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Efficient CH selection for Traffic Congestion Reduction and To Improve Network Connectivity in Vehicular Adhoc Networks

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Abstract

Vehicular ad hoc network (VANET) is an innovative technology that has attracted many researchers and the industrial sector. The increase in vehicle movement and the requirement for effective traffic management systems have resulted in the development of VANETs. The Super Cluster Head based Efficient Traffic Control (SCHETF) model aims to alleviate traffic congestion and decrease energy consumption in VANETs through a novel integration of Cluster Head (CH) election, cluster gateway formation, and effective data transmission. SCHETF utilizes a parameter-driven CH election process that considers factors such as network connectivity, distance, speed, and trust levels. This approach guarantees the most suitable CH selection, reducing energy expenditure while enhancing network efficiency. The model assesses network connectivity through indicators like traffic flow and lane weights, ensuring precise determination of link reliability. Metrics for distance and speed are normalized to evaluate the changing behavior of vehicles, while trust ratings are given based on historical and community information to improve reliability. The creation of cluster gateways reduces unnecessary cluster formations by implementing Cluster Gateway Creation (CGC) at strategic sites, lessening communication load, and boosting cluster stability. Efficient data transmission is accomplished by appointing several Cluster Gateway (CGW) within clusters. A backoff timer mechanism gives priority to the CGW that is farthest from the CH for message forwarding, avoiding unnecessary repetitions and guaranteeing effective message dispatch. The model is smart clustering and gateway strategies lessen signaling load during handovers and enhance resource management in dynamic vehicular settings. The SCHETF model offers a thorough framework for tackling the challenges faced by VANETs, providing scalable and energy-efficient communication options. This improves data distribution, assures dependable connectivity, and plays a crucial role in the progress of intelligent transportation systems. The model has been put into practice through experimentation in Network Simulator 2 (NS2). The parameters considered in this study encompass energy efficiency, throughput, packet delivery ratio, end-to-end delay, packet loss, and routing overhead. To undertake a comparison study, the developed SCHETF findings are compared to older approaches such as Evolutionary Algorithm-based Vehicular Clustering Technique (EAVCT), Region Collaborative Management for Dynamic Clustering (RCMDC), and Novel Hypergraph Clustering Model (NHGCM). The outcomes indicate that the suggested SCHETF strategy outperforms previous methods.

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1. Introduction

VANETs are a highly trending technology, and they occupy a maximum of the applications of intelligent communication which concentrate on providing road safety and vehicle entertainment [1],[2]. In the network formation, the vehicles are referred to as the ad-hoc systems in which the communication between the moving vehicles takes place in a wireless medium for useful information transmission. Then the collected data is processed again to recreate the new model and the vehicles are free to stay and leave the network. Due to rapid mobility, changes among the vehicles in the network frequent disconnection will happen and that can be able to reduce the network transmission quality [3], VANETs enhance road safety and vehicle communication by allowing cars to share information wirelessly. They use cluster-based structures, selecting leaders using fuzzy logic to address issues like changing landscapes and connectivity challenges. Additionally, using Cognitive Radio (CR) technology improves the use of available frequencies, making communication more efficient in both city and country settings [4].

In earlier studies, the notion of clustering was introduced to group all vehicles into clusters, with each cluster consisting of a CH and a Cluster Member (CM). The CH organizes the members in its cluster and other intra-cluster and inter-cluster communication will take place in the network. Intelligent Transport Systems (ITS) use technologies like Vehicle Ad hoc Networks (VANETs) to improve road safety and traffic flow through communication between vehicles (V2V) and between vehicles and infrastructure (V2I). Clustering in VANETs helps with scalability by grouping vehicles and using cluster heads to manage data. Reliable link-based clustering ensures efficient routing by considering how vehicles move and the changing network conditions [5]. Later, certain challenges are created in the clustering process they are improper CH selection leads to network failure, and untruth CH selection leads to higher data loss among the moving vehicles in VANETs. Therefore, highly trustworthy, and proper CH selection is very essential to create a stable network. VANETs, along with IoT, Cloud, and Fog computing, enhance traffic management by enabling Vehicle-to-Vehicle (V2V) and Vehicle to Everything (V2X) communication. V2X connects vehicles to infrastructure to manage congestion and traffic systems. However, V2V faces challenges like network partitioning caused by the movement of vehicles. To improve stability and reduce overhead in VANETs, clustering organizes vehicles into groups with a CH for coordination and Cluster Gateways (CGW) for communication between different clusters [6].

