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Dissemination of Emergency Messages in Vehicular Networks

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***Abstract*—Vehicular Ad-hoc networks (VANETs) support the design and implementation of safety applications. These are more efficient and cost-effective and can be used in isolated places without Internet. In this paper, we propose a system where a notification can be sent to an ambulance in case of an accident and the ambulance reaches the spot in minimum possible time through the shortest path. The ambulance can notify the vehicles on the way of its arrival so that they take alternate paths to make way for the ambulance.**

***Index Terms*— VANET, AODV, Ambulance, Throughput.**

I. INTRODUCTION

The vehicle has become an extension of human and its progress is clearly visible over time. Modern technological advancements branched into various fields and its impact lead to the creation of intelligent systems by automation, data analysis etc. The results of these advancements lead to Safer Navigation, Assistance in navigation, and Safety in the transport system, Pollution monitoring, analysis and risk assessment and Traffic Management. Internet of Things takes the credit for majority of these recent advancements. The greatest achievement of this has been the Google Autonomous Car in [1]. Advancements in IOT branched into vehicles and created a subdomain within itself called the Internet of Vehicles (IOV) with a proper architecture stack, network model, challenges and its own aspects. This led to the evolution of VANETs. There are five primary layers in this architecture Vehicle to Vehicle, Vehicle to Road, Vehicle to Infrastructure, Vehicle to Devices and Vehicle to Sensors in [2]. The safety application is one of the most significant sectors in vehicular ad hoc networks (VANETs) because of the enormous number of traffic accidents encountered. The emergency messages are broadcasted among vehicles in VANETs to avoid accidents. The communication in 2G/3G faces the challenges such as narrow bandwidth, high cost and low quality. VANET can be used to transmit large amounts of important data from ambulance over to hospital. The scheme termed as Ambulance Traffic Control System controls the traffic lights in intersection and turns them green when an ambulance nears the signal. This helped the injured or patients to reach the hospital at the earliest [3,4]. Inspired by the above works, a model for dissemination of emergency message in a vehicular network for an ambulance to reach the site through the shortest path and minimum time has been designed in this paper.

II. LITERATURE STUDIES

As this work includes VANETs, AODV and DSR protocols, Dissemination of data, Image capturing, a survey has been done on these topics.

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A. ITS and VANETS

Vehicular communication is limited by various factors since the broadcast message range is limited and unidirectional transfer isn't always possible hence the data is relayed across nodes by hopping in various directions in [5].As with any smart network system, this is also susceptible to various attacks such as the worm attack along with the electromagnetic attack that can be intentional and the mitigations of the said process is described in [6, 7]. The usage of VANETs that fall under the umbrella of Intelligent Transportation System might be questionable since techs like ABS, ESC and other innovations take place in the automotive industry. It is certain that if warning messages reach the drivers beforehand many accidents can be avoided. The exchange of data done between vehicles is of interest for various governments, car manufacturing industries and academia, as efficiency and safety are achieved on roads. Inter vehicle communication (IVC) has four major advantages- coverage area is broad, reduced latency as a direct communication among vehicles is experienced, no power challenges and almost nil service fees in [8]. The problem with VANETs is continuous mobile nodes, changing topology, unstable networks and sometimes coverage issues. A better implementation is the combination of LTE and Cloud integration for better bandwidth, less interference and noise in [9]. VANET's applications include but not limited to Road Accident Prevention, Traffic management, infotainment among others. As with any model, there is a Software Defined Network (SDN) framework for VANET with Network Virtualization and a presence of VPV aka Virtual Private Vehicles that enables multitenant support in [10]. VANETs work by using an OBU (Onboard Unit) that has GPS, storage capabilities and an electronic map inbuilt. There can be an 802.11p enabled device mapped to this OBU which enables the connection of a phone to the car in [11]. There are Roadside Units (RSU) and Infrastructures to handle the entire system's communications. The entire system as a whole is distributed but at the same time collaborative. The idea being the RSU and the centralized servers get all the relevant data off the vehicles, GPS off the OBU which helps in early congestion detection and prediction and this data helps in managing congestion much more efficiently in [12].

