Towards Efficient Data Transmission using Energy-based Clustering Model (ECM-EDT) in Heterogeneous VANET

Article *in* TEST ENGINEERING AND MANAGEMENT · April 2020

R.Dhanapal Rd
Karpagam Academy of Higher Education

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

Towards Efficient Data Transmission using Energy-based Clustering Model (ECM-EDT) in Heterogeneous VANET

Dr. N. Yuvaraj[*1], Dr. G. Saravanan[2], R. Dhanapal[3] and M. Premkumar[4]

[1*] Assistant Professor, Department of Information Technology ,J.K.K.Nattraja College of Engineering and Technology,
NH-544 Natarajapuram, Komarapalayam-638183, Tamil Nadu, India.
E-mail:yuvait09@gmail.com

[2]Assistant Professor, Department of Computer Science and Engineering, Erode Sengunthar Engineering College,
Erode-638057, Tamil Nadu, India.
E-mail: gsaravanan.pacet@gmail.com

[3]Assistant Professor,Department of Computer Science and Engineering, Karpagam Academy of Higher Education, Coimbatore City, India – 641 021.
E-mail:dhanapalramasamy.p@gmail.com

[4]Assistant Professor, Department of Information Technology, Mahendra Institute of Technology, Namakkal, Tamil Nadu, India.
E-mail:mpremkumarit@gmail.com

Article Info
Volume 83
Page Number: 12585 - 12596
Publication Issue:
March - April 2020

Article History
***Article Received**: 24 July 2019*
***Revised**: 12 September 2019*
***Accepted**: 15 February 2020*
***Publication**: 18 April 2020*

Abstract

Vehicular Ad-hoc Networks (VANETs) are the distributed network that does not have any central control for providing efficient data communication among the vehicles involved and between the communications with Road Side Units (RSUs). In current scenario, VANETs are becoming a promising research domain for enhancing traffic efficiency, vehicle and road safety and also safety of public lives and properties by assuring well-defined traffic flow. Moreover, in heterogeneous VANET, the vehicles are more dynamic and highly mobile in nature, hence, topological changes affect the efficient data transmission over vehicles. This issue can be effectively fixed by incorporating clustering technique in VANET, which performs combining vehicles with respect to their location, mobility and density. Through clustering, the vehicles of VANET utilize the available bandwidth effectively, increases network lifetime and produces higher throughput. With that note, this paper concentrates on developing an Energy-based Clustering Model (ECM-EDT) for ensuring efficient data transmission between Node_Vehicles. The Cluster Head_Vehiclefor framed cluster is elected on the basis of connection parameters and processing abilities of Node_Vehicles. Additionally, Data Distribution Strategy (DDS) includes Head_Vehicle reconcile, infused for data hand-over and based on the Energy Utilization Factor of Vehicles. Further, ECM-EDT is experimented in NS2 and comparative analysis is made with the factors such as data traffic, throughput, packet drop, and energy utilization ratio and network lifetime. The results evidence that the proposed model outperform existing models.

Keywords: *Road Side Units (RSUs); Energy-based Clustering Model; Data Distribution Strategy (DDS); Energy Utilization Factor; Data Transmission.*

TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

1. INTRODUCTION

In typical, VANETs are designed by employing the Mobile Ad-hoc Network (MANET) paradigms with the vehicular domains based on unstructured configuration of wireless networks[1] [2]. Initially, the VANET communications were designed for providing data sharing between two cars. Later, the application has been extended to develop an Intelligent Transportation System (ITS) and designed in such a manner to attain Vehicle-to-vehicle and Vehicle to Infrastructure communications. Moreover, in order to provide communication with the vehicular nodes and their surroundings, the VANET are considered to be furnished with On-Board Unit (OBU) and sensor units. The Road Side Units (RSUs) are located at the deliberated position along road to ensure consistent communication between vehicles. Because of the high node mobility, the topology of the devices is changing often. During data transmission, there is an increased chance for data loss that creates greater impact on the overall network performance and communication of VANET. Hence, reducing efficient data transmission in VANET has become a research area and myriad researches are done for mitigating the problem [3].The general framework of heterogeneous VANET is presented in Figure 1.

