A Novel approach to Stable Cluster Head Selection with respect to Energy and Distance

Abhay Patil
Research Scholar
Department Computer Science and Engineering
Madhav University, Abu Road Sirohi Rajasthan
Mail id: aeversova@gmail.com

Dr. Ganpat Joshi
Associate Professor
Department of Computer Science and Engineering
Madhav University Abu Road, Sirohi, Rajasthan
Mail id: shiv.joshi322@gmail.com

Abstract-The Ad-hoc network is a major component of wireless networks. There are two types of networks that are commonly used in this type of system: the MANETs and the VANETs. The former is an ad-hoc network that consists of nodes that are connected to each other. The other is a vehicle-based network that combines the RSU and vehicles. The development of the Vehicle-based Advanced Network (VANET) has been regarded as a major field of research that focuses on improving the safety and efficiency of vehicles. Unlike the MANETs, VANETs are not only mobile, but they also feature highly mobile vehicles. This makes it very challenging to design a network that will work seamlessly with these types of vehicles. One of the most common challenges that a network can face is the clustering of vehicles. There are various techniques that are used to solve this issue, but not all of them are able to provide a comprehensive overview of all the issues. The goal of a cluster design is to create stable clusters that are designed to meet the needs of the users. One of the most critical factors that has to be considered when it comes to designing a network for the VANET is the selection of the cluster head. In this article, we will discuss the various aspects of the cluster head selection algorithm that are being used in the development of the network and also shows the result which shows promising output.

Keywords- MANET, VANET, Cluster Head, Cluster Selection, Routing Protocols

Introduction

Due to the increasing number of vehicles, the need for more safety and comfort applications has increased. Researchers are working on developing technologies that can help reduce the number of fatal accidents on the road. One of these is the development of an intelligent transport system. The goal of the intelligent transportation system (ITS) is to provide a safe and comfortable ride for people. It is designed to enhance the safety of drivers by providing them with the latest information and features. In addition, improving the routing protocols for vehicles is also a vital part of this process[1].

A vehicle-to-vehicle or vehicle-to-infrastructure network, or VANET, is a type of ad-hoc network that can be used to transmit data between vehicles and the road infrastructure. It can also support various applications, such as traffic safety and Internet access. The two main types of communication within the network are vehicle-to-vehicle and vehicle-to-infrastructure. The use of the IEEE 802.11p standard and the DSRC communication model is a crucial component of the development of an intelligent transportation system. Due to the random and rapid movement of nodes in the network, it can sometimes break down the quality of service. This issue can be solved by implementing clustering protocols.

In order to improve the performance of the network, a process known as clustering is carried out. This process involves splitting the network into small groups. The various parameters of this process help improve the network's performance. Besides improving the network's performance, clustering also contributes to the effective allocation of resources and the balancing of load. Various techniques are based on clustering, and its implementation can vary depending on the requirements of the system. The goal of the VANET is to provide the best possible security and routing for both passengers and drivers. In the clustering process, vehicles are considered as nodes, while other nodes are considered as cluster members.

The members of a cluster are known as normal nodes, while the special nodes known as CH are those who are responsible for transferring information between the clusters. When it comes to choosing the appropriate CH for a VANET[2], it is a challenging task. Having the right number of CH and increasing the lifetime of clusters can help improve the network's performance. There are many methods that can be used to create a cluster-forming algorithm for VANETs. One of the most important factors that can be considered when it comes to developing a successful clustering system is maintaining its stability. In order to provide a comprehensive overview of the various algorithms used in the process, this paper will discuss the parameters that are used in the selection procedure.

RELATED WORK

Marzak et al.[3] expressed that regardless of the environment, VANET should be capable of communicating with one another. The clustering algorithm can be used in this network to improve its scalability and robustness. However, due to its high mobility, it is difficult to establish stable clusters. Due to the increasing number of dropped packets, the overhead caused by failure notifications and route repairs significantly increases, which leads to poor delivery ratios and delays in transmission. In this paper, we present a model that takes into account the stable nodes in a cluster and calculates their value using YATES algorithm.

Md. Aseem Salem et al.[4] proposed spectrum sensing system to evaluate the trust values of a particular user group. It uses a deep learning network known as LSTM to train its system for detecting different types of signals and noise conditions. Its ability to reduce the false rate has greatly improved. The proposed framework is tested in China's Sichuan province's Chengdu, which has various vehicular mobilities. Through a comparative study, it has been shown that the clustering algorithm can improve the cluster head stability and performance. In addition, it can increase the network's energy efficiency and packet delay ratio.

