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Efficient and Reliable Cluster Head Selection Mechanism to broadcast collision information in Vehicular Ad-hoc Network

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Abstract-

Recent technology developments and researches in all aspects on information technology makes the Vehicular Adhoc Network (VANET) to develop the communication terminologies for their own network to perform effective communication. Some of the common areas of VANET considered for research such as routing, security, message broadcasting and so on have been improved to communicate and transmit the packets in a prominent manner. Therefore, the architecture of the VANET is remodified as per the three common scenarios such as purely ad hoc, cellular and hybrid. As the topology of the VANET keeps changing due to node mobility, hence the routing becomes more vital and needs an effective approach to transmit data between source and destination node. Additionally, VANET comprises of number of routing protocols to overcome such issues and one of the powerful and efficient clustering based multipath routing protocol named AOMDV is considered. This paper proposed a novel scheme of electing better and most efficient cluster head among the nodes according to the distance between cluster & members and number of hops for data transmission using the proposed AOMDV protocol. Experimental result shows the effectiveness of the proposed scheme with the existing models based on throughput and delivery ratio of packets (PDR).

Keywords: *VANET, AOMDV, Cluster Head, Cluster Member, Throughput*

INTRODUCTION

The number of revolutionary vehicle safety-oriented technologies such as the ABS, seatbelts, airbags, rear view cameras, Electronic Stability Control (ESC) is that alarmingly amid road accidents. Governments, the manufacturing industries and academia have been widely viewed as promising concepts of a future implementation of the Intelligent Transport System, thereby achieving security and efficiency on almost crowded motorways, for the direct interchange of kinematic data between cars via ad hoc network environments, called vehicular ad hoc network (VANET). The VANET is a MANET subset, with mobile nodes. Inter vehicle communication (IVC) offer four major advantages compared to MANET and other cellular systems: wide coverage area, relatively low latency due to direct wireless communication, little to no power problem to service charges (Eze et al.,2014).

In order to create a smart transport system, VANET integrate with the few elements of ad-hoc wired based and wireless networking by communicating between vehicle-to-vehicle and roadside systems. VANET's main aim is to ensure health and protection for people, through information on accidents, instability on traffic information in engaging with road drivers. Every node or vehicle has a VANET system that immediately shape an Adhoc network and can transmit the messages requested through the wireless network. A vehicle could communicate directly with other vehicles known as V2V communications, or a vehicle could communicate with an provided infrastructure such a Road Side Unit (RSU) known as V2I (Vehicle-to-Infrastructure (Lakshmi et al., 2012).

In today's world, there are many significant VANET applications. Such uses range from critical medical care to comfort and leisure. A VANET must meet the needs of ever evolving users, and should comply with the available technology requirements and architectures.

Some of the key applications (Saibh ur Rehman et al., 2013) of VANET can be summarized as follows,

1. Road Traffic Safety
2. Traffic Engineering or Efficiency
3. Comfort and Quality of Road Travel
4. Dynamic Topology
5. Frequent Disconnections
6. Predictable Mobility Patterns
7. Use of Other Technology
8. Stringent Delay Constraints

Proper routing is one of the key issues in VANET research. The maintenance and road exploration of route for transmitting messages in multi-hop networks in VANET is difficult due to the nature of the mobile ad hoc nodes. Most routing protocols are currently available and used under different road conditions ((Hartenstein & Laberteaux, 2009), (Chekima et al., 2015)). VANETs have several different characteristics than MANETs, such as road pattern limitations, no network size limits, dynamic topology, movement models and limitless energy supply. All these features made it impossible for the VANET community to establish successful routing protocols. The key aspect is the mobile nodes that travel rapidly (Dinesh & Deshmukh, 2014).

Some of the common parameters of VANET is described in the below table I.

TABLE I PARAMETERS OF VANET

SNO	Parameter	Description
1	High Mobility	Usually in VANET the nodes are moving at high speed. This makes harder to predict a node's position and protecting the privacy.
2	Rapid topology changes	Due to high node mobility and random speed of vehicles, the position of node changes frequently. Therefore, the network topology in VANET tends to change its topology frequently.
3	Unbounded network size	VANET may implemented in a city, several cities or for the whole country. Then the network size is geographically unbounded.
4	Frequent exchange of information	The ad hoc nature of VANET motivates the nodes to gather information from the other vehicles and road side units. Hence the information exchange among nodes become frequent.
5	Wireless communication	Design of VANET is meant for the wireless environment. Nodes are connected and exchange their information via wireless. Therefore, some security measure must be considered in communication for safe and secure transmission.
6	Time critical	The information in VANET must be delivered to the nodes with in time limit so that a decision can be made by the node and perform action accordingly.
7	Energy sufficient	The VANET nodes have no issue of energy and computation resources. This allows VANET usage of demanding techniques such as RSA, ECDSA implementation and also provides unlimited transmission power

Some of the common issues in VANET is detailed in Figure 1.

