International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Multi-hop Cluster Based Algorithm for Handover Management in Vehicular Adhoc Networks

Poonam Thakur, Anita Ganpati

Abstract- This paper presents the framework of cluster-based architecture for Vehicle to Vehicle (V2V) communication network. A cluster-based algorithm (VMCA) for multi-hop clustering will be designed which will be used in V2V communication. The algorithm will be simulated using the ns3 simulator and its performance will be compared with other existing multi-hop clustering algorithm discussed in the literature review. It is expected that the simulation results will prove this new cluster-based algorithm to be the optimum one when compared with the other of the same type. Once the validity of that algorithm is done, it will be improved to provide handover management in hybrid VANET architecture. We will simulate the complete scenario using ns-2 and some real mobility simulator for VANETs. The simulation results expected to show that the proposed cluster-based algorithm will be the optimum solution approach to the VANET handover in a hybrid architecture.

Keywords- V2V, V2I, multi-hop, ns2, clustering, handover.

I. INTRODUCTION

With the increasing demand for smart interactive vehicles for safety applications or entertainment applications, there is great research going on in the field of Vehicular Adhoc networks. VANETs is the kind of Adhoc network which is used in enhancing road safety and driving comfort [18]. VANETs mostly consists of V2V and V2I communication for the exchange of messages between the vehicles and the RSU. The vehicles equipped with multiple onboard units are the mobile nodes that keep on changing its position continuously and very frequently. The roadside units are the fixed devices/ base stations installed on the side of roads. The major characteristics of VANET are highly dynamic topology which frequently keeps on connecting and disconnecting, self-organized, self-managed, enough energy and computing power, short radio transmission range, delay-sensitive data exchange and low bandwidth network [1]. The V2V communication is based on the dedicated short-range communications (DSRC) technology; while the V2I communications based on 4G, LTE/LTE-A, GPRS/3G, Wi-Fi or WiMAX. Another kind of communication known as hybrid vehicle communication is also there in which communication occurs among vehicles as well as between vehicles and nearby fixed infrastructure of RSUs.

Revised Manuscript Received on 30 July 2019.
***** Correspondence Author
Poonam Thakur*, Department of Computer Science, Himachal Pradesh University, India
Anita Ganpati, Department of Computer Science, Himachal Pradesh University, India

Clustering refers to a technique of grouping of vehicles based on some predefined metrics such as density, velocity, speed, geographical locations of vehicles, etc. Under the cluster structure, mobile nodes may be assigned different status or functions such as Cluster Head (CH), cluster member (CM).

The use of clustering has shown very efficient solutions to various problems in MANETs. The notion of cluster organization has been extensively used for Vehicular Adhoc Networks in several issues such as hierarchical organization, routing, data dissemination, etc. But the review of various handover techniques and clustering algorithms of VANETs have revealed that no doubt, the use of clustering schemes have received great interest and attention in topology management and routing but the use of clustering in issues like QoS, Security and handover management is still very less explored. Due to a large number of nodes and a lack of routers, a flat network scheme may cause serious scalability and hidden terminal problems in VANETs [2]. So there is a need to have an insight into the use of cluster-based mobility for managing handover.

VANET deals with the number of different issues due to its special characteristics but we are understanding the use of clustering in handover. While dealing with clustering, in a highly dynamic environment like VANETs the important task is Cluster head (CH) selection and cluster formation. So we will propose a new multi-hop clustering scheme in which CH selection will be done based on the fuzzy TOPSIS which is going to be the first in the literature. Cluster maintenance will also be given equal importance to CH selection in the proposed scheme.

Moreover, there is a requirement to explore the use of clustering to determine whether it can prove to help improve the handover management of Vehicular Adhoc Networks. So, the above-proposed cluster-based algorithm will be modified for providing mobility management with the assumption that the use of a proposed cluster-based scheme handover can be reduced.

The paper below is distributed as: unit II is going to review the literature. Unit III is going to give the research design. After that Unit IV provides the Results followed by Unit V which presents the conclusion.