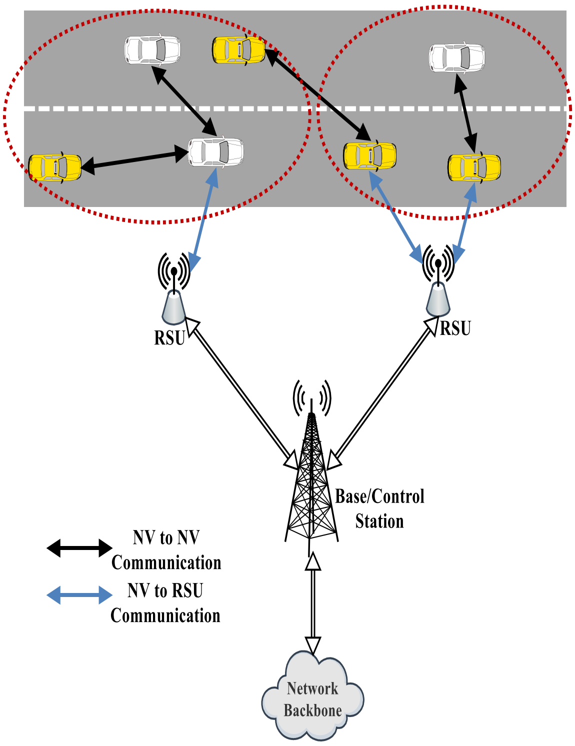

Figure 1: General Framework of Heterogeneous VANET

The construction pattern of VANET is completely adaptive based on the up-to-date traffic flow and the environment with the help of wireless communication protocols and Global Positioning Systems (GPS). Vehicle to vehicle communication is involved in short and medium communication standards and minimal implementation costs. And, Vehicle to infrastructure communication provides the effective data distribution in better coverage in wider areas [4]. The main intention of heterogeneous VANET applications is to afford accident free traffic management, comfortless of passengers and road safety[5].In this, providing efficient data communication has become a challenging issue. On considering the VANET properties given below, the proposed model is developed in this work.

1.1.Properties of VANET:

A. Highly Dynamic Topology:

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

The vehicles in VANET are moving in very fast and uneven speed on roads. This makes frequent topological changes in the network [6].

B. Frequent Link Breakages:
Because of frequent topological changes, there is an increasing possibility of link breakages in the designed Vehicular Networks.

C. Unlimited Resources:
In VANET, there are no constraints in storage capacity and battery power in moving vehicles, which not available in MANET computations.

D. Mobility Model:
The mobility model of VANET is designed on the basis of the road type, traffic flow, vehicle velocity, driving fluency of drivers, etc.

E. Distribution Model of Vehicles:
Because of the factors such as traffic flow, patterns, road kinds, driving fluency, vehicle speed, etc, the distribution model of Node_Vehicles (NV) in VANET follows non-homogeneous pattern.

F. Communication with OBU:
It is considered that the vehicles are endowed with OBU for providing information about the connectivity of vehicles.

G. Geographical Limitations:
The vehicles in VANET are geographically limited based on their location and position.

Based on these VANET properties, the developed Energy-based Clustering Model is designed. In that the Head_Vehicle (HV) for each cluster is elected on the basis of metrics such as connection parameters and processing abilities of Node_Vehicles. DDS is also incorporated in this work for efficient data transmission, which is applied when the vehicles have minimal energy. Moreover, effective data transmission management is concentrated in this work to enhance the throughput and reduce packet loss.

1.2.Paper Organization:

The remainder of this paper is organized as follows: Section 2 deliberates a brief overview about the related works. Section 3 contains the description of the work process of proposed Energy-based Clustering Model with Data Distribution Strategy (ECM-EDT) in VANET. Section 4 contains the Simulations results and comparative analysis for evidencing the efficiency of data transmission using ECM-EDT. Finally, the paper is completed with the conclusion in Section 5 that also presents some directions for future work.

2. RELATED WORKS

In [7], the authors have designed a protocol called Cluster-Head Gateway Switch Routing Protocol (CGSR) for performing multi-level based routing in earlier days of routing design. Moreover, the nodes are framed into clusters based on hop counts. The Cluster-head administrates the remaining nodes with in a cluster. Using the cluster-heads, the protocols efficiently involved in data transmission through the gateway nodes. The major drawback of this model is, the process of cluster maintenance was being complicated in the throughout routing process [8]. In advanced manner, 'Software Agent' was used for data collection from a particular region for distributing gathered data to the corresponding VANET is given in [9]. The software agent collects the location oriented data such as geographical and positional information for perfect decision making in the Network on data distribution.

Simple and Efficient Adaptive Dissemination (SEAD) is presented in [10] for Vehicular networks. The data distribution was performed in SEAD based on the density of

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

vehicular nodes and data directions. There was no beacon sharing about vehicle velocity, vehicle position, etc. The authors of [11] analyzed two VANET techniques such as slotted data transmission and continuous transmission. Moreover, the methods followed delay based approach, in which every node at reception end based on specific waiting time for acquiring the data. Redundancy based Protocol (RBP) has been designed and examined in [12], which is the integrated model of probability and delay based data transmission in VANET. Based on the vehicular density, the slotted based transmission technique has been applied.

In advanced manner, Internet of Things (IoT) has been a growing research field. VANET is also relay on that for advanced road safety and vehicle communication through wireless techniques. Based on that, the authors of [13] and [14] projected the scheme based on various elements such as energy resources, concerns and materials in cluster formations to provide communication between heterogeneous machines. The explained model has been adapted for providing effective vehicle based communication. But, the authors have not focused on the mobility speed of nodes in the vehicular network.

