Proficient Clustering based Broadcasting for VANET using LEACH and AOMDV Protocol

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Abstract— Recently, Vehicular Ad Hoc Network (VANET) applications have increased enormously. Due to the ad hoc nature and ease of installation, more applications are developed. In addition, the utilization of VANET improves the need for security, energy efficiency, and other parameters needed to enhance the competence of network lifetime. This paper PC-LEADV (Proficient Clustering – LEACH and AOMDV) focuses on improving the energy efficiency of the VANET through LEACH protocol. Additionally, VANET comprises several routing protocols to overcome such issues, and one of the powerful and efficient clustering-based multipath routing protocols, AOMDV, is considered. This proposed work attempts cluster formation and Cluster Head (CH) election through energy-efficient parameters such as distance and residual energy. The proficiency of the proposed work achieves better compared with previous results.

Keywords—*network lifetime, cluster head election, cluster formation, energy efficiency, residual energy*

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I. INTRODUCTION

Daily the Vehicular Ad Hoc Network (VANET) applications are increasing as VANET can reach the geographical areas where humans or others cannot go, improving the need for VANET. Some widely used areas are military, medical, and so on [1].

VANET consists of tiny nodes with a small processor, RAM and small non-rechargeable battery. The sensors are deployed in any geographical area to acquire the data from the environment and forward the collected information to the sink node or base station (BS). Humans can use the collected data for different processes [1,2]. The deployed sensors still sense the battery drains and die in the deployed environment.

VANET protocol stack architecture consists of physical, data link, network, transport, and application layers. The routing protocols of VANET are generally classified into three primary types plane routing, grade routing and position routing. Research on potential collaboration in data gathering and processing in sensor nodes was conducted in past years. It results in innovative techniques to eliminate the energy inefficiency required to maintain the network's lifetime. In addition, the protocol stack should facilitate routing protocols of VANET for energy-efficient route discovery and data relay from source to sink node [2]. Fig.1 presents the architecture of VANET.

Routing is a challenging task compared to mobile ad hoc or cellular networks. The global addressing model does not apply to VANET due to the huge number of member nodes. ID maintenance is also a high-issue task for a mobile environment [3]. Thus, traditional IP-based communication cannot be possible for VANET. The self-organizing nature of VANET is the best affordable feature of VANET still, it requires a battery for each formation.

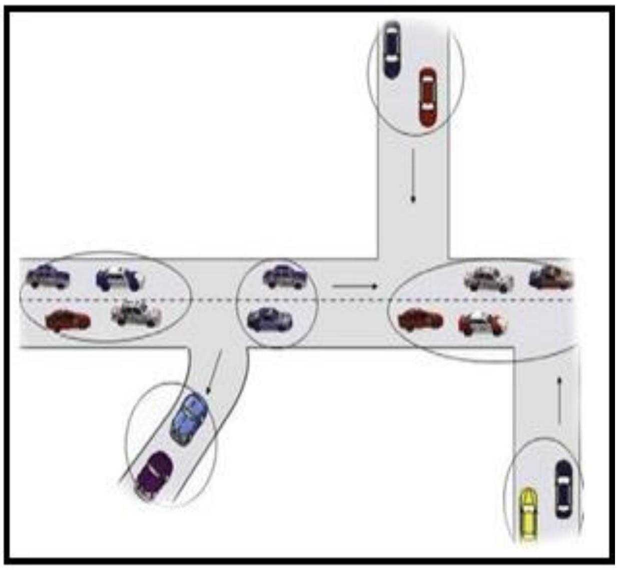

Figure 1. Schematic Diagram of Vehicle Clusters

To create an intelligent transport system, VANET integrates with the few elements of ad-hoc wired-based and wireless networking by communicating between vehicle-to-vehicle and roadside systems. VANET's main aim is to ensure health and protection for people through information on accidents and traffic information in engaging with road drivers. Every node or vehicle has a VANET system that immediately shapes an Adhoc network and can transmit the messages requested through the wireless network. A vehicle could communicate directly with other vehicles, known as V2V communications, or a vehicle could display with a provided infrastructure such as a Road Side Unit (RSU) known as V2I (Vehicle-to-Infrastructure [2].

