An Intelligent Cluster-Based Energy Efficient Optimization Algorithm to Improve the Network Performance in VANET

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Abstract
VANETs are a type of mobile ad hoc network that provides significant mobility to its users. The network that disseminates information among automobiles to aid with roadside traffic monitoring, navigation and vehicle safety. In the VANET, clustering solves the scalability problem while also making the network more robust. To accomplish efficient resource usage, the research proposes an energy-efficient clustering mechanism. Cluster creation relies on the node's optimized energy processing ability. In a similar setting, the proposed technique is validated using NS2, and its performance is compared to existing residual energy-based clustering. In terms of energy usage, packet delivery, and delay, the results show that the suggested technique outperforms.
Keywords: VANET, cluster, performance, and energy.

I. Introduction

VANETs (Vehicular Ad Hoc Networks) are a type of mobile ad hoc network that allows users to move around freely [1]. Ren et al. [2] recently devised a convolution layer based on vehicle velocity, direction, and expected link lifetime. The network used to disseminate data among automobiles to aid with roadside navigation, traffic monitoring, and vehicle safety. In terms of infrastructure, scalability, and applicability, IoV (Internet of Vehicles) represents a step forward from typical VANETs [3]. IoV offers potential options for taking VANETs to the next level. At the road level, this extension allows for multiple connections between humans, vehicles, and roadside units. The main benefit of IoV is that it makes internet access simple and quick. The vehicles in the network communicate information such as their location, time, and direction. In addition, the network provides information such as parking data, infrastructure availability, and complex applications.

Figure 1 depicts the IoV Architecture, which is made up of two main components: a backbone network and a network services. The access network is made up of two components: a roadside unit and an onboard unit. The vehicles equipped with a communication unit on board. The GPS, vehicle-to-X (X might be a vehicle, a human, or the internet) module, data collecting module, and input-output module are all part of the board unit. On the other hand, a roadside unit is a computer module installed on the roadside to enable vehicle communication. The internet, transportation control centre, and cloud centre are the three main components of the backbone network.

Clustering in VANET solves the scalability problem, minimizes costly long-distance communication, and enhances network resource accessibility by offering service locally. Clustering is a critical operation in the VANET to obtain the most efficient resource availability. Clustering is the process of breaking down a network into tiny groups of nodes known as cluster members, each of which is led by a cluster head. Various clustering strategies have been proposed in the literature to manage and construct the VANET cluster. The majority of these are intended for single-hop communication, such as communication between cluster heads and cluster members. Because clustering is established by single hop communication, these techniques can cover a tiny area with a high possibility of overlap. Because the VANET is very mobile and has an unexpected topological character, the single hop communication based clustering approach was shown to be ineffective. As a result, multi hop communication-based clustering algorithms have been presented in the literature to address issues like network coverage and stability that single hop communication-based clustering systems have. The phenomena of mobility and distance to pick the cluster head are also included in multi hop clustering. In the event of a primary cluster head failure or absence, these procedures also included the selection of secondary cluster heads. Work [4] proposed distributed multi hop clustering, in which the cluster head is chosen based on the characteristics of the neighbour node, but work reviewed it and concluded that cluster selection is based on various metrics, which in turn leads to control packet overhead and degrades network performance. Ren et al. assessed the work and determined that it had excessive control packet overhead and poor performance. Furthermore, Hassanabadi [5] proposed a method of clustering in VANETs based on affinity propagation, but Ren evaluated it and determined that affinity propagation creates network loops that cause communication delays. Mobility-based cluster creation algorithms have been devised for VANET in the literature by [5], but these approaches suffer from control packet overhead and packet collision.

