Improving Mobility-aware Routing in Vehicular Ad hoc Networks Considering Two Level Architecture

Omid Abedi and Soltan Mohammad Soltani
Department of Computer Engineering, Shahid Bahonar University of Kerman, Kerman, Iran
Email: oabedi@uk.ac.ir; Mohdsoltani@yahoo.com

Abstract**—**In VANET, moving vehicles each act as one moving node. Because of the large mobility of vehicles, the topology of the network is unstable. This instability of the network and its rapid changes have created a major challenge with regard to mobility management. Optimizing routing across automotive networks improves network node mobility management and minimizes clustering changes. As a result, in this study, the node clustering method was used for greater stability in node mobility. This study aims to significantly reduce changes in network topology, which means a decrease in clusters, as well as a significant increase in cluster survival. A random mobility model was considered in NS-3 and the speed of the nodes was randomized between 0 and 30 m/s. The simulation results showed that the proposed protocol has a high rate of accepted packages and the average survival of nodes and at the same time low cluster changes, which has a significant effect on improving mobility.

Index Terms**—**Mobility management, VANET, protocol, clustering, routing

I. Introduction

Every year, a very large amount of countries' capital is spent on compensation for human and financial losses due to traffic accidents and problems caused by urban and interurban traffic situations [1]. For this reason, the need for a computer infrastructure system to receive and analyze vehicle information [2] and to send them relevant and practical information is felt more than ever [3]. The use of an intelligent transportation system is a suitable plan that has been proposed to solve existing traffic problems. Intelligent transport systems consist of different parts [4] and different areas of work [5] that we deal with one of the most important parts of that system, is the networks of cars [6]. Extensive efforts are being performed globally by governments [7], industries and academic institutions for the Reduction of high-speed road traffic accidents [8]. Alert messages dissemination protocols based on vehicular ad hoc networks (VANETs) have strong potential in the reduction of high-speed road traffic accidents [6]. Alert messages can convey early warning messages to the vehicles about an emergency situation ahead [9].

VANET is a new technology in the ad hoc network that communicates between vehicles moving on the road or wherever we need their information [5]. VANET Intercar Nets are a special type of MANET that is designed to provide safety between vehicles and amenities for passengers and drivers [8]. The unique features of VANET networks are high speed and frequent topology change, which distinguishes this network. Due to the increasing number of vehicles on roads and urban environments, the use of VANET networks has been very important in recent years. This type of network does not have a special structure in which nodes are the same vehicles that are moving. The driver's decision, high speed, and continuous movement of vehicles have created unique features in this network, so routing for data transmission in this network is a key issue. The density of vehicles on the roads is increasing day by day, providing facilities to passengers such as emergencies, safety alerts, assistance to drivers, etc. is a new technology [7].

Every year, a very large amount of countries' capital is spent on compensation for human and financial losses due to traffic accidents and problems caused by urban and interurban traffic situations [8]. For this reason, the need for an IT infrastructure system to receive and analyze information from vehicles and send appropriate and practical information to them is felt more than ever. The use of an intelligent transportation system is a suitable plan that has been proposed to solve the existing problems in traffic. Intelligent transportation systems include different parts and areas of work that we deal with one of the most important parts of this system, namely car networks [10].

The major drawback of the VANET network is mobility management. To improve the performance and scalability of vehicles, the multi-cluster is concentrated in the VANET network [9]. To develop efficient and scalable communications in the VANET network as well as to improve mobility clustering based on predicting the life of the research network [9]-[11].

Frequent data deliveries are common in VANET due to the wide mobility of vehicles. These received services reduce manipulation delays and packet losses, which reduces the services provided by VANET.

In addition, high mobility can lead to frequent network fragmentation. This partitioning predisposes the route to become invalid and they must be rediscovered for service delivery [8].

Layer mobility management solutions such as SIP session implementation protocol [6] require an external

Manuscript received April 23, 2022; revised September 19, 2022.
doi:10.12720/jcm.17.10.820-829

location management server to find the MN location when handling. Application layer solutions are delayed due to the message and response nature of these protocols. An MN may suffer from communication interruptions during transmission. A re-message inviting an MN must be sent to the Corresponding Node (CN). MN must wait for the CN response before it can resume communication [5]. Transport layer solutions such as mobile protocol transfer protocol MSTCP and TCP [7] are not suitable. In scenarios where both nodes are mobile unless support for other layers is provided [7].

As with application layer solutions, transportation layer solutions also require an external localization management server. Furthermore, the carrier layer solution does not support interface boxes. A simple way to integrate geographical constraints into motion modelling is to limit the movement of nodes along the road on the map. A map is a pre-defined map in a simulated environment [6]. A way to use a random graph is to model a map of the town. This chart can be created randomly or preset or a map of an actual town. The main graphics of the custom buildings are the city and the model edges of streets and motorways between buildings [8].

Clustering is the process of grouping nodes (mobile devices, sensors, vehicles, etc.) that are geographically adjacent according to some laws [7]. These rules vary from algorithm to algorithm and are key factors in building stable clusters. Due to the rules of radio signal propagation, more natural and ideal clusters are displayed as a circle with the head in the center and the nodes are placed around the head [8]. Each cluster can communicate directly with the members of its cluster, and the different members of the cluster can also communicate directly with each other, or in the worst case, communicate with each other through the cluster. Some clusters are called single-step clusters, so that both nodes can communicate with each other in one step or less. But very few single-step clusters are selected simply because of the simplicity of the solution. The available samples used are more than one step and are called multi-step clusters.