In today's world, there are many significant VANET applications. Such uses range from critical medical care to comfort and leisure. A VANET must meet the needs of ever-evolving users and comply with the available technology requirements and architectures.

Proper routing is one of the critical issues in VANET research. The maintenance and road exploration of the route for transmitting messages in multi-hop networks in VANET is difficult due to the nature of the mobile ad hoc nodes. Most routing protocols are available and used under different road conditions [4, 5]. VANETs have several distinct characteristics to MANETs, such as road pattern limitations, no network size limits, dynamic topology, movement models and limitless energy supply. All these features made it impossible for the VANET community to establish successful routing protocols. The critical aspect is the mobile nodes that travel rapidly [6].

Due to such differences, many new algorithms were proposed. To minimize the energy consumption, many routing techniques were proposed. The proposed work also focuses on achieving the energy efficiency of VANET.

A. LEACH Protocol

Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is introduced by Heinzelman et al.

This protocol is one of the foremost protocols used to elect the CH for each round using its threshold function $T(n)$ in Eq. 1.

$$T(n) = \begin{cases} \frac{p}{\left(1 - p \times \left(r \bmod \left(\frac{1}{p}\right)\right)\right)}, & if\ n \in G \\ 0, & otherwise \end{cases} \quad (1)$$

Where p denotes the probability of the nodes to become CH, r denotes the round which is ended, G denotes the set of nodes which not act as CH in the last $1/p$ rounds [7].

LEACH follows a simple process for the election of CH. Each node is assigned a numerical value between 0 – 1 (Zero – One). After this process, the assigned value is checked with the threshold value, and the node which holds a lesser value than the threshold value is elected as CH for that round. This is a continuous process for each round. In this election, the node which holds lesser energy, the node far away from BS, and the node not maintaining the centrality in a cluster may become CH which leads to a decrease in the efficiency of the network. To avoid such flaws, the proposed scheme follows the election of CH with the modified threshold function [6,7].

The proposed PC-LEADV focus in selecting CH based on distance and residual energy of node. Distance is considered as distance between neighbors and distance between BS.

Section II related works discuss the latest research works of different authors. Section III presents PC-LEADV in detail, and experimental results are discussed in Section IV. Finally, Section V concludes with a conclusion.

II. RELATED WORKS

In [1] proposed, a mechanism called message passing in VANET through LEACH protocol. The work focused on the delivery of data from source to BS. Passing message (sensed data) through a definite route is the idea of the proposed work. This work needs a high packet delivery ratio, achieved through forming an effective routing technique. The proposed cluster formation technique focused on developing the cluster by electing a CH node based on a distance metric. Distance is considered between the node and neighbor node. Therefore, the cluster formed with highly reachable neighbours, and the data transmission begins in the proposed work. The pitfall of this scheme is that the cluster formation with a highly reachable neighbor is a good technique but the residual energy of the node is not at all considered. The node without energy is simply useless while transmitting the data.

In [2], proposed energy efficient improved SEP (Stable Election Protocol) protocol for VANET. The proposed work enhances the energy efficiency of the network by selecting the proficient routing path to deliver the sensed data. SEP focus on finding the shortest path from source to BS and neighbor nodes. The sensor nodes are stable in this format, so selecting an appropriate route for data transmission is easy. This scheme focused on the route discovery process for each communication in a stable configuration. This reduces the network's lifetime due to the loss of energy for route discovery.

In [3] delivers an energy utilization model for VANET. Using Particle Swarm Optimization (PSO) with Simulated Annealing (SA) produced the best chain formation technique for cluster formation. The unequal energy consumption is reduced through sub-optimal cluster formation. CH communicates through a multipath fading technique to the far distance node. It eliminates the communication overhead in the network. The residual energy of the node is not considered while transmitting data, and the distance between the source node and BS is also not mentioned.