Xialou chang et al.[5] proposed framework is designed to help self-organized VANETs establish stable clusters and reduce the vehicle status change frequency on highways. It also introduces a new clustering algorithm called the CH selection method. Through a simulation, we can confirm that the proposed mechanism can improve the security of VANETs.

Bevish Jinila et al.[6] proposed framework uses a rough set of fuzzy clustering techniques to establish clusters in a VANET. For instance, a vehicle in a cluster with more than one transmission range is assigned a boundary vehicle. The proposed framework takes into account the membership value of the vehicles and establishes a cluster with appropriate members. According to the theoretical analysis, the rough set based fuzzy scheme can provide a 10 to 20 percent increase in average lifetime of the cluster and a 20 to 25 percent increase in head lifetime compared to the existing approaches.

M.S kakkasageri et al.[7] evaluate the performance and effectiveness of the proposed clustering scheme were compared with that of an existing framework. It was found that the proposed scheme performed better in terms of its cluster formation time, member selection time, and head selection time.

A.H Abbas et al.[8] aimed to investigate the handover problem that occurs after the cluster formation and the cluster-head election in a given area. As the cluster moves from one base station to another, it encounters interference between the two signals. This causes the cluster information to get lost in the overlapping area. The goal of this study was to develop an innovative method called Intelligent Cluster-Head, which is a controller that can be used to solve the handover problem between two clusters. The proposed method was evaluated using the VMaSC-1hop method. The results of the study revealed that the proposed method can achieve a total packet loss of 0.8% and a 99% network efficiency.

Anita Bavalatti et al.[9] proposed method to composed of mobile and static agents that are designed to establish communication between the vehicles and the RSU. The RSU agent is responsible for choosing the appropriate cluster head based on the connectivity with the neighboring nodes and the vehicle speed. The proposed method takes into account the various factors that affect the cluster life cycle, such as the vehicle speed and the node density. It then distributes the maintenance of the cluster to the cluster head agent. The performance parameters of the proposed method are simulated in the NS2 framework. Besides the vehicle speed, other factors such as the selection time and the communication range are also taken into account to improve the overall efficiency of the system.

A. malathi et al.[10] develop a new clustering technique that is suitable for the VANET environment. This method takes into account the velocity and distance as parameters to create a stable cluster structure. In addition, we have also developed a method that allows super cluster-head selections.

Md asim salem et al. [11]expressed that secondary user can utilize the free spectrums of primary users without any correlation. In this study, we also took into account the various parameters such as the vehicle's average velocity, distance, lane weight, and network connectivity level. The proposed method provides a stable and secure cluster structure compared to the state-of-the-art techniques. In order to evaluate its effectiveness, extensive experiments were conducted. The results of the simulations confirmed the advantages of the proposed method.

Meysam Azizian, Soumaya Cherkaoui et al.[12] proposed the DCEV distributed clustering algorithm that allows vehicles to be placed into non-overlapping clusters depending on their relative mobility. The formation of the cluster is carried out through a D-hop clustering scheme, which allows each node to select its cluster head at a specific distance. The DCEV method uses a new metric to determine the optimal route for a vehicle to its cluster head within a D-hop neighborhood. Each node in the cluster calculates the relative mobility value of the route. The most stable route is then computed by the nodes. The results of the experiments validated the performance of the DCEV clustering algorithm. The simulations show that the proposed method can efficiently build stable clusters.

Hsueh-Wen Tseng et al.[13] studied to develop a new clustering technique that is suitable for the VANET environment. The method takes into account the various parameters such as the vehicle's average velocity, distance, lane weight, and network connectivity level. To ensure that the optimal cluster head is selected, we have developed a simulation model and an analytic model. The results of the studies revealed that the proposed method significantly improves the cluster stability.

ROUTING PROTOCOLS IN VANET

There are various routing protocols as shown in fig.1 that are designed to improve the performance of VANET. The goal of these protocols is to reduce the packet loss and delay in the communication process. They also enhance the throughput of the communication. The chart shows the different types of routing protocols that were used in the VANET network[2], [14], [15]. The cluster-based, geocast, position-based, and broadcast-based protocols are classified as Topology-based.