Clustering in vehicle networks is a method that can be used as a difficult solution to propagate the message optimally, reduce overhead costs and also reduce the delivery time of the messages. Dynamically segmenting eliminates the notion of a fixed base [2]. Dynamic clustering is a technique for forming a group of moving vehicles that do not have a physical connection. A dynamic grouping physically moves along the road and vehicles leave the grouping in accordance with their speed and proximity to the grouping. It is important to note that vehicle-to-vehicle communications have several advantages that negate the concept of road infrastructure. As more flexibility, independence from road conditions, and also for developing countries and lack of infrastructure are very useful [4].

Each cluster contains at least one cluster that is selected by other cluster members [24]. After clustering, nodes in the cluster may communicate directly with each other. On the other hand, inter-cluster communication is done through headers, and all messages transmitted, are prevented from being sent and messages are sent hierarchically through headers. Thus, the use of limited communication resources such as bandwidth is improved and packet routing is facilitated, which reduces the delay of sending messages and reduces interference in sending messages [25].

Cluster stability is an important concept that is clustering algorithms attempt to achieve and has been proposed as a performance measure for evaluating clustering algorithms. The parameters used for evaluating the stability of clustering algorithms are cluster durability and the number of the cluster changes [26].

Intelligent clustering algorithms can play a significant role in VANET by increasing network load management, scalability, optimization and balancing. Clustering is the aggregation or gathering of nodes and one of the nodes is called a CH or cluster node [9]. Network clustering is the aggregation of nodes according to their similarities [10]. The similarity between nodes can be measured by the distance between nodes and the availability of bandwidth, speed and direction of vehicle modes. Various clustering algorithms differ according to certain clustering rules [11]. The size of the cluster in VANET is based on the transmission range of the vehicle mode. A cluster of vehicles is directly related to the communication constraints on these nodes. When creating these clusters, due to other important parameters such as transmission range, network size, and the number of nodes, the speed, and direction of the nodes are also very important because the lifespan of these clusters is directly increased and the overall performance of the whole network can Be optimized indirectly [12]. In this scenario, an intelligent node clustering is required that provides the minimum number of clusters, CH, and longevity of the clusters. This reduces the cost of communication to the system by minimizing the total cluster to the optimum and increasing the cluster life. This reduces the resource requirements of VANET, which ultimately increases the network life. The more time we spend on the nodes of a cluster, the better the performance of the networks. Clustering of network nodes is a difficult NP problem and the selection of HCs plays an important role in this clustering process. The role of EC includes training and eliminating clusters, choosing topology to maintain and provide resources to cluster members [13].

Due to the high mobility in VANET, cluster stability is the main challenge when using clustering. The main contribution of this paper is mobility aware clustering method which finds stables cluster. For cluster formation, speed and direction are considered and nodes in the same cluster have low difference in these metrics. Therefore, routes between cluster heads have more stability.

In the following sections of this article, related research, the proposed method of the article, evaluation of the findings of the proposed method in comparison with the conducted research, and conclusions will be discussed.

II. Related Research

VANET and help boost road safety. The number of wireless devices available to use in vehicles is increasing today. Some of these products include Global Positioning Systems, Laptops & Mobile Phones, Es. Communications in this type of network increase in the demand for vehicle-to-vehicle (V2V) and road-to-road (RVC) and infrastructure vehicle (V2I) communication. VANET can be considered a complete routing protocol because It has a series of different characteristics such as road pattern limit, dynamic topology, motion model, no limit on network size, no limit on source energy, etc. Environments lacking infrastructure structure and network dynamics with high dynamics lead to continued network segmentation [14]. VANET networks can be regarded as part of intelligent transport systems (ITS). Intelligent Transportation Systems are the main application of the VANET network, which includes a variety of applications such as traffic control, traffic monitoring, collision avoidance, and road data collection. Intelligent Transportation System (ITS), which represents a wide range of applications such as traffic analysis, traffic observation, global positioning system, traffic system management, and diversion in ways that support the traffic scenario. For example, existing roadside units (RSUs) monitors traffic congestion on the roads and send all traffic information to the traffic control center, which analyzes traffic flow control to prevent traffic congestion [15]. In the event of a road accident, nearby vehicles share this information with roadside units, which then send warning messages to move vehicles, or communicate with the emergency response unit. Another important application for VANET is the Internet connection to space nodes while on the move, so users can send email, download music or play games to the rear seat occupants [3], [5].

Researchers have focused on improving VANET networks through clustering as well as stability [13]-[20] However, the purpose of mobility management has been evaluated only in the field of energy management of network nodes and not much attention has been paid to the discussion of network stability, which in this research has tried to improve mobility management by considering network stability. In the studies, each cluster includes at least one cluster selected by the other members of the cluster. After clustering, Researchers have focused on improving VANET networks through clustering as well as stability [13]-[20] However, the purpose of mobility management has been evaluated only in the field of energy management of network nodes and not much attention has been paid to the discussion of network stability, which in this research has tried to improve mobility management by considering network stability.

In the studies, each cluster includes at least one cluster selected by the other members of the cluster. After clustering, the nodes within the cluster can communicate directly with one another. On the other hand, inter-cluster communication is via headers and all broadcast messages are prevented from being sent and messages are hierarchically routed via headers. In this research, a method that can enhance the use of limited communication resources such as bandwidth and facilitate packet routing has not been studied. In this search, the proposed method reduces the time to send messages and reduces interference in sending messages.

The presented clustering algorithm in [9] is designed for mobile networks and works in automotive networks. This algorithm is based on the smallest identifier algorithm but uses the signal strength level mobility parameter which is obtained from consecutive receptions. Its efficiency is moderate because it is not designed and optimized for automotive networks, but is frequently used for comparison with other clustering solutions in automotive networks.

