TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

Comparison of Various Clustering Techniques in VANETS

[1]Chaitanya Nukala, [2]C. Hrishikesava Reddy, [3]G. Rajasekhar Reddy

[1,2,3] Department of CSE, Rajeev Gandhi Memorial College of Engineering & Technology(Autonomous), Nandyal 518 501, Andhra Pradesh, India.

Article Info
Volume 82
Page Number: 9554 - 9563
Publication Issue:
January-February 2020

Abstract:

In recent years, there will be a fast expansion in numerous vehicles flying on road. The concentration will be to enhance the navigation standards & road security with assistance of ITS. There will be a requirement for new services & applications in environment of vehicle for comfort & safety. The technical advancement is improved to prevent collisions, to access "uninterrupted internet facilities", to foresee road accidents, to understanding road situations, to extent the capacity of storage, to expand the range of transmission, and to avoid the wireless links interference. The idea of this manuscript will be to enhance ITS to develop the safety of road & navigation procedure. There are numerous methods in n communication. The efficient & effective methods are enhanced to identify the conditions of road with the support of "vehicular communication". This manuscript provides the foundation of "intelligent vehicle transport framework". Different reviews on clustering, VANET modeling, &it's based methods are deliberated. Followed by a survey of MAC protocols, hybrid cluster methods for VANET road security applications, multi-level &multi-hop broadcast protocol are examined.

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 12 February 2020*

Keywords:—*cluster head level (CHL), "Vehicular ad hoc network (VANET)", MAC Protocols, Intelligent transportation system (ITS), Mobility Clustering (MOBIC), lowest identifier (LID), TTL (time-to-live), Gauss–Markov mobility (GMM), connected dominating set (CDS), chain-branch-leaf (CBL), link reliability (LREL)*

1. INTRODUCTION

VANET is the basement for ITSs that expects toward accomplishing consistent web connectivity among vehicles on the road [1]. With the improvementsof novel generation wireless communication methods, intelligent vehicle, vehicles equipped with wireless interfaces have able to offer ITS services [2] like vehicle navigation, traffic monitoring [3], close-by data services, &"mobile vehicular cloud computing". Hence, the formation of a stable communication & network administration will be the very challenging task because of "uneven spatial distribution"& high mobility of vehicles in VANETs.

The method of clustering will be testified to be with a capable answer to enhance the

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

scalability & routing reliability by organizing the same vehicles into multiple virtual clusters [4]. Every cluster has a head that is answerable for handling communication in cluster. The cluster vehicles might connect directly through an intra-cluster communication, whereas vehicles in diverse clusters might accomplish inter-cluster correspondence byheads of cluster. The initially prominent clustering methods were intended for MANETs [4], like for example, such that the well-knownLID [5] & MOBIC [6].

After, few other methods were planned for clustering in MANET. Lately, few methods were executed in VANETs. Nevertheless, because of the channel situations & characteristic mobility of VANET, these methods must be adapted as stated by the interesting properties. The clustering methods suggested for VANETs have utilized in communication networks to segment comparable vehicles into clusters [7]. Consequently, clustering methods might adequately restrict the channel contention between cluster parts to guarantee reasonable channel access. Furthermore, under administration ofcluster head, the clustering methods might give spatial reuse of assets like bandwidth [8]. Provided the high of VANETs, how to choose the head of cluster & how to enhance stability of cluster get to be critical challenges. Based on VANETs method, various applications are improved for the ITS. An ordinary sort of application will be to spread security messages between vehicles, comprisingcongestion information & accident warning [9], [10].

An alternate sort of application is likewise significant for effective VANET deployment [11]. The Infotainment benefits offer much agreeable experience for both passengers &drivers with different applications like close-by multimedia application &data access [12]. Dissimilar from past clustering methods that concentrates on vehicular mobility; we suggest novel metric LREL for head assortment of cluster. The heads of cluster are chosen in distributed path. Furthermore, we recommend a routing protocol through utilizing the suggested architecture of clustering. We choose bridge nodes at intersections to associate in road situations. The bridge node plays as routing way decision maker by checking the delay to incur for information transmission over the road sections.