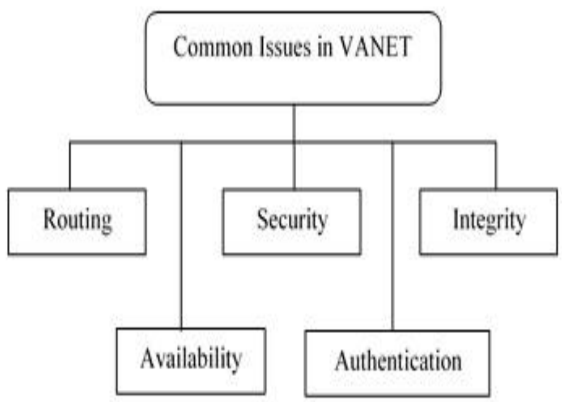

Fig. 1. Common issues in VANET.

Some key factors of VANET which considered in this paper is Routing issues in VANET occurs due to the high topological network (Routing issue) and VANET is the key component in the transport system. Due to the volume of the road traffic, it affects the safety of an individual, therefore, this issue should be eradicated (Security issue) (Samara et al., 2010). Considering the possibilities mentioned above, avoidance of the upcoming transport accident is an open problem with the alarming traffic flow on highways, towns and metropolitan regions. Various road safety solutions include traffic control and channeling, using technology such as warning systems, digital maps, and so forth were developed. Collision alert devices also introduced as an important part of the active protection of vehicles. VANET systems using inter-vehicular communication (IVC) to avoid accidents and the Intelligent Transport Network (ITS) can be incorporated.

Generally, the message from vehicles contains about time, space and agents details with the original message where the source and destination is going to receive and share. This message's validity is according to the relevance and road condition. Therefore, the message validity has also plays a vital role. Sometimes the irrelevant messages may transfer from any vehicle to the other where it may cause some consequences too. In

VANET, the message consists of live information therefore whenever the condition changes the vehicles must capture the status and to update the older content to the latest before transmitting it to the other vehicles. Suppose road accident in a certain area before an hour may create a worst traffic but there may no traffic jam right away. Consequently the data verification also plays a vital role in VANET. In such situation VANET is in demand whenever a better improvements in market.

Section II details the existing works on cluster head selection and collision broadcast on VANET. The problem statement is presented in section III and the proposed work is detailed in Section IV. Section V shows the simulation results of the proposed work and Section VI concludes paper.

LITERATURE REVIEW

(Haider et al 2020) presented a collison avoidance scheme in bi-directional traffic scenarios. The author proposed a modified K-medoid algorithm for estimating the collision probability with the expected state of nodes. The novel benign factor is implemented with adaptive deceleration for collision avoidance. In addition, the scheme mitigates inter-cluster and intra-cluster collisions to minimize congestion in communication and latency in transmission. The proposed work performs better warning in a situation when the probability level exceeds the predefined threshold value. Additionally, the encapsulated safe speed ensures the collision avoidance from the upcoming threat. This scheme performs efficiently in terms of stability in between and inside the cluster and collision avoidance.

(Srivastava et al., 2020) proposed a probabilistic broadcasting mechanism using fuzzy-based for information dissemination in VANET. Due to insignificance resource consumption, VANET becomes network crowded and rise network storm often. However, to avoid such insignificances beaconless approach is proposed and control packet flow and minimise the collision and packet drop rate. The goal of this work is to minimal broadcast between vehicles to achieve better packet delivery ratio through broadcast suppression technique to utilising the vehicle's buffer efficiently. The proposed work outperformed in terms of average delay and minimal rebroadcasting compared with other techniques.Increased interest in ad hoc vehicle networks has led to huge investments over the last decade. VANET (Vehicle Ad-hoc Network) is a modern technology field that is commonly used in self-contained systems. Due to rapid changes in topology and frequent disconnections, an effective routing protocol is difficult to conceive. Several VANET routing protocols have recently been proposed. Most approaches have ignored parameters such as environmental changes that affect the performance of real VANET applications. Environmental changes in VANET can have an impact on efficiency and output. In paper (Oranj et al., 2016) proposed an ant-colony optimization routing algorithm and a DYMO (Dynamic MANET on-demand) protocol to respond to environmental change. Ant Colony Optimization Algorithm is a probabilistic technique commonly used to locate graphical paths. In this document, two parameters were considered for assessing the paths identified: the delay time and (ii) the reliability of the path. Ns-2 was used to implement the proposed algorithm and to monitor its performance through a variety of environmental changes. The results showed that the proposed ant colony routing algorithm is better than other well-known methods, such as Ad Hoc on Demand Distance Vector (AODV).