The cluster head creates a bottleneck, and communication is impossible to maintain [6]. To solve the aforementioned issue, work by ren proposed an efficient hierarchical clustering strategy for generating clusters in multi-hop VANETs in order to maximize resource utilization and network longevity. The topic of cluster head communication resources is not addressed in this study. As a result, if a node in the communication line has an extra overload that exceeds its capacity to handle it, it acts as a bottleneck. It occurs in the network due to a lack of energy or a buffer overflow. It's a single plug through which traffic flows faster than it can handle. It is due to energy constraints in the VANET. To solve the problem, the study proposes a cluster head selection method based on the node's optimum energy and processing capability. With the help of NS-2, the suggested mechanism was validated, and the results were computed in terms of remaining packet delivery, energy, and latency.

The remainder of the article is arranged as follows: the next section intended the cluster head choice based on the node's optimized energy and processing ability, the next section validated the designed method in terms of various measures, and the work concluded with chapter concludes scope.

II. Cluster creation in VANETs is dependent on the processing ability and node's energy

The proposed mechanism took into account the VANETs environment, which includes cars, roadside units, onboard units, the internet, the cloud center, and the transportation control center. The vehicles are GPS-enabled and serve as a communication device, with the work being classified as a mobile node. The cars also include an onboard unit that allows them to communicate with each other and with roadside equipment. A roadside unit is a fixed communication point installed along the side of the road to facilitate V2I communication. The transportation control center is a hub that connects the internet to the access network (AN). The cloud center is a virtual server that saves and distributes resources in order to complete cluster construction. If two vehicles are in communication with each other, there is direct communication between them. There is communication between automobiles and roadside units, as well as vice versa, in a single or multi-hop configuration, depending on the position of the roadside units and vehicle. Finally, there is vehicle-to-internet communication (V2I), which connects automobiles to the internet via roadside equipment and a transportation control center.

To improve network performance, the work suggested a novel optimized energy and processing capabilities of the node method for V2I communication. The proposed project assumes that vehicles are connected to the internet via roadside equipment and get information about nearby vehicles. The suggested work determines the cluster head based on the optimum energy and computation ability of the node. Registration, acquiring neighbor node information, cluster head selection and clustering formation and maintenance are all part of the proposed effort. In terms of cluster head selection, the work is an extension of the previous work, namely residual energy based clustering [7]. The remainder of the work, such as acquiring neighbor node maintenance and information, registration, is identical to the existing EHCP.

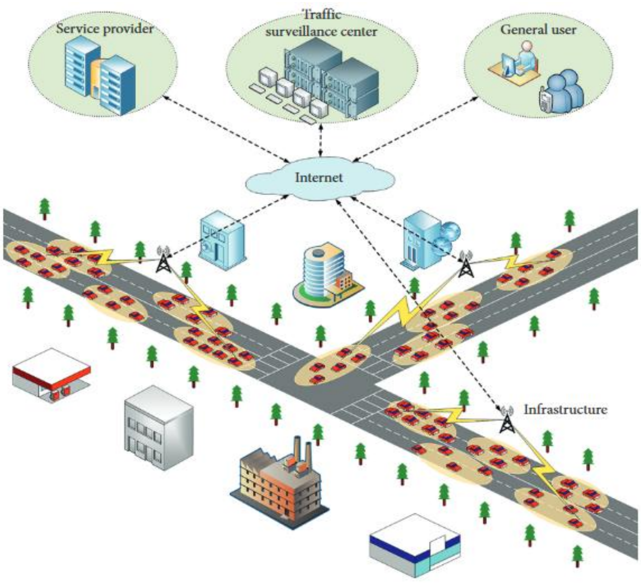

Fig 1: Cluster-based VANET architecture for vehicular service scenarios.