2. RELATED WORK

The unique clustering methods are suggested in late 1980s. Meanwhile then, an expansive number of cluster-oriented studies are presented to MANETs in general &VANETs specifically [4]. The vehicle clustering will be a possibility method to enhance the networking protocols scalability for VANET situations. For “cluster-based routing protocols”, heads of cluster take tasks for maintenance & discover of routingways that lessen the control overhead to incredible extent 13]. Because of high-speed versatility of vehicles, network topology progressions regularly [14]. Under this condition, the maintenance price of cluster increments fundamentally. Thus, how to structure the stable groups & handle their stability throughout correspondence is a key problem in clustering methods for VANETs. Numerous clustering methods intended for VANETs are recommended rely on mobility measurements for cluster framing instruments. The mobility features, comprisingdirection, speed, & vehicles location, are exceptionally imperative for VANET grouping methods.

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

The work [15] suggested a "passive clustering"method relies on "predefined speed intervals". They establish vehicles inside the similar speed interval into clusters. Nevertheless, the speed interval will be not a best metric to evaluation due to2 vehicles with much same "speed around the interval gap"may be separated under separate clusters. The work [16] utilized the "distance-based criteria" in cluster development methods. Moreover, they utilize a central server to handle the splitting events & cluster merging.

The work [17] recommended a "distributed mobility-based grouping algorithm"rely on information clustering method known as affinity propagation. They utilize the metric of"mobility in cluster creation process"& vehicular position toward joining together the present & future positions. Numerous clustering methods are suggested for VANET based on aggregate of weighted values. The work [18] suggested a priority-based grouping methodology. The necessity is computed as stated by the assessed speed deviation & duration of travel. The work [19] exhibited a "lane-based clustering method" that chooses vehicle as head of cluster with highest CHL. The CHL is ahybrid metric joining the vehicle's relative position, traffic flow condition, & relative speed.

The work [20] recommended the clustering method based on vehicle's destination. As stated by their mechanism, vehicles with same destinations have to structure a cluster. The weighted metric will be calculated as mixture of relative destination, present position, relative speed, & last end of vehicles. The methods of clustering for VANET might be sorted under two classes of multi-hop &one-hop clustering.

The previously stated methods [16]-[20] are dependent upon single-hop groups in that cluster parts are one-hop out from CH. The One-hop group topology might diminish the cluster maintenance overhead & decrease cluster re-affiliation due to fewer data exchanges are needed [21]. Though, the density of vehicles &transmission range affect the cluster size. In high vehicular density, information impact might occur in clusters. On the divergent, a vehicle might neglect to recognize neighbors in low density. Lately, numerous works are suggested for multi-hop grouping methods. The work [22] recommended MDMAC that may be a change for DMAC. MDMAC has the capacity to structure k-hop groups toward presenting the TTL parameter for message conveyance.

The work [23] recommended a multi hop grouping plan to VANETs. The multihop groups are constructed dependent upon relative versatility among vehicles in multihop separation. The work [24] recommended a single-hop clustering method known as MOSIC dependent upon the transforms of relative vehicular versatility. It utilizes the GMM model to portability predication & makes vehicle have the ability to prognosticate its versatility relative with its neighbors. In latest years, few specialists develop semi clusters to VANET situations. The work [25] suggested a novel variant for cluster that known as the "microtopology (MT)". The MTbehaves as an essential part of routing ways that comprises of wireless

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

links among vehicles &vehicles along the road. The work [26] suggested SCRP that will be an estimated cluster-based routing protocol dependent upon CDS. The SCRP chooses fewvehicles as ruling vehicles to structure a virtual spine in network.

The authors in [27] outlined a moving-zone-based construction modeling to information conveyance in VANETs. Comparable to formation of cluster, the moving zone may be self-organized by vehicles that are same development designs. The work [28] suggested the CBL clustering plan that combines the majority of the data on configuration of road, link quality, & vehicle mobility. The work [29] suggested a SDN-based wireless communication explanation to handle resources of network that might schedule diverse network resources & diminish the price of communication.

The work [30] recommended a channel prediction-based planning methodology to helpful information spread in VANET that diminishes the data dissemination delay &communication overhead. The authors in [31] suggested a disseminated information replication method with data carrier distribute the information distribution tasksto various nodes to speed the procedure of dissemination. In survey, clustering methods are suggested for reason for QoS support, load balancing, &information transmission over VANET scenario [2]. For instance, the work [32] suggested a "cluster-based directional routing protocol for VANETs"that deliberates moving directions for cluster head determination.

The authors in [33] shaped the clusters utilizing direction &position data of vehicles. Dissimilar to these investigators, we deliberate the dependability of joins among vehicles. We set dependent upon another metric known as LREL, for selection of cluster head. Furthermore, we recommend a LLT-based neighbor inspecting plan tofilter out flimsy neighbors that might lessen redundant message exchanges.