The algorithm presented in [10] is suitable for urban areas. Clusters form before intersections and are predicted based on the direction of travel. Cars that have the same turnover at the intersection are in a cluster with each other. The location of the vehicle, destination and route must be known to help the algorithm work, so proper digital maps and accurate location information are required. Knowing the destination can be a problem because users usually do not use route guidance systems for known routes.

The algorithm [11] tries to follow exactly the pattern of network mobility and prolong the survival time of the cluster. As the destination of the car is a key factor in the algorithm, clustering based on the current location criteria, speed, and temporary and final destination also occurs, and knowing its final destination can be a problem because drivers usually do not use guidance systems for known routes. Cluster size varies depending on congestion, speed and minimum bandwidth required by service quality, these parameters can be predetermined.

The paper [12] presents a multi-step clustering solution that uses the relative mobility between vehicles with a distance of several steps as a parameter that is calculated using the message delay per node, their sum is calculated for each node and for the other nodes. Nodes are released. The thread is the node that has the least amount of total mobility, and also the stability of the cluster is increased by delaying the re-clustering process when the two threads are within each other for a few moments. This avoids re-clustering when, for example, two branches with different directions come together for a few seconds. Simulations for the Manhattan Highway and Model have shown that multi-step clustering increases cluster life and cluster members and reduces the number of cluster changes.

The chief goal proposed in [13] is to form stable clusters with long service life for reliable communication. Clustering is done with a complex parameter based on the high density of communication, traffic situation and connection quality, which can later be achieved by predicting the motion of the node, which can be achieved through GPRS or other similar systems, as well as the signal-to-noise ratio. The link is obtained.

The goal [14] is to increase cluster stability by avoiding clustering when a group of vehicles is moving in different directions. To do this, each node needs to know its current position, speed and direction of movement, which is received via GPS or similar services.

This algorithm uses delivery time that nodes can communicate and avoids clustering in cases where the directions are the same but the communication time is short, for example overtaking time. The life time parameter in messages allows multi-step clusters to be created.

Shared clusters are one of the rare features in clustering presented in [15]. This property is caused by multi-state nodes that are the head of one cluster, the normal member of one or more other clusters. Using this feature, communications between clusters are routed only through the header. All nodes in a cluster are in the eclipse communication range, although not all nodes near a vertex of a cluster are necessarily members of that cluster. The algorithm uses speed, location and travel direction as clustering parameters and data is obtained through GPS or similar services.

The algorithm designed in [16] is based on the critical points of the local network in a distributed method. Its ultimate goal is to form large clusters and provide a high degree of connection. This algorithm does not tend to have long cluster head survival times or low cluster head changes. This means that it is good if it changes the connections better.

Another clustering algorithm is presented in [17] which is a fast random clustering algorithm that follows a different idea. Instead of carefully selecting the top of the cluster and forming stable clusters, it tries to form clusters very quickly and the cluster is optimized during the maintenance phase.

The solution presented in [18] focuses on improving the MAC layer by vehicle clustering, and Sarkhosh allows coordination to access the shared environment. Its main purpose is to ensure the immediate delivery of safety messages and non-instantaneous communication from car to car effectively. This algorithm uses the direction of vehicle movement as a clustering parameter, so it depends on services such as GPS or similar systems.

In the resolution presented in [19] examines a passive clustering approach with three parameters. Vehicle density, channel quality and link tolerance. Vehicle density is calculated by counting the number of bacon messages received from neighboring vehicles. Link quality is defined as the quality of the two-way link transfer and the expiration time of the link as the tolerance of the link. In this algorithm, the first node that is introduced as a header dominates other nodes in its communication range. A cluster also needs at least two nodes of gateways to communicate between clusters.

[26] An Energy and Mobility Delivery Protocol (EM-ARP) has been proposed to improve information, entertainment services by reducing latency and energy consumption in VANET. The proposed method consisted of two algorithms using the transversal paradigm. In the first stage, the proposed EM-ARP dynamically selected vehicles (CRVs) based on battery power and mobility of nodes in the destination direction. For example, the new routing algorithm balances high mobility, direction, and energy inequality to improve the quality of information flow and distribution. Second, the best path between source and destination is estimated through the value of trust along the path, and the number of jumps and congestion along the path is calculated by considering three important factors such as link expiration time (LET). The path with the highest confidence value is selected for the multimedia data network and security information. After extensive simulation using the network simulator (NS-2.34), the proposed EM-ARP performance for energy consumption, reliability, packet delivery ratio, and end-to-end latency criteria are examined by changing the network size, vehicle speed, and packet size. The simulation results showed that the proposed EM-ARP system worked better than existing temporary routing methods based on different performance criteria.

In [25] routing protocols for VANET (AODV, DSDV, DSR, and OLSR) were applied in real-world mobility tracking and their performance was analyzed on packet reception, packet reception rate, packet loss ratio, and packet delivery ratio. Simulations have been carried out by SUMO and NS3 simulators. The results showed that of these routing protocols, AODV had the best efficiency and reached the highest level of PDR. On the other hand, in the two-beam emission loss model, almost all routing protocols have very low closed loss ratios except AODV.

The solution presented in [24] Analysis of the effect of real mobility tracking on position-based routing protocols was carried out simulations. Traces for Cross Routing (IBR), Greedy Environment Less Routing (GPSR), and Intersection-Based Routing of Ant Colony Optimization (ACO-IBR) were applied. The effect of mobility tracking was evaluated using parameters such as latency, throughput, and success rate (SDR). The results showed that the choice of the correct movement model is the key to achieving the actual performance of the simulation. ACO-IBR minimizes latency and offers a higher delivery and throughput ratio for all real mobility models.