II. LITERATURE REVIEW

Zhen Xia ZH. et. al. [3] used the multi-hop cluster scheme to establish stable vehicle groups in VANETs. To represent relative mobility between vehicles in multi-hop distance they have introduced a new mobility metric. They have claimed to be the first one to introduce the concept of multi-hop clusters for VANETs. Using simulation results they have demonstrated the clustering of vehicle nodes efficiently.

SeyhanUcar et. al. [4] have introduced a vehicular multi-hop algorithm for stable clustering (VMaSC). They have used speed difference to calculate the least mobility between the nodes. This least mobility is used for selecting the cluster head in multiple hops. This approach has designed stable multi-hop clusters in a dynamic scenario using the minimum number of cluster heads. They have claimed to be the first one to simulate multi-hop clustering using realistic vehicle mobility which is generated using realistic mobility generator SUMO. Simulation results have shown if considering cluster head and cluster member duration as evaluation parameters the VMaSC clustering is better than the N-hop clustering.

DeganZh. et. al. [5] have proposed a passive multi-hop clustering algorithm that ensures the coverage and stability of the cluster. In this paper, they have proposed a priority-based neighbor following technique which is used to find optimal neighbor nodes that can join the same cluster. The technique increases the stability of the overall clustering process by selecting the most stable node among all the nodes in the N-hop range as Cluster Head. Cluster merger is used in cluster maintenance for further improving the stability and reliability. Simulation using ns2 is used for performance evaluation and comparison of the proposed algorithm.

L. Zhang et. al. [6] proposed a k-hop clustering approach. This approach decides the CH based on three main factors i.e. vehicle mobility, highest connectivity, and host ID. The cluster formation approach applied in this case is similar to the max-min k-hop heuristic approach. In the proposed scheme the location information is announced periodically following the velocity of the vehicle, which leads to a reduction in the transmission overhead. The given approach focuses on link activation and deactivation based on the radio link expiration time and the number of cluster members connected to a particular cluster head, this process also leads to an increase in cluster stability.

Cheng et al. [7] proposed a multi-hop clustering scheme for VANETs. In this scheme, the CHs are selected passively using the concept of neighborhood follow the relationship between vehicles. The proposed vehicle following strategy is expected to decrease the cluster formation cost largely. The stability of the cluster can also be improved efficiently using passive clustering. Cluster maintenance can be done easily using a distributed manner for selecting a target. The proposed scheme is simulated using ns2 and Vanet Mobi Sim. Performance evaluation and comparison with n-hop have shown that this approach has increased the cluster stability and also improved the cluster maintenance.

G. Wolny et al. [8] [9] proposed the concept of density-based multi-criteria clustering. Stable and long-living clusters are formed using this approach. The multiple criteria considered consists of the position of vehicles both current position and predicted position, the radio link quality & the number of neighbors. Every vehicle has to be verified before becoming the member of a cluster even if it meets the necessary conditions based on defined the multi-criteria. The cluster size and longevity is greatly influenced by the constraints proposed in the paper. They have used the concept of clustered and non-clustered vehicles.

Xiang Ji et at. [10] have proposed a link-reliability based clustering algorithm (LRCA). The algorithm defines a novel neighbor sampling technique based on link lifetime. This technique is used before clustering to filter unstable nodes. The proposed scheme mainly consists of cluster head selection, cluster formation, and cluster maintenance. They have also proposed a routing protocol using LRCA. The proposed scheme outperforms cluster stability.

Ghada H. Alsuhli et al. [11] have proposed a clustering algorithm that uses the concept of double-head. This double-head algorithm has improved stability and thus improved the performance. They have given considered the cluster maintenance phase as a medium to improve stability and performance. Few evaluation metrics are also proposed by them which are analyzed under various mobility scenarios, vehicle densities, and radio channel models. This proposed approach has created minimum numbers of stable clusters for highways and urban scenarios.

Abubakar Bello Tambawal et al [12] have developed an enhanced weight-based clustering algorithm (EWCA). This is a cluster-based technique for cluster formation, cluster maintenance. The proposed algorithm is also a double CH based technique where the primary key and secondary key is there in each cluster. Simulation is done using which has shown that the proposed algorithm has improved the cluster stability and reduced the communication overhead thus providing reliable delivery of safety applications.