B. Protocols

When operations such as forwarding of data, route creation, decision making for forwarding message, maintenance, recovery of route when error occurs or in establishing a new route are considered, routing protocols play an important role. There are protocols such as proactive, reactive and hybrid. Along with these, communication strategies like unicast, geo-cast and broadcast are also frequently done. The routing protocols find the best possible route towards the destination and retain them for transmitting the data. The different protocols that works on Routing in VANETs has been discussed and the strategies for the calculation are shown. These protocols are categorized into seven groupings- geo-cast routing, Adhoc, delay tolerant, cluster-based etc. Ad-hoc type routing often has been a mixture of a Mobile Adhoc Networks (MANETs) and VANET which are allotted with a short bandwidth and they manage the short radio range. Ad-hoc on-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) are some popular standard routing protocols. These are reactive routing protocols which dynamically find the path when the destination is known. The routing from any vehicle to a gateway vehicle is estimated by considering the number hops from the starting point. The challenge faced by such type of routing protocols is scalability. AODV is based on the Bellman-Ford algorithm. To avoid loops and ensure new route validity, it uses a sequence number (SN) which makes it different from other on-demand routing protocols. The basic operations of AODV are route discovery and route maintenance. DSR is a uniform reactive routing protocol, simple and very efficient, it calculates route when necessary like AODV. DSR is an on-demand routing protocol that is based on a method of source routing. In this algorithm, nodes place the route that the packet must follow from a source to a destination in the header of a packet. The two major steps of this protocol are route discovery and route maintenance. The performance of these two routing protocols is analysed for realistic city traffic scenario in terms of throughput, packet delivery ratio (PDR), average end to end delay (EED), and jitter. The best routing protocol is determined considering the density network and area size. AODV is shown to outperform DSR in this work. It is observed that the change in size of the area influences the performance more compared to the change in number of nodes. The other parameters like mobility models, transmission range and speed are the parameters listed in their future work. Performance can also be analysed for other parameters like overhead and packet loss in [13-15]. VANETs simulators are used to apply the routing protocols and analyse their performance before using them in real-world test beds. The Network Simulator 2 (NS-2) is one such simulator. DSR protocol has proven itself suitable to small clusters compared to its peer protocols. AODV has proven itself suitable to the city and the highway scenario.

C. Data Dissemination

Active research and development have been taking place in the domain of VANETs over quite some time now. Even with the huge amount of work that goes into this field, we will not be able to ensure that emergency messages reach the destination successfully with parameters such as low end to end delay, very high throughput and high delivery ratio at one time. A model to ensure this is shown in [16]. A methodology to overcome packet loss along with performance as compared to standard approaches is seen in [17]. A system where vehicle communication occurs with the desired parameters while using tools such as single fiber fault detection data communication chain. The two biggest new and upcoming concepts in wireless network communication are CRN-Cognitive Radio Networks that has information about the entire environment and uses that to allow effective communication between the users and VANETS: Vehicular Adhoc Networks that allows communication between vehicles on the road even while travelling [18].A protocol called CAIR in [19] which overcomes the problems in VANETs by optimizing the selection of routes along with maintaining optimal parameters such as high connectivity and overall lower delay. A technique is proposed in which there is maximum channel utilization that is using the channels that won't be used by the users in the VANET under a normal urban scenario of a single lane. The system not only senses the network but also minimizes the overall end to end delay in [20].

D. Image Capturing

The application recognizes two types of objects, that is real-world objects and few low-level objects [21] to get necessary data such as location, route and accident from a real-time photo taken by the vehicles travelling on the road. A vehicular cloud is formed by a group of onboard navigation units placed on each vehicle. Based on the embedded system in [22], an onboard camera uses a simulator to implement the algorithm for efficient lane changing, navigation to transfer data to central cloud from vehicular cloud using the roadside cloud in a real-time environment. The camera placed on the dashboard of vehicles captures an image and broadcasts it through a wireless channel after compression. The data about the opposite lane is delivered with less end-to-end delay and good visual quality [23] to drivers of vehicles driving behind.