Cluster-based File Transfer (CFT) model was given in [15] for providing highly secured file transmission in vehicular network environment. Moreover, in that model, the vehicle member in a particular cluster helped their corresponding head vehicles for acquiring the file contents which was demanded. The model especially worked well on handling with high mobility speed of vehicles in data transmission. But, the design patter of the model was not applicable in complicated traffic scenarios of vehicular network. Furthermore, in [16], the clustering operations were effectively done with Evolutionary Game Theory (EGT) based protocol. For appropriate cluster formation with optimal sizes and selection of CHs, the entire utility function has been used. Based on the traffic flow in VANET, an intelligent naive bayes probabilistic estimation practice (ANTSC) model was given in [17]. This model increased the cluster stability for longer time but the security of the data transmission has not been considered in the network. For minimizing the delay in data delivery and increasing throughput, Street-Centric Routing Protocol has been given in [18]. Traffic Light Aware Routing Protocol was provided in [19] based on the traffic on street roads and distance between the nodes in between.

3. PROPOSED MODEL

The work process of the proposed Energy-based Clustering Model with Data Distribution Strategy (ECM-EDT) is described in this section. The model aims to maintain the clustering consistency of network, thereby, reducing the energy utilization rate and increasing network life span. It is considered that all Node_Vehicles (NVs) are embedded with GPS and cluster tables are also maintained for handling the location based operations. The proposed model is more effective in performing with dynamic environment in which the mobility rate and vehicle directions are not stable. For evaluating the node mobility and connection sustainability features, the energy based clustering model is proposed here for selecting efficient cluster head_vehicle based on the signal strength, vehicle_velocity and energy-efficiency. Moreover, Data Distribution Strategy is incorporated in this model to reduce the bandwidth usage and traffic density of vehicles. In effective data transmission, the load is balanced among all nodes effectively,

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

when the vehicles are at lower energy levels, thereby, data traffic is management well with this. The operations of the proposed model includes,

1. Formation of Clusters
   i. Discovery of Neighbour Vehicles
   ii. Computation of Energy Utilization Factor
   iii. Cluster Head_Vehicle Selection
2. Data DistributionStrategy for Traffic Management
   i. Reconcile function

The proposed clustering model with moving vehicles is presented in Figure 2. Initially, the network is framed with some set of vehicles and connections between them. For forming clusters, the neighbour nodes are found to create a table based on the connections. Here, clusters are formed with the nodes that are at 1-hop distance from one another. Efficient Head_Vehicles are elected for providing effective data transmission with the base station and the member_vehicles (MVs). Route Discovery is performed based on the connection request and the factors involved. Optimal route for data transmission is determined on the vehicle_velocity, which also includes the energy of vehicle and data transmission rate. Further, it is checked for Data Distributionissues, off-loading are performed by storing the data contents in the local storage at servers and then distributed to multiple nodes. Before transmitting the content from HV to other MVs, the HV chcks for the connection availability and data rate to be required for the data communications. The communication is stopped when the Load_queue becomes NULL.

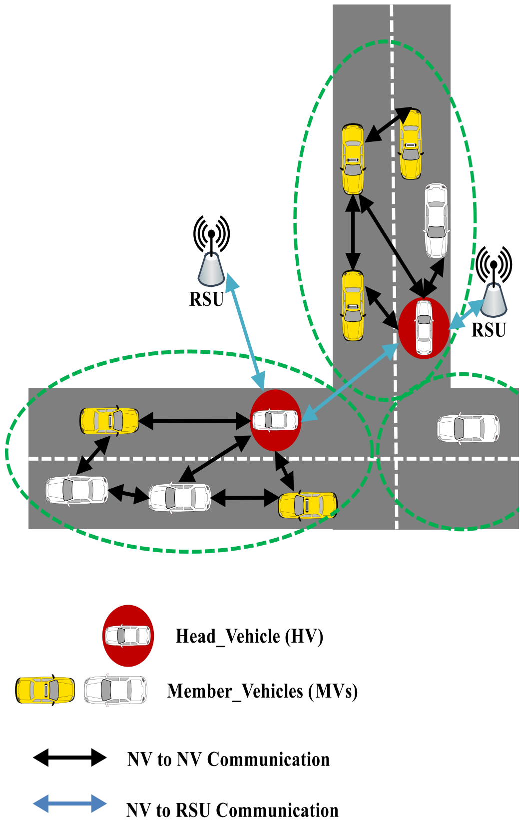

Figure 2: Scenario of ECM in VANET

3.1.Formation of Cluters

3.1.1. Discovery of Neighbour Vehicles:

In the designed vehicular network, discovering neighbour vehicles plays a vital role for appropriate functioning of the overall network. Moreover, this process includes the finding process of all the nearby nodes, which are in the specific communication range. When a new vehicle is comes into the network, it transmits a neighbour_query to find the nearest nodes and waits for the reply message. This handshake process is to be done within defined time, otherwise, it is declared to be expired and the neighbour_query message is to be retransmitted. The entire network function is basically depending on the efficient communication between the neighbour vehicles. The overall process of the proposed model is given in Figure 3. Clustering is performed following the process of discovering neighbour vehicles. It typically enhances the data transmission rate and minimizes the communication overhead in VANET. The vehicles that are in the single hop distance from the source with minimal distance are framed into single cluster.