The Ad Hoc Vehicle Network (VANET) is a network with high mobility nodes or vehicles. Many techniques have been proposed to improve VANET communication efficiency; one of these techniques is vehicle node clustering. In the clustering process, cluster nodes (CNs) and cluster heads (CHs) are selected or selected. The longer cluster life and the less efficient networking of VANETs contributes to the number of CHs. (Adil, 2016) proposes a new clustering algorithm based on ACONET Ant Colony Optimization (ACO) called VANET. This algorithm creates optimized clusters for robust VANET communication. The transmission range, direction, node speed and load balancing factor (LBF) parameters are considered for optimized clustering. ACONET is empirically compared to state-of-the-art methods, including Multi-Objective Particle Swarm Optimization (MOPSO) and Clustering Techniques for Comprehensive Learning Particle Swarm Optimization (CLPSO). In addition to the efficiency of the algorithms, a wide variety of tests are carried out through the difference in grid size, the transmission variety of nodes and the total number of network nodes. The results indicate that ACONET significantly outperformed the competitors.

Intelligent Transportation Systems (ITS) applications have been first implemented in Vehicle Ad-Hoc VANET, with the main objective of providing network vehicles and providing useful information about the status of road traffic. In addition, several papers have been written with ITS enhancements. VANET must be able to interact, regardless of traffic density and vehicle position, in any setting. The use of the cluster algorithm in VANET is successful since the algorithm makes the network more stable and scalable. Nonetheless, due to the high mobility of the nodes, stable clusters are difficult to obtain. Many parcels are lost and road repairs or warnings of failure, with low delivery ratios and long transmission delays, trigger overhead rises. The work of (Marzak et al., 2015) proposes a model that uses the YATES algorithm to calculate the value of stable nodes. This process aims to resolve the stability of the clusters.

The ad hoc vehicle network (VANET) is an ad hoc mobile network subset. VANET has become an active research sector aimed at improving vehicle and road safety, improving traffic quality and improving drivers and passengers' comfort. Owing to high mobility and dynamism, the routing of messages to their final destination in VANETs is a difficult task. These problems can be tackled by clustering techniques. Clustering is a mechanism of vehicle grouping based on some predefined metrics, such as vehicle density, speed and geographical position. Vehicle ad hoc network clustering (VANET) is a dynamic topology control mechanism. Many of the clustering algorithms from VANET are based on ad hoc mobile networks (MANETs). VANET nodes are, however, distinguished by their high mobility and the presence of VANET nodes in the same geographical proximity does not mean that they have the same mobility patterns. Therefore, the VANET clustering schemes will consider the speed and velocity of nodes to create a stable clustering structure. (Malathi & Sreenath, 2017) introduce a new clustering technique suitable for the VANET environment in order to improve the stability of the network cluster. Distance and speed are used as a parameter in this technique to build a relatively stable cluster structure. Additionally, a super cluster-head selection algorithm is proposed.

PROBLEM STATEMENT

Generally, VANET considers all vehicles as a node and each node can communicate with others wirelessly. Additionally, it turns all vehicles as wireless router or a node to communicate each other within 100-300 meter range. The primary objective of the network is to transmit current road status and information about obstacles with location information from each vehicle to others to provide a better road safety. Clustering in other networks such as WSN, MANET is an easy task compared to VANET because of the node’s speed, transmission of data, location information and so on. However, clustering is in need to overcome redundancy of sending same packets to the vehicles in a range. Clustering can possible in VANET by making a vehicle as cluster head which receives the current road scenario and it forwards the same data to the nearby vehicles within a range. The cluster head should continuously update its location to the member nodes; therefore, the redundancy of data is increased significantly in the network that increases the false information transmission. Sometimes, the same message is also transmitted from more than one vehicle in the same cluster, which gives data redundancy. The accident vehicle forwards about the accident and vehicle information to the bi-directional vehicles without any delay and still the accident vehicle is stopped manually. Henceforth, the data redundancy is occurred most of situation in VANET and needs an effective cluster head selection mechanism to improvise the network as set down in this paper.

PROPOSED METHODOLOGY

Vehicle ad hoc networks (VANETs) are created using the Mobile Ad Hoc Network Principles (MANETs) by spontaneously creating a wireless data-exchange network in the vehicle domain. Vehicle ad hoc network clustering is one of the strategies used to transfer data within a cluster from one node to the next. Managed systems for the clustering of adjacent vehicles are critical to the achievement of secure and effective safety communications. Among unlimited vehicles (Offor, 2012),

1. With radio frequency communications, so many vehicles can interface.
2. Such messages can be dispersed anywhere by crippling the network grid.