In [4] proposed, an efficient clustering through Improved LEACH. The research focused on electing the CH, which holds higher residual energy than the other node. This leads to electing the best CH for the cluster, but still, the communication between the nodes is not considered in this scheme. This feature leads to less packet delivery ratio. The basic need of VANET is to collect data from the environment, which is affected highly by less packet delivery ratio.

In [5] proposed improved Bat Algorithm (BA) for LEACH protocol for effective data transmission. This algorithm forwards the data through a unique faster shortest path communication between the source node and destination to reach BS as early as possible. In addition, the proposed model achieves a higher data delivery ratio than the other models. The network's lifetime remains unstable due to the inefficient CH election process.

III. PROPOSED WORK

The proposed PC-LEADV focused in two major processes. They are,

- Energy efficient CH election & cluster formation
- Higher packet delivery ratio

Traditional cluster strategies in nodes of VANETs may not successfully form efficient cluster groups and organize cluster vehicles. More organizational processes need to be developed with the VANET setting in mind. The cluster layout should be based on the space-time stability of ad-hoc networks consisting of mobile nodes.

Cluster Components: The solution consists of three parts, the cluster header, the cluster gateway and the cluster member.

Cluster Head:-This is the local cluster leader who arranges the transmission and transmission of the data.

Gateway Cluster:-A non-cluster header node that accesses the adjacent node and transfers data between clusters.

A cluster member:-This is generally referred to as the ordinary cluster node that participates in the same cluster without any interlinking of neighboring clusters [8-10].

The PC-LEADV achieves the above processes by setting up two parameters distance and residual energy.

The residual energy of the node is the first parameter of the proposed scheme, where energy is the primary constraint in electing CH. The effectiveness of clustering formation is measured based on the network's performance, which is mainly retained in energy of the node [11]. The sensor node consumes energy in sensing the data and forwards it to CH. Elected CH delivers the data to the nearby CH or BS. The electing CH must have high energy because it has to aggregate the data and forward it to BS, whereas the nodes only have to deliver the sensed data. This shows that the residual energy is one of the primary constraints in electing CH. The basic formulae for finding the residual energy in Eq.2.

$$Resi_{egy} = \frac{EGY_{current}}{EGY_{maximum}} \quad (2)$$

Where $EGY_{current}$ specifies the current volume of the residual energy and $EGY_{maximum}$ specifies the maximum energy of a node means the energy of a node when it is fully charged. The above formula denotes that the node with high residual energy will be selected as CH.

The distance between neighbor nodes is obtained using Eq. 3.

$$distance_{neigh} = 1 - \left[\frac{\sum_{i=1}^{N} distance_i}{N\ X\ distance_{max}}\right] \quad (3)$$

Where $distance_{neigh}$ denotes the distance between the neighbors, $distacne_i$ denotes the distance of node i and $distance_{max}$ denotes the maximum distance of a node, and N indicates the number of neighbor nodes.

The CH must communicate with BS often because the CH must collect the data from the member nodes and forward it to BS. This transmission consumes the energy of CH. Therefore, the node to act as CH is to calculate the distance between the CH and BS. Less distance will improve the performance [12]. The distance is calculated as in Eq.(4).

$$BS_{dist} = \frac{Distance_{BS}}{Distance_{far}} \quad (4)$$

Where, Dis_{BS} denotes distance to BS and Dis_{far} denotes the distance of a node which is far away from the network.

This paper proposed a high-grade algorithm for the selection of CH under the MAC protocol. The VANET routing protocol focuses on location-based, data-centric and application-dependent. The primary research is on the cluster routing protocol in VANETS and examines the advantages and drawbacks of the current protocol belonging to VANETS. Based on the problems in the original protocol, the selection of cluster heads, special node processing, and inter-cluster routing problems, respectively, proposed an improved Cluster Head Selection Mechanism [13]. The proposed algorithm is detailed in Fig. 2.