3. Comparative Study

In comparative investigations, many researchers proposing new clustering methods seek to show execution benefits of suggested algorithm utilizing simulations in a range of metrics have compared against 1 or more recognized other clustering methods. Frequently the selection of approach against that execution will be to compare is determinedly impacted toward the free accessibility of "source code for simulations", alternately the presence of adequate detail in the relating publication(s) to permit for direct execution in specific simulation environment. Numerous manuscripts cited in this study present this kind for performance examination. Numerous methods aimed at particular applications were compared to "non-cluster-based alternatives" for specific applications in its place, like a "cluster-based routing method" compared to "traditional MANET routing protocol".

Figure 1 represents the affiliation rate of surveyed methods under the experimentally derived URC channel & free space path loss method. The oversimplified method provides an very optimistic perspective of performance, & hides disparities among relative execution of grouping systems that have seen whereas a much realistic method is utilized.

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

Figure 2 demonstrates the connections among the approaches assessed in this review. The approaches have requested clockwise in place of the publication date. The clear characteristic of this examination may be that numerous surveyed clustering approaches have compared to MANET methods to equal issues.

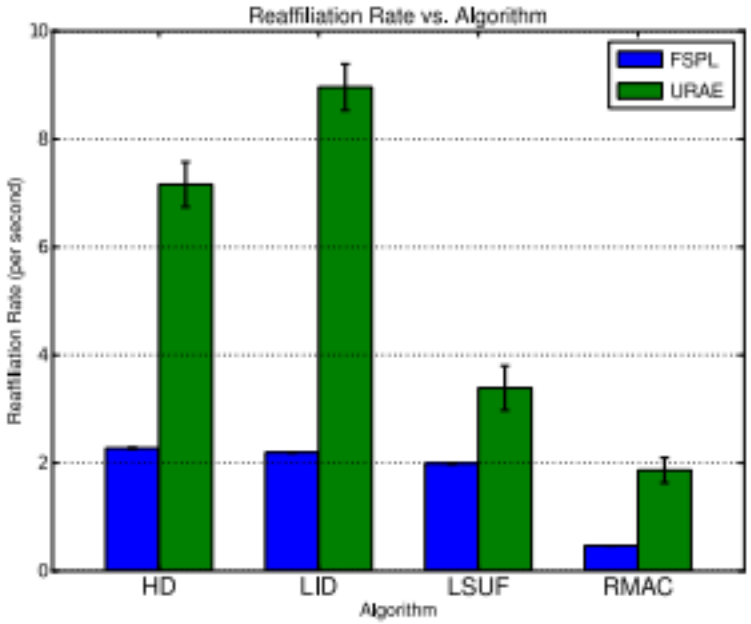

Fig. 1.Reaffiliation rate of surveyed procedures under experimentally-derived URC channel model & free space path loss

The easiest method provides an excessively idealistic perspective of performance, and hides differences among relative execution of clustering processes that are seen while a much realistic method will be utilized.

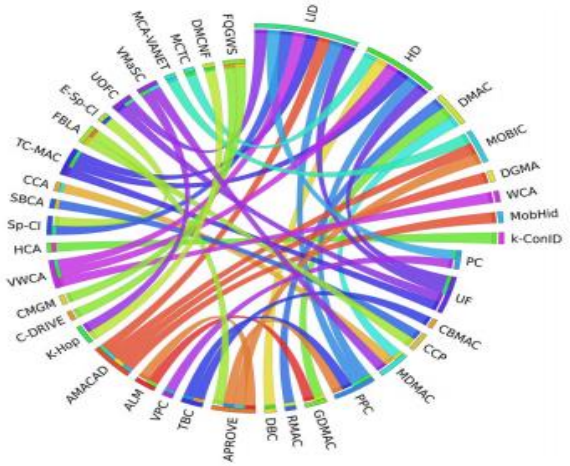

Fig.2. Cluster comparisons

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

The approaches are organized clockwise in place of the publication date. The algorithm color, & ribbon colour, which is being suggested, and ribbon prompts the approach to that it was compared. The MANET approaches are out from the circle edge. The figure made with Circos [34].