Clustering form of the clustering process is available in recent research, and they perform both the single hop and multi-hop data transmission, centralized model, distributed model, high-speed network, and low-speed networks. The transmitted information in the CH consists of mobility details, and topological values like location, speed, and contextual data. The logically constructed VANET structure is illustrated in Figure 1 [7].

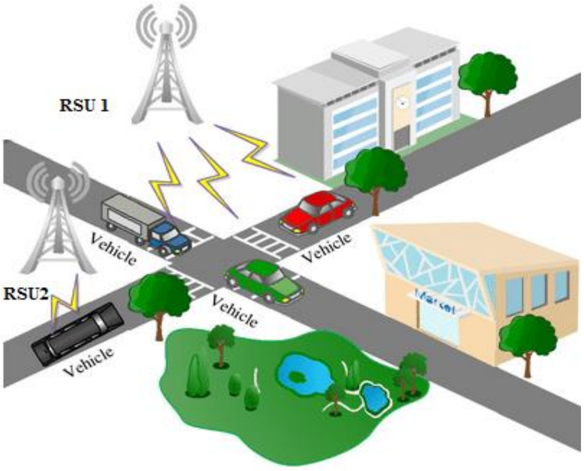


Figure 1. Logical Structure of VANETs [7]

Nowadays VANETs clustering process needs a well-organized, constant, and high-quality performance in the vehicle's communication. VANETs enhance road safety by enabling communication between V2V and between vehicles and V2I. However, routing in VANETs is challenging due to changing vehicle layouts. Current protocols, including position-based, broadcast-based, and infrastructure-based methods, have limitations such as high overhead and cost. Cluster-based protocols help address these issues by organizing vehicles into clusters, with a CH overseeing data transmission and reducing control message overhead. This clustering improves handover efficiency and lowers signaling overhead by managing data session transfers collectively through the CH instead of through individual vehicles [8]. For that purpose, this study proposed a stable parameters CH selection with extended traffic features based vehicular communication. The following is a summary of this article's contributions:

- This article proposed an effective clustering model and traffic control from VANETs to attain high-quality communication in VANETs. The major steps in this proposed system are parameters-based CH election, improved traffic creation, cluster gateway creation, and efficient data transmission.

- During the parameters-driven process of selecting cluster heads, various factors such as network connectivity, distance measurement, speed calculation, and trust evaluation are taken into account to identify reliable cluster heads for ensuring efficient communication.

- Improved traffic creation is attained through probability calculation among the vehicles. Cluster gateways are created to attain effective inter-cluster communication.

- In conclusion, optimal data transmission is the primary focus of this model as implemented in NS2. The essential parameters used for evaluating performance include energy efficiency, throughput, packet delivery ratio, end-to-end delay, packet loss, and routing overhead.

The organization of the article is given here. In section 2 the earlier researches about the clustering process and its drawbacks are identified. Section 3, proposed the SCHETF method in terms of parameters-based CH election, improved traffic creation, cluster gateway creation, and efficient data transmission. Section 4 encompasses the performance analysis and subsequent discussions of the obtained findings. The article is ultimately ended in section 5.