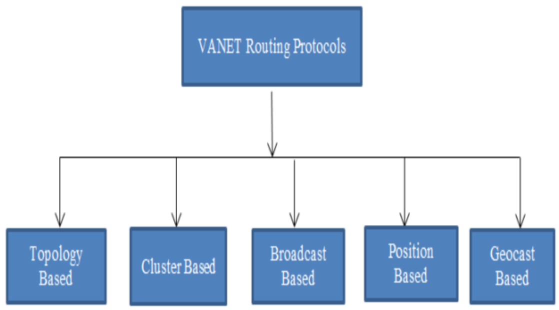

Fig. 1: Various routing protocols in VANET

i. **Topology Based -** The two main categories of routing protocols that are used in the topology-based world are reactive and proactive.

Proactive Routing protocols : The table-driven approach is considered to be a proactive routing technique. The various algorithms that are related to this category have the smallest routes. The table-driven approach ensures that the data collected by the connected nodes is stored and maintained in a consistent manner. It also updates the routing table when the network topology changes. The advantages of this type of routing protocol are low density and high bandwidth. However, it is not ideal for VANET due to its overhead and high traffic density. There are only a few examples of proactive routing techniques that are commonly used in today's network environment. These include the Dynamic Destination Route Vector (DSDV), Fisheye State Router, and Optimized Link State Router.

Reactive Routing: On-demand action routing techniques are commonly referred to as reactive routing protocols. They maintain the routing table periodically. The main function of reactive routing techniques is to create and maintain routes that are appropriate for the various communications that are required in a network. One of the main advantages of this type of routing protocol is its ability to adapt to the changes in the network topology. Unfortunately, reactive routing techniques are not ideal for VANET due to their lack of security features. Some of the reactive protocols that are commonly used in this type of environment include the Ad-Hoc on-Demand Distance Vector, PROAODV, and the Dynamic MANET on Demand.

Hybrid Routing: The features of the reactive and proactive routing protocols are known as hybrid routing. This type of routing provides the scalability required by the VANET. It also benefits from the link-state and distance vector-based routing techniques. Due to its advantages, the overhead cost of this type of routing is rising.

ii. **Cluster Based Routing protocols** : The nodes are placed in a cluster, which is a group of similar characteristics, in a cluster-based routing protocol. The transmission of messages is carried out between the cluster member (CM) and other CHs. Similar to how nodes are placed in a group, the characteristics of the cluster are also similar. There are three types of nodes in the cluster: gateways, cluster CM, and nodes. Most of the cluster-based routing protocols that are commonly used in today's network are mobility adaptive clustering, DMAC, RMAC, and HCA. O-LEACH is a high-speed network that can be used in a monitored area. Orphan nodes are nodes that are not connected to the CH but reside in an uncovered area..

iii. **Broadcast based routing protocols**: A broadcast-based routing protocol is used in VANET to share data between multiple nodes. It can perform various tasks such as announcing the road condition and performing other tasks. One significant limitation of this protocol is that it only works in a limited number of nodes. A typical example of a broadcast routing protocol is the UMB, which is an urban multi-hop protocol. It can be used for various applications such as broadcasting in static to a mobile device, and position-aware reliable broadcast routing.

iv. **Position based routing protocols**: A position-based routing protocol uses a GPS device to determine the geographical position of the vehicle nodes. It does not require a link between the destination and source nodes. The protocol can be used in VANET using either the non-DTN or delay-tolerant networks. Non-DTN protocols such as LAR, MORA, and TOSS are examples of DTN protocol. Some examples of VADD include MaxProp, FFRDV, and GeoSpray.

v. **Geocast based routing protocols**: This type of routing protocol only sends information to vehicles within a certain geographical region, which is called Zone of Relevance. The messages received from outside the zone are ignored by the vehicles in that region. There are various geocast routing protocols available in the area.

CLUSTERING IN VANET

The clustering process of the VANET network is carried out according to the behavior of the nodes. The cluster is composed of the various groups of nodes. The cluster's members are known as Cluster Head (CH) and Cluster Member (CM)[2], [14]–[16]. The node with the most attractive communication with the other nodes in the cluster is identified as the CH. The main task of the CH is to allow CM to communicate with the other members of the cluster. The cluster algorithms are divided into two categories.