Traditional cluster strategies in nodes of VANETs may not be successful in forming efficient cluster groups and organizing cluster vehicles. More organizational strategies need to be developed with the VANET setting in mind. The cluster layout should be based on the space-time stability of ad-hoc networks consisting of mobile nodes.

Cluster Components: The solution consists of three parts, the cluster header, the cluster gateway and the cluster member.

Cluster Head:-This is the local cluster leader who arranges the transmission and transmission of the data.

Gateway Cluster:-A non-cluster header node that accesses the adjacent node and transfers data between clusters.

Cluster member:-This is generally referred to as the ordinary cluster node that participates in the same cluster without any interlinking of neighboring clusters (Saravanan et al., 2018).

Gateway is a node that connects the two network clusters, the gateway node is specific to the two separate clusters that are shown in Figure 2 in order to transfer information from one node to another. Preferred node-based routing in node creation. In a cluster, a cluster of nodes identified as part of a cluster and a node is configured to transmit the packet as a cluster header to the other cluster. This helps to ensure high scalability in large networks, but there is a risk that highly mobile nodes may be delayed (Jiang et al., 2016).

Vehicles will be grouped into various clusters based on geographical positions, motion directions, speed and many other metrics. Vehicle Clusters will be presented in Figure 3.

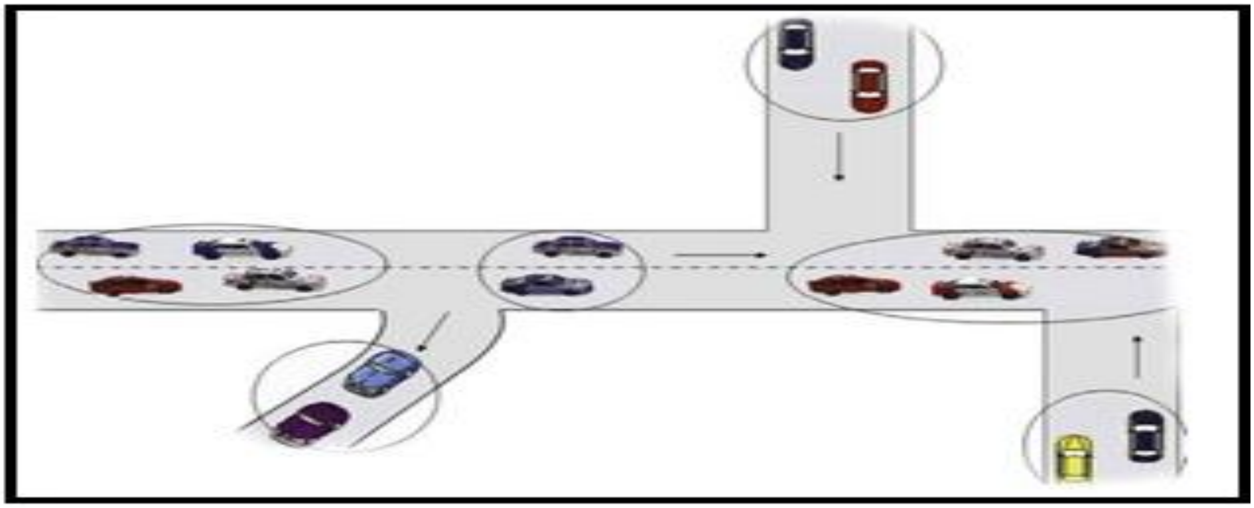

Fig.2 Schematic Diagram of Vehicle Clusters

In this paper, proposed a high-grade algorithm for the selection of CH under the MAC protocol. The VANET routing protocol focuses on location-based, data-centric and application-dependent. The primary research the cluster routing protocol in VANETS and examine the advantages and drawbacks of the current protocol belonging to VANETS. Based on the problems in the original protocol, the selection of cluster heads, special node processing, and inter cluster routing problems respectively, and then proposed improved Cluster Head Selection Mechanism.