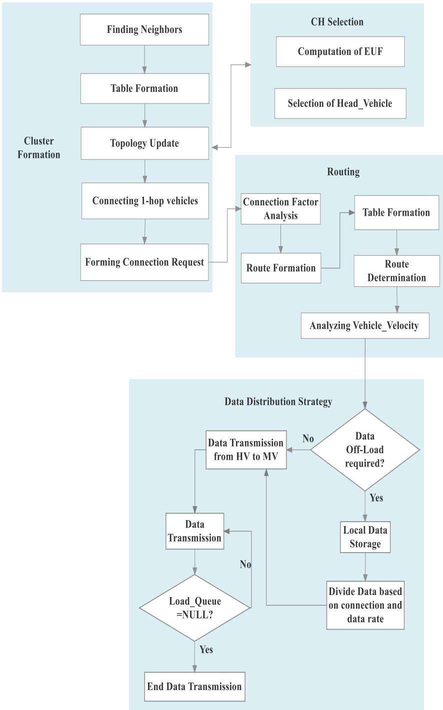

Figure 3: Operations Involved in the ECM-EDT in VANET

3.1.2. Computation of Energy Utilization Factor (EUF)

Here, the energy utilization of each Node_Vehicle (NV_i) is given as $\eta(NV_i)$ at the instant 't'. Moreover, it is determined by the equation (1), as follows,

$$\eta(NV_i) = \mathrm{NB}(NV_i) \times 1 \times \mathrm{EB}(NV_i) \times \mathrm{S_i} \times \mathrm{t} \quad (1)$$

Where, 'NB' states the number of bits that are forwarded, 'EB' is the energy utilized for transmitting each bit of data and the sampling rate of data is given as '$\mathrm{S_i}$' for each vehicle NV_i . Further, the energy utilization is computed, for each vehicle that transmits data to another vehicle in the cluster with the consideration that the hop count number HC(n)=1. It can be stated that the energy utilized by the HV is greater than other nodes and the computation is given as follows,

$$\eta(HV) = HC(HV) \times \sum_{i=0}^{n} \eta(NV_i) \quad (2)$$

Where '$HC(HV)$' is the total hop counts for transmitting data from the Head_Vehicle to the sink or RSU and 'n' is the number of clusters that are framed in the defined VANET. Here, the effective head node selection is based on the residual energy of each vehicle. Each vehicle is probable to be a head node for a period of time 't' and hence, the remaining time (t/n), the vehicular node will be as Member _Vehicle (MV). Therefore, the total energy utilization factor for a particular node for being a Head_vehicle and Member_vehicle at time 't' and 't/n' is determined as follows,

$$EUF(NV_i) = \left(\mathrm{NB}(NV_i) \times 1 \times \mathrm{EB}(NV_i) \times \mathrm{S_i} \times \frac{\mathrm{t}}{\mathrm{n}}\right) + \left(\left(\frac{\mathrm{t}}{\mathrm{n}}\right) \times HC(HV) \times \sum_{i=0}^{n} \eta(NV_i)\right) \quad (3)$$

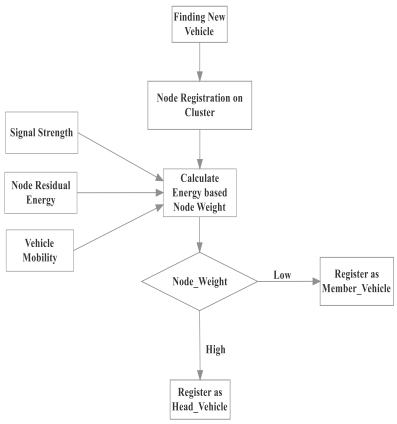

Figure 4: Pictorial Representation of Cluster Formation and HV Selection in ECM-EDT

3.1.3. Cluster Head_Vehicle Selection:

As mentioned above, in this proposed model, the Head_Vehicle for each cluster is selected on the basis of based on the residual energy (RE_i), Vehicle Mobility (VM_i) and signal strength (Sig_i). According to the Node weight is calculated for each NV and it is given in equation 4.

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

$$Node\ Weight\ (NW) = RE_i + VM_i + Sig_i \quad (4)$$

From the results, the vehicle with greater NW, higher Sig_i, minimal mobility value and with high energy and signal strength are effectively elected as the Head_Vehicle for all MVs in a particular cluster. The Figure 4 presents the pictorial representation of operations involved in Cluster Formation and Head_Vehicle Selection.