III. MOTIVATION

The accepted response time for an ambulance to reach the site determined by the NFPA is 8 mins. While the average time taken by the ambulances to reach increased from 10 mins in 2010 to 25 mins in 2017 even when the number of calls it responded to was increased by four times. The above survey demonstrates the problem in real world and we based our entire study to come up with a solution to reduce the response time. VANETs provides various support and solutions to various problems and this work aims to make use of this and various protocols to help in traffic routing to make way for the ambulance thus in turn reducing the effective response time.

IV. PROBLEM DOMAIN

The real-world problems pose various challenges across various domains. One of the key challenges in the domain being the ever-changing traffic. To put it in technical terms this problem touches upon networking, routing, real world data mapping and message dissemination and unlike a traditional network where the data would be relayed through a medium, this problem poses a problem of a domain where in the entire network is unstable and can't be determined or known beforehand, so it touches upon protocols like AODV that are used in situations like this wherein they help to understand the network and help in routing. The domains are clearly explained in the literature survey wherein each domain and its tools and methodologies are explained.

V. PROBLEM DEFINITION

The problem involves the network simulation of vehicles in and this is achieved by simulating the vehicles, traffic and traffic scenarios in a virtual simulation using NS3. Protocols such as AODV are applied to the environment that helps in routing by utilizing the network knowledge and algorithms such as CAIR to reach the destination at the earliest using the rapid communication This work also relays information to the vehicles in the route of the ambulance regarding the arrival of the ambulance so that they can take alternative routes to clear out the route to help the ambulance reach much faster.

VI. STATEMENT

The dissemination of emergency messages across a vehicular network such that the average response time or arrival time is greatly reduced using VANETs and other protocols to assist in this matter under a network simulation as of now.

VII. INNOVATIVE CONTENT

A. Vanet

It allows interaction of data between nodes basically vehicles in this case on an ad hoc network environment called VANET. This system allows to share data among vehicles without the need for a centralized network and it is effective, implementable and its cheap to run and isn't a subscription so once implemented there is no cost to use the system.

B. Protocols

This helps in routing and in turn helps in guiding the vehicle to reach from source to destination. The real-world scenarios pose lots of problems and scenarios and the algorithms are checked and compared across to make sure that the message or the vehicle in this case can make effective decisions.

C. Message Dissemination

The actual relaying of data from the source to destination is done. This is used to ensure that the data successfully reaches the destination along with meeting expected criteria like lower end to end delay and high packet delivery ratio into consideration.

VIII. DESIGN

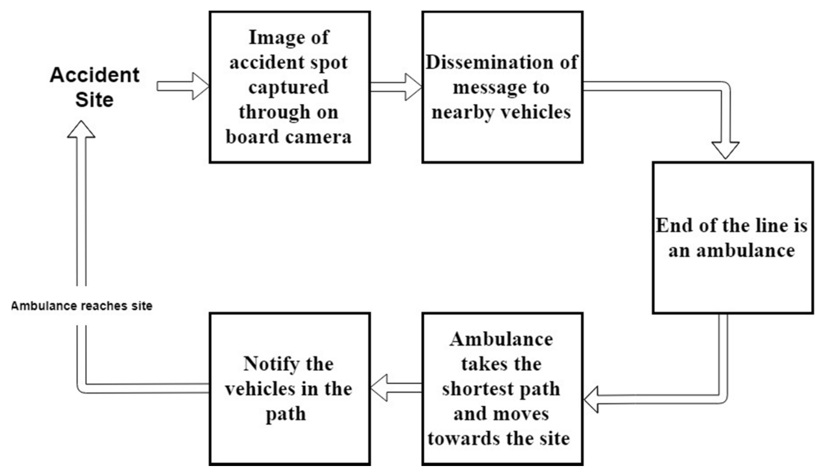

Figure 1. Proposed Block diagram of the System

In the system architecture as shown above, in case of an accident the vehicles passing by will capture the image and disseminate the message to the nearby vehicles which then transfer the message to the next nearby vehicles and so on. At the end of the string is an ambulance. The ambulance on receiving the message will run a routing protocol which gives back the shortest path which is used to move towards the site. The ambulance when moving towards the site will notify all the vehicles in the path of its arrival and the vehicles makes an effort to take an alternate path. The ambulance can then reach the site with minimum delay.