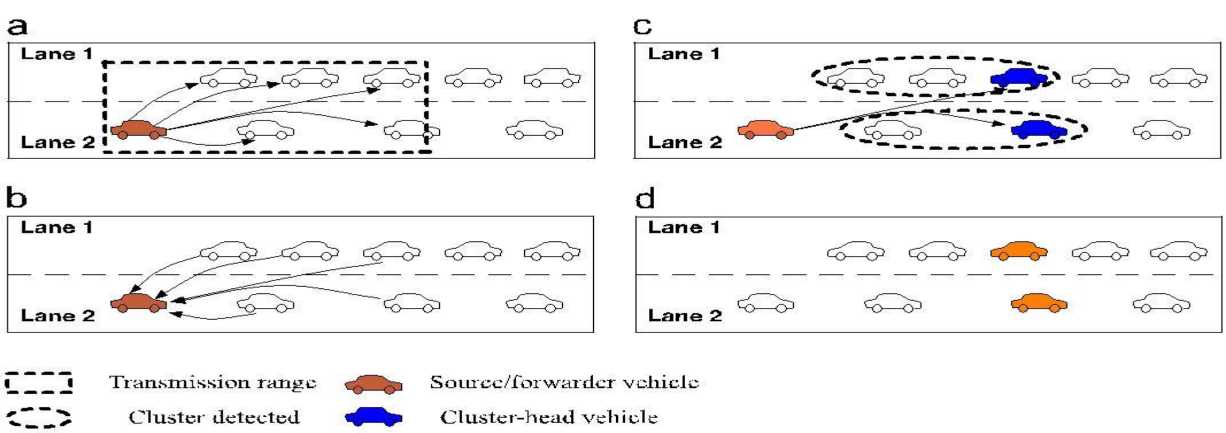

Fig. 3. VANET Clustering Scheme

EXISTING ISSUES IN CLUSTER HEAD SELECTION MECHANISM

Some of the common existing issues in the mechanism of cluster head selection are detailed here.

- Choosing better and needed CH among nodes is a vital issue.
- Keeps on evolving changes between the CH nodes and member nodes.
- Selection of CH based on more number of data delivered or received.
- location access and location based information sharing cannot determine a better CH selection.
- Interchange of state between stable and election state.
- Partitioning of cluster based on location and cluster based vehicles determination.
- Determining single point-to-point route and need of necessary transmission power.
- In a situation such a CH becomes dead then the network doesn’t elect another CH still the message transmission ends (upto initial allocated time).
- Ratio of number of CH nodes, addition of new nodes and deletion of existing death nodes needs further topological changes.

The proposed methodology focused in solving such issues mentioned above through multipath routing and modified CH election.

PROPOSED CLUSTER HEAD SELECTION MECHANISM

Based on the problems identified in the original protocol, the revised protocol called the Enhanced Head Selection Mechanism is proposed in this paper and is shown in Fig.3. After the first round, the BS based on its distance from the BS, the number of times to be chosen, chooses the next CH and the number of adjacent nodes, and alternate CH nodes and more logical and rational multi-hop inter-cluster routing are established.

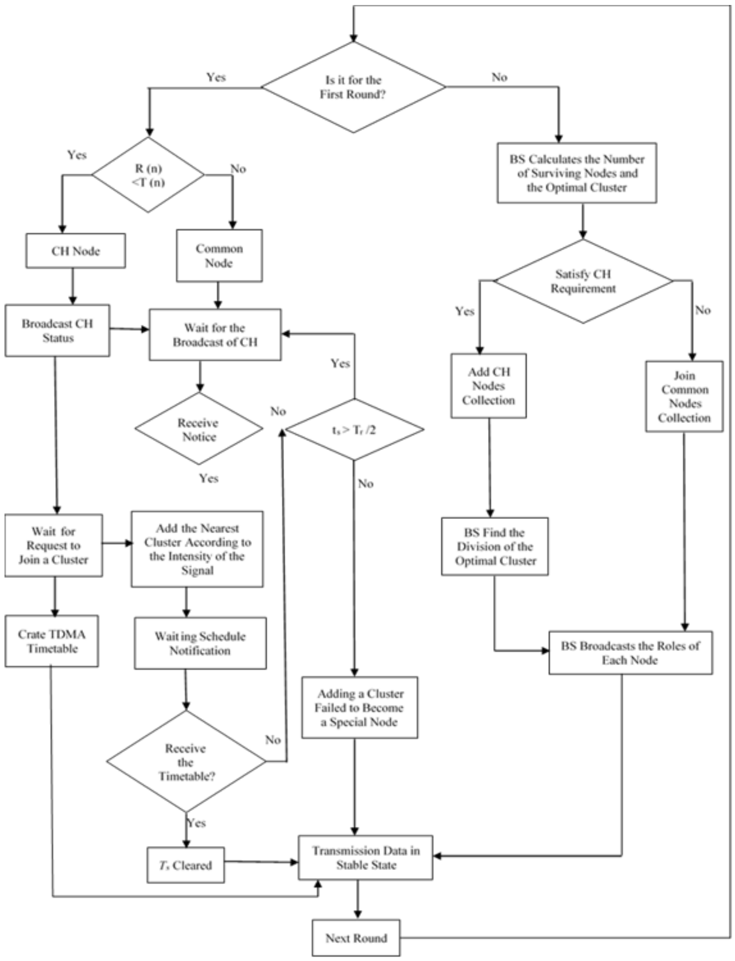

Fig. 3. Flow of Improved Cluster Head Selection Mechanism

The proposed algorithm is detailed in Figure 4.