3.2. Incorporation of Data Distribution Strategy:

In the proposed model, mutual data transmission methodology is used by incorporating Data Distribution Strategy (DDS). Here, the network is considered as heterogeneous, contains different vehicles to be communicated. The initial process is to frame the route formation for providing data communication between vehicles. For that, the cluster head HV1 broadcasts the route request message to the vehicles in the route path, when it receives request query from a vehicle. When the HV1 does not get reply message within specific time, then, the vehicle send request to another node. If the HV2 gets the request, it is checked with the table and the address is cached based on the similarities in the table contents. Following, the HV2 has the probability of becoming cluster head in the process of reconcile modelling. The head vehicle checks for connection status of the belonging member. The Head_Vehicle performs data transmission based on the data rate provided by the MV. When there is case that the HV receives the request for data from several MVs, multicast based transmission is performed.

With respect to the vehicle specifications, the data are stored in the local storage available at the Head_Vehicle. Further, the store data from head vehicle is distributed over the member vehicles in a particular cluster. It is the responsibility of the HV, in which the data is to be transmitted based on the data rate determined by the MV. Moreover, the data traffic is to be managed here with the assured data transmission to the appropriate destination, even in the high mobility of vehicles and frequent link breakages.

3.2.1. Reconcile Function:

The data off-loading from a head vehicles is considered to be completed, when the MV will reconcile to its own head node with respect to the threshold rates of similar locations. Based on the topology, higher threshold (H_T) and the lower threshold (L_T) are randomly selected, which are calculated based on the following equations.

$$H_T = \frac{1}{2}(L(NV_H) + M_n) \quad (5)$$

$$H_L = \frac{1}{2}(L(NV_L) + M_n) \quad (6)$$

Where '$L(NV_H)$' denotes the location of vehicle having more neighbours in a single hop distance and '$L(NV_L)$' stands the location of vehicle that is having less neighbour nodes in 1 hop. 'M_n' is the mean number of vehicles in the single hop to the total number of vehicles presented in the network. Hence, an efficient data transmission is accomplished with the proposed model. The Table 1 presents the pseudo code of the proposed Energy-based Clustering Model (ECM-EDT).

Table 1: Pseudo code of the Proposed ECM-EDT in VANET

1. Begin
2. Cluster Formation with vehicles single-hop distance
3. Function Head_Vehicle Selection
4. {
5. Find neighbour vehicles broadcasting Hello_Message
6. Receive Reply_message frc

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

neighbours
7. Check status for Neighbour vehicles
8. if Location (Neighbour vehicle) communication range then
9. Vehicles =NOT REACHABALE
10. End if
11. Check Signal Strength of neare vehicles
12. Get the vehicle mobility
13. $\forall Node\_Vehicle$ Compute Ener Utilization Factor
14. $\forall Node\_Vehicle$ Compu Node_Weight
15. If Value (Node_Weight(NV_i))>Val (Node_Weight(NV_{i+1})) then
16. End if
17. }
18. Declare NV_i as Head_Vehicle
19. Incorporate DDS
20. {
21. Perform Data Off-Load frc Head_Vehicle
22. Perform Reconcile Function
23. Define Threshold rates
24. MV returns to Own HV
25. If Load_queue=NULL then
26. Stop DDS
27. End if
28. }
29. End

4. RESULTS AND DISCUSSIONS:

The proposed model ECM-EDT is experimented with Network Simulation Tool (NS2). Further, Comparative Analysis is made with the results of existing models such as Simple and Efficient Adaptive Dissemination (SEAD), Redundancy based Protocol (RBP) and Cluster-based File Transfer (CFT) in terms of factors such as throughput, packet drop, and energy utilization ratio,packet delivery ratio and network lifetime. The basic parameter settings for VANET with the proposed model are given in Table 2.

Table 2: Simulation Parameters and Values

SIMULATION PARAMETERS	VALUES
Simulator Tool	NS-2.34
Simulation area	$3000\times3000m^2$
Simulation Time	300 Sec
No. of roads	40
Vehicle_Velocity	5-40 m/s
No. Of Vehicles	100 to 150
Vehicle Movement	Random Motion
MAC Protocol	802.11 DCF
Transmission Range	250m
Propagation Model	Two Way Ground
Traffic type	16 CBR
Packet Size	Upto 2048 Kb
Traffic Type	CBR
Transmission Rate	4pckts/sec

The major aim of the proposed model is to develop an Efficient Data Transmission with increased throughput and network lifetime with minimal energy consumption. The model is also to be developed in such a manner to increase the rate of packet delivery with less delay and loss rate. Here, the Packet Delivery Rate is evaluated with respect to the vehicle mobility. The results are presented in the chat given in Figure 5. It can be observed from the chart that the proposed ECM-EDT achieves better rate of packet delivery rates than the compared models. Another important factor for EDT is determining packet drop and the results are shown in Figure 6. Here, Packet Drop Rate is evaluated with respect to the vehicle mobility. As it is portrayed in the chart, the proposed model produces minimal drop rate than others. In average, the packet drop rate of ECM-EDT is evaluated as 1.4%, which is the lower value than others.