Table 2.1 Comparison of Clustering Techniques

Author	Clustering Technique	Methodology Used	Limitations
Gupta N et. al [35]	Mobility based clustering algorithm to prioritize messages in the order of node speed	Cluster Cognitive Medium Access Control (CCMAC) protocol	Lengthen the delivery of safety messages within the band
Kwon J.H et.al [36]	Neighbor stability-based VANET clustering (NSVC)	Transmission scheduling method supports emergency message	To reduce the topology changes and to diminish the delay in formation of cluster
Wang H et. al [37]	VANETs group vehicles into clusters toassist communication.	Comprehensive analysis model	System throughput & packet loss probability
SahooA et. al [38]	To optimize a routing zone clustering method for VANETs with the use of ACO.	Ant Colony Optimization	Zone based
Da Silva et. al [39]	Utilizes proactive caching in the "network formed by Access Points (APs)".	Trajectory aware Content (TraC).	highway traffic, urban traffic
UcarS et. al [40]	"Vehicular Multihop algorithm for Stable Clustering and Long Term Evolution"	multi-hop cluster based IEEE 802.11p-LTE	Delay and control overhead, cluster stability
Shanmugasundaram G et. al [41]	VANET multilevel cluster algorithm	cluster overhead slave selection technique is introduced,	cluster head-to-head communication
Bi Y et. al [42]	forwarding node selection system	UMBP	message transmission speed&one-hop delay

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

Omar et. al [43]	"Wireless Access in Vehicular Environments" (WAVE).	VeMAC protocol	on-road demonstrations
Bian C et. al [44]	"Named Data Networking (NDN)" architecture	geo-based NDN design approach	Urban VANET, to remove the cache redundancy
OcheM et. al [45]	Internet Protocol Television services	Analytical model	bandwidth allocation, delay and loss control
RautS et. al [46]	collision prediction system	probability at "highway intersection Intelligent Control Unit (ICU)"	monitors and transmits beacon messages

4. CONCLUSION

The VANETs are in particular & MANETs are in general needs members to harmonize their correspondence & goal to ensure channel's fair distribution. Dissimilar the wider Internet that will be a common reason carriage service, which commonly expects moderately "stable network topology", a VANET is a persistently progressive network, with a number of applications served frequently having varying. Certainly, the work [36] noted that a universally useful clustering approach with its control frames might interference with objective to accomplish. For many investigators, VANETs, unlike Internet is highly particular applications. Therefore, protocol outline procedure must start with the proposed requisition. The protocol might be planned around these obstacles; or obstacles might be innovatively utilized to protocol's benefit. Lastly, the protocol must be assessed for an exact channel, which accounts for as numerous known proliferation phenomena as probable, for correlation to the latest competing protocols. A development in method & investigation of VANET issue will quicken the roll-out for this technique.

References

1. B. T. Sharef, R. A. Alsaqour, and M. Ismail, "Vehicular communication ad hoc routing protocols: a survey," Journal of Network & Computer Applications, vol. 40, no. 1, pp. 363–396, 2014.
2. R. S. Bali, N. Kumar, and J. J. P. C. Rodrigues, "Clustering in vehicular ad hoc networks: taxonomy, challenges and solutions," Vehicular Communications, vol. 1, no. 3, pp. 134–152, 2014.
3. J. Jeong, H. Jeong, E. Lee, T. Oh, and D. H. C. Du, "SAINT: self-adaptive interactive navigation tool for cloud-based vehicular traffic optimization," IEEE Transactions on Vehicular Technology, vol. 65, no. 6, pp. 4053–4067, 2016.
4. C. Cooper, D. Franklin, M. Ros, F. Safaei, and M. Abolhasan, "A comparative survey of VANET clustering techniques," IEEE Communications Surveys & Tutorials, vol. 99, p. 1, 2017.
5. C. R. Lin and M. Gerla, "Adaptive clustering for mobile wireless networks," IEEE J Selected Areas in Communications, vol. 15, no. 7, pp. 1265–1275, 1997.
6. P. Basu, N. Khan, and T. D. C. Little, "A mobility based metric for clustering in mobile ad hoc networks," in Proceedings of the International Conference on Distributed Computing Systems, , Mesa, AZ, USA, April 2001.
7. M. Fathian and A. R. Jafarian-Moghaddam, "New clustering algorithms for vehicular

