PREVENTING DATA COLLISION BY ENHANCED SAFETY OR ALERT MESSAGE BROADCASTING STRATEGY IN VEHICULAR AD-HOC NETWORK (VANET)

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ABSTRACT

A vehicular adhoc network (VANET) is a mobile adhoc network in which moving road vehicles are network nodes. The major problem faced in VANET is transmitting the safety message or an ALERT message between the vehicles to avoid collisions. The large number of vehicles moving in a particular area will cause the data congestion that results in a long delay on delivering the messages. Clustering the vehicles into groups is an efficient approach to broadcast the messages with a less delay and high delivering ratio. The performance of the clusters is greatly influenced by the selection of Cluster Heads (CHs). In this paper, the formation of clusters and cluster head selection is formulated as optimization problem in order to maximize the efficiency of the network energy and link quality. The formulated problem has been solved using two approaches: Density based Clustering and the cluster heads selection using Differential Evolution (DE) Algorithm. By combining these approaches the safety or Alert messages will be transmitted easily to all the vehicles by dynamically adapting transmission power and contention window size. The performance of the proposed ESMBS protocol is compared and evaluated against the existing AdvB and CBAPA protocols.

Keywords: vehicular adhoc network, clustering, DE algorithm, collision, cluster heads (CHs).

1. INTRODUCTION

Vehicular adhoc network is one of the interesting areas which create a mobile network using moving cars as nodes. It makes each and every vehicle into a wireless router that is 100-300 meters around approximately. If any vehicle drops out of the network or fall out of the range of the signal, other vehicle can join in to create a network by connecting vehicles to one another [1]. Emergency messaging is one of the attracted applications of VANET. Here drivers can receive emergency messages immediately through direct transmission. So the drivers take actions to hazardous situations appropriately. For instance, the vehicles can slow down near the accident zone or stop before getting collided with the preceding vehicle or taking a detour, lanes can be changed.

VANET supports intelligent inter vehicle communication and it is emerged as a platform to provide traffic safety and improve performance. To improve the comfort of travel and road safety, VANET is one of the promising aspects.

The architecture of the vanet comprises External information and management, information connector, application protocol layer, data, multi-hop and single-hop message dissemination. [2] [3] [4].The VANET network model consists of road side units (RSUs) which are fixed over the network, On Board Units (OBUs) embedded in vehicles that communicate either with other and Trusted Authority (TA) that provides certificates and distributing secret keys to all OBUs in the network[5].

In VANET, the foremost function is distributing the protection messages to the near vehicles to evade the traffic and collision. Due to the active mobile nodes, the network topologies modify effectively in VANET and the vehicles encompass a constraint among their topology because the road is forecasted [6] [7].

2. LITERATURE REVIEW

V. Hemakumar and H. Nazini [13] offered an optimized traffic signal managing system. The VANET is formed by equipping all vehicles with onboard location and speed sensors. To communicate with infrastructure, wireless radio is installed at the intersection. Whenever the vehicles enter into the traffic area, they broadcast their positional information. The controller stores it in a temporary log which runs platooning algorithm to group the vehicles based on the data dissemination by the vehicles. Then the oldest job first algorithm will be applied so that each vehicle crosses the intersections at equal delays. This algorithm works well with light and medium vehicular traffic loads. But under heavy traffic load, the performance of the algorithm degenerates to the vehicle actuated traffic method.

The cluster based routing algorithm is proposed by Samira *et al.* [14] which is scalable, reliable and distributed. In this algorithm, the speed deviation of the vehicles and the remaining time to destination while selecting the cluster head is taken into consideration. In the distributed environment, the nodes are divided into number of overlapping or disjoint 2 hop diameter clusters. The data structures used are Neighbor table, Cluster adjacency table (CAT), two hop topology database. To maintain the cluster membership information, the cluster head is selected for each cluster. To become a cluster head, the node with low speed deviation and high travel time is given more chance. By selecting the appropriate cluster head, the end to end delay has been substantially reduced in the proposed algorithm.

The work by Pampapati Hubballi *et al* [15] implements Agent based Dynamic Clustering for Hybrid VANET (ADCHV). The agent technology is used by the proposed approach in which the moving vehicles make the dynamic topology stable. Agent resides in the Road Side Unit (RSU) initiates the formation of cluster and selects the cluster head based on the vehicle's neighbor list and position. If the cluster head fails or move out of coverage area, the vehicle agent will replace the cluster head. This approach considered the following performance parameters: Cluster formation time, cluster heads chosen time and duration of the cluster.

B. Ramakrishnan *et al* [17] offered an emergency message broadcasting and collision avoidance scheme for the vehicular ad hoc network. The proposed scheme initiates the formation of clusters and choosing the cluster head which is responsible for avoiding interference and management of clusters. Then during emergency event, the message is forwarded to cluster head which in turn broadcast the message to all cluster members. The proposed scheme is simulated for DSDV, AODV, and DSR protocols through the standards of 802.11 and 802.11p in SHWM, Manhattan and interstate mobility representation. It is concluded that AODV performs better in SHWM when this proposed scheme is used. Here two MAC layer protocols are used to improve the reliability during emergency message transmissions.

R. Thenmozhi *et al* [3] proposed a cluster based architecture for preventing accident and rear-end collision in VANET. Here the vehicles moving in the same road and direction will be grouped as clusters. The vehicles are classified as Cluster Head (CH), Sub cluster head (SCH) or Ordinary vehicle (OV). Here the vehicle has to advertise to become the cluster head. Based on the local vehicle density, the transmission range and power are calculated. Message prioritization is done and congestion window value is given. Here the probability of the collision will be estimated and emergency event will be detected. Then the vehicle will issue a warning message to all the members in the cluster. The performance of the clusters is greatly influenced by the selection of Cluster Heads (CHs). But this approach is not mentioned clearly in the existing system.