Song Jian et al [13] have proposed an improved MAP choice scheme. They have introduced a multicast mechanism based on HMIPv6 for managing Macro/Micro mobility. The results have shown a decrease in the frequency of macro-mobility handover and an increase in the reliability of communication.

F. Azzali et al [14] have proposed a vertical handover decision algorithm. This algorithm uses a Fuzzy Logic, to increase performance in terms of QoS for heterogeneous VANET. The proposed Fuzzy Logic algorithm has shown improvement over the RSS Threshold-based algorithms in terms of the average percentage of handover QoS. It has achieved 20%improvement in handover latency, 21% in case of latency & 13% in terms of packet loss.

Khalid Abdel Hafeez et al [15] have proposed a novel cluster head selection approach. In this proposed approach the relative speed within neighborhood and distance of vehicles is used as a metric for deciding the cluster heads. They have given due importance to cluster maintenance where drivers' behavior is the main parameter which decides the future speed and position of all cluster
members. They have used a learning mechanism using a fuzzy logic inference system for prediction of future speed. The proposed algorithm has a shown high cluster head lifetime based on simulation results. Simulation has also shown that the cluster topology is more stable with less communication & coordination in between members of a cluster. A comparison with other schemes is also done during the simulation.

III. RESEARCH DESIGN

This study is to design a cluster-based model for V2V and V2I communication in VANET and check the effect of clustering on handover. A hybrid architecture is used for V2I environment. Once the complete algorithm is designed it is simulated using an ns2 simulator.

Some realistic mobility simulator like SUMO will be used to support ns3 simulations. The process flow of the proposed cluster-based model is given below in figure 1.

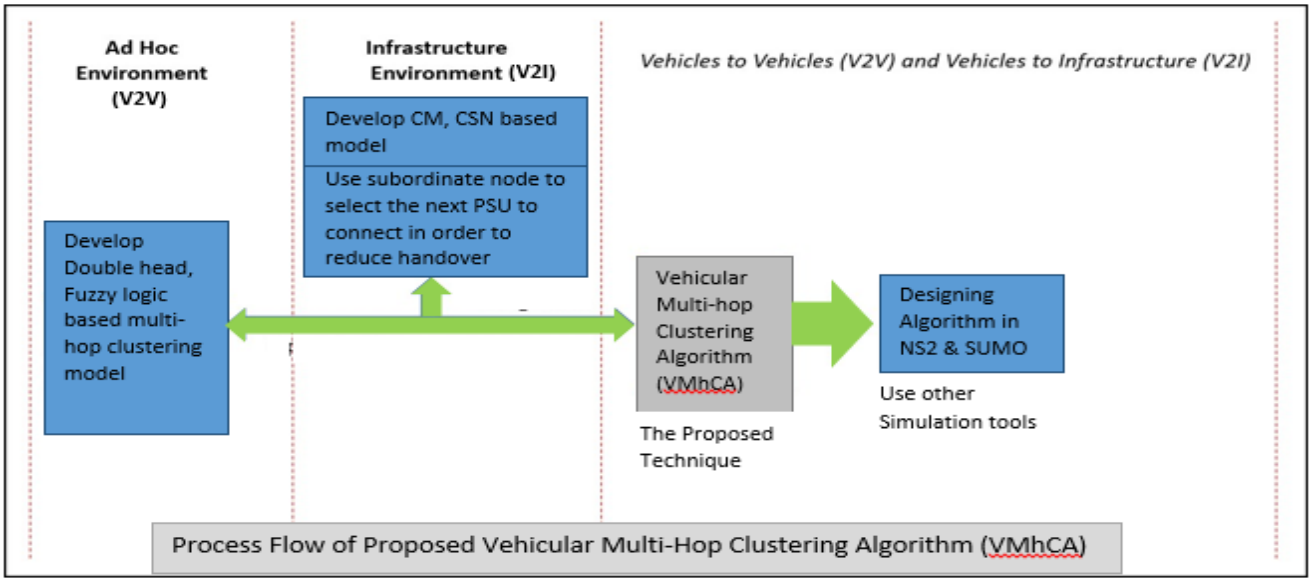


Figure 1. Process flow of VMCA

The objective of this study is to propose a multi-hop cluster-based algorithm for Vehicular Adhoc Networks. The methodology of research for achieving the objective includes steps like developing the knowledge base about the handover and clustering in VANETs by detailed and comprehensive literature review, developing the algorithm for V2V communication, simulating and evaluating it, extending the designed algorithm for V2I communication based hybrid architecture. The research methodology is shown with the help of the flowchart given below:

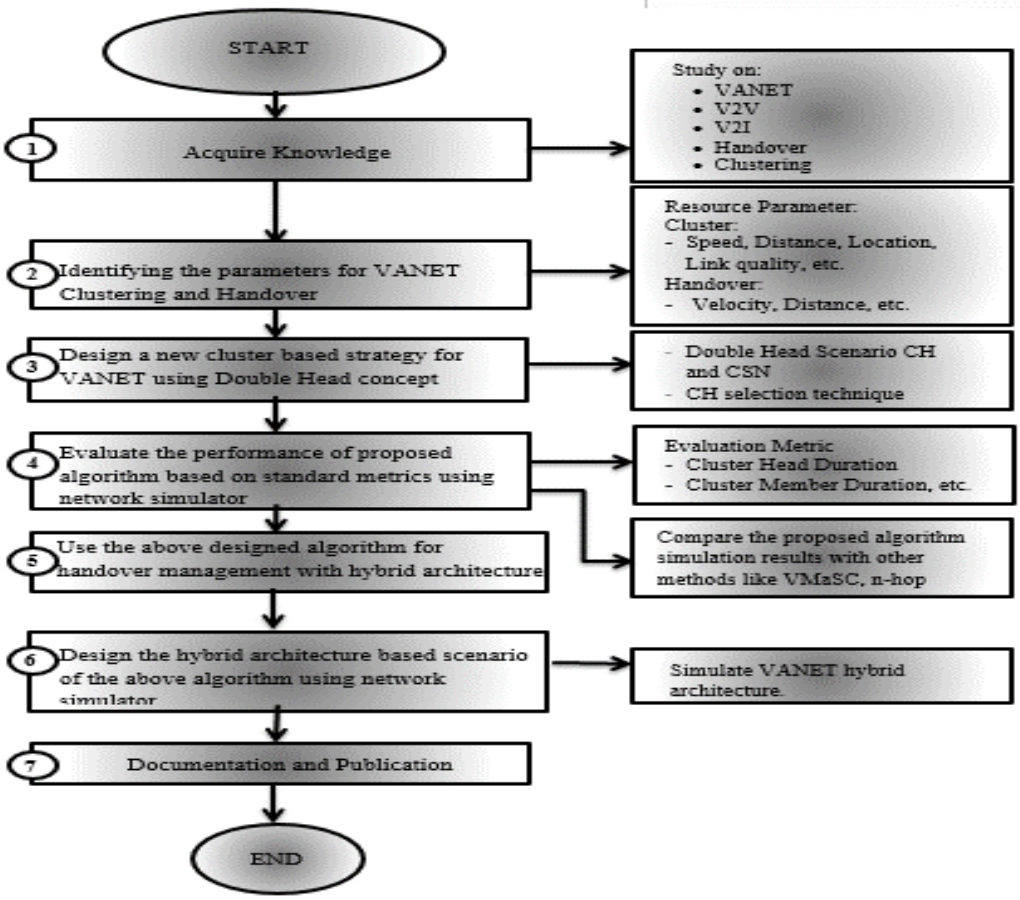


Figure 2. Flowchart of research methodology

IV. RESULT

Below are some of the findings that shows the drawback of previous studies and comparison of methods.