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

ad-hoc network in a highway communication environment," Wireless Networks, vol. 21, no. 8, pp. 2765–2780, 2015.
8. G. V. Rossi, F. Zhong, W. H. Chin, and K. K. Leung, "Stable clustering for ad-hoc vehicle networking," in Proceedings of the Wireless Communications and Networking Conference, pp. 1–6, Edinburgh, UK, December 2017.
9. S. Ucar, S. C. Ergen, and O. Ozkasap, "Multihop-cluster-based IEEE 802.11p and LTE hybrid architecture for VANET safety message dissemination," IEEE Transactions on Vehicular Technology, vol. 65, no. 4, pp. 2621–2636, 2016.
10. B. Liu, D. Jia, J. Wang, K. Lu, and L. Wu, "Cloud-assisted safety message dissemination in VANET-cellular heterogeneous wireless network," IEEE Systems Journal, vol. 99, pp. 1–12, 2017.
11. P. Salvo, M. D. Felice, F. Cuomo, and A. Baiocchi, "Infotainment traffic flow dissemination in an urban VANET," in Proceedings of the Global Communications Conference, pp. 67–72, Atlanta, GA, USA, December 2013.
12. M. Oche, R. Md Noor, and A. Jalooli, "Quality of service management for IPTV services support in VANETs: a performance evaluation study," Wireless Networks, vol. 21, no. 1, pp. 315–328, 2015.
13. K. Abboud and W. Zhuang, "Stochastic modeling of single-hop cluster stability in vehicular ad hoc networks," IEEE Transactions on Vehicular Technology, vol. 65, no. 1, pp. 226–240, 2016.
14. X. Ji, H. Q. Yu, G. S. Fan, and W. H. Fu, "SDGR: an SDNbased geographic routing protocol for VANET," in Proceedings of the IEEE International Conference on Internet of Eings, pp. 276–281, Exeter, UK, June 2017.
15. O. Kayis and T. Acarman, "Clustering formation for intervehicle communication," in Proceedings of the Intelligent Transportation Systems Conference (ITSC), pp. 636–641, Hong Kong, China, October 2007.
16. J. Chen, C. Lai, X. Meng, J. Xu, and H. Hu, "Clustering moving objects in spatial networks," in Proceedings of the International Conference on Database Systems for Advanced Applications, pp. 611–623, Bangkok, *ailand, April 2007.
17. C. Shea, B. Hassanabadi, and S. Valaee, "Mobility-based clustering in VANETs using affinity propagation," in Proceedings of 14 Mobile Information Systems the Global Telecommunications Conference, pp. 1–6, FL, USA, December 2010.
18. Z. Wang, L. Liu, M. C. Zhou, and N. Ansari, "A position-based clustering technique for ad hoc intervehicle communication," IEEE Transactions on Systems Man & Cybernetics Part C, vol. 38, no. 1, pp. 201–208, 2008.
19. S. Almalag Mohammad and C. Weigle Michele, "Using traffic flow for cluster formation in vehicular ad-hoc networks," in Proceedings of the Local Computer Networks, pp. 631–636, Denver, CO, USA, October 2010.
20. M. M. C. Morales, C. S. Hong, and Y. C. Bang, "An adaptable mobility-aware clustering algorithm in vehicular networks," in Proceedings of the Network Operations and Management Symposium, pp. 1–6, Maui, MI, USA, April 2011.
21. M. Ren, L. Khoukhi, H. Labiod, J. Zhang, and V. Veque, "A ` mobility-based scheme for dynamic clustering in vehicular ad-hoc networks (VANETs)," Vehicular Communications, vol. 9, pp. 233–241, 2016.
22. G. Wolny, "Modified DMAC clustering algorithm for VANETs," in Proceedings of the International Conference on Systems and Networks Communications, pp. 268–273, Sliema, Malta, October 2008.
23. Z. Zhang, A. Boukerche, and R. Pazzi, "A novel multi-hop clustering scheme for vehicular ad-hoc networks," in Proceedings of the ACM International Workshop on Mobility Management & Wireless Access