3. PROBLEM IDENTIFICATION AND SOLUTION

Generally, Vehicular ad hoc network (VANET) is intended to develop the traffic management and security driving derived from the access of internet. The major problems involved in the existing method are collision and network flooding. Using the existing scheme the collision occurred areas are identified and the emergency message also transmitted successfully. The problem is that it forwards a message only to nearby vehicles and this process is not much efficient because any vehicle who is apart from collision area may visit the same problematic area. The performance of the clusters is greatly influenced by the selection of Cluster Heads (CHs). But this approach is not mentioned clearly in the existing systems.

It is essential to convey messages to the overall vehicle in a region. During the message transitions towards many vehicles, there will be high energy consumption in the network which degrades network lifetime. To make the process reliable, selection of Cluster head (CH) is more important. So we propose a new method for a safety message broadcasting in order to avoid the collision and also to increase the network lifetime.

We use the optimization method to identify the collision affected area and pass the signal to avoid traffic with the safety messages. The message broadcasting is a significant role because the message is the notification for avoiding traffic accident. The main aim of this work is to provide the safety message for the vehicular network in case of road accidents or collision by suggesting the drivers to take the alternate route to reach the destination.

3.1 Network model

In VANET, the foremost function is distributing the protection messages to the near vehicles to evade the traffic and collision. Due to the active mobile nodes, the network topologies modify effectively in VANET and the vehicles encompass a constraint among their topology because the road is forecasted. The Figure-1 illustrates the structural design of VANET on conveying the protection message in the crisis situation.

The process involved in the proposed method includes cluster formation, cluster head selection and broadcasting safety messages. The proposed method is explained clearly in the further section. In this section the architecture is explained with a model. Here it is a four way road in which the vehicles travel along the ways. The GPS is the kind of network which is related to the wireless network through the vehicles. Based on the position and movement, the vehicles get clustered to make the communication easy. The number of vehicles has been counted using the sensor network. The Figure-1 clearly explains the system model of our proposed method. Each set of vehicles has been grouped with the set of clusters and each cluster has been under the control of cluster head. When there is a collision between the vehicles, the sensor node gets the notification regarding the changes caused in the movement of vehicles. It immediately broadcast a message regarding the collision to the nearest cluster head. Then the cluster head forwards a message to the vehicles present in the cluster.

3.2 Proposed methodology

In the VANET message transmission is one of the difficult tasks. As all the vehicles move in a high speed, the collision caused in a particular area will make the collision or traffic in the entire surrounded region. So it is necessary to send the alert message to the surrounded area so that the other vehicle will not get affected by the collision and also by waiting. If the other vehicular came to know the collision in particular area they may find other way to reach the destination or they may find some other time to move. In order to make the travelling easier by avoiding collision and any other further accident, it is necessary to build a safety message broadcasting in an efficient and quick manner. Thus we implemented a clustering method in our proposed system. We designed vehicles in the form of clustering by grouping a set of vehicles with some specifications. In the proposed method, we separate the methodology into three segments like cluster formation, cluster head selection and broadcasting

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safety message. The clustering is performed using the density based clustering algorithm and the cluster head is selected using the differential evolution algorithm and the data will be transmitted successfully by dynamically adapting transmission power and contention window size with the specified cluster head.

3.2.1 Cluster formation - Density based clustering

Based on the density, the clustering [19] will be done by grouping the vehicles. The density indicates the speed, location and position of the vehicles. Some important features used to create the cluster in this anticipated method are:

- Connectivity level of node
- Link quality includes position and distance of each node.

Connectivity level of node

In this phase, the node determines the number of connections involved in the network and estimates whether it is sparse or a dense network. The density is measured by counting the active links in the network. First the entire node sends a HELLO message to show their availability. The TTL is set to 1. If the node gets a response of ACK packet more than the threshold value then it can be confirmed that it is a dense area. If the response is less than the threshold value then it is a sparse area and it does not require any cluster concept.

Determining link quality

In this phase, we determine the speed, link quality and distance among the nodes. Here the node selects its neighbor with a reliable connection because it is difficult to form the cluster at each time. It has to be constant with respect to particular time interval. The HELLO message is sent to every node and the received node responses with their current position, speed and their direction. This has been measured using the global positioning system (GPS). Using this measurement the link quality has been evaluated for the future purposes.

In this algorithm clustering can be taken place by the distributed method, in which every node executes the clustering algorithm. Suppose, if a vehicle requires discovering a CH, then it sends a message "Request" to the entire neighbors. If it is not received the response, it establishes the cluster formation procedure. Based on the direction, the moving vehicles can be clustered. Each vehicle send the Hello message to its node group, that the message includes ID, the speed V, and position. Afterward, it locates the limitation in an array of region and resolve.

The distance between the vehicle N and its neighbor Z: With (x, y) is the location of the node.

$$\text{Distance D} = \sqrt{(x-x1)^2-(y-y1)^2} \tag{1}$$

According to the density related clustering algorithm, the vehicles can form cluster effectively. The nodes have been clustered by means of the resolute position, location and the distance of each node. Afterward it is essential to discover the cluster head to construct the communication faster. So, we utilize the optimization algorithm to select the cluster head in easy manner.

3.2.2 Cluster head selection - DE Algorithm (Differential Evolution)

To select the cluster head from the cluster we use the differential evolutionary optimization algorithm. The input data are given from the output determined from the density based clustering algorithm such as the position, speed and distance.