2. Related Work

The main purpose of this section is to provide a robust overview of Network Connectivity in Vehicular Adhoc Networks. Bi et al., [9], presented a new clustering algorithm for VANETs improves cluster stability by adding communication factors to the Affinity Propagation (AP) algorithm. It uses a weighted method to evaluate how a vehicle's inclusion affects cluster stability, aiming for overall balance. In [10], a control strategy using fuzzy logic for VANETs to improve scalability, stability, and spectrum management. It uses multi-criteria decision-making to choose cluster heads by looking at factors like signal strength, speed, and spectrum prices. In order to presented optimal features Awan et al,. [11], claimed that a trust-oriented clustering method for VANETs focuses on improving cluster reliability and security. This method selects dependable CHs based on the trust, reputation, and experience of nodes. It includes a backup head selection process to ensure stability and prevent the spread of false information from malicious or compromised nodes. In [12], the CB-MAC protocol is designed for VANETs. It changes the chances of transmission based on the size of the cluster. The protocol determines the best number of clusters using Markov chain analysis and creates equations for the likelihood of transmission and cluster size.

In order to make applied dynamic clustering model for VANET, Cheng et al,. [13], proposed a dynamic clustering model for keeping network connections in urban VANETs, focusing on complicated road conditions. It introduces a connectivity prediction strategy based on vehicle features and node density, which improves routing reliability. In [14], Vehicles in clusters cause the most interference in clustering based VANETs. To lower this interference, the text suggests using a dual-slot transmission method with a graph-based algorithm. In [15], a PMC algorithm designed for VANETs to address challenges related to stability and reliability caused by moving vehicles. The PMC algorithm uses a method that prioritizes neighbouring vehicles to choose cluster heads and adds a process for merging clusters to enhance stability.

Khan et al., [16], claimed that the MFCA-IoV aims to improve cluster management and increase network efficiency. It is compared to existing methods looking at factors like node speed, direction, and transmission range. In [17], the MC-COCO4V2P algorithm addresses network congestion caused by safety messages in Vehicle-to-Pedestrian communication. It sorts pedestrians into groups based on their location and direction, using different channels for cluster and safety messages. Another application that presented by Rivoirard et al, [18], the Chain-Branch-Leaf (CBL) clustering method is compared to the Multipoint Relaying (MPR) approach in vehicular ad hoc networks. CBL reduces the number of relay nodes and routing traffic, leading to improved stability.

Traffic clustering routing is consided such a great tools for hybrid vehicular networks. In order to achieve that, Qi et al,. [19], proposed Traffic Differentiated Clustering Routing (TDCR) method to improve data transmission in a DSRC and Cellular-V2X vehicle network. DCR uses a centralized single-hop clustering approach along with a two-phase heuristic algorithm to send aggregated data through multi-hop V2V or cellular networks. In [20], the Direct primary Authentication (DPA) seeks to improve the reliability of V2V communication and proposes an alternative link to boost V2I communication in Controlled Authentication (CAN). It enhances V2V reliability, and combining both strategies with existing CAN improves overall V2V and V2I communication reliability. In [21], the Diverted Path Method (DPM) is designed to improve the reliability of vehicle-to-vehicle (V2V) communication and offers a better link for vehicle-to-infrastructure (V2I) communication in CAN. Ullah et al,.[22], suggested a cluster-oriented V2V and V2I network for self-driving cars shows improved connectivity and throughput. Multilane highways and greater connectivity compared to traditional V2I networks, even with moderate vehicle density. In [23], the RBO-EM strategy addresses broadcast storms in VANETs by forming vehicle clusters and using mobility metrics for stable groups and effective emergency message sharing. Information relaying nodes are selected based on link stability to reduce retransmissions and communication load. In order to obtain energy savings and enhance VANET connectivity, Sun In [24], proposed a method for saving energy by using parked vehicles as communication points in vehicular networks. It focuses on improving clustering and reducing energy use affected by the environment.