The vehicles on capturing the image in case of an accident first uses a compression algorithm through a compression algorithm. This can then disseminate the message based on the CAIR algorithm. The ambulance then receives the message and can act on moving towards the site.

The message is received by the ambulance and it chooses the best path to move towards the site through the AODV routing algorithm which takes the shortest path available. The message of its arrival is broadcasted to the nearby vehicles so it can make way. The ambulance can reach the site in the minimum time.

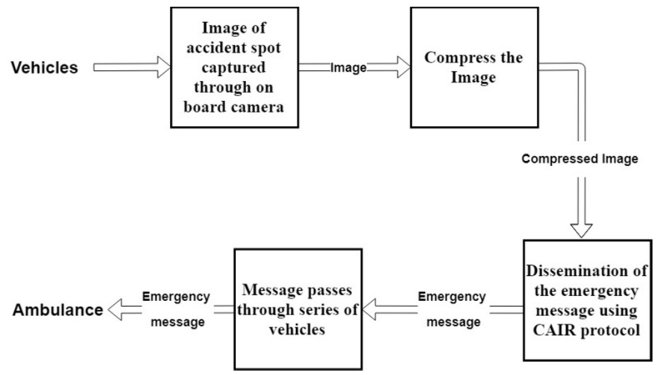

Figure 2. Proposed subsystem of Vehicles and Image Capturing

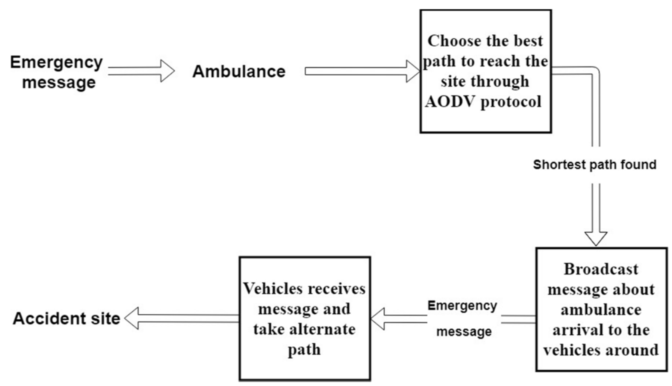

Figure 3. Proposed subsystem of Ambulance and Routing Protocol

IX. Solution Methodologies

The following proposed system involves the use of NS3 for the simulation of a topology and simulation of the system. The vehicles are represented as nodes in the simulation and upon the integration of the various proposed algorithms, the response time from the source destination would be calculated and compared against various existing methodologies.

X. Comparison Of Results

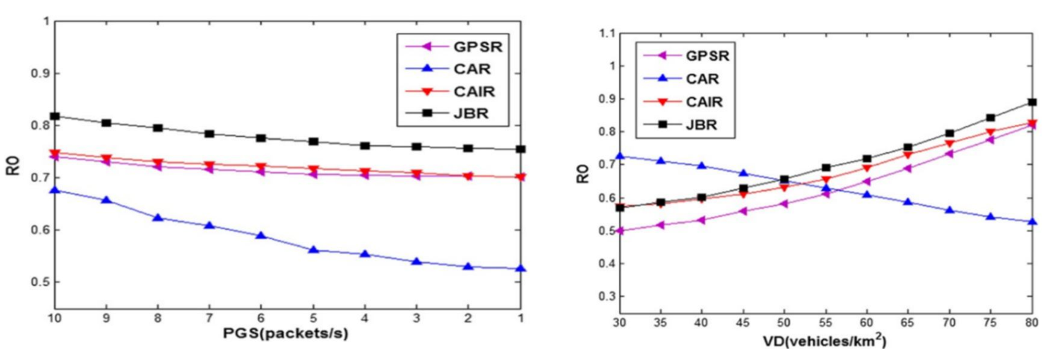

Figure 4. Impact of packet generation speed on routing overhead on left and Impact of vehicular density on routing overhead on right in [19]