The goal of the cluster maintenance process is to predict the link failure among the nodes. This process helps improve the cluster's stability. Fig.2 shows the arrangement of the network based on the cluster's members. The node with the most attractive communication with the other nodes in the cluster is identified as the CH. The cluster's internal communication is carried out through two routes: intra- and internal- cluster communication. The latter allows the cluster to reduce the amount of load that the other nodes in the network are exposed to. The cluster also plays a vital role in the transmission of radio transmissions by identifying and communicating with the appropriate channels.

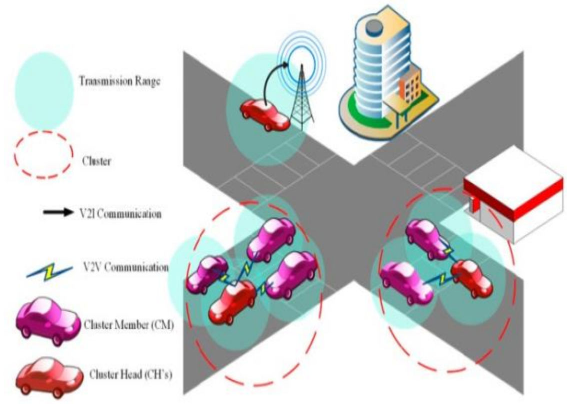

Fig. 2 Cluster head selection archi

TECHNIQUES USED FOR CLUSTERING

In this section, we will talk about some of the clustering techniques that have been used to solve various problems related to the MAC routing protocol. An enhanced distribution channel access (EDCA) was also designed to improve the efficiency of the routing system. The dual challenges of sending and receiving safety messages are the variable and fixed control channel interval (CCI) for safety. The optimal routing parameter for the MACA is achieved through the implementation of the emergency message priority system. The variable channel is also outer-performed compared to the fixed system.

A reliable and stable data dissemination scheme is proposed to solve the issue of network connectivity failure. The system takes into account the link stability and the vehicles that will forward the data. The goal of the scheme is to provide a secure and stable transmission of data. It is carried out through a combination of a mathematical expression and a greedy approach. The break links are recovered from the information connection using the edge weights. The driver prediction plays an important role in the clustering of the system. In order to improve the efficiency of the cluster, a machine learning framework called Nave Bayes Prediction is developed. This method analyzes the habits of a driver and predicts their overtaking and speed decisions.

The optimal driving pattern for the VANET is determined by the various factors that affect its performance, such as the relative speed of the vehicle, the number of lanes traveled, and the type of vehicle. The development of a probabilistic direction aware scheme for controlling the cooperative collision avoidance is also carried out to improve the cluster's stability. In the primary stage, a dynamic cluster is formed, and then inter-cluster, intera cluster CCA is performed. The formation of the clusters is carried out through a modified k-medoids algorithm. After the clustering process is completed, the estimated speed and distance of vehicles are computed.

The clustering algorithm takes into account the various factors that affect the likelihood of a collision and the speed of the vehicles. The optimal safe speed for the vehicles is determined by taking into account the benign factor, which can provide a warning against the collision. The security issue is a critical component of the VANET due to its effect on the network's performance. This issue is solved by implementing a fuzzy-based management system for detecting a trustworthy vehicle. A comparison of the two models FCMS1 and FCMS2 is conducted to analyze the clustering process in the network.

The three input parameters of the FCMS1 model are vehicle relative speed, vehicle security, and vehicle degree of centrality. In the case of FCMS 2, the fourth input parameter, vehicle trustworthiness, is added to the model. This increases the performance of the model in achieving cluster stability. The performance of the VANET is affected by the various factors that affect its security and traffic information. This issue is solved by implementing efficient routing protocols. These allow the computation of complex scalar multiplications to be performed faster. The use of a paralleling technique allows the different nodes in the network to perform independent tasks at the same time.

CLUSTER FORMATION

The formation of a cluster is one of the most critical phases of the VANET's communication process. It is divided into two phases: the initial generation and the maintenance. Although the literature on this subject is relatively small, many researchers have talked about it. The survey results indicate that the security and stability of the cluster are some of the most common issues that the network encounters. The design of a cluster can enhance its security and stability. This is done through the use of an enhanced weight-based clustering method known as the EWCA. This method can help minimize the formation of unstable clusters and improve their performance in emergency message transmission situations.