III. Proposed Method (Clustering to Improve Mobility Management Based on Optimising Routing)

In the VANET cluster, the cluster head (CH) plays a major role in the cluster formation process. A vehicle that is part of a cluster is known as a cluster member (CM).

Apart from CH and CM, certain algorithms use two CMs to communicate with other clusters for CH, called cluster gates (CG). If specified as GC, all members of a cluster are referred to as CM. Won CH, zero/ one/ two CGs, and any number of CMs may be within a cluster. In VANET clustering, CH acts as a moving router and CM acts as a moving node. The role of the MC is located between the MC and the MC. The cluster is formed on the basis of criteria such as the average relative speed of the vehicle, acceleration, position, direction, degree of the vehicle, vehicle density, transmission range, etc. The CE is selected from the most stable of the participating vehicles [3]. The other vehicles join the cluster as CM. Therefore, CH selection is part of the cluster development process and separate MC selection criteria are not required. CH and CM maintain a routing table containing cluster CH and CM information for intra-cluster communication [14]. However, the CM does not maintain routing tables for other clusters, maintained by the CH, as required. A major network is thus considered to be a group of small networks or clusters [19].

The coverage of a cluster is limited by the CH transmit field (TR), as shown in Fig. 2. Since the distance covered by the CH is limited by its TR, the vehicle in the cluster may be associated with a disconnected CH [6]. The relative speed of the two vehicles may vary at any time as a function of the speed of the two vehicles [7]. When the position of a vehicle is at the edge of a cluster, the vehicle may enter and exit the (TR) CH continuously due to relative speed changes, and the vehicle will be frequently disconnected from the CH. Therefore, data loss will be very high when the vehicle stays at the edge of the cluster [11]. Therefore, certain algorithms geographically prefer the vehicle as CH for reliability.

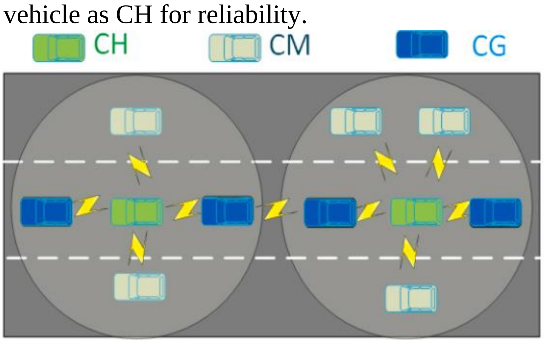

Fig. 1. Conception of basic clustering in VANET

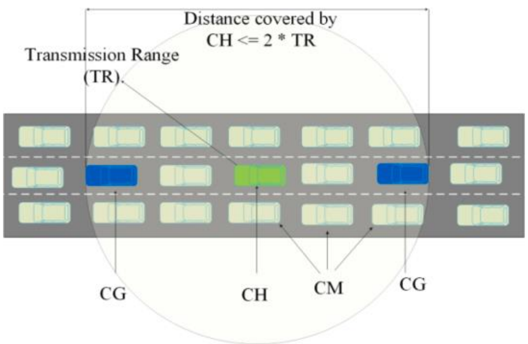

Fig. 2. Different element of clustering in VANET

In the VANET network, due to the movement of nodes and their displacement at any moment, a vehicle may enter or exit that has displacement in the cluster because of the position of the vehicle in the cluster changes. With such changes, some nodes can be in the position of the barrier [20]. Now, the state of such a node should be determined because if the door node is not considered, it is unclear to which cluster such a node belongs. In this paper, by considering the position of the gateway node in the cluster, it improves the condition of the clusters and reduces the chances of the clusters, and as a result, shows the average of the cluster changes less than the previous algorithms [21].

To improve mobility management in the previous algorithms, the following methods are used:

- The closest place to the average: A car is selected as the headboard where the absolute difference of the candidate location is closer to the origin than the average location of all cars.
- Closest to average speed: A car is selected as the header if the absolute difference between the candidate speed and the average speed of all cars is closer to the origin.

First, a barrier node selection subprocess for the proposed algorithm model is considered, which determines the state of the barrier node. If a node is within the range of two clusters, this node is the bridge. Calculate the distance of this node from both headers and place it on each header that is closer to that cluster. So, first, the algorithm, after executing the process of determining the head of this process, the gate node must also be executed to determine the position of the node in the cluster. Adding a protocol node selection subprocess to the algorithm improves the performance of the cluster [22]. When a car travels on the path of a vehicle, it is given two closed clusters. This node should be defined to which cluster it belongs. By calculating the distance of this node from each cluster, the shortest distance can be determined, such that the node is allocated to a cluster with a shorter distance. Has it. This eliminates the need for the gateway node to program for incoming messages, because in this algorithm, because the nodes are interconnected, the node is positioned and reduces overhead, and there is no need to re-cluster the network, and the average lifespan of the cluster head Also increases.

Cluster stability is an important concept that is clustering algorithms attempt to reach and has been proposed as a performance measure to assess clustering algorithms. The parameters used to evaluate the stability of clustering algorithms are cluster sustainability and the number of cluster changes. the proposed algorithm lead to better routing, increase efficiency and increase Speed is provided to prevent congestion of data with uncertainty.

A. *Propose Clustering Method*

Clustering is considered to be one of the most efficient methods for routing in VANET. In VANET, nodes have considerable mobility, so using the cluster is inevitable and can result in better routing.