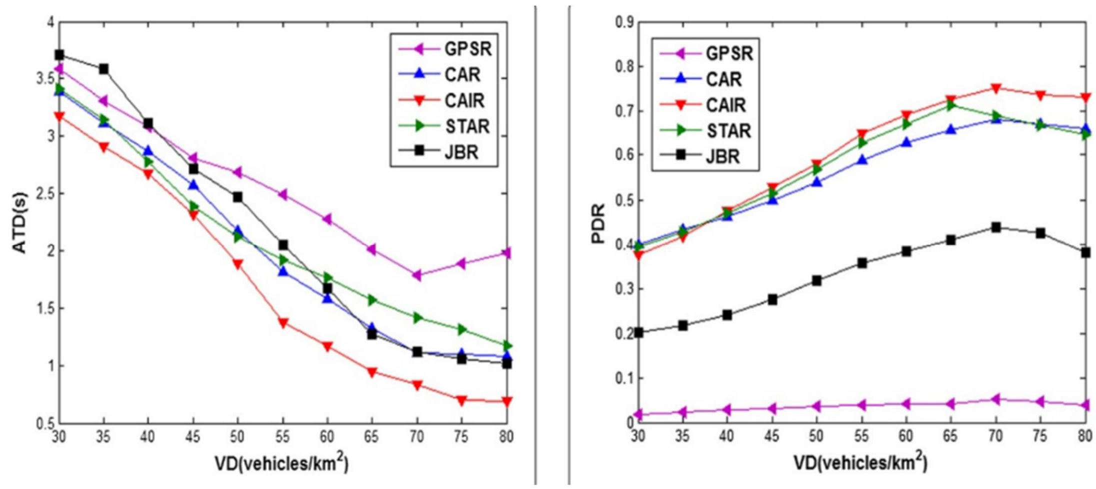

Figure 5. Impact of vehicular density on average transmission delay on left and Impact of vehicular density on packet delivery ratio on right in [19]

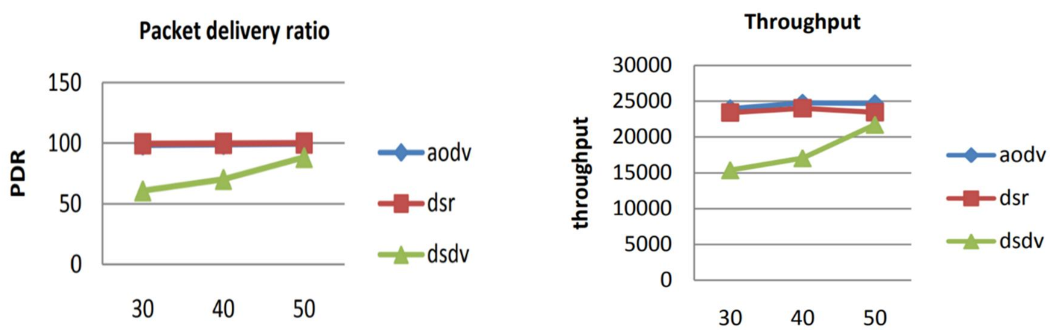

Figure 6. Comparison of Packet Delivery Ratio and number of nodes in left and Throughput and number of nodes in right in [24]

The different message protocols were used in comparison among various parameters to find out the most optimal one. The parameters included Packet Delivery Ratio: The successful delivered packets to the overall sent, Routing Overhead: The amount of data needed to control in addition to the data being sent out and Average Transmission Delay: The time delay between the generation and the time by when it reaches its destination and these parameters were compared against the rate at which packets were being generated and the average density of vehicles in a region in [23]. These results help in guiding of selection of various protocols that help in solving our problem. Upon integrating these protocols into the simulation, the simulated response time would be compared with other implementations to observe the difference in response time.