Afterward, the crossover and steps are followed by the function of DE algorithm. At last we establish the fitness value as the best vector that has been obtained as a cluster head. Suppose, if the formation of cluster is based on this optimization process then the cluster head is well designated by the DE function. Generally, the algorithm authenticates the node by means of the less speed and the middle of lane indicated as a cluster head because node is constant in the cluster for some time. So, it does not necessitate the instantaneous selection of the cluster head.
DE algorithm is mostly employed to resolve the real world optimization difficulties, which is a simple population [20] based optimization algorithm. This algorithm encompasses four progressions such as initialization, mutation, cross over and selection.

DE algorithm

a) Initialization

The initialization of the algorithm is based on the randomly chosen population through the NP vectors. Each vector is indicated as a chromosome or genome contains D optimized variables and forms the solution to the optimization problem.

In differential evolution the random generation has been represented as R= {0, 1, …Nmax}

$$x_i^R = [x_{i,1}^R, x_{i,2}^R.....x_{i,D}^R] \tag{2}$$

denotes ith solution to the Rth generation.

The population of Rth generation is represented as

$$x^R = [x_1^R, x_2^R.....x_{NP}^R] \tag{3}$$

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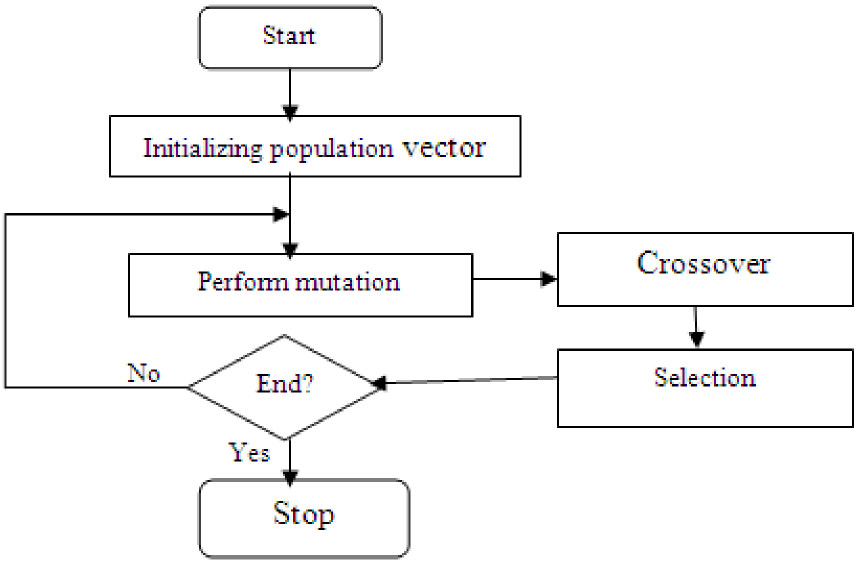

Figure-1. DE algorithm.

b) Mutation

Mutation is performed once the initial population is created. A mutant vector, γ_i^R, for $x^R i$, i ∈ {1, 2... NP} is formed for each member of the population x^R at generation R by summing the randomly chosen two vectors weighted differences to a third one from the population as denoted in the equation (4)

$$\gamma_i^{R+1} = x_{s1}^R + F \times (x_{s2}^R - x_{s3}^R) \tag{4}$$

Where s1, s2 are the randomly selected values with the range from 1 to NP differ from the base vector index i. In this the scalar factor F controls the variation based on the amplitude. The scalar factor is constantly denoted as 0.5

c) Crossover

To enhance the population's potential diversity, cross over operation is performed. For each individual x_i^R a trial individual γ_i^R is generated as follow:

$$u_{ij}^{R+1} = \{ \begin{matrix} \gamma_{ij}^{R+1} if (Q_j \leq CR) or (j = jrand) \\ x_{ij}^R \end{matrix} \tag{5}$$

Where Q_j is a random number in the range [0, 1] and jrand is a randomly chosen integer in the range [1, D]. The crossover threshold CR € [0, 1] is used to decide the trial solution.

d) Selection

It is the final phase in the optimization process which determines which of the vectors should be chosen for next generation based on the fitness value. At this point, one to one opposition is carrying out by the trial and parent value. The evaluation function is denoted as

$$x_i^{R+1} = \{ \begin{matrix} \gamma_i^{R+1}, if (\gamma_i^{R+1}) \leq f(x_i^R) \\ x_i^R \end{matrix} \tag{6}$$

Where $f(x_i^R)$ is the fitness value for x_i^R.

3.2.3 Transmission of messages

Once the cluster head is selected, each vehicle runs an algorithm individually to adapt both transmitted power and Contention Window (CW) size periodically [3]. The probability of collision between nearby vehicles is calculated and included in the contention window metrics. This ensures the occurrence of proper updates of transmission power and CW [AC (Access Category)] values based on the local vehicle density and the network condition respectively. Thereby the occurrence of any emergency event or collision is informed to each vehicle by its cluster head so as to prevent accidents and rear end collision