The results of the simulation revealed that the distributed system-based approach to improve cluster stability and reduce the overhead delay significantly outperforms the traditional methods. The main objective of the passive-based approach is to provide a stable cluster that can overcome the communication overhead in the VANET. The use of a passive cluster formation method ensures that the message is transmitted efficiently. The enhanced Quality of Service (QoS) and safety of data communication through the use of deep reinforcement learning are also improved by implementing this approach. The updated Q-learning tables can help improve the performance of the link failure prediction.

The proposed framework provides a suitable data transmission method among the vehicles. It also minimizes packet loss. The clustering protocol, which is known as AWCP, is designed to take into account the various factors that affect the stability of the cluster, such as the highway ID, speed, and direction. The highway identification information used in the development of a cluster is also taken into account to improve its structure stability. The results of the simulation revealed that the method significantly lowers the communication overhead while maintaining or improving the packet delivery performance.

CLUSTER HEAD SELECTION

The selection of a cluster host (CH) is dependent on the behavior of its neighbors and other CHs. This determines the efficiency of the cluster and the reliability of the network. A reliable vehicle node is very important to ensure that the network is stable and that the relaying and routing functions are performed properly.

RESULTS

Fig. 3, fig.4 and fig.5 show the energy consumption of proposed method which shows the better outcome as compared to others. Fig. 6, fig.7 and fig.8 shows the energy and time comparison of sending various amount of data in VANET.

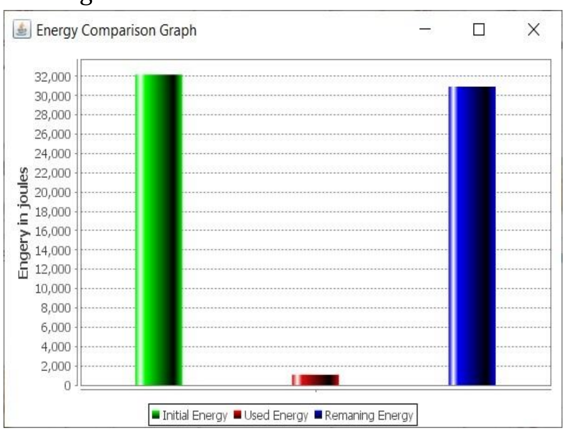

Fig. 3 Random Cluster Head Selection (Energy Utilisation Graph for 40 Nodes)

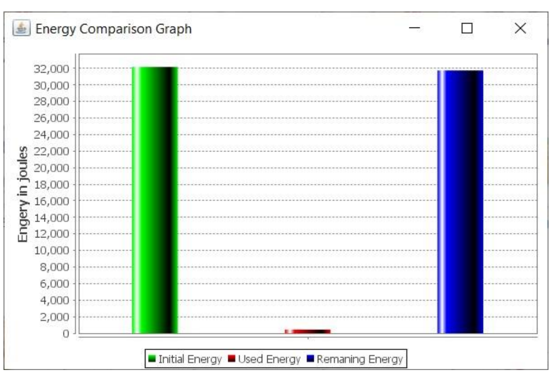

Fig. 4 Stable Cluster Head Selection with respect to Energy and Distance (Energy Utilisation Graph for 40 Nodes)

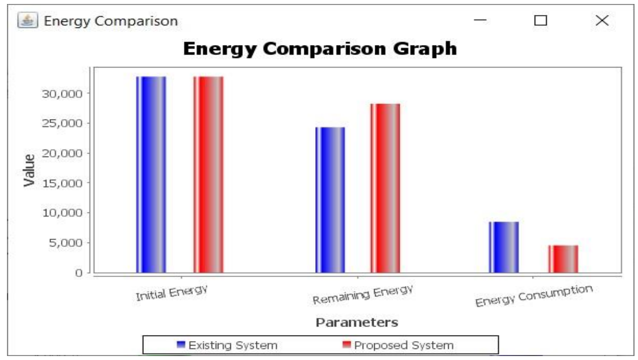

Fig. 5 Energy Comparison Graph of Existing System and Proposed System (40 Nodes)

Table 1 shows the energy consumption of nodes while creating cluster head.