XI. Justification of Results

For the dissemination protocol, it is seen that Simulation results showed that CAIR outperforms other algorithms in terms of ATD and PDR at the cost of additional overhead and this can be explained with the way it works and the intersection optimal selection and mechanism of greedy forward routing along with the store and carry forward scheme. All these ensures that CAIR provides better and stable communication along with high packet delivery ratio and very low delays in Urban environments as from the experimental results in [19]. AODV was selected as the routing protocol, for the reason that the packet delivery ratio, throughput exhibited are more and in addition the average delay is less as compared to DSR. After integrating these into the system a detailed comparison would be added to see the differences in the average response time.

XII. Future Work

Since the current work incorporates various protocols to make the system much more efficient, we additionally propose the introduction of RSU in the system with the capacity to help in faster communication plus the added benefit of communication even in the presence of nearly null vehicles to relay the information. The introduction of integrated message service into Google Maps that would make sure that the person not only gives way for the vehicle but also that the person will be provided with the alternative route suggestions that will help the vehicle also to reach his destination as early as needed.

XIII. CONCLUSION

The system in this work proposes to replace the existing 2G/3G/4G communication methods used in emergency message transmission. In our system data transmission happens in case of an emergency situation using vehicular communication in VANETs. The system will show the vehicle in front of an accident capturing the images and transmitting the same to the ambulance, which moves towards the area of accident through the shortest path in minimum time. Vehicles in the path of the ambulance get notified of its presence. AODV protocol which is a reactive protocol using the Bellman-Ford Algorithm is used by the ambulance to determine the shortest path. The CAIR protocol will be used by the cars to solve frequent disconnections and the random distribution of vehicles by selecting an optimal route, hence minimizing end to end delay.

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REFERENCES

[1] U. Gerla, M. Lee, E.K. Pau, G. Lee, “Internet of Vehicles: From Intelligent Grid to Autonomous Cars and Vehicular Clouds;” *IEEE Comput. Soc. Washington, DC, USA*, pp. 241–246, 2014.

[2] O. Kaiwartya, “Internet of Vehicles: Motivation, Layered Architecture, Network Model, Challenges, and Future Aspects,” *IEEE Access*, vol. 4, no. c, pp. 5356– 5373, 2016.

[3] P. H. Lee and T. C. Huang, “A geocasting application for ambulance service,” *2014 Int. Conf. Comput. Network. Communication. ICNC 2014*, pp. 1086–1090, 2014.

[4] F. Y. Leu, M. H. Chen, Y. L. Huang, and C. C. Lin, “Controlling traffic lights for ambulances,” *Proc. - 2012 7th Int. Conf. Broadband, Wireless. Computer. Communication. Applications. BWCCA 2012*, pp. 462–467, 2012.

[5] A. Kesting, M. Treiber, and D. Helbing, “Connectivity statistics of store-and-forward intervehicle communication,” *IEEE Transport. Intelligent. Transport. Systems.*, vol. 11, no. 1, pp. 172–181, 2010.

[6] Q. Zhang and A. Boukerche, “A Novel Infrastructure Based Worm Spreading Countermeasure for Vehicular Networks,” *IEEE Transport. Intelligent. Transport. Systems.*, vol. 19, no. 7, pp. 2188–2203, 2018.

[7] P. Angskog, P. Nasman, L.-G. Mattsson, “Resilience to Intentional Electromagnetic Interference Is Required for Connected Autonomous Vehicles,” *IEEE Transport. Electromagnetism*, pp. 1–8, 2018.

[8] E. C. Eze, S. Zhang, and E. Liu, “Vehicular ad hoc networks (VANETs): Current state, challenges, potentials and way forward,” *ICAC 2014 - Proc. 20th International. Conference for Automation. Computer. Future. Automation. Computer. Manufacturing.*, September, pp. 176–181, 2014.