In this article, time is defined as time slots as a function of the level of network dynamics. The length of each slot is indicated by T. There is an inverse relationship between node mobility and a T-value. In other words, if the network has highly dynamic, the T-value is considered as low. The lower the mobility of the nodes, the greater the size of the position. This time slot is based on estimating machine speed and achieving the target for different network nodes. The speed and direction of the node in the TN time slot are calculated based on a combination of the last slot (TN-1) and the average of the previous slots (T0, T1, T2,…, TN-2) (formulas 1 and 2) in which the speed in the last slot Is equal to sin-1 and so is the mean of the previous velocities and α is the coefficient of mobility. The higher the mobility, the closer to 1, and the lower the mobility, the closer to 0.

$(0 \leq \alpha \leq 1)$

$$Sn = \alpha * Sn\text{-}1 + (1\text{-} \alpha) * \bar{s} \tag{1}$$

$$dn = \alpha * dn\text{-}1 + (1\text{-} \alpha) * \bar{d} \tag{2}$$

Estimated speeds and directions based on formulas (1) and (2) are used in the clustering to enhance routing. In routing, we must determine the threshold speed and threshold direction in the network, which are defined by the threshold speed with Sth and the threshold direction with dth. We must keep in mind that the vehicles are in a cluster due to the common transmission range, having a minimum difference in speed and direction different from the threshold limit. This means that the feeds that are in the range of transmission to each other and also the difference in speed and direction difference is less than the threshold are placed in a separate cluster. The speed difference between the two nodes is defined as opposite, in which Sn, I, and Sn, j is the speeds of nodes I and j in the slot Tn, respectively.

$$\Delta \mathbf{Sn} = |\, \mathbf{Sn}, \mathbf{i} - \mathbf{Sn}, \mathbf{j} \,| \tag{3}$$

In this regard, the difference in the direction of the two nodes is defined as opposite, in which dn, I, and dn, j are the directions of nodes i and j in the Tn slot, respective

$$\Delta \mathbf{dn} = |\, \mathbf{dn}, \mathbf{i} - \mathbf{dn}, \mathbf{j} \,| \tag{4}$$

Given that in each clustering, the speed and direction of the node play an important role, based on the above two formulas for clustering, the following equation is used in which N is the total number of nodes in the network. Those created considering the formula of various clusters and nodes are placed in each cluster that will naturally have the same mobility.

$$\begin{cases} \delta s_n < S_{th} \\ \delta d_n \leq d_{th} \end{cases} \forall i \in N \tag{5}$$

B. Routing in VANET

The routing protocol defines the path to send and receive packets between moving nodes, which plays an important role in VANET's performance. In VANET, routing protocols are divided into five categories: topological-based routing protocols, location-based routing protocols, cluster routing protocols, geocast routing protocols, and broadcast routing protocols. Topology-based routing protocols are based upon network topology. Most basic topological protocols attempt to use the least amount of computation time to send a packet over the network, balancing the possible paths. These routing protocols use communication row information and store this information in a table before sending data from the source node to the destination node.

Several routing protocols fall into this category, including AODV, PGB, DSR, TORA, and JARR. Hybrid Routing Protocols have been introduced to reduce the running costs of controlling Proactive Routing Protocols and reduce the initial path detection delay of Reactive Routing Protocols. Routing protocols that fall into this category include ZRP, [5] HARP. Numerous works of nature-inspired ad hoc networks, algorithms inspired by insects, birds, ant colony optimization (ACO) and neural network, artificial bee colony (ABC), can be said to have been successfully used to develop efficient routing algorithms. It shows. This algorithm has some advantages over other algorithms, for example, it reduces the routing overhead by sharing local information for future routing decisions, it also examines many ways to choose a route, and it chooses the most optimal route. The ABC algorithm is based on the intelligent behavior of bees in which each bee is a network node and acts according to the algorithm to find the optimal path [22].

Due to the limitations of the vehicle, a good protocol design method is to adopt a method in which the mobility support solution uses the available information as much as possible to avoid overload. In addition, providing a distributed solution means that there is no central element that has the information of the whole system and decides on the handoff process, and the important information is considered concisely and not as a centralized set. Therefore, all the required information is available locally on each node and no communication overhead is added.

Various methods are used to refresh the routing tables for each node. This algorithm is based on two theories of distance effect and update frequency so that two nodes with a large distance between them seem to move slower than each other, which means that the farther node seems to move slower. Nodes that move more slowly update unnecessary data than nodes that move faster.

This algorithm does not need to exchange large amounts of control information like the Proactive protocols, and unlike Reactive algorithms, because there is no path detection, there is no delay in routing to the network.

In this algorithm, the amount and speed of production of control messages are determined and optimized according to the amount and speed of movement of each node; The control messages will be allowed to move around the network before being rendered unusable, depending only on the relative (geographic) distance between the moving node and the updating routing tables. In this method, the number of copies in addition to the number of mutations of the control messages that will move are both optimized without losing quality. This means that the proposed algorithm uses more available bandwidth and energy per node to send data messages than existing protocols. This algorithm is permanently loop-free because data messages are propagated away from their source in a specific path. It is adaptable to movement because the frequency at which it propagates path information depends on the size and speed of the nodes.

Sending information in the proposed algorithm, all nodes tend to associate with other nodes in the network and fully cooperate in the network protocol. Any node that wants to share in the network wants to send packets to other nodes. Consider the minimum number of hops required to send a packet from each node at the edge of the network to another node in the opposite position as the network diameter and assume that the network diameter is small (approximately 5 to 10 hops).