A permutation-based model is necessary to reduce the overheads in vehicular ad hoc networks. In terms of reducing the overheads, Zhang et al,. [25], mentioned that the limits of resource allocation costs in VANETs. It focuses on time-division multiple access (TDMA) and cluster-oriented methods, to understand how to balance system efficiency with resource allocation costs, which is useful for assessing the capacity of VANETs. In [26], the AMONET clustering algorithm uses Moth-Flame Optimization (MFO) to improve communication in highly mobile VANETs by creating optimized clusters. This leads to better network performance and reduced routing costs. Collaborative management scheme is proposed by B. Liu [27], which called RCMS for dynamic clustering in Green VANETs. Using the State Resemblance Prediction (SRP) model with Region-Based Collaborative Management Scheme (RCMS), improves network efficiency and communication stability, as demonstrated by thorough experiments. In [28], a new method for consistently selecting a cluster head (CH) in VANETs. It uses a combination of vehicular-hypergraph-based spectral clustering and deep learning for spectrum sensing. For that purpose, in this proposed work SCHETF method is developed and it is elaborated in the next section.

3. Proposed SCHETF Method

Developing a congestion-free network model with lower energy utilization is the cause of creating this proposed model SCHETF, which is the combination of parameters-based CH election, improved traffic creation, cluster gateway creation, and efficient data transmission. The diagram in Figure 2 displays the workflow of the SCHETF method.

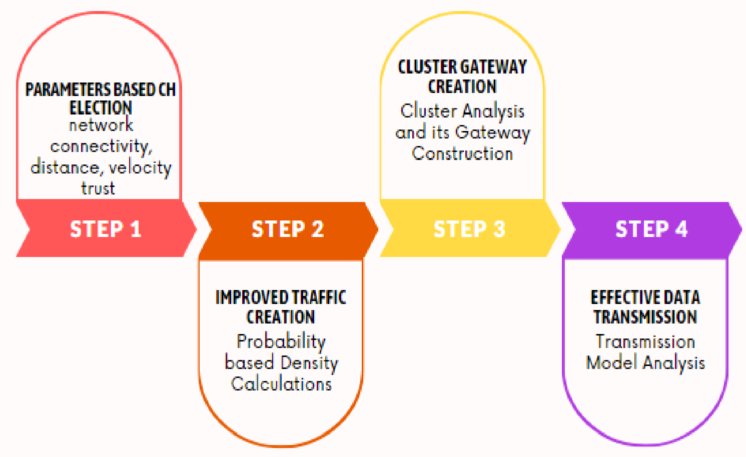


Figure 2. Workflow of SCHETF Method

3.1 Parameters for CH Election

The primary goal of the CH election is to minimize the network's energy consumption. Utilizing parameters to select the ideal CH is considered one of the most effective methods for accomplishing the task flawlessly. The factors considered in this CH selection process include (i) network connectivity, (ii) distance calculation, (iii) velocity calculation, and (iv) trust calculation. These parameters and their calculations are described elaborately. The CH selection process is illustrated in Figure 3.

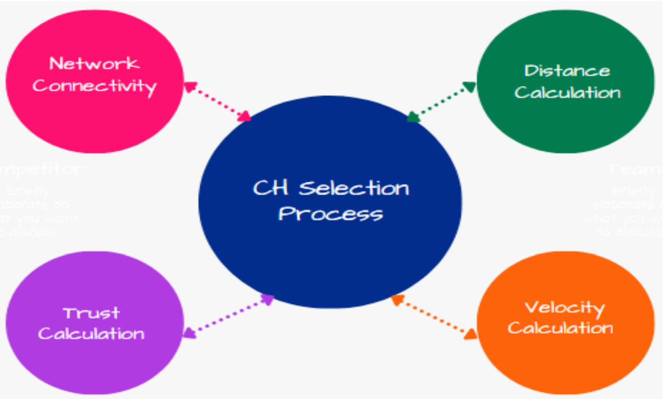


Figure 3. CH Selection Process

A. Parameters For CH Election

The Network Connection Level (NCL) determination relies on the interplay of network connections and traffic within each network. The complete network, denoted as the NCL, is represented by the variable α, whereas the traffic lane is denoted by the variable β. The two formulations are shown in equations (1) and (2).