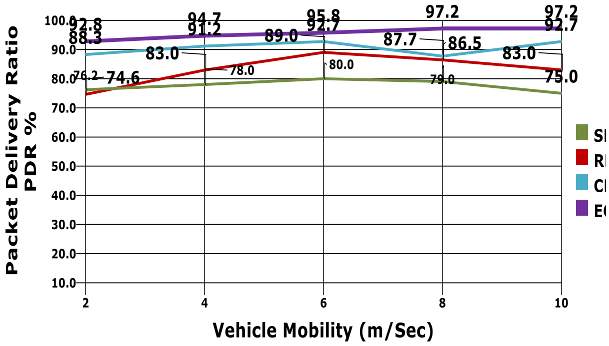

Figure 5: Packet Delivery Ratio Vs Vehicle Mobility

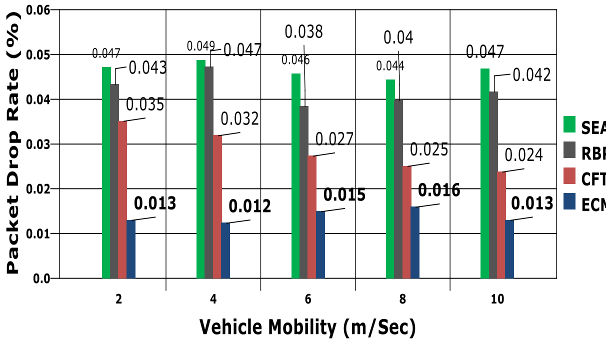

Figure 6: Evaluation of Packet Drop Rate

Further, transmission delay is computed and the results are displayed in Figure 7. Here, the delay on efficient data transmission among vehicles is computed against the total simulation time, which is taken here as 300 seconds. It is clearly observed from the Figure that the proposed model shows lesser delay than compared models, which is very much needed in efficient data transmission.

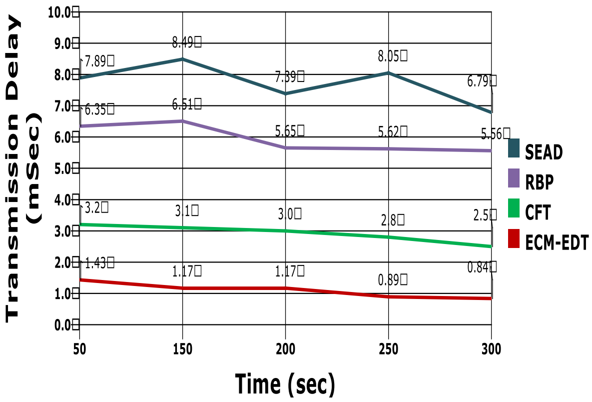

Figure 7: Transmission Delay Vs Simulation Time (sec)

The next important factor to be considered in testing the proposed model is the lifetime of formed clusters, based on the longevity of Head_Vehicle (HV) and Member_Vehicle (MV). It is described that the total time when a NV can be a Cluster head or be a member vehicle for longer periods. Hence, the model does not require for frequent cluster reformation. This also increases the cluster stability and the network lifetime. The following graphs presented in Figure 8 and Figure 9 contains the results of lifetime sustained by the HV and MV with respect to the vehicle mobility, respectively. In the propose Energy based clustering model, the head vehicles are elected on the basis of residual energy, node capabilities and vehicle mobility of each vehicle and the member vehicles are designed by discovering appropriate neighbours. Therefore, the sustainability of clusters is maintained for longer time in the proposed model than the compared work such as SEAD, RBP, CFT and ECM-EDT. Moreover, the average cluster stability is given in Figure 10.