Packets may be defective or lost along with networks, the receiving node of the defective packet can detect the error and discard it. All nodes in the network may be displaced without prior knowledge, and this displacement may be continuous, depending on the need in different scenarios, the speed of the nodes can be considered constant or variable.

When a source node S needs to send a m message to a destination node R, it refers to its routing table for routing information to node R. Based on this information, node S selects nodes in the path of node R from among its adjacent nodes and sends the message m to them. Each of these nodes does the same thing in turn. The message is sent to those nodes that can be accessed from S to R. Therefore, the neighbors of a certain node in a certain range choose their path. This is guaranteed; That node or can be found with a certain probability of p.

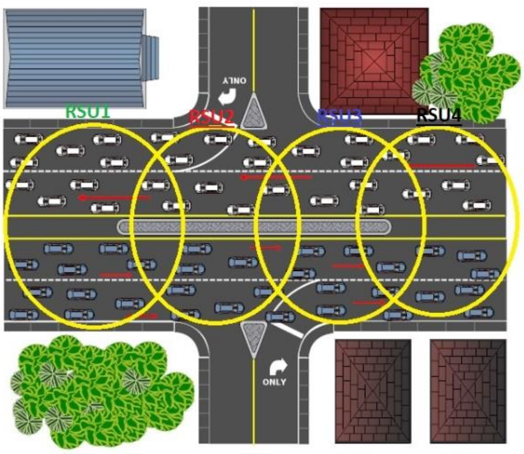

Fig. 3. VANET structure in Case study

The proposed algorithm uses the Flooding method to send packets in the angular range [v −α, v + α] as shown in Fig. 3, which consists of the source node to the destination node, through all neighboring nodes in the sending range.

We know that packets reach the destination with a probability of more than 80%, which, among all routing algorithms of this protocol has a good performance in terms of ensuring the probability of packets reaching the destination [8].

A resource-based responsive diagram where the path is calculated if needed. The path is the same as the digital maps expressed in the different paths, and that map is supposed to be already stored in the memory nodes. The source node defines a path to send, and during the route, the middle nodes help the destination node and erase the path for it. Each intermediate node creates the best position for the nodes using GPS and digital maps, representing, for example, the fastest route or the shortest route. Compared to sending packages based on location, fewer packages are used.

If there are no devices in that path, the information is passed to another path that performs better than GPRS because a relatively long diversion path can be created in the VANET network due to obstacles. Wherever the information reaches the node, the node itself decides whether to send this information or not. This decision is based on the node that sent that information.

The mode defines the source of the path and the middle nodes receive the necessary map and information. Each node of a timer takes into account the path and the latest information sent to it, the nodes closer to the path in the timer have a shorter number. Their information expires.

Intermediate nodes get all their information from digital maps and do not need their neighbor information.

We first consider the simple case in which the packet must be sent along the path flow that is specified as the regular steps of the straight sections. Here we set each node in a received packet according to this position relative to the route and the transmitter.

$$T_{out} = \alpha^{\frac{D_t}{D_l}} \qquad (6)$$

DT The distance between the node and the nearest path, DL The distance of the last node which sent the package. α is a constant which corresponds to the unity of time.

If one node is received, another receives a copy of the package before the expiry of the time. Then, the timer is stopped and the package is removed from the shipment queue. Another, on expiry of time, the packet is processed by the MAC layer for transmission. As a result, the packet is sent by the node with the least All. The node is in the best position farther from the last node and closer to the path.

The required information is carried by sifting and the information in the packet header, which includes: path, coordinates of the last node of the packet source ID met packet sequence number and number of hops. To avoid cycles, each node must maintain a list of recently received packages (source ID and sequence number).

Can run beyond any MAC, such as multiple access control schemes, but its performance depends on the MAC features used to it. Note that this transmission is resistant to transmission errors and collisions because its correct operation is sufficient for one of the neighboring nodes to receive this packet. In addition, in the unlucky case that no packet node successfully receives a packet node can detect the problem and then resend the packet, as in the original routing, the overhead depends on the number of sections to encode the path. Before sending a packet, the sender node changes the path information just by holding the segments [9].

In the first step, vehicles are grouped into two groups in each RSU area covered, as shown in Fig. (4). A group of cars moving to the right and a group of cars moving to the left. So here the direction of each car indicates which group each car belongs to.

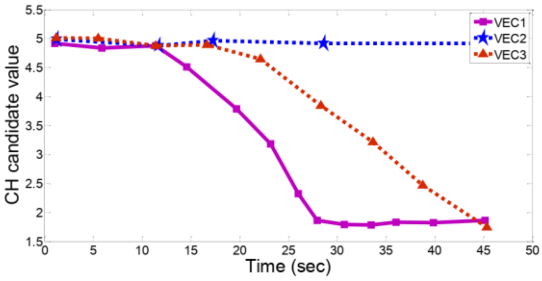

Fig. 4. The average survival rate of clusters

Sending and receiving information is done by vehicles and CH selection is done every second. The distance between the CH and the vehicles varies as well as the speed of the vehicles. During the simulation the CH candidates and vehicles are shown in Fig. 3. The simulation results are provided only for vehicles within the area covered by 1-RSU.

IV. Results and Discussion

A random mobility pattern is considered in NS-3, and the speed of the nodes varies randomly from 0 to 30 m/s. Performance analysis included delay settings, number of packets received to destination, number of packets not received, and network congestion. Results from the proposed methodology are compared with research by Aloshi *et al*. (2020) [19].