III. Selection of Cluster Head

VANETs are made up of N vehicles in a communication area of m*n km2. The communication rage, let r km, is the same for all vehicles. GPS can determine the location and time of each node, and this information can be shared with neighboring vehicles. To process information through them, all of the vehicles have a buffer capacity of L kbs and an energy of E joules. To avoid the vehicle becoming an intermediate bottleneck node for multi hop communication, the cluster head is chosen based on the node's optimized energy and processing ability. The nodes with E joules of energy must process the greatest number of packets, letting 'Pi' packets pass through it, where i=2,3,...n, and each packet has a size of l kbs, and this consumes the node's el energy. Consider a packet that needs to be processed through any node with E joules of energy. The energy consumption is calculated using the following equation:

$$\boldsymbol{E(P_i) = E_r + E_t + E_p} \quad \textbf{(1)}$$

Then the remaining energy of the node is computed as follows;

$$\boldsymbol{E_{rem} = E - E(P_i)} \quad \textbf{(2)}$$

To compute optimized energy, and processing ability of the node let N with its energy E joules, and its remaining energy after one packet process is about $\boldsymbol{E_{rem}}$ joules, is followed by below considerations;

1. Data packets must be communicated through node must node be greater than to combined energy consumption at most E joules.
2. Need to process as much as possible packets through the node in an available energy E joules.
3. Complete communication must happen partial transmission is not applicable.

Paper computed the remaining energy after processing the one packet through the node in the multi hop communication model by equation (1), and (2). To compute the optimized energy, and processing ability of the node, The n-Topples knapsack algorithm with of positive values is used in this study.

The packets that needs to process through the node are Pi', where i=,2,3….n

- Each packet consumes the $\boldsymbol{E(P_i)}$ joules of energy to process through the node, and after processing the one packet the remaining energy of the node is $\boldsymbol{E_{rem}}$ and can be computed by equations (1), and (2).

To achieve the objective, work needs to determine the energy consumption by packets processing through the node in joules E Є $\{P_1, P_2 \ldots P_n\}$ to

Maximize $\sum P_i$ where I Є E Subject to $\sum E(P_i) \leq E_{rem}$

To compute the optimized energy, and processing ability of the node with available energy capacity 'E' joules, and energy consumption after one packet is about $\boldsymbol{E(P_i)}$, and remaining energy about Erem, the procedure is to try all the possibilities of subsets of E to build the two dimensional array as follows

J[0…..n,0…. Erem]∀1≤Pi ≤n&0≤E(Pi) ≤Erem

Such that J[I, Erem] is going to determine the optimized energy[13], and processing ability of the node with data packets which consume the $\boldsymbol{E(P_i)}$ energy to process. The entries of the array J[I, Erem] gives the optimized energy, and processing ability of the node. However work avoids the following considerations; Where J[n,Erem] is an array having the maximum flows to evaluate from a specific intermediate node. At the same time, in the following circumstances, array elements are not taken into account.

1.J[0,Erem]=0, ∀0≤ E (P_i) ≤ Erempacket does not processed

2. J[i, Erem] = - ∞∀ E (P_i) < 0, not acceptable

Optimization solution is as follows

$$J[I, E_{rem}] = \max (J[I-1, \boldsymbol{E(P_i)}], J_i + J[i-1, \boldsymbol{E(P_i)} - \boldsymbol{E(P_{i+1})}]$$
$$\forall\ 1 \leq i \leq n \text{and} \quad 0 \leq \boldsymbol{E(P_i)} \leq E_{rem}$$

Knapsack adds an additional Boolean array Keep [I, $\boldsymbol{E(P_i)}$] to calculate the optimum energy and computing capability of the node, which becomes one if the node decides to process the Pi' the packet in J[and zero otherwise. The algorithm for calculating the node's optimum energy and processing capability is shown below.

Algorithm

Initialization for Y⟶1 to y

create initial position for every swarm

1. *Q← 0// for initialization*

2. ***While*** *Q ≠ END*

Node density with best position is calculated

*4. **Do** //for every particle*

5. Calculate £ and

*6. **If** (*

7. Calculate

8. Find new velocity £

9. P = P +1

*10. **End if***

*12. **End do***

*13. **End while***

Algorithm1. Algorithm to calculate the optimized energy, and processing ability of the node

IV Results Evaluation

Proposed mechanism of optimized energy, and processing ability of the node for cluster head selection has been evaluated with the help of NS-2with extension of VanetMobiSim. The simulation environment consists of one-directional road with 5 km of length with 3 lanes, the simulation parameters re shown in table 1. The number of vehicle considered are 100, and the area of simulation is about 1000m *1000 m. The mobility of vehicles are set with 10-40 m/s. EHCP values are compared with the obtained the results. The performance evaluation[8] parameters are lifetime, packet delivery, and delay.