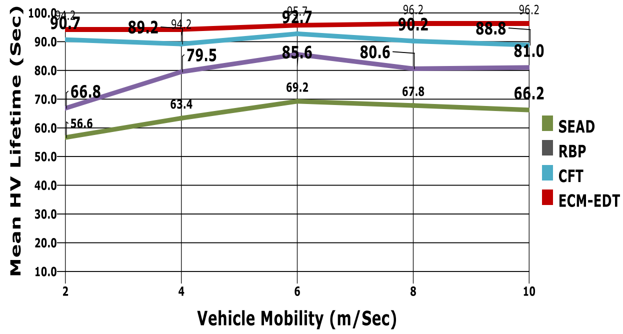

Figure 8: Head_Vehicle Stability Vs Vehicle Mobility

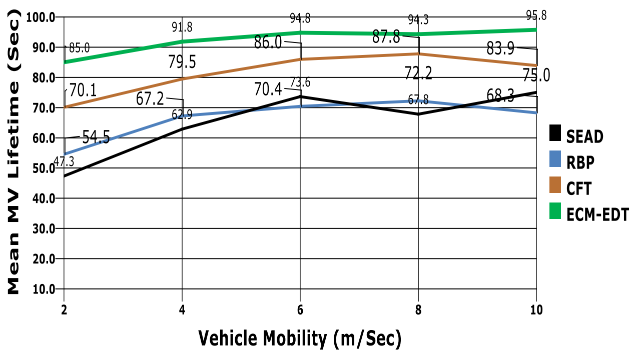

Figure 9: Member_Vehicle Stability Vs Vehicle Mobility

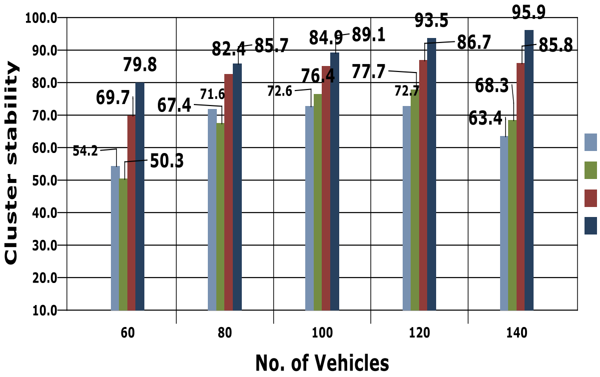

Figure 10: Comparison of Cluster Stability among Models

The Figure 11 depicts the obtained results for throughput evaluation, which is an important factor to be evaluated in data transmission. From the figure, it is given that the average throughput attained by the proposed model is 6% more than compared models.

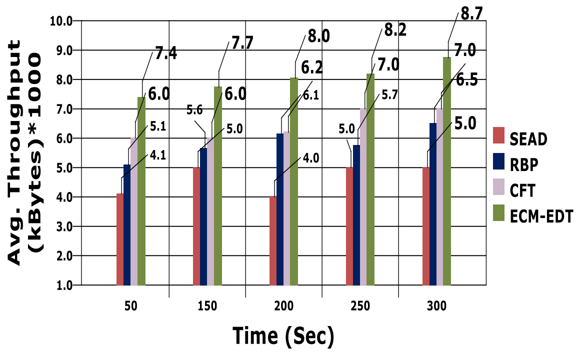

Figure 11: Throughput Evaluation between Models

Analyzing Energy Utilization rate for every node in the proposed model is very important to be evaluated in evidencing the proposed model. Here, the node_weight of each Vehicles is computed and framed the clusters. Using DDS, the data are transmitted with optimal rate of energy consumption. The average energy consumed for EDT in the proposed model is about 12.3J, which is 40% lower than compared works. The energy is efficiently consumed by the nodes in VANET and the results are given in Figure 12. With respect to vehicle mobility, the EUR calculated for the proposed model is lesser and optimally utilized for data transmission in ECM-EDT.

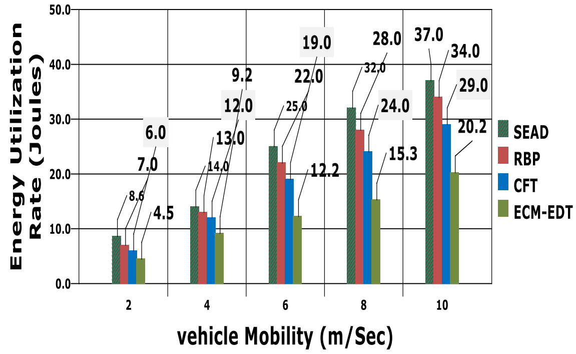

Figure 12: Energy Utilization Rate of Models

5. CONCLUSION AND FUTURE WORK:

This paper presents an Energy-based Clustering model for Efficient Data Transmission in VANET communications. In the developed ECM-EDT, the clusters are formed by discovering the neighbour nodes within specific communication range. Further, the selection of Head_Vehicle for each cluster is done with the analysis of factors such as remaining energy, signal strength, node capabilities and mobility of each member vehicles in the defined VANET. The data is acquired from the base station by the HV and transmitted to the other MVs effectively by using Data Distribution Strategy. Moreover, balancing load among vehicles is obtained by the incorporation of reconcile function, in which the member vehicles are rejoined with their own cluster based on certain threshold. The results of the proposed model with respect to packet delivery rate, packet drop, transmission delay, network lifespan, average throughput and Energy Utilization Rate, are compared with the existing models and have proved that the proposed model performs well in EDT in VANET communications.

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

This work can be focussed on the secure side of data transmission in VANET with efficient routing model in future process.

REFERENCES:

[1] Hyun Yu "A VANET Routing based on the Real-time Road Vehicle Density in the City Environment" IEEE Conf. on Ubiquitous and Future Networks (ICUFN), 2013, pp 333 – 337.