Table 1 Comparison of existing and proposed system

	Inatial Energy of Nodes	**Remaining Energy of Nodes**	**Energy Consumption of Nodes**
Existing System	32802	29762	3040
Proposed System	32802	31133	1669

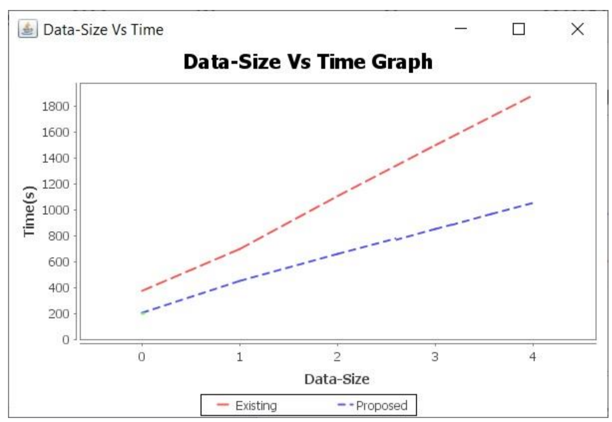

Fig. 6 Data Size VS Time Comparison Graph for Data transmission between nodes

Table 2 Comparison of existing and proposed system

Sr. No.	**Data Size (KB)**	**Existing System (in Sec)**	**Proposed System (in Sec)**
1	**8**	377	197
2	**16**	701	375

3	**32**	1105	572
4	**64**	1502	840
5	**128**	1886	1061

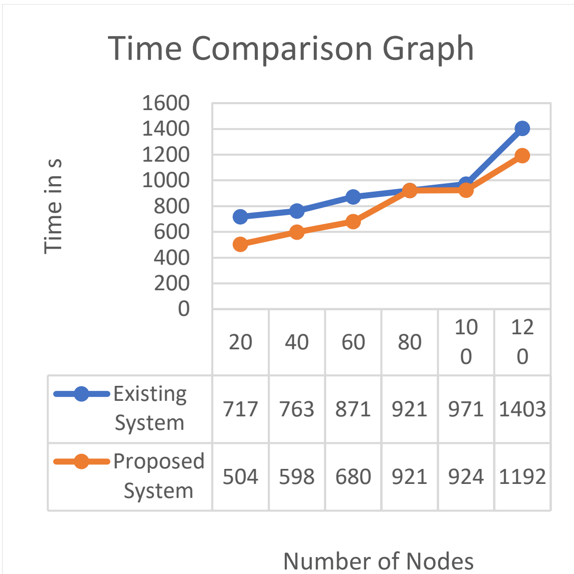

Fig. 7 Required time to transfer data with respect to increase in number of nodes graph

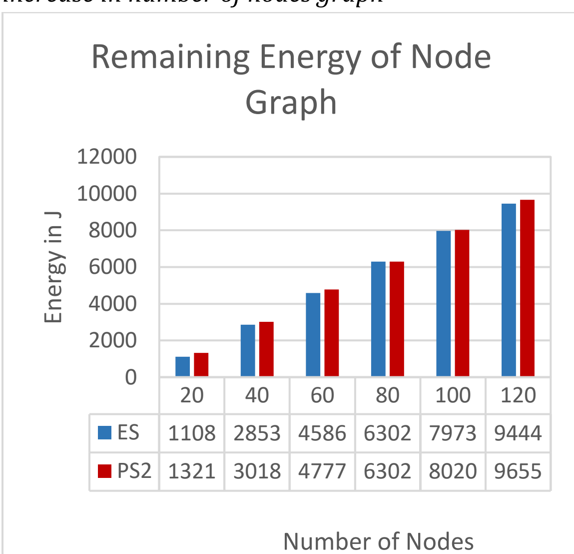

Fig. 8 : Remaining energy of nodes after data transfer with respect to increase in number of nodes graph

Conclusion

A clustering routing protocol is ideal for VANET. It can be used in a wireless environment, and it can be deployed without a fixed infrastructure. The clustering algorithm takes into account the various aspects of data transmission and stability. This study aims to provide a framework for the development of a routing system. A novel cluster selection algorithm for VANET is proposed. The heads of the clusters are elected and reelected according to their relative distance and speed from their members. The proposed system's high stability is attributed to its ability to adapt to the behavior of the drivers on the road and its learning procedure, which predicts the future position. In this paper, we present a clustering algorithm that takes into account the various factors that affect the stability of a node, such as its distance, speed, and probability parameters. It reduced the energy and time consumption to achieve the faster communication between vehicles and RSUs.

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