$$\beta_i(t) = \sum_j A(i,j,t) \qquad (1)$$

Here the variable " j " represents the adjacent potential vehicle, whereas the value of " $A(i,j,t)$" is assigned a value of 1 when the connection terminates at a time " t ". In an alternative scenario, the value will be null.

$$\beta_i(t) = \sum_{j_{TF}} A(i,j_{TF},t) \qquad (2)$$

The variable j_{TF} represents the traffic flow inside a certain lane for vehicles. The estimation of the net connection of the vehicle i in a lane, traffic (TF) is as follows:

$$NCL_i(t) = B_i(t) + (a_i(t) \times LW_{TF}) \quad (3)$$

Where the variable LW_{TF} denotes the weight of the vehicle i within its lane.

$$P_{Nnorm} = \frac{NCL_i - \min(NCL_x)}{\max(NCL_x) - \min(NCL_x)} \qquad (4)$$

Through these calculations, the connectivity is performed among the vehicles.

B. Distance Calculation

To determine the average distance level, it is necessary to calculate the absolute distance of each vehicle within a designated lane. The symbol used to represent the estimate formula is δi.

$$\delta i = \frac{\sum_j \sqrt{(x_j - x_i)^2 - (y_j - y_i)^2}}{NV} \qquad (5)$$

Where j represent the randomly selected car from the subset of i. During the frame, we performed a calculation to estimate the average distance between cars inside a given traffic lane, specifically focusing on vehicles. i. The variable X_i is denoted as follows:

$$X_i = \frac{\sum_{jTF} \sqrt{(x_j - x_i)^2 - (y_j - y_i)^2}}{NV_{TF}} \qquad (6)$$

where NV_{TF} represents the aggregate count of cars using the identical traffic lane as vehicle i, whereas j is a randomly selected vehicle that is associated with the vehicle i.. The average distance level (ADL) is determined using below equation 7,

$$ADL_i = X_i + (\delta i \times LW_{TF}) \qquad (7)$$

In Equation (8), the normalized average distance is computed.

$$P_{Dnorm} = \frac{ADL_i - \min(ADL_x)}{\max(ADL_x) - \min(ADL_x)} \qquad (8)$$

Through these calculations, effective distance calculation is performed among the vehicles.

C. Velocity Calculation:

It is referred to as the average speed of the cluster head and all vehicles located within its communication range. The comprehensive measure of average velocity denoted by σiIs determined using Equation (9).

$$\sigma i = \frac{\sum_{NV} |Vel_i - Vel_j|}{NV} \qquad (9)$$

Now, the AVL, denoted as ρi, represents the vehicle i,

$$\rho i = \frac{\sum_{jTF} |Vel_i - Vel_{jFT}|}{NV_{jTF}} \qquad (10)$$

The AVL for a vehicle is,

$$AVL_i = \rho i + (\sigma i \times LW_{TF}) \qquad (11)$$

$$P_{Vnorm} = \frac{AVL_i - \min(AVL_x)}{\max(AVL_x) - \min(AVL_x)} \qquad (12)$$

Through these calculations, velocity calculation is performed among the vehicles.

D. Trust Calculation:

Here in this model, the trust calculation is based on the vehicle history and neighbor vehicle localization. According to the past data history, the trust score is allocated to the vehicles from 0.1 to 0.5. Through this process, trust is analyzed and the vehicles that maintain a high trust score and as well with high energy will be elected for the data transmission in the maximum of the times.

3.2 Cluster Gateway Creation:

In some instances, a small number of cluster members have previously designated themselves as cluster gateway nodes for two cluster heads. The remaining CMs may be accessed through the CGWs of both clusters. Assume, for example, there are three channels: CH1, CH2, and CH3. Chapter 1 includes CGW1, CGW2, and CGW3, while Chapter 3 contains CGW4 and CGW5, which are currently part of Chapter 2's collection of Community Managers. When CH1 sends a message, its CGWs, specifically CGW1, CGW2, and CGW3, are responsible for ensuring that the message reaches CH2. It is essential to inhibit any transmission originating from CH2 due to the ability of these CGWs to include all CMs associated with CH2. Therefore, it can be concluded that the establishment of cluster 2, under the management of CH2, does not provide any advantages and should not be initiated in the initial stages. This work employs many techniques to mitigate the occurrence of the undesired cluster issue, as shown by CH.