Publication	Background	Major finding	Method	Debate
[3] (2011)	Claimed to be the first one to introduce the concept of multi-hop clusters for VANETs. A new mobility metric is introduced which represents relative mobility between vehicles in multi-hop distance. Considered 2-hop, 3-hop, 4-hop communication.	A new mobility metric to represent N-hop mobility is introduced. This metric proves that relative mobility of vehicles affects the stability of the clusters.	Multi-hop clustering scheme. CH selected based on aggregate mobility metric.	Considered only mobility as a metric for deciding CH, other parameters can be used like link quality etc. Security problem can be taken into account.
[4] (2013)	Introduced a multi-hop algorithm for Stable Clustering in the vehicular environment. Choose the node with the least mobility as cluster head. Speed mismatch between the neighboring nodes is used for calculating the least mobility.	Deciding the CH based on relative mobility will increase the stability of the Cluster. The average of the relative speed of all the same direction vehicles is used for calculating the relative mobility.	Multi-hop clustering scheme. CH selection on the basis of the relative mobility	Checked only same direction vehicles. Only cluster formation is given consideration. Cluster maintenance can be considered.
[5] (2018)	A priority-based neighbor-following strategy is proposed to select the optimal neighbor nodes to join the same cluster. Ensures the coverage and stability of cluster.	A priority based neighbor-following strategy is introduced in cluster formation. Improved cluster stability and reliability	Multi-hop clustering scheme. CH selection based on number of followers and relative mobility.	Multiple metrics like link quality, mean distance can be used for deciding CH.
[7](2015)	Neighborhood follow relationship between vehicles is used to find out the CH. Based on the assumption that the passive clustering can enhance the stability of the clusters to large extent.	Improved stability and reliability compared to previous available versions	Multi-hop clustering based on one-hop stability. CH selection based on neighborhood follow strategy	Security can be taken into account. Can be combined to some other techniques to find the most stable CH.
[10] (2018)	A link-reliability based clustering algorithm (LRCA) is proposed. to provide efficient and reliable data transmission. A neighbor sampling technique is designed using link lifetime which is applied before clustering to remove unstable nodes.	Use of link reliability and link life time for cluster formation improves the stability to a large extent.	A V2V communication using cluster-based data transmission. CH selection is done on the basis of LREL (link reliability).	Periodic beacon messages are sent only in 1-hop vicinities. Can be improved to be usable for real-time applications in VANET.
[11](2019)	A mobility based double-head clustering algorithm is designed that exploits vehicle speed, position, direction, link expiration time, signal-to-noise ratio. Mobility based general purpose clustering approach	Creates minimum number of stable clusters. While working on cluster maintenance, the use of link expiration time and SNR improves the stability and the performance.	Single-hop clustering. Each cluster has double head.	Use of machine learning techniques should be exploited to optimize the different algorithm parameters in real-time..
[12](2019)	Enhanced weight-based clustering algorithm was developed. The algorithm takes care of cluster formation, cluster maintenance. A secondary cluster head as a backup is used to support the PCH. Use of secondary cluster head enhances the cluster stability.	Simulation results showed 40-45% increase in the stability of cluster as compared to other approaches. Communication overhead is reduced and the overall performance has increased.	Single-hop clustering. Weight based cluster head selection method used.	Deals with safety message dissemination only. Can be extended for multi-hop environment.
[14](2017)	A fuzzy logic based vertical handover decision algorithm with the aim to improve the QoS performance in heterogeneous VANET.	The proposed algorithm has shown better performance in term of QoS when compared to RSS threshold based algorithm. Simulation is used to validate the results. Handover latency, packet loss & end-to-end delay is also reduced using the proposed technique.	Fuzzy logic based vertical handover decision.	The algorithm based on Fuzzy Logic cannot be considered as certain, unambiguous. It can be a vague system.

V. CONCLUSION

The significance of this study is to provide a cluster based technique for V2V and V2I communication in VANETs. This study develops an algorithm for defining cluster head based on FUZZY TOPSIS method. Some other new features like use of subordinate node, use of priority lists, node following strategy have been added to increase the stability of the cluster. There will be double cluster head in a cluster where subordinate is not selected by the primary head but will be decided based on the Rank Index calculated using different parameters. This cluster based architecture is further used for handover management in VANET.

Conflict of Interest

The authors declare that there is no conflict of interest in this publication.

Acknowledgements

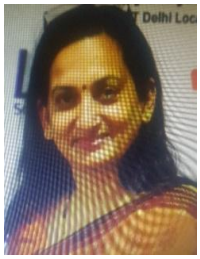
This work was undertaken as a research proposal in Himachal Pradesh University.