Proposed method

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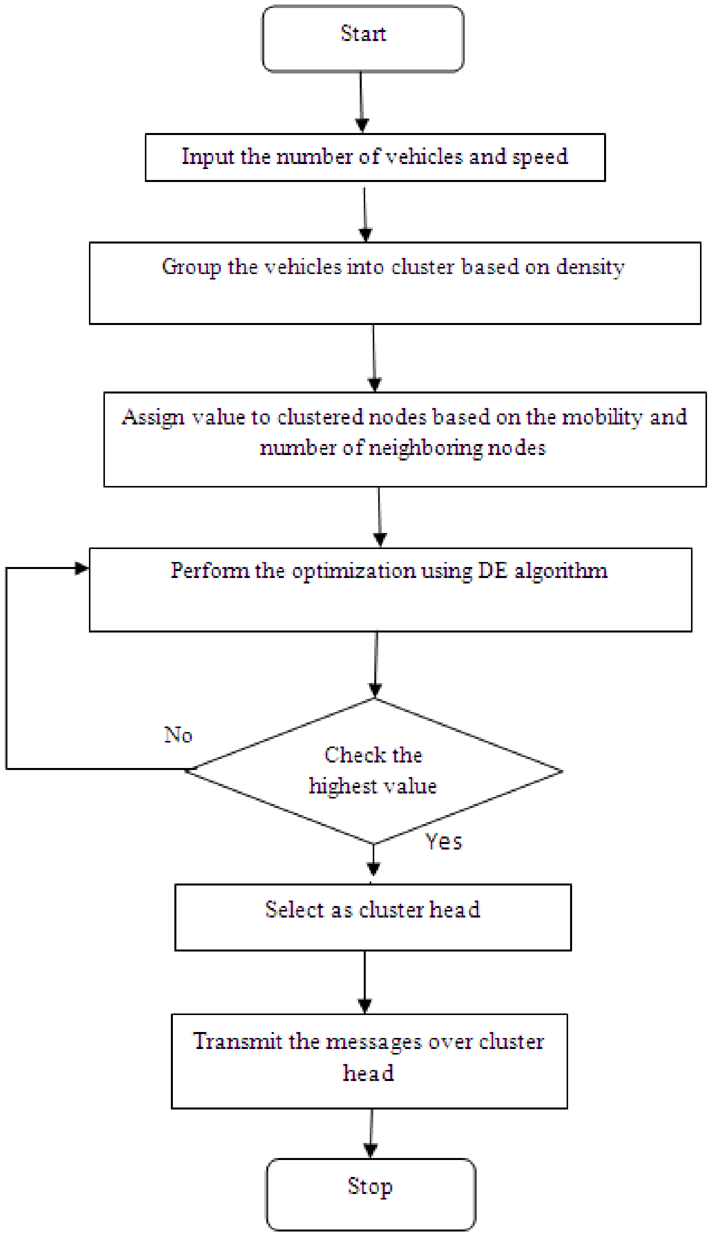

Figure-2. Proposed method.

If any collision takes place between two nodes, the network will obtain a warning so that there is an alteration in the vehicles or the nodes progression.

In order that, it come the collision position and send a safety message through the CRL channel which is recognized by means of the network only for conveying protection messages. The alert message is initially conveyed to the cluster head when there is a collision in the cluster. Then the cluster head forwards the message to the nearer cluster head and the vehicle nearer to the collision area blocked immediately. Additionally the cluster head convey the message to the cluster member. Through the warning obtained from the cluster head, the entire vehicles may find another route to reach the destination.

And also, we here included some emergency vehicles. Generally, the emergency vehicles like ambulance are getting more affected for the period of traffic. In this situation, the safety message will avoid them from traffic and the vehicular will create an innovative method. Therefore our proposed method supplies a competent method to convey the safety messages in the direction of the vehicle and evade the additional impact or disaster. In the optimization algorithm, the best node is used to obtain a fewer energy utilization. Consequently, it assists to augment the network lifetime and construct a dependable communication through the network.

4. RESULTS AND DISCUSSIONS

The NS2 is a simulation tool used for evaluating the performance of our proposed method. The nodes are placed randomly in the area of 1000 x 1000 meter area. Each node has a radio propagation range of 250m and the

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channel capacity is 2Mbps. Each process runs with the simulated time of 100s.

Here each vehicle is assumed to be moved in a same average velocity. The IEEE 802.11 transmission protocols are used to transmit the safety messages. The size of the message is fixed as 100 bytes with the transmission rate of 6Mbps. The number of vehicles is fixed as 100 and the switching channel is equal to 50ms. The existing method of AdvB scheme is measured against the proposed method and proves that the proposed method is better compared to the existing method. The performance is measured using the various metrics such as packet delivery ratio, collision, latency, dropping and transmission time.

Table-1. Simulation parameters.

Simulation parameters	Values
Network area	1000x1000
Simulation time	100sec
Traffic type	UDP/CBR
Node speed	5,10,15,20 m/sec
MAC protocol	IEEE802.11
Transmission range	250m
Packet size	1024 bytes
Mobility model	Random waypoint

The results are plotted in the form of graph by varying the nodes, speed of the routing protocol on transmitting the messages if any collision happened. The existing AdvB scheme is compared with the proposed method in VANET in hybrid wireless network. The proposed method is more efficient than the existing scheme.

4.1 Performance metrics

The performance of the protocol has been evaluated using the number of metrics such as packet delivery ratio, collision, latency, drop and transmission time.

Packet delivery ratio

Packet Delivery Ratio (PDR) is defined as the number of vehicles successfully received safety messages in a given time interval to the number of message sent at the time of collision from the base node.

$$\text{Packet delivery ratio} = \frac{\sum Packetreceive}{\sum Packetsend}$$

Packet drop rate

The packet drop rate shows the number of unsuccessful messages delivered to the vehicle during the time of collision.

$$\text{Packet drop rate} = \frac{N_{total} - N_{received}}{N_{total}}$$

Collision

The interference or any accident occurred between the vehicles is termed as collision. It is the number of collision events happening in a given time interval.

Latency

Latency is the average expected time of transmitting the messages from source to the destinations.

$$\text{Latency} = \frac{\sum_{i=1}^{N} delay}{Numberofreceivedpacket}$$

Throughput

Throughput represents the total number of bits forwarded within a given second. It is measured in bps.