The coverage of cluster members (CMs) inside a certain CH becomes evident when the collective groups of neighboring clusters' CGWs can provide coverage. Once a CH is expected, it promptly chooses its CGC according to the following criteria. The placement of CGCs should ideally be situated towards the border of the CH since it has the greatest possibility of evolving into a CGW in the future. Every CM maintains a log of the distance between itself and its CH and disseminates this information to neighboring nodes. In cases where a CM does not receive a distance value surpassing its distance to its CH, it identifies itself as a CGC. Before transmitting a Cluster Head Access (CHA) message, a vehicle acquires relevant data about its neighboring vehicles and initiates a $backoff$ timer, which is determined by the subsequent equation.

$$backoff = T_{max}\left(1 - \frac{D_{CGC,vi}}{2D_{max}}\right)T_{random} \qquad (13)$$

When $D_{CGC,v}$ is the distance between a vehicle vi and CGCs, and D_{max} denotes maximum permitted transmission range, $Time_{max}$ is defined as the maximum differed time. T_{random} has been introduced to prevent a collision between two vehicles that are near one another. When a vehicle approaches a CGC, a timer initiates, prolonging the process and lowering the likelihood of it transforming into a CH. By using this technology, unnecessary clusters may be reduced and network performance can be improved. Let's suppose that CH1 identifies itself as the CH, while CGC1, CGC2, and CGC3 are anticipated to function as Cluster Gateway Candidates. This prediction is based on their locations along CH1's perimeter. The CGCs distribute their sculptures to v1, v2, v3, and v4, along with any neighbouring entities.

Each vehicle starts a $backoff$ timer, which is based on a predetermined value (12), before transmitting a CHA message to its neighboring vehicles. The possibility of vehicles, such as v1 and v2, becoming CHs is reduced due to the extended duration it takes them to broadcast CHA messages near CGCs. Conversely, given that the backoff duration assigned to vehicles located furthest from the CGCs, namely v3 and v4, is configured to be short, it is very probable that they will be selected as CHs. Since v1 mostly overlaps with the content already covered in CH1, it is not a viable option for inclusion as a separate chapter. Due to the growing number of connected mobile devices receiving connection handover declarations from CH1 and v1 when transitioning to CH2, a significant amount of client gateways will consequently be established. In this scenario, the criteria outlined in equations (11) and (12) are used to guarantee a proficient distribution and choice of CHs among the cars. Due to its central positioning and ability to maintain a safe distance from CH1, v3 is often considered the optimal choice for CH.

3.3 Effective Data Transmission:

In most cases, it is impractical for a CGW to be comprised of a solitary vehicle, since several cars within the same cluster may be classified as CGW Group members. According to the data shown in Figure 5, three vehicles, namely CGW1, CGW2, and CGW3, have been identified as CGWs. This designation is based on their concurrent inclusion in both CH1 and CH2. Only CGW1, CGW2, and CGW3 are authorized to transmit a message sent by either CH1 or CH2 to another CH. The capacity of a single transmission from CGW1, CGW2, or CGW3 to provide coverage for the specified area is apparent. Nevertheless, it is important to note that all CGWs will execute the same function without any supplementary coverage area. To address this issue, each CGW starts a $backoff$ timer that is proportional to its distance from its CH, as described by the Expression below:

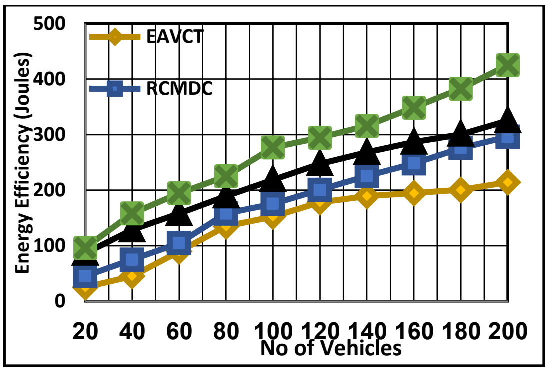
Where $Time_{max}$ refers to the greatest difference in time. $D_{CGW,CH}$ represents a difference in distance between a CGW and its CH, whereas D_{max} represents the maximum allowable gearbox range. The inclusion of a random time delay denoted as T_{random}, serves the purpose of mitigating any conflicts that may arise between two proximate vehicles. The message received from CH1 is sent by CGW1 due to its position being the farthest, resulting in its timer expiring first.

Upon receiving the identical message from CGW1 within the designated $backoff$ period, both CGW2 and CGW3 promptly terminated their retransmission efforts. If the $backoff$ timer has elapsed and both CGW2 and CGW3 fail to receive an identical message from CGW1, they will proceed to execute the task of forwarding the message.

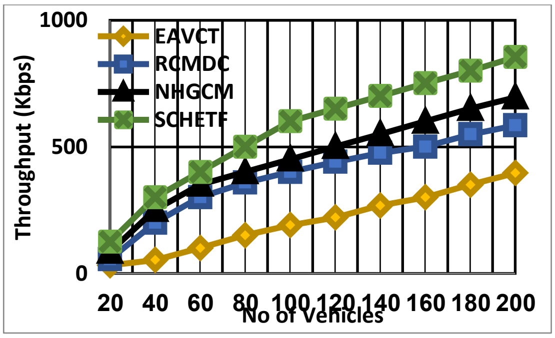
4. Simulation Environments

The proposed SCHETF has been experimentally demonstrated and compared with previous methods such as EAVCT [23], RCMDC [24], and NHGCM [25]. The simulation is conducted using the NS2 platform, including the Simulation of Urban Mobility (SUMO) mobility generator. The performance study delves into various attributes, such as energy efficiency, throughput, packet delivery ratio, and end-to-end delay. The following parameters are calculated to assess the system's performance. Figure 4 (a) illustrates the graphical representation of energy efficiency, demonstrating that the proposed SCHETF achieves superior efficiency. The proposed SCHETF strategy has an energy efficiency of 425.23%, which is higher than the EAVCT strategy's 214.23%, the RCMDC strategy's 296.25%, and the NHGCM plan's 325.14%. The SCHETF system performs better in terms of energy efficiency than the EAVCT, RCMDC, and NHGCM by values of 211, 128.98, and 100.09, respectively. Figure 4 (b) implies the throughput calculation and that it is shown at the proposed SCHETF produced higher throughput. In comparison, the throughputs of EAVCT, RCMDC, and NHGCM are 396.17, 584.17, and 695.23 kbps, respectively. The proposed SCHETF method has a throughput of 854.23. The proposed SCHETF system therefore performs better than EAVCT, RCMDC, and NHGCM by values of 458.06, 270.06, and 159 kbps, respectively.