1 **Initialisation:** *V = set of vehicles*
2 No_V = *Number of vehicles in cluster*
3 S_i = *Speed of vehicle in V*
4 S_{avg} = *average speed of all vehicles*
5 (x_i, y_i) = *current coordinates of the vehicle*
6 w_1 = *distance*
7 w_2 = *number of messages received*
8 w_3 = *percentage of Packet Loss* ($0 \le W_1, W_2, W_3 \le 1$ *and* $W_1 + W2 + W3 = 1$).
9 *velocity of a vehicle* V_i^m *calculated using*
V_i^m = *velocity of a vehicle i in the cluster m*

$$\Delta V = \frac{\sum i \in V^m \left| V_i^m - V_j^m \right|}{Nov \times w_1 (w_2 - w_3)}$$

10 Utility function of CH in m

$$U_i^m = \frac{Nov^m, S_{avg}}{1 + e^{-S\left(\frac{S_{avg} \times w_2}{V_{(x_i, y)} \times w_2}\right)}}$$

11 Average Utility function is identified

$$\Delta V_i^{m,n} = S_i \Delta S_{avg} w_2 + S_i \Delta Nov w_2$$

12 If $\Delta V_i^{m,n} \le 0$ Then
13 CH election is followed as default
14 Else
15 CH is elected based on proposed V_i^m

PERFORMANCE ANALYSIS

SIMULATION ENVIRONMENT

Table II below displays the simulation model used for the proposed analysis. It describes the different simulation parameters.

TABLE II SIMULATION PARAMETERS AND VALUES

PARAMETERS	VALUE
Channel	Wireless channel
Antenna	Omni/Directional Antenna
MAC Protocol	IEEE 802.11
Routing Protocol	AOMDV

No. of Nodes	100
Simulator	NS 2.35
Simulation Time	600 Sec
Protocol	AOMDV
Traffic Status	Continuous arrival

PERFORMANCE PARAMETERS

The VANET output analysis is performed using the parameter dependent on the limited accurate transmission.

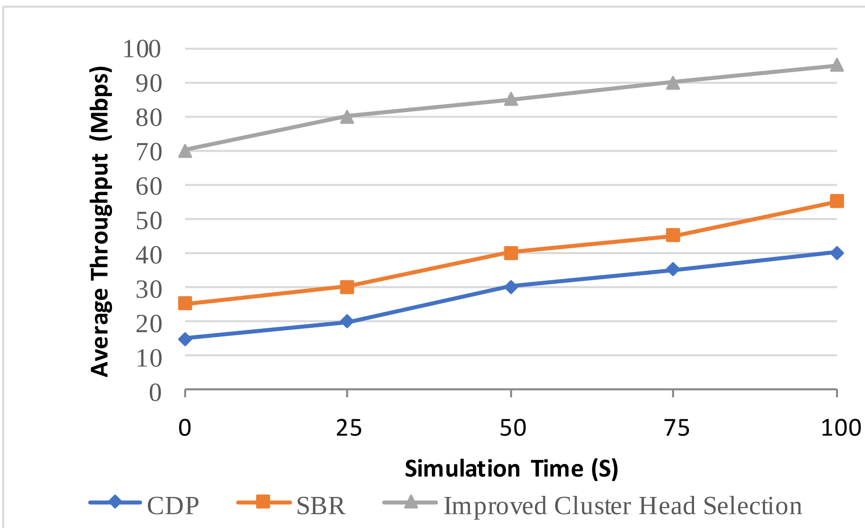

Fig. 4 Comparison of Throughput

Throughput: The throughput shows the correct cluster detection occurred when the packet exchange rate was significantly increased. Figure 4 shows the performance of vehicles on the motorway scenario. Compared to the SBR method, the efficiency of the proposed method increases by 50%.