Transmission time

It is the average time taken to deliver a message to all the vehicles.

4.2 Simulation results

Here the existing CBAPA and AdvB schemes are compared against our proposed method and the graphs are plotted based on the performance metrics such as the collision, packet delivery ratio, latency, transmission time and throughput.

The Figure-3 shows the number of vehicles received the messages at the time of collision successfully. While comparing with the existing methods, it clearly shows that the proposed method outperforms AdvB by 20% and CDBAPA by 42% respectively. It is evident that our proposed ESMBS method is better than the existing method in terms of transmitting the packets to more vehicles during collision.

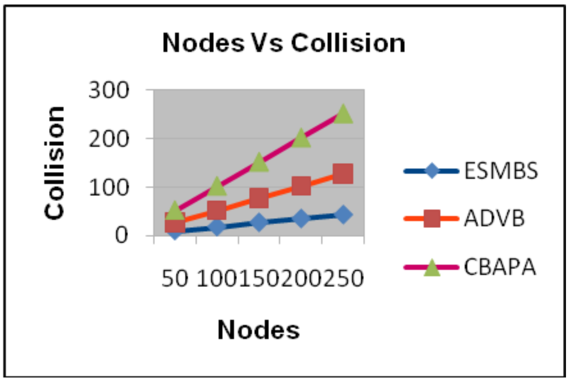

Figure-3. Nodes vs collision.

The Figure-4 and Figure-5 shows the packet delivery ratio and packet drop ratio by varying the number

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of nodes. It clearly shows that the message delivery ratio is higher than the existed methods. The proposed ESMBS outperforms AdvB by 30% and CDBAPA by 44% in terms of message delivery. And the dropping rate of proposed method is less than the existing ones. The AdvB scheme has the dropping rate at 67% and CBAPA at 80%. Hence it is proved that the proposed method is highly reliable in data delivery and avoid the maximum dropping of data during the transmission of messages to the vehicle at high rate at the time of collision.

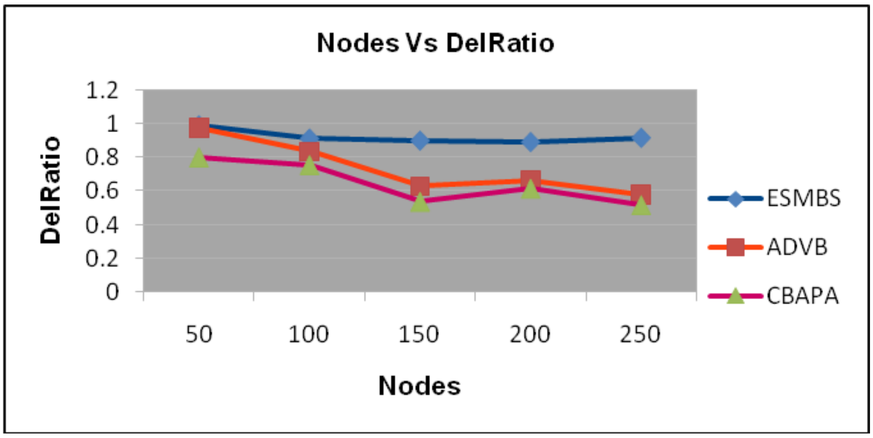

Figure-4. Node vs delivery ratio.

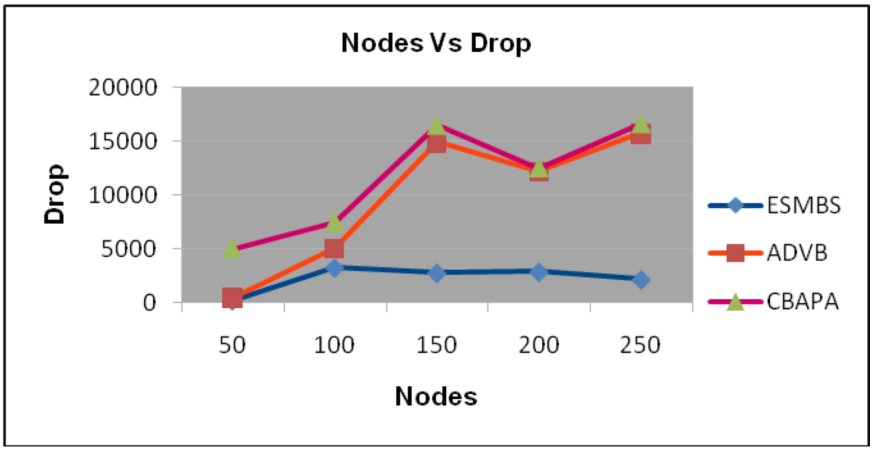

Figure-5. Node vs drop.

The Figure-6 shows the latency between the proposed and existing methods. The ESMBS scheme outperforms AdvB by 63% and CDBAPA is 70% in terms of latency. Mostly in the VANET there is a problem of latency because all the nodes i.e. the vehicles are moved in a high speed. So the data transmission within the time may delay.