[2] J. Zhang, X. Hu, and Z. Ning, "Energy-latency Trade-off for Energy-aware Offloading in Mobile Edge Computing Networks," IEEE Internet of Things Journal, pp. 1-13, 2017, doi:10.1109/JIOT.2017.2786343.

[3] S. Yousefi, M. S. Mousavi, and M. Fathy, "Vehicular ad hoc networks (VANETs): challenges and perspectives," in Proc. 6th Int.Conf. ITS Telecommun., Chengdu, China, Jun. 2006, pp. 761-766.

[4] Bononi L., and Felice, M. D. "A cross layered MAC and clustering scheme for efficientbroadcast in vanets." In Mobile Adhoc and Sensor Systems, 2007. MASS 2007. IEEE International Conference on, pp. 1-8. IEEE, 2007.

[5] S. Al-Sultan,M. M. Al-Doori, A. H. Al-Bayatti, and H. Zedan,"A comprehensive survey on vehicular Ad Hoc network,"Journal of Network and Computer Applications, vol. 37, no. 1, pp.380–392, 2014.

[6] JavadBadali, parvinfartuandMortazaMokhtariNazarlou. "Improving data transmission in the VANET using multi-criteria decision making method based on fuzzy logic." International Journal in Foundations of Computer Science & Technology (IJFCST), Vol. 3, No.6, November 2013.

[7] Chiang, C.C. "Routing in clustered multihop mobile wireless networks with fading channel". In Proceedings of the IEEE SICON, Singapore, 14–17 April 1997; pp. 197–211.

[8] Y. Li,M. Zhao, andW.Wang, "Intermittently connectedvehicleto-vehicle networks: detection and analysis," in Proceedings ofthe 54th Annual IEEE Global Telecommunications Conference (GLOBECOM '11), pp. 1–6, December 2011.

[9] Edison P., Tales H., Flavio R., Carlos E., Tony L, "Exploring geographic context awareness for data dissemination on mobile ad hoc networks". Ad Hoc Netw. 2013, 11, pp. 1746–1764.

[10] Achour I., Bejaoui T., Busson A., Tabbane S., "SEAD: A simple and efficient adaptive data dissemination protocol in vehicular ad-hoc networks". Wirel. Netw. 2016, 22, pp. 1673–1683.

[11] Achour I., Bejaoui T., Busson A., Tabbane S., "Delay-based strategy for safety message dissemination in vehicular ad hoc networks: Slotted or continuous?" In Proceedings of the 2016 International Wireless Communications and Mobile Computing Conference (IWCMC), Paphos, Cyprus, 5–9 September 2016, pp. 268–274.

[12] Achour I., Bejaoui T., Busson A., Tabbane S., "A redundancy-based protocol for safety message dissemination in vehicular ad-hoc networks". In Proceedings of the IEEE Vehicular Technology Conference, Boston, MA, USA, 6–9 September 2015; pp. 1–7.

[13] Tsiropoulou E.E., Mitsis G., Papavassiliou S., "Interest-aware energy collection & resource management in the machine to machine communications." Ad Hoc Netw. 2018, 68, pp. 48–57.

[14] Tsiropoulou E.E., Paruchuri S.T., Baras J.S., "Interest, energy and physical-aware coalition formation and resource allocation in smart IoT applications." In Proceedings of the 51st Annual Conference on Information Sciences and Systems (CISS), Baltimore, MD, USA, 22–24 March 2017.

[15] Q. Luo, C. Li, Q. Ye, T. H. Luan, L. Zhu, and X. Han, "CFT: A Cluster-based File Transfer Scheme for highway VANETs," in Proceedings of the ICC 2017 - IEEE

March - April 2020
ISSN: 0193-4120 Page No. 12585 - 12596

International Conference on Communications, pp. 1–6, Paris, France,May 2017.

[16] A. A. Khan, M. Abolhasan, andW. Ni, "An Evolutionary Game Theoretic Approach for Stable and Optimized Clustering in VANETs," IEEE Transactions on Vehicular Technology, vol. 67, no. 5, pp. 4501–4513, 2018.

[17] A. Mehmood, A. Khanan, A. H. H. M. Mohamed, S. Mahfooz, H. Song, and S. Abdullah, "ANTSC: An Intelligent Na¨ıve Bayesian Probabilistic Estimation Practice for Traffic Flow to Form Stable Clustering inVANET," IEEEAccess, vol. 6, pp. 4452–4461, 2017.

[18] X. Zhang, K. Chen, and X. Cao, "A Street-Centric Routing Protocol Based on Microtopology in Vehicular Ad Hoc Networks," IEEETransactions on Vehicular Technology, vol. 65, no. 7, pp. 5680- 5694, Jul. 2016.

[19] Q. Ding, B. Sun, and X. Zhang, "A Traffic-Light-Aware Routing Protocol Based on Street Connectivity for Urban Vehicular Ad Hoc Networks," IEEE Commun. Lett., vol. 20, no. 8, pp. 1635-1638, Aug. 2016.