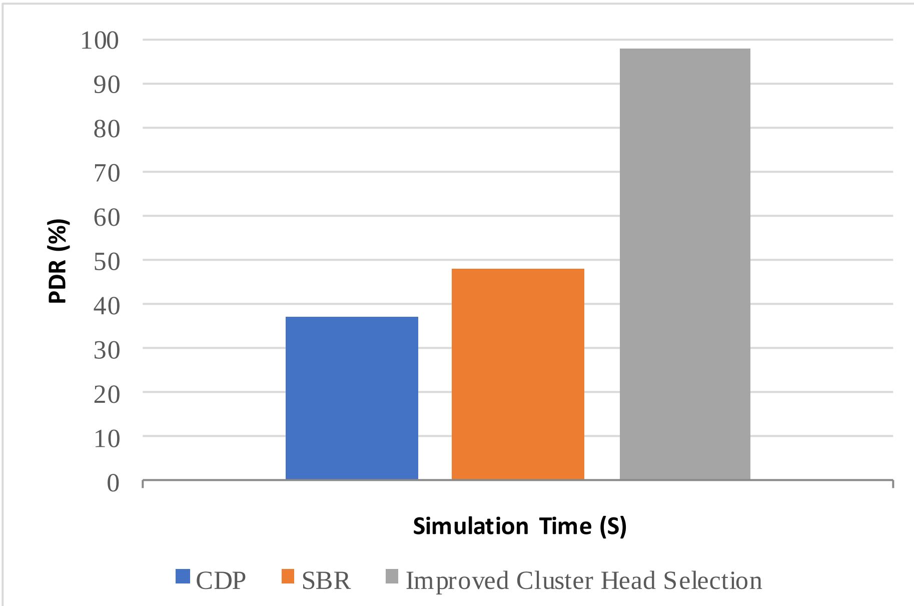

Fig. 5. Comparison of Packet Delivery Ratio

Packet Delivery Ratio: Packet delivery ratio is defined as the number of received packets and the number of transmitted packets. This increases since packets are transmitted efficiently to intermediate nodes. It is in Figure 5 indicates that the solution proposed is 50% higher than the SBR solution.

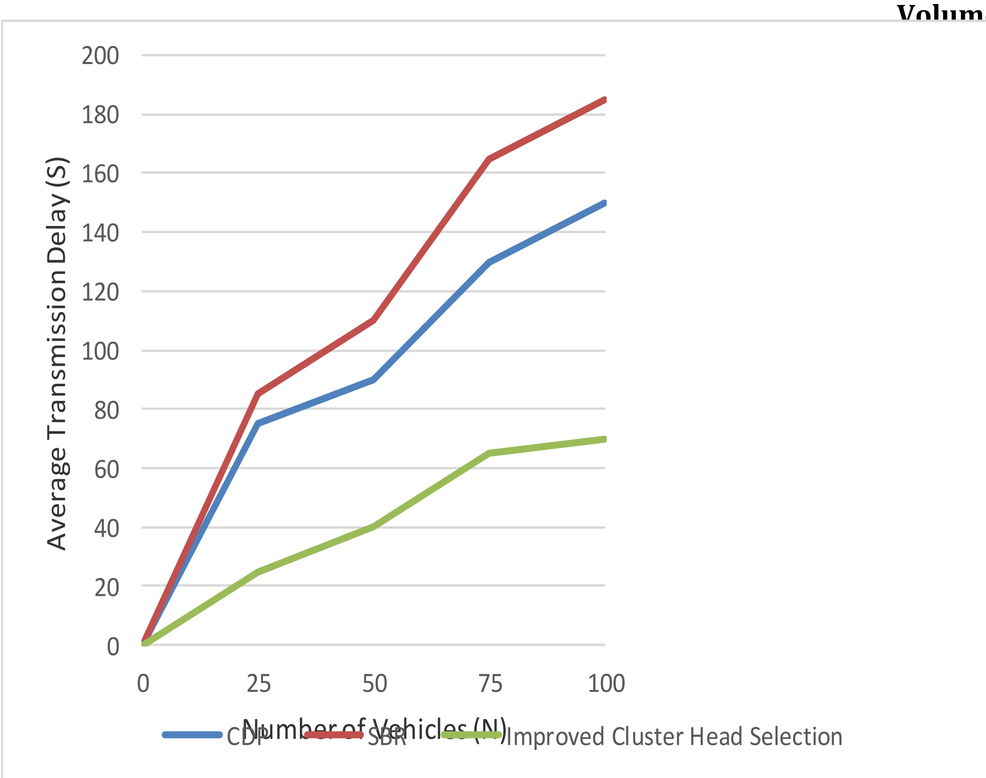

Fig. 6. Comparison of Average transmission delay

Average Transmission Delay: Average transmission delay is defined as an average of delay in seconds between source and destination vehicles . It is in Figure 6 indicates that the solution proposed is 35% lesser delay than the SBR solution.

CONCLUSIONS

1. The VANET clustering algorithm works by combining mobile nodes with groups called clusters. According to a set of rules, and the choice of a node called the Cluster Header (CH) between the cluster and the remaining network is the same as the wireless infrastructure access point. Depending on the specification, the basic functions of the cluster head vary as does the mechanism by which it is selected. The clustering algorithm used to connect cluster nodes must ideally be robust for node instability and unpredictable changes in the topology of the network and the cluster and ensure stable VANET-back communication.

2. Cluster Heads are chosen and play a key role in VANETS cooperation. This paper introduces a new approach for the collection of VANETS clusters. The proposed Head Selection Mechanism for Clusters will be based on the number and the distance between the heads of the clusters and the members. As all mobile nodes are in VANET, this article considers the vehicle speed and vehicle location when the cluster head is selected. Output analysis is performed on the basis of the packet's throughput and delivery ratio. The findings show that the suggested solution provides a substantially higher percentage of improvements in both parameters.