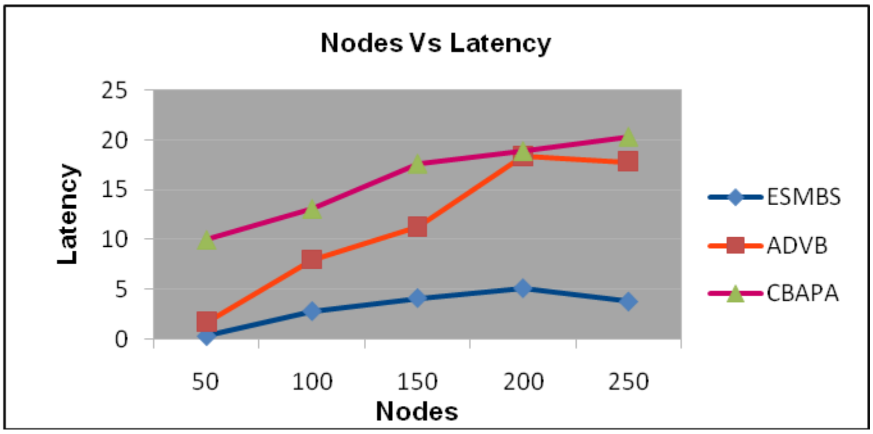

Figure-6. Node vs latency.

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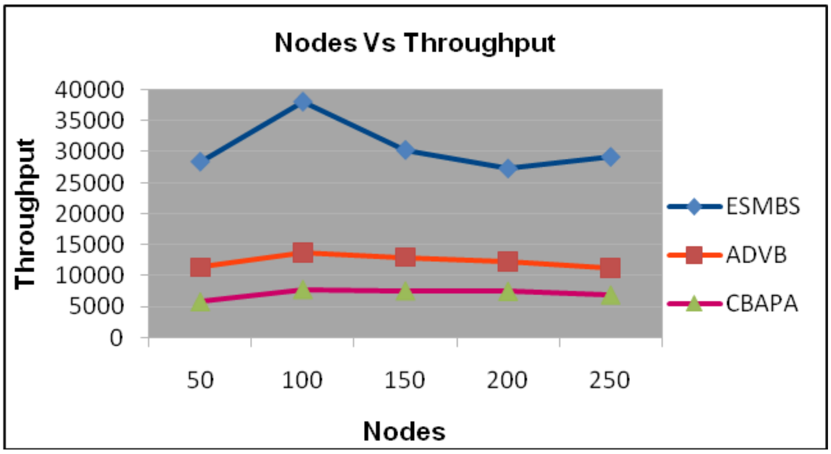

Figure-7. Node vs throughput.

The Figure-7 shows the throughput of the network of nodes. The graph clearly shows that ESMBS outperforms AdvB by 50% and CBAPA by 78% in terms of throughput.

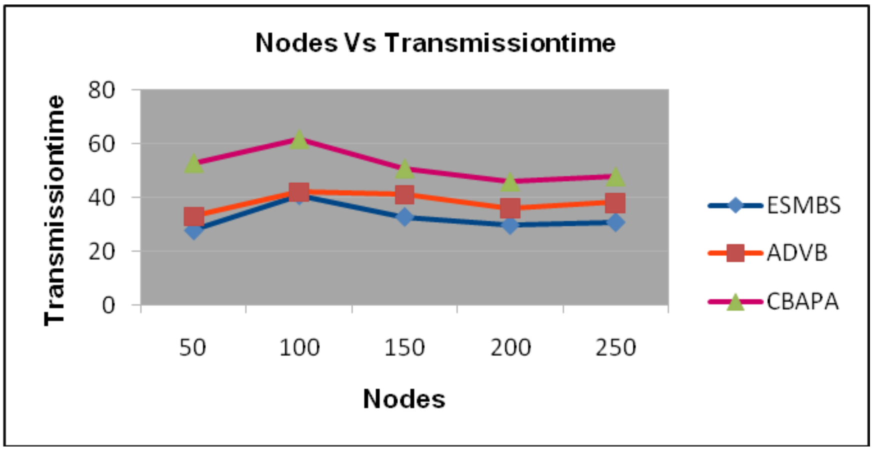

Figure-8. Node vs transmission time.

The Figure-8 shows the transmission time of messages between each vehicle. The time taken to transmit the message is less when compared with the existing methods. The graph clearly shows that ESMBS outperforms AdvB by 14% and CBAPA by 58% in terms of transmission time.

Figure-9. Speed vs collision.

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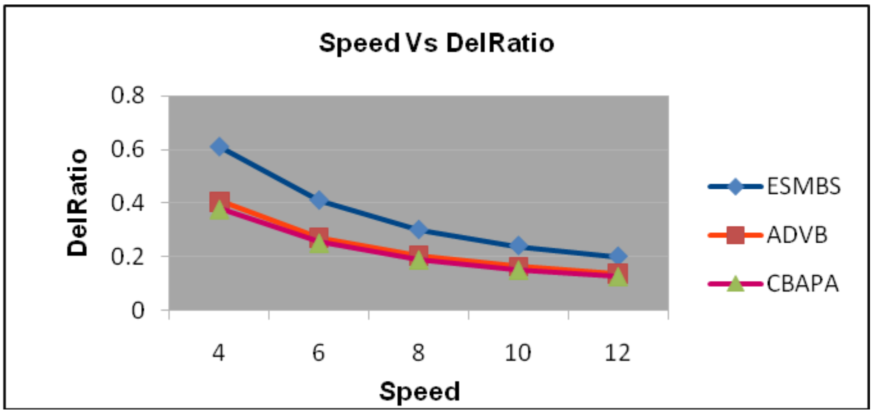

Figure-10. Speed vs delivery ratio.