[9] M. Syfullah and J. M. Y. Lim, “Data broadcasting on Cloud-VANET for IEEE 802.11p and LTE hybrid VANET architectures,” *3rd IEEE International. Conference*, pp. 1–6, 2017.

[10] A. Bhatia, K. Haribabu, K. Gupta, and A. Sahu, “Realization of flexible and scalable VANETs through SDN and virtualization,” *Int. Conf. Inf. Networks.*, vol. 2018–January, pp. 280–282, 2018.

[11] X. Li, Y. Feng, and F. W. Q. Qian, “When smart phone meets vehicle: A New On-Board Unit scheme for VANETs,” *Proc. - 15th IEEE Int. Conf. Comput. Inf. Technol. CIT 2015, 14th IEEE Int. Conference. Ubiquitous Comput. Communications. IUCC 2015, 13th IEEE Int. Conference. Dependable*, pp. 1095-1100, 2015.

[12] C. Jayapal and S. R. S, “Road Traffic Congestion Management Using VANET,” *Jalappa Inst. Technol.*, 2016.

[13] D. V. C. P. Pramod Mutalik, “A Survey on Vehicular Ad-hoc Network Protocols for improving safety in Urban cities,” vol. 1, pp. 840–845, 2017.

[14] E. Khoza, C. Tu, and P. A. Owolawi, “Comparative Study on Routing Protocols for Vehicular Ad-hoc Networks” *2018 Int. Conf. Adv. Big Data, Computing. Data Communications. Systems.*, pp. 1–6, 2018.

[15] Y. Meraihi, D. Acheli, and A. Ramdane-Cherif, “QoS performance evaluation of AODV and DSR routing protocols in city VANET scenarios,” 2017 5th Int. Conf. Electrical. Eng. - Boumerdes, ICEE-B 2017, vol. 2017– January, pp. 1–6, 2017.

[16] I. K. Virdaus, M. Kang, S. Shin, C. G. Lee, and J. Y. Pyim, “A counting-based broadcast model of emergency message dissemination in VANETs,” *Int. Conf. Ubiquitous Future. Networks, ICUFN*, pp. 927–930, 2017.

[17] W. Liu, Y. Yang, and M. Zhu, “Research on inter hospital and ambulance data transmission using LT coding over VANET,” *2013 ICME Int. Conf. Complex Med. Egg. C. 2013*, pp. 119–123, 2013.

[18] H. Idriss, A. El Mouallem, A. Ahmad, Z. El Bazzal, and A. Muhieddine, “Data Forwarding using Dynamic Chains in VANETs,” *2018 Int. Conference. Computer. Applications*., pp. 291–296.

[19] Chen Chen, Yanan Jin, Qingqi Pei1 and Ning Zhang. “A connectivity-aware intersection-based routing in VANETs”

[20] C. Fu, “Minimum-Delay Routing in Single Lane Express Way CR-VANET,” *2018 5th Int. Conf. Electronics. Electron. Eng.*, pp. 355–359, 2018.

[21] T. Toth, J. Janech, and E. Krak, “Query based image processing in the VANET,” *Proc. - 5th Int. Conf. Comput. Intell. Communed. Syst. Networks, CICSyN 2013*, pp. 256–260, 2013.

[22] J. Joshi, K. Jain, and Y. Agarwal, “CVMS: Cloud based vehicle monitoring system in VANETs,” *2015 Int. Conf. Connect. Veh. Expo, ICCVE 2015 - Proc.*, pp. 106–111.

[23] E. Belyaev, P. Molchanov, A. Vinel, and Y. Koucheryavy, “The use of automotive radars in video based overtaking assistance applications,” *IEEE Trans. Intell. Transp. Syst.*, vol. 14, no. 3, pp. 1035–1042, 2013.

[24] V. Rajeshkumar, P. Sivakumar “A Comparative Study of AODV, DSDV and DSR Routing Protocols in MANET Using Network Simulator-2 “. India International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 12, December 2013