REFERENCES

1. Eze, E. C., Zhang, S., & Liu, E. (2014, September). Vehicular ad hoc networks (VANETs): Current state, challenges, potentials and way forward. In 2014 20th International Conference on Automation and Computing (pp. 176-181). IEEE.
2. Lakshmi, K., Thilagam, K., Rama, K., Jeevarathinam, A., & Priya, S. M. (2012). Comparison of three greedy routing algorithms for efficient packet forwarding in VANET. International Journal of Computer Technology and Applications, 3(1), 146-151.
3. Sharma, Vishal, Harsukhpreet Singh, and M. Kaur. "Implementation and Analysis of OFDM based IEEE 802.11 g VANET." *IJCNWMC, Trans-Tellar* (2013): 47-54.
4. Saibh ur Rehman, S., Khan, M. A., Zia, T. A., & Zheng, L. (2013). Vehicular ad-hoc networks (VANETs)-an overview and challenges. Journal of Wireless Networking and Communications, 3(3), 29-38.
5. Hartenstein, H., & Laberteaux, K. (Eds.). (2009). VANET: vehicular applications and inter-networking technologies (Vol. 1). John Wiley & Sons.
6. SRIVASTAVA, SAURABH, et al. "ALL UNIT INTERCONNECTION ALGORITHM FOR VEHICULAR AD-HOC NETWORKS." International Journal of Computer Networking, Wireless and Mobile Communications (JCNWMC) 3.1, Mar 2012, 123-130
7. Chekima, A., Wong, F., & Dargham, J. A. (2015, December). A Study on Vehicular Ad Hoc Networks. In 2015 3rd International Conference on Artificial Intelligence, Modelling and Simulation (AIMS) (pp. 422-426). IEEE.
8. Dinesh, D., & Deshmukh, M. (2014). Challenges in vehicle ad hoc network (VANET). International Journal of Engineering Technology, Management and Applied Sciences, 2(7), 76-88.
9. MALISUWAN, SETTAPONG, and WASSANA KAEWPHANUEKRUNGSI. "Ad Hoc UAV LTE Networks for Critical Communications." *International Journal of Computer Networking* 6.1 (2016).
10. Samara, G., Al-Salihy, W. A., & Sures, R. (2010, May). Security issues and challenges of vehicular ad hoc networks (VANET). In 4th International Conference on New Trends in Information Science and Service Science (pp. 393-398). IEEE.
11. Haider, S., Abbas, G., Abbas, Z. H., Boudjit, S., & Halim, Z. (2020). P-DACCA: A probabilistic direction-aware cooperative collision avoidance scheme for VANETs. Future Generation Computer Systems, 103, 1-17.
12. PALIWAL, NEHA, and SHIV PRAKASH. "Energy Efficient And Congestion Controlled Relay Node assignment in Cooperative Ad Hoc Network." *International Journal Of Computer Networking, Wireless And Mobile Communications (IJCNWMC)* 3.4 (2013): 67-76.
13. Srivastava, A., Prakash, A., & Tripathi, R. (2020). Fuzzy-based Beaconless Probabilistic Broadcasting for

Information Dissemination in Urban VANET. Ad Hoc Networks, 102285.

14. Oranj, A. M., Alguliev, R. M., Yusifov, F., & Jamali, S. (2016). Routing algorithm for vehicular ad hoc network based on dynamic ant colony optimization. Int. J. Electron. Elect. Eng, 4(1), 79-83.
15. Adil, F. (2016). Intelligent clustering in vehicular ad hoc networks (Doctoral dissertation, University of Engineering & Technology Taxila-Pakistan).
16. Marzak, B., Toumi, H., Talea, M., & Benlahmar, E. (2015, June). Cluster head selection algorithm in vehicular Ad Hoc networks. In 2015 International Conference on Cloud Technologies and Applications (CloudTech) (pp. 1-4). IEEE.
17. Malathi, A., & Sreenath, N. (2017). An efficient clustering algorithm for Vanet. International Journal of Applied Engineering Research, 12(9), 2000-2005.
18. Offor, P. (2012). Vehicle ad hoc network (vanet): Safety benefits and security challenges. Available at SSRN 2206077.
19. Saravanan, D., Janakiraman, S., Kumar, G. A., & Sathian, D. (2018). Optimal Route Optimization in Vehicular Networks–A Survey. International Journal of Pure and Applied Mathematics, 119(14), 385-393.
20. Jiang, X., & Du, D. H. (2016). PTMAC: A prediction-based TDMA MAC protocol for reducing packet collisions in VANET. IEEE transactions on vehicular technology, 65(11), 9209-9223.