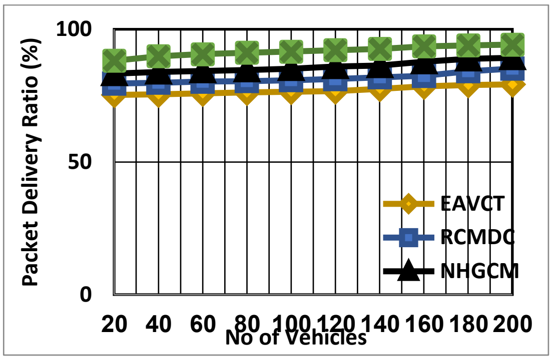
Figure 4 (c) shows the packet delivery ratio performance demonstrates that the suggested SCHETF algorithm shows superior performance. In comparison to established techniques such as EAVCT, RCMDC, and NHGCM, with performance rates of 79.23, 85.17, and 89.25 correspondingly, the newly introduced SCHETF system achieves an impressive packet delivery rate of 94.23. Over previous methods, this is a significant improvement. As a result, by values of 15, 9.06, and 4.98, respectively, the SCHETF system displayed demonstrates a higher packet delivery rate compared to the EAVCT, RCMDC, and NHGCM systems. Figure 4 (d) illustrates the end-to-end delay of the methods examined in this study across different numbers of vehicles, confirming that the proposed SCHETF results in reduced end-to-end delay. Compared to the previous processing times of 256.14 ms for EAVCT, 231.14 ms for RCMDC, and 185.14 ms for NHGCM, the SCHETF offers a lower processing delay of 125.46 ms. The end-to-end delays of the SCHETF system exhibit reductions of 130.68, 105.64, and 59.68 ms compared to EAVCT, RCMDC, and NHGCM.



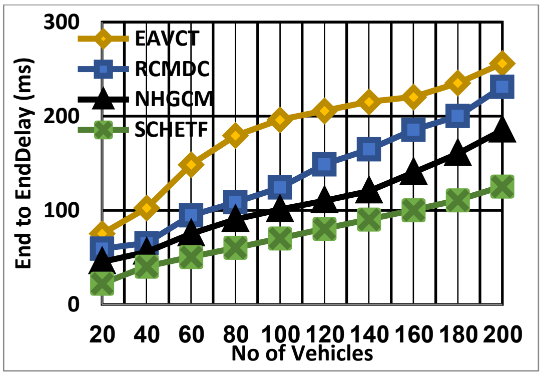
(a)



(b)



(c)



(d)

Figure 4. Performance of (a) Energy efficiency, (b) for throughput, (c) for packet delivery ratio, and (d) for end-to-end delay

6. Conclusion

The proposed SCHETF model effectively tackles significant issues in VANET by creating a congestion-free network framework that utilizes less energy. By incorporating parameters-based CH election, enhanced traffic generation, CGW formation, and effective data transmission techniques, this model improves overall network performance and dependability. In the SCHETF model, the CH election is crucial for reducing network energy usage.

The consideration of parameters such as network connectivity, distance, speed, and trust guarantee that CHs are selected optimally to ensure stable and efficient communication. These computed metrics facilitate a fair and intelligent allocation of cluster responsibilities, resulting in an extended network lifespan and lower overhead. The establishment of CGWs further boosts the effectiveness of inter-cluster communication. The tactical placement of CGWs at cluster edges and their function in relaying messages among CHs removes unnecessary data transmissions, thus conserving energy and lessening latency. This layered structure greatly improves data distribution while preserving strong network connectivity in a dynamic VANET context. Efficient data transmission in the SCHETF model is realized through a well-organized system that prioritizes transmissions according to CGW locations and implements random backoff timers to avert collisions. This guarantees dependable message delivery even in high-velocity, densely populated traffic scenarios, reducing packet loss and increasing throughput. The SCHETF model also addresses the issue of superfluous clusters and overlapping areas by utilizing criteria such as vehicle positioning and connectivity to enhance CH and CGW formation. This ensures that the network sustains a streamlined framework with minimal redundancy, further enhancing its scalability and resilience. The SCHETF model presents a holistic solution for VANETs by focusing on energy efficiency, congestion alleviation, and data reliability. Its methodical approach to CH election, CGW formation, and data transmission offers a solid foundation for managing highly dynamic vehicular networks.

Future applications of this model may investigate its incorporation with advanced technologies such as machine learning and real-time traffic forecasting to further improve its efficiency and adaptability. The simulation results indicate that the SCHETF technique described outperforms existing methods in end-to-end delay, efficiency, packet delivery ratio, and throughput. The future research is based on the cross-later approach for further enhancement to give maximum coverage and minimum delay during communication in the urban environment.

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