Finally, Eq.2, Eq. 3 and Eq.4 are combined with Eq. 1 to elect the best CH for each round.

1 **Initialisation:** *V = set of vehicles*

2 No_V *= number of vehicles in cluster*

3 S_i *= Speed of vehicle in V*

4 S_{avg} *= average speed of all vehicles*

5 (x_i,y_i) *= current coordinates of the vehicle*

6 w_1 *= distance*

7 w_2 *= number of messages received*

8 w_3 *= percentage of Packet Loss (* $0 \le W_1, W_2, W_3 \le 1$ *and* $W_1 + W2 + W3 = 1$*).*

9 $Resi_{egy} = \frac{EGY_{current}}{EGY_{maximum}}$

10 $distance_{neigh} = 1 - \left[\frac{\sum_{i=1}^{N} distance_i}{N\ X\ distance_{max}}\right]$

11 $BS_{dist} = \frac{Distance_{BS}}{Distance_{far}}$

12 $CH_{elec} = \left\{\frac{EGY_{current}}{EGY_{maximum}} + \left[1 - \left[\frac{\sum_{i=1}^{N} distance_i}{N\ X\ distance_{max}}\right]\right] + \frac{Distance_{BS}}{Distance_{far}}\right\}$

13 CH is elected

14 Else

15 CH is elected based on proposed $\boldsymbol{V_i^m}$

16 *velocity of a vehicle* $\boldsymbol{V_i^m}$ *calculated using*

$\boldsymbol{V_i^m}$ *= velocity of a vehicle i in the cluster m*

$$\Delta V = \frac{\sum i \in V^m \left|V_i^m - V_j^m\right|}{Nov \times w_1(w_2 - w_3)}$$

17 Utility function of CH in m

$$U_i^m = \frac{Nov^m, S_{avg}}{1 + e^{-S\left(\frac{S_{avg} \times w_2}{V_{(x_i,y)} \times w_2}\right)}}$$

18 Average Utility function is identified

$$\Delta V_i^{m,n} = S_i \Delta S_{avg} w_2 + S_i \Delta Nov w_2$$

19 *CH is elected*

Figure. 2 Proposed algorithm

IV. EXPERIMENTAL RESULTS

The results are obtained by running the simulation NS2, with 100 nodes from 0 – 99 and specifying the100th node as BS with a simulator time of 3600 seconds.

Table II below displays the simulation model used for the proposed analysis. It describes the different simulation parameters.

TABLE II SIMULATION PARAMETERS AND VALUES

PARAMETERS	***VALUE***
Channel	Wireless channel
Antenna	Omni/Directional Antenna
MAC Protocol	IEEE 802.11
Routing Protocol	AOMDV
No. of Nodes	100
Simulator	NS 2.35
Simulation Time	600 Sec
Protocol	AOMDV
Traffic Status	Continuous arrival

Fig. 3 shows the packet delivery ratio of the network.

Packet Delivery Ratio: Packet Delivery Ratio is defined as the number of packets successfully received and the number of packets transmitted. It increases due to the successful transmission of packets by the intermediate nodes. Fig. 3 shows that the proposed approach increases by 56% compared to previous methods.

Fig. 3 shows the packet delivery ratio of the network.

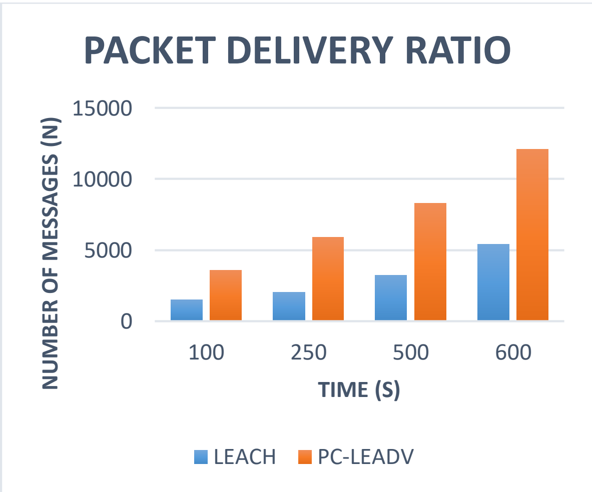

Figure. 3 Packet Delivery Ratio

Remaining energy consumption: The energy consumption is the best parameter to determine the proficiency of the proposed and existing works. The proposed work attains 44% lesser energy consumption than the existing schemes.