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

(MobiWac), pp. 19–26, Miami Beach, Fl, USA, October-November 2011.
24. A. Ziagham and M. R. Noorimehr, "MOSIC: mobility-aware single-hop clustering scheme for vehicular ad hoc networks on highways," International Journal of Advanced Computer Science & Applications, vol. 7, no. 9, 2016.
25. X. M. Zhang, K. H. Chen, X. L. Cao, and K. S. Dan, "A streetcentric routing protocol based on microtopology in vehicular ad hoc networks," IEEE Transactions on Vehicular Technology, vol. 65, no. 7, pp. 5680–5694, 2016.
26. M. A. Togou, A. Hafid, and L. Khoukhi, "SCRP: stable CDSbased routing protocol for urban vehicular ad hoc networks," IEEE Transactions on Intelligent Transportation Systems, vol. 17, no. 5, pp. 1298–1307, 2016.
27. D. Lin, J. Kang, A. Squicciarini, Y. Wu, S. Gurung, and O. Tonguz, "MoZo: a moving zone based routing protocol using pure V2V communication in VANETs," IEEE Transactions on Mobile Computing, vol. 16, no. 5, pp. 1357–1370, 2017.
28. L. Rivoirard, M. Wahl, P. Sondi, M. Berbineau, and D. Gruyer, "Chain-branch-leaf: a clustering scheme for vehicular networks using only V2V communications," Ad Hoc Networks, vol. 68, pp. 70–84, 2018.
29. Z. He, D. Zhang, and J. Liang, "Cost-efficient sensory data transmission in heterogeneous software-defined vehicular networks," IEEE Sensors Journal, vol. 16, no. 20, pp. 7342– 7354, 2016.
30. F. Zeng, R. Zhang, X. Cheng, and L. Yang, "Channel prediction based scheduling for data dissemination in VANETs," IEEE Communications Letters, vol. 21, no. 6, pp. 1409–1412, 2017.
31. J. Zhu, C. Huang, X. Fan, S. Guo, and B. Fu, "EDDA: an efficient distributed data replication algorithm in VANETs," Sensors, vol. 18, no. 2, p. 547, 2018.
32. T. Song, W. Xia, T. Song, and L. Shen, "A cluster-based directional routing protocol in VANET," in Proceedings of the IEEE International Conference on Communication Technology, pp. 1172–1175, Jinan, China, September 2011.
33. Y. Ohta, T. Ohta, and Y. Kakuda, "An autonomous clusteringbased data transfer scheme using positions and moving direction of vehicles for VANETs," in Proceedings of the Wireless Communications and Networking Conference, Paris, France, April 2012.
34. M. I. Krzywinski et al., "Circos: An information aesthetic for comparative genomics," Genome Res., vol. 19, no. 9, pp. 1639–1645, 2009. [Online]. Available: http://genome.cshlp.org/ content/early/2009/06/15/gr.092759.109.abstract
35. Gupta, Nishu, ArunPrakash, and Rajeev Tripathi. "Medium access control protocols for safety applications in Vehicular Ad-Hoc Network: A classification and comprehensive survey." Vehicular Communications 2.4 (2015): 223-237.
36. Kwon, Jung-Hyok, et al. "Neighbor stability-based VANET clustering for urban vehicular environments." The Journal of Supercomputing 72.1 (2016): 161-176.
37. Wang, Huixian, et al. "VANET modeling and clustering design under practical traffic, channel and mobility conditions." IEEE Transactions on Communications 63.3 (2015): 870-881.
38. Sahoo, Arundhati, et al. "An optimized cluster based routing technique in VANET for next generation network." Information Systems Design and Intelligent Applications. Springer, New Delhi, 2016. 667-675.
39. da Silva, Vitor Borges Coutinho, Miguel Elias M. Campista, and Luís Henrique MK Costa. "TraC: A Trajectory-aware Content distribution strategy for vehicular networks." Vehicular Communications 5 (2016): 18-34.
40. Ucar, Seyhan, SinemColeriErgen, and OznurOzkasap. "Security vulnerabilities of IEEE 802.11 p and visible light communication based platoon." 2016 IEEE

January - February 2020
ISSN: 0193 - 4120 Page No. 9554 - 9563

Vehicular Networking Conference (VNC). IEEE, 2016.
41. zhanmugasundaram, G., et al. "A Multilevel Clustering Using Multi-hop and Multihead in VANET." Proceedings of the International Conference on Data Engineering and Communication Technology. Springer, Singapore, 2017.
42. Bi, Yuanguo, et al. "A multi-hop broadcast protocol for emergency message dissemination in urban vehicular ad hoc networks." IEEE Transactions on Intelligent Transportation Systems 17.3 (2015): 736-750.
43. Omar, Hassan Aboubakr, Ning Lu, and WeihuaZhuang. "Wireless access technologies for vehicular network safety applications." IEEE Network 30.4 (2016): 22-26.
44. Bian, Chaoyi, et al. "Boosting named data networking for data dissemination in urban VANET scenarios." Vehicular Communications 2.4 (2015): 195-207.
45. Oche, Michael, RafidahMd Noor, and Johnson IhyehAghinya. "Network centric QoS performance evaluation of IPTV transmission quality over VANETs." Computer Communications 61 (2015): 34-47.
46. Raut, Swati B., Preeti R. Bajaj, and Latesh G. Malik. "Prediction of vehicle collision probablity at intersection using V2V communication." Int. J. Sci. Eng. Res 6 (2015): 295-300.