Vehicles can communicate amongst themselves using the MAC IEEE 802.11 layer. All results are achieved by the number of different nodes within the network. The parameters for the simulation parameters are detailed in the table below:

This Fig. 5 shows the potential vehicles for the head of the cluster, which is created using the algorithm we described. We can see that in the first 15 seconds with 1, vec3, vec4, and vec5 are our best candidates for the leading cluster. But after 15 seconds, vec5 distanced itself from the top candidates. Similarly, in 25 seconds, vec3 will be eliminated from the best candidates. Hence, one of vec1 and vec4 can be selected as cluster head in this simulation. Fig. 6 shows the average survival of the clusters in terms of number of nodes, the survival rate of the cluster is defined as a measurement of stability. The diagram indicates that the proposed method is less stable than the search [19] with an increase in the number of nodes.

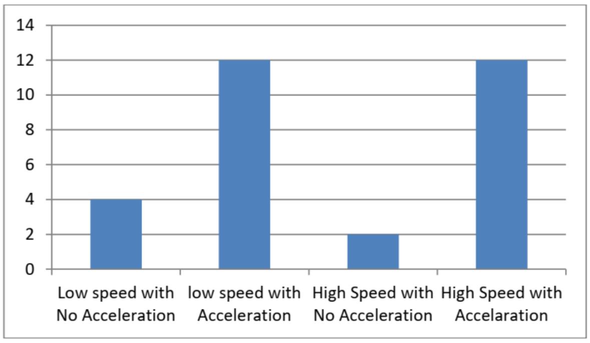

Fig. 5. The number of changes in the cluster

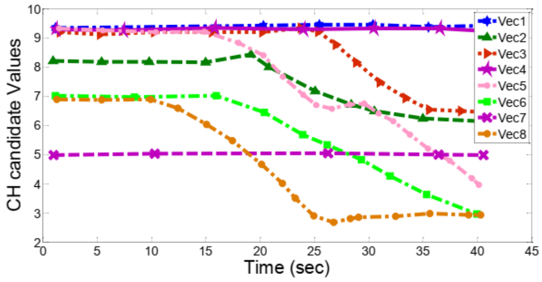

Fig. 6. CH Candidates and vehicles

Table I. Simulation Parameters

Parameter	Simulator	Area Space	Number of Nodes	Package Size	Package Interval
Measure	MATLAB	500m*500m	10-40	1000 bytes	Seconds 0.07

As shown in the Fig. 7, the number of packets accepted at the destination of the proposed method was better than the number of nodes compared to the search [19]. Lost packets are the amount of packets lost while transferring packets from the source node to the destination node.

V. Conclusion

In this research, a proposed method based on speed and direction threshold was used in order to make clustering efficient in vehicle network routing. As mentioned above, many traffic issues and accidents can be resolved by providing drivers and vehicles with the right information at the right time [25]. Vehicular networks may provide the necessary vehicle communications. Clustering can be used to maximize message propagation and reduce message delivery times. In this article, first, an overview of automotive networks was said and then the method of clustering in automotive networks and clustering methods in these networks were discussed and their advantages and disadvantages were stated. In each of the proposed designs, different dimensions of the issues and challenges related to clustering in the vehicle networks were taken into account. These problems include: resistance to disconnection, high mobility of vehicles, highly dynamic topology, control of communication overheads, and quality of service [26]

Our objective of this document is to provide a clustering algorithm to increase cluster sustainability and thus provide more stability for vehicle networks. Stable clustering methods reduce the re-clustering overhead. Furthermore, the use of clustering can result in more node coordination and less interference. While the cluster is formed, cluster members select a member as the cluster, the fewer cluster changes lead to greater cluster stability. To achieve this objective, cluster members must choose a member with the potential to remain a member for a longer time than other members. Our proposed method is to form a cluster based on the speed, direction, and density of traffic flow. Because each vehicle has a different speed, direction, and location, clustering algorithms must consider these parameters to group vehicles, because grouping vehicles with different speed and direction differences create clusters with survival time. Downhill [27]

In addition, according to the urban and highway environments in this type of network, the proposed algorithm should be able to cluster cars optimally and efficiently in both urban and highway environments. Because the density of cars in the urban environment is much higher than in the highway environment, it creates high-density clusters and thus increases the overhead in these environments, on the other hand, the low density of cars in the highway environment creates clusters with Large numbers and reduced efficiency are grouped [28]. Therefore, an algorithm should be presented both in dense urban environments and in the highway environment to increase network efficiency and reduce network disruption. To solve this problem, the density parameter is included in the clustering. And considering the simulations performed with different speeds and also the number of variable vehicles and comparing the proposed method with three other methods in similar conditions, it was shown that the proposed method forms more stable clusters, and the average survival time of the cluster in the proposed method has a significant improvement over other methods.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Omid Abedi and Soltn Mohammad Soltani conducted this research. VCE trained and analyzed the model with data and wrote the paper. The results was verified with the simulation model. All authors had approved the final version.

References

[1] D. T. Dao, C. M. Huang, M. S. Chiang, and V. T. Nguyen, “A load-considered handover control scheme for Distributed Mobility Management (DMM) using Software Defined Network (SDN) in the vehicular environment,” in *Proc. IEEE Eighth International Conference on Communications and Electronics (ICCE)*, 2021, pp. 70-74.

[2] P. Sankaranarayanan and R. Gayathri, “distributed mobility management scheme for all ip based next generation heterogeneous networks,” *Journal of Computational and Theoretical Nanoscience*, vol. 16, no. 4, pp. 1332-1334, 2019.