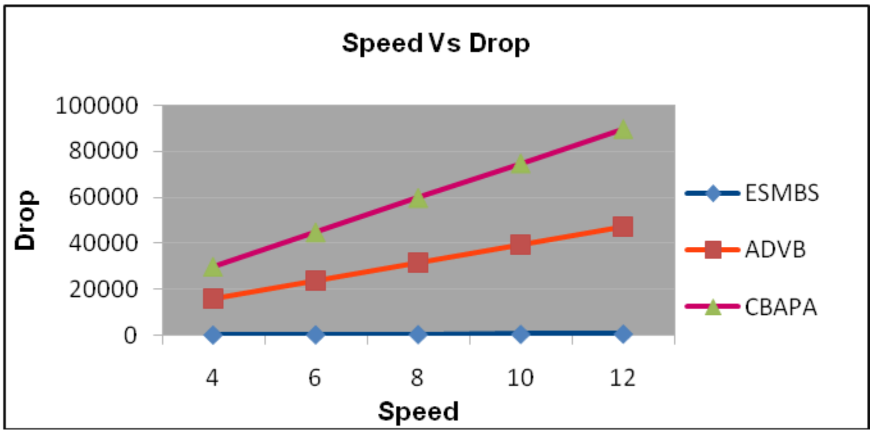

Figure-11. Speed vs drop.

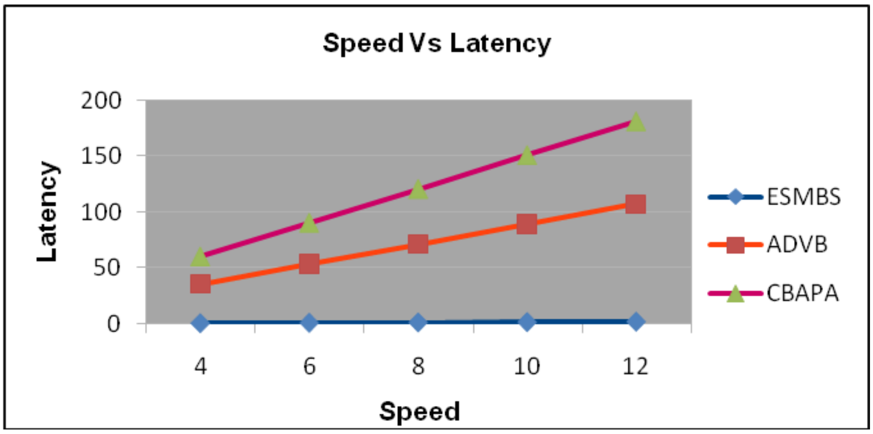

Figure-12. Speed vs latency.

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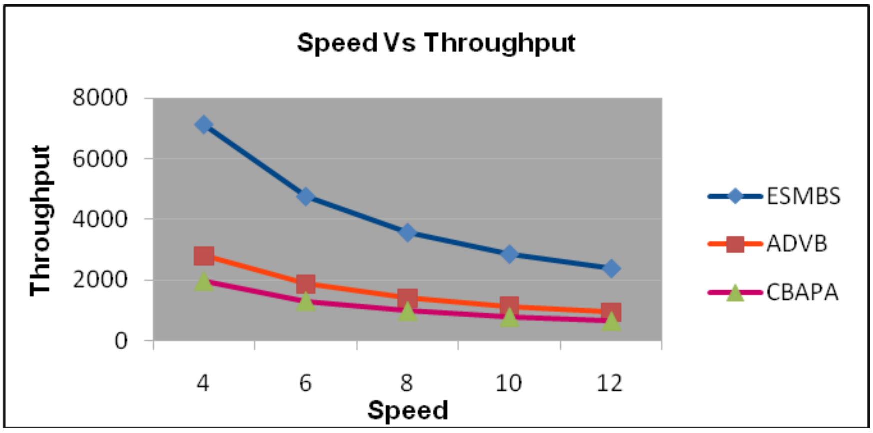

Figure-13. Speed vs throughput.

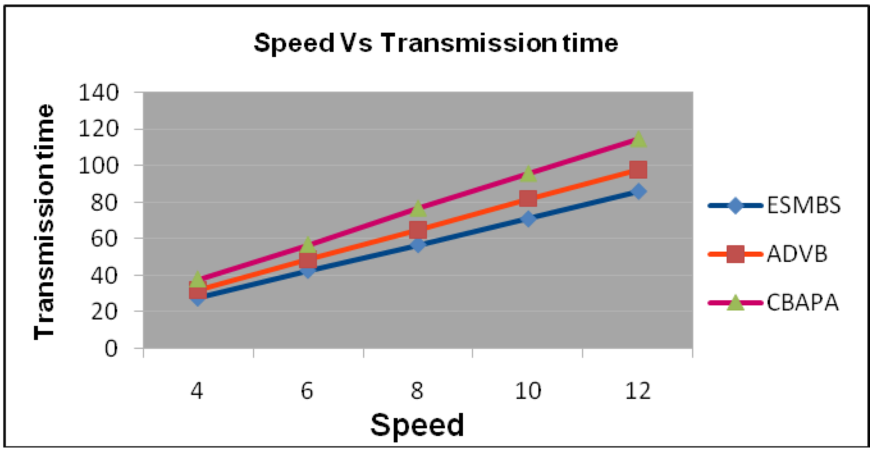

Figure-14. Speed vs transmission time.