REFERENCES

1. Car-to-Car Communication Consortium. (2007) "C2C-CC Manifesto," Version 1.1, August 2007, available at http://www.car-to-car.org/fileadmin/ documents/pdf/C2C-CC manifesto 09 24 v1.1.pdf.
2. Rasmeet S Bali, Neeraj Kumar. (2014) Joel J.P.C. Rodrigues, "Clustering in vehicular ad hoc networks: Taxonomy, challenges and solutions", Vehicular Communications.
3. Z. Zhang, A. Boukerche, R Pazzi. (2011) A novel multi-hop clustering scheme for vehicular ad-hoc networks, Paper presented at the Proceedings of the 9th ACM international symposium on Mobility management and wireless access. pp. 19-26.
4. SeyhanUcar, S.C. Ergen, O. Ozkasap. (2013) VMaSC: Vehicular Multi-hop algorithm for stable Clustering in Vehicular Adhoc Networks, IEEE Wireless Communications and Networking Conference: Networks. pp. 2381-2386
5. D. Zhang, Hui Ge, T. Zhang, Y. Y. Cui, X. Liu, G. Mao. (2018) New Multi-Hop Clustering Algorithm for Vehicular Adhoc Networks, IEEE Transactions on Intelligent Transportation Systems.
6. L. Zhang, H. El-Sayed. (2012) A novel cluster-based protocol for topology discovery in vehicular ad-hoc network, Procedia Comput. Sci., pp. 525-534.
7. Y. Chen, M. Fang, S. Shi, W. Guo, X. Zheng. (2015) Distributed multihop clustering algorithm for Vanets based on neighborhood follow, J. Wireless Commun. Netw., pp. 1-12.
8. G. Wolny. (2008) Modified DMAC clustering algorithm for VANETs. In Systems and Networks Communications, pp. 268-273
9. S. Kuklinski. et al. (2009)Density Based Clustering algorithm for Vehicular Ad-Hoc Networks. Int. J. Internet Protocol Technology, Vol. 4, No. 3, pp. 149-157.
10. X. Ji, H. Yu, G. Fan, H. Sun, L. Chen.(2018) Efficient and Reliable Cluster-Based Transmission for Vehicular Adhoc Networks, Hindawi Mobile Information Systems, 9826782
11. G. H. Alsuhi, A. Khattab, Y A. Fahmy. (2019) Double- Head Clustering for Resilient VANETs, Hindawi Wireless Communications and Mobile Computing, 2917238.
12. Abubakar Bello Tambawal et al. (2019) Enhanced weight-based clustering algorithm to provide reliable delivery for VANET safety applications, PLOS ONE, pp 1-19.
13. Song Jian et al. (2007) An Improved Fast Handover Algorithm based on HMIPv6. Proc. of the Int. Multi-Conference on Computing in the Global Information Technology (ICCGI'07) IEEE.
14. F. Azzali et al. (2017) Fuzzy Logic-Based Intelligent Scheme For Enhancing Qos Of Vertical Handover Decision In Vehicular Ad-Hoc Networks, International Research And Innovation Summit (IRIS). IOP Conf. Ser. Mater. Sci. Eng. 226 - 012081.
15. Khalid Abdel Hafeez et al. (2012). A Fuzzy-Logic-Based Cluster Head Selection Algorithm in VANETs. IEEE ICC 2012. pp. 203-207.
16. Poonam Thakur, Anita Ganpati. (2019) Survey on Handover techniques in VANET. International Journal of Computer Science and Engineering, Vol.7, Issue.6 pp.236-250.

AUTHORS PROFILE

Poonam Thakur is a research scholar in the Department of Computer Science at Himachal Pradesh University Shimla. She has done her Mtech from Lovely Professional University and B.E from Sant Longowal Institute of Engineering and Technology Sangrur. She has published various research articles in the field of computer networks and has a teaching experience of around five years. She is a member of the Computer Society of India & Indian Science Congress Association.



Dr. Anita Ganpati is a Professor in the Department of Computer Science at Himachal Pradesh University. She has a teaching experience of 18+ years and has published approximately 65+ research papers in journals & national and international conference. She is a member of different professional bodies like Computer Society of India, International Association of Engineers (IAENG) Honkong and Society of Digital Information & Wireless Communication (SDWIC) USA. She has chaired various sessions in national & international conferences and seminars.