[3] J. W. Guck, A. Van Bemten, M. Reisslein, and W. Kellerer, “Unicast QoS routing algorithms for SDN: A comprehensive survey and performance evaluation,” *IEEE Communications Surveys & Tutorials*, vol. 20, no. 1, pp. 388-415, 2018.

[4] W. B. Jaballah, M. Conti, and C. Lal, “A survey on software-defined VANETs: Benefits challenges and future directions,” in *Proc. 25th International Conference. Automation Computing*, Apr. 2019, pp. 1-17.

[5] L. Nkenyereye, L. Nkenyereye, B. A. Tama, A. G. Reddy, and J. S. Song, “Software-Defined vehicular cloud networks: architecture applications and virtual machine migration,” *Sensors*, vol. 20, no. 4, pp. 1092-1105, 2020.

[6] A. Bradai, A. Benslimane, and K. D. Singh, “Dynamic anchor points selection for mobility management in software defined networks,” *Journal of Network and Computer Applications*, vol. 57, pp. 1-11, 2015.

[7] S. Singh and S. Agrawal, “VANET routing protocols: issues and challenges,” presented at the Proceedings of 2014 RAECS UIET Panjab University Chandigarh, 06 – 08 March, 2014.

[8] K. Kandali and H. Bennis, “A routing scheme using an adaptive K-Harmonic means clustering for VANETs,” in *Proc. International Conference on Intelligent Systems and Computer Vision*, Fez, Morocco, 2020, pp. 1–5.

[9] B. Hamid and E. E. Mokhtar, “Performance Analysis of the vehicular ad hoc networks (VANET) routing protocols AODV, DSDV and OLSR,” in *Proc. Information & Communication Technology and Accessibility (ICTA), 2015 5th International Conference on IEEE*, March 2016.

[10] M. Abdelfettah, *et al*., “A cooperative game based mechanism for autonomous organization and ubiquitous connectivity in VANETs,” *Simulation Modelling Practice and Theory*, 2021.

[11] S. Hosmani and B. Mathapati, “Efficient vehicular ad hoc network routing protocol using weighted clustering technique,” *Int. J. Inf. Tecnol.*, vol. 13, pp. 469–473, 2021.

[12] P. Sankaranarayanan and R. Gayathri, “Distributed mobility management scheme for all IP based next generation heterogeneous networks,” *Journal of Computational and Theoretical Nanoscience*, vol. 16, no. 4, pp. 1332-1334, 2019.

[13] W. B. Jaballah, M. Conti, and C. Lal, “A survey on software-defined VANETs: Benefits challenges and future directions,” in *Proc. 25th International Conference. Automation Computing*, Apr. 2019, pp. 1-17.

[14] G. Husnain and S. Anwar, "An intelligent cluster optimization algorithm based on whale optimization algorithm for VANETs (WOACNET)," *PLoS ONE*, vol. 16, no. 4, 2021.
[15] R. Ali, *et al*., "Adaptive k-means clustering for Flying Ad-hoc Networks," *KSII Transactions on Internet & Information Systems*, vol. 14, no. 6, 2020.
[16] P. Sankaranarayanan and R. Gayathri, "Distributed mobility management scheme for all IP based next generation heterogeneous networks," *Journal of Computational and Theoretical Nanoscience*, vol. 16, no. 4, pp. 1332-1334, 2019.
[17] H. Ghassan, S. Anwar, and F. Shahzad, "Performance evaluation of CLPSO and MOPSO routing algorithms for optimized clustering in vehicular ad hoc networks," in *Proc. 14th International Bhurban Conference on Applied Sciences and Technology*, 2017.
[18] H. A. Ghada, A. F. Yasmine, and K. Ahmed, "Bio-inspired metaheuristic framework for clustering optimisation in VANETs," *IET Intelligent Transport Systems*, vol. 14, no. 10, pp. 1190–1199, 2020.
[19] A. J. Kadhim and S. A. H. Seno, "Energy-efficient multicast routing protocol based on SDN and fog computing for vehicular networks," *Ad Hoc Networks*, vol. 84, pp. 68-81, 2019.
[20] A. J. Kadhim and S. A. H. Seno, "Maximizing the utilization of fog computing in internet of vehicle using SDN," *IEEE Communications Letters*, vol. 23, no. 1, pp. 140-143, Jan. 2019.
[21] N. Noorani and S. A. H. Seno, "SDN- and fog computing-based switchable routing using path stability estimation for vehicular ad hoc networks," *Peer-to-Peer Netw*., Appl. 13, 948–964, 2020.
[22] S. Malik and P. K. Sahu, "A comparative study on routing protocols for VANETs," *Heliyon*, vol. 5, no. 8, 2019.
[23] Thakur and R. Malekian, "Internet of vehicles communication technologies for traffic management and road safety applications," *Wireless Personal Communications*, 2019.
[24] B. Yelure and S. Sonavane, "Performance of routing protocols using mobility models in VANET," in Next Generation Information Processing System. Advances in Intelligent Systems and Computing, P. Deshpande, A. Abraham, B. Iyer, and K. Ma, Eds., vol. 1162. Springer, Singapore, 2021.
[25] R. R. Sarkar, A. Chakrabarty, and M. Z. Rahman, "VANET routing protocols in real-world mobility tracing," in *Proc. 13th International Conference on Computational Intelligence and Communication Networks*, 2021, pp. 96-101.
[26] S. Shafi and D. V. Ratnam, "A trust based energy and mobility aware routing protocol to improve infotainment services in VANETs," *Peer-to-Peer Netw*., Appl. 15, pp. 576–591, 2022.