The Figure 9 to 13 shows the result of collision, delivery ratio, drop, latency, throughput, transmission time by varying the speed of nodes. When comparing the performance of the protocols, the proposed ESMBS outperforms AdvB by 32% and CBAPA by 61% in terms of collision, AdvB by 15% and CCBAPA by 19% in terms of delivery ratio, AdvB by 60% and CBAPA by 79% in terms of drop, AdvB by 50% and CBAPA by 75% in terms of latency, AdvB by 55% and CBAPA by 75% in terms of throughput and AdvB by 55% and CBAPA by 75% in terms of transmission time

5. CONCLUSIONS

In this paper, the cluster head selection was formulated as optimization problem aiming at disseminating the safety or alert messages more effectively in vehicular network. The formulated problem has been solved using the three approaches: density based clustering, Cluster head selection and transmission of messages. In density based clustering, the nodes have been clustered by means of the resolute position, location and the distance of each node. From that cluster, the cluster head is selected to know the best vehicle for transmitting the messages to all other vehicles. The cluster head is selected based on the fitness value using the DE algorithm. Thereby the occurrence of any emergency event or collision is informed to each vehicle by its cluster head so as to prevent accidents and rear end collision by dynamically adapting transmission power and contention window size periodically. The proposed scheme can control various performance metrics such as the collision, packet delivery ratio, packet delay ratio, latency, transmission time and throughput. The proposed scheme broadcasts the alert or safety messages by reducing the probability of collisions. The proposed ESMBS scheme outperforms the existing AdvB and CBAPA schemes through detailed simulations.

REFERENCES

[1] 12. Wikipedia. 2012. Vehicular ad-hoc network. http://en.wikipedia.org/wiki/Vehicular_ad-hoc_network, 23 February.

[2] M. Ylizaliturri-Salcedo, S. Delgadillo-Rodriguez, J. Garcia-Macias and M. Tentori. 2013. Participatory Sensing for Improving Urban Mobility. Journal of Ubiquitous Computing and Ambient Intelligence. pp. 378-381.

[3] R. Thenmozhi and Dr. S. Govindarajan. 2016. Cluster based Architecture for preventing accident and rear-ends collision in VANET. Indian Journal of Science and Technology. 9(48): 1-7.

[4] C. Lo, W. Peng, C. Chen, T. Lin and C. Lin. 2008. CarWeb: A Traffic Data Collection Platform. The Ninth International Conference on Mobile Data Management (mdm 2008).

[5] U. Lee, B. Zhou, M. Gerla, E. Magistretti, P. Bellavista and A. Corradi. 2006. Mobeyes: smart mobs for urban monitoring with a vehicular sensor network. IEEE Wireless Communications. 13(5): 52-57.

[6] H. Zhu, M. Li, L. Fu, G. Xue, Y. Zhu and L. Ni. 2011. Impact of Traffic Influxes: Revealing Exponential Intercontact Time in Urban VANETs. IEEE Transactions on Parallel and Distributed Systems. 22(8): 1258-1266.

[7] S. Zhao, L. Fu, X. Wang and Q. Zhang. 2011. Fundamental relationship between Node Density and delay in wireless ad hoc networks with unreliable links. Proceedings of the 17th annual international conference on Mobile computing and networking - MobiCom '11.

[8] IEEE standard for information technology-Telecommunications and information exchange between schemes-Local and metropolitan area networks-Specific requirements-Part 11: Wireless LAN medium access control (MAC) and physical layer (PHY) specifications. IEEE Std 802.11-2007 (Revision of IEEE Std 802.11-1999), IEEE 2007.

[9] IEEE standard for information technology-Telecommunications and information exchange between schemes Local and metropolitan area networks-Specific requirements Part 11: Wireless LAN medium access control (MAC) and physical layer (PHY) specifications, IEEE Std 802.11-2012 (Revision of IEEE Std 802.11-2007), IEEE 2012.

[10] Bhumkar, SP, Deotare, VV & Babar, 'Accident Avoidance and Detection on Highways', International Journal of Engineering Trends and Technology, vol. 3, no. 2, pp. 247-252, 2012.

[11] Sam. 2014. A Time Synchronized Hybrid Vehicular Ad Hoc Network of Roadside Sensors And Vehicles For Safe Driving. Journal of Computer Science. 109(9): 1617-1627.

[12] C. Lu, C. Chang, I. Liu and J. Li. 2014. Novel Advanced Broadcast Scheme for Efficient Safety Message Collision Alleviation in Vehicular Networks. Wireless Personal Communications. 77(4): 2793-2816.

[13] V. Hemakumar, H. Nazini. 2013. Optimized Traffic Signal Control System at Traffic Intersections Using Vanet. International Journal of Computer Engineering. 15(3): 36-43.

[14] Samira Jalalvandi and Reza Rafeh. 2016. A Cluster-Based Routing Algorithm for VANET. IEEE International Conference on Computer and Communications.

[15] Pampapati Hubballi, A.V. Sutagundar, Ravikant Belagali. 2016. Agent based Dynamic Clustering for Hybrid VANET. International Conference On Recent Trends In Electronics Information Communication Technology.

[16] Bochrak, Elhab. 2015. Cluster Head Selection Algorithm in Vehicular AdHoc Networks. In proceeding conference of IEEE transactions.

[17] Ramakrishnan, B. *et al*. 2015. Cluster Based Emergency Message Broadcasting Technique For Vehicular Ad Hoc Network. Journal of Wireless Networks. 23(1): 233-248.

[18] Jyotsna Rao Dawande. 2009. Sanjay Silakari A Survey of all Existing Clustering Protocols in VANETS but Main Emphasis of Survey Laid on currently using Protocol i.e TCDGP. International Journal of Computer Applications. 118(6).

[19] Slawomir Kuklinski and Grzegorz Wolny. 2009. Density Based Clustering Algorithm for VANETs. International conference of research and technology.

[20] Riham S. Elhabyan and Mustapha C.E. Yagoub. 2015. Evolutionary Algorithms for Cluster Heads Election in Wireless Sensor Networks: Performance Comparison. In proceeding conference of Science and Information.

[21] P. Papadimitratos, A. La Fortelle, K. Evenssen, R. Brignolo and S. Cosenza. 2009. Vehicular communication systems: Enabling technologies, applications, and future outlook on intelligent transportation. IEEE Communications Magazine. 47(11): 84-95.