMITCE – 2014)*, Istanbul, Turkey, 2014.

[17] R. Ando, K. Noda, Y. Mimura, M. Yamazaki, J. Yang, H. Ogino, K. Takeuchi and N. Ikeda, "Long-Term Effect Analysis of Dynamic Speed Display Sign in Streets," in *2017 4th International Conference on Transportation Information and Safety (ICTIS)*, Banff, AB, Canada, 2017.

[18] Z. Liu, "A Survey of Intelligence Methods in Urban Traffic Signal Control," *International Journal of Computer Science and Network Security, IJCSNS,* pp. 105-112, 2007.

[19] D. Jomaa, S. Yella and M. Dougherty, "Triggering Solar-Powered Vehicle Activated Signs using Self Organizing Maps with K-means," in *The Third International Conference on Intelligent Systems and Applications (INTELLI 2014)*, Seville, Spain, 2014.

[20] J. C. B. Lopez and H. M. Villaruz, "Low-Cost Weather Monitoring System with Online Logging and Data Visualization," in *2015 IEEE International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM)*, Cebu City, Philippines, 2015.

[21] Wikipedia, "General Packet Radio Service (GPRS)," 2019. [Online]. Available: https://en.wikipedia.org/wiki/General_Packet_Radio_Service. [Accessed 2019].

[22] C. Yawut and S. Kilaso, "A Wireless Sensor Network for Weather and Disaster Alarm Systems," in *2011 International Conference on Information and Electronics Engineering* , Singapore, 2011.

[23] M. S. Zahrani, K. Ragab and A. U. Haque, "Design of GPS-based System to Avoid Camel-Vehicle Collisions: A Review," *Asian Journal of Applied Sciences,* pp. 362-377, 2011.

[24] "The Effect of Weather Fronts on GPS Measurements," *Innovation,* pp. 52-60, 1998.

[25] B. SmartWorks, "Smart Internet of Things Technologies," 2019. [Online]. Available: http://www.bb-elec.com/Tech-Support/Brochures/B-B-Adaptive-Traffic-SS.aspx. [Accessed 2019].

[26] X. Yang, L. Liu, N. Vaidya and F. Zhao, "A Vehicle-to-Vehicle Communication Protocol for Cooperative Collision Warning," in *The First Annual International Conference on Mobile and Ubiquitous Systems: Networking and Services, 2004*, Boston, MA, USA, 2004.

[27] S. A. Raza, H. Saleem and S. Habib-ur-Rehman, "MCMC Simulation of GARCH Model to Forecast Network Traffic Load," *International Journal of Computer Science Issues (IJCSI),* vol. 9, no. 3(2), pp. 277-284, 2012.

[28] H. Saleem, "Novel Intelligent Electronic Booking Framework for E-Business with Distributed Computing and Data Mining," *International Journal of Computer Science and Network Security, IJCSNS,* 2019.

[29] H. Saleem, "Towards Identification and Recognition of Trace Associations in Software Requirements Traceability," *International Journal of Computer Science Issues (IJCSI),* vol. 9, no. 5(2), pp. 257-263, 2012.

[30] H. Saleem and S. M. A. Burney, "Imposing Software Traceability and Configuration Management for Change Tolerance in Software Production," *IJCSNS - International Journal of Computer Science and Network Security (ISSN:1738-7906),* vol. 19, no. 1, pp. 145-154, 2019.

[31] H. Saleem, K. B. Muhammad, A. H. Nizamani, S. Saleem and A. M. Aslam, "Data Science and Machine Learning Approach to Improve E-Commerce Sales Performance on Social Web," *International Journal of Computer Science and Network Security (IJCSNS),* vol. 19, 2019.

[32] H. Saleem, M. K. S. Uddin and S. Habib-ur-Rehman, "Strategic Data Driven Approach to Improve Conversion Rates and Sales Performance of E-Commerce Websites," *International Journal of Scientific & Engineering Research (IJSER),* 2019.

[33] Tienxi, "Capacity-Transportation Engineering-Lecture 02 Slides-Engineering, Slides for Transportation Engineering," Korea University of Science and Technology – Daejeon and Seoul, 2012. [Online]. Available: https://www.docsity.com/en/components-transportation-engineering-lecture-02-slides-engineering/51830/. [Accessed 2019].

[34] Wikipedia, "Li-Fi," 2019. [Online]. Available: https://en.wikipedia.org/wiki/Li-Fi. [Accessed 2019].

[35] C. Mercer-Myers, "What is Li-Fi? Everything you need to know," 2018. [Online]. Available: https://www.techworld.com/data/what-is-li-fi-everything-you-need-know-3632764/. [Accessed 2019].