Fig. 4 shows the average remaining energy.

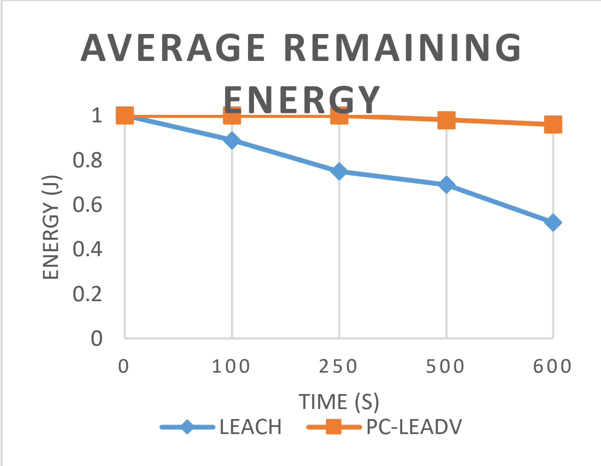

Figure.4 Average remaining energy

In the Proposed scheme, PC-LEADV performs better in maintaining better-remaining energy, packet delivery ratio and a good number of nodes alive than the existing approaches, thus proving PC-LEADV obtains energy efficiency. The network becomes stable compared to the existing models for a certain period. Finally, the energy efficiency enhances the lifetime of the VANET.

Fig. 5 shows the total number of alive nodes for the simulation time. The proposed work PC-LEADV maintains 44% of better proficiency than the LEACH protocol and supports a maximum of 95 alive nodes.

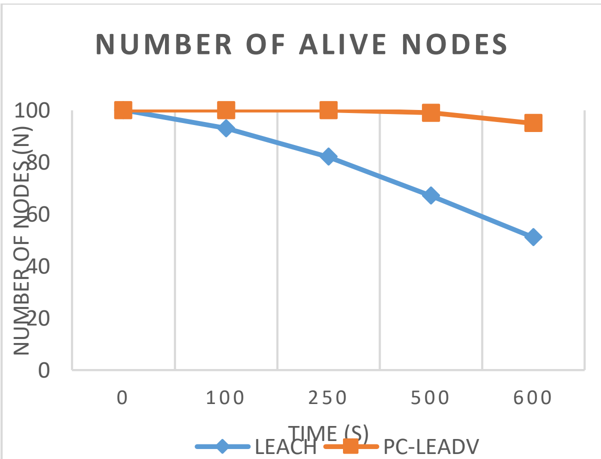

Figure. 5 Number of Alive Nodes

V. CONCLUSION

The VANET clustering algorithm works by combining mobile nodes with groups called clusters. According to a set of rules, the choice of a node called the Cluster Header (CH) between the cluster and the remaining network is the same as the wireless infrastructure access point. Depending on the specification, the basic functions of the cluster head vary as does the mechanism by which it is selected. The clustering algorithm used to connect cluster nodes must ideally be robust for node instability and unpredictable changes in the topology of the network and the cluster and ensure stable VANET-back communication.VANETs are utilized to sense the data from various areas humans cannot reach. Thus, VANETs need energy-efficient models to survive. The proposed scheme PC-LEADV provides a better model for an energy-efficient network. This model elects CH based on residual energy, the distance between CH and BS, and the distance between node and members. The simulation result shows that the proposed methodology is better than the existing methods.

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