Table-1: Simulation Parameters

Network, Parameters	Values
Compunction range	100-300m
No. of Road side units	3
Mobility	Random
Network layer	RCRP
Simulation, Time	1500 s
Mobility	10-40 m/s
Mobility Communication.	Two-Ray-Ground
Queue	Drop-Tail
Energy	100j
Simulation area	1000m x 1000m
Traffic	CBR

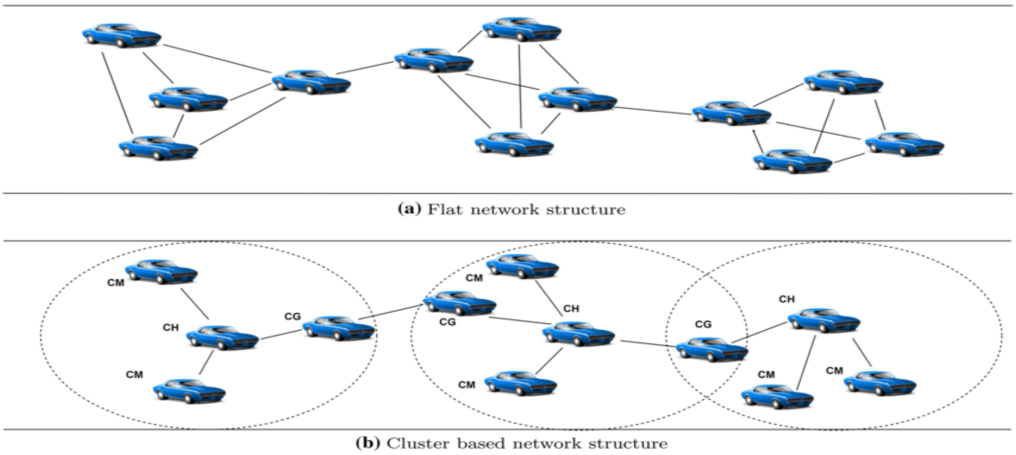

Fig 2: Flat and Cluster based network structure

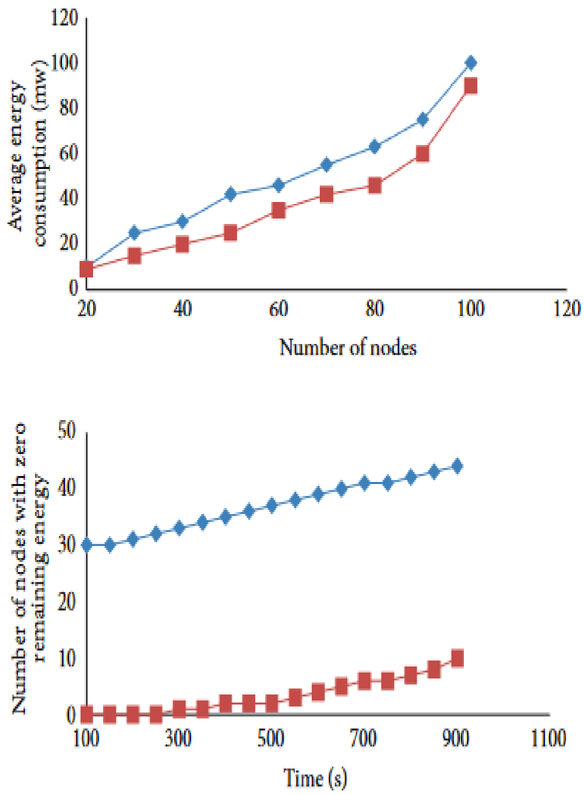

Figure 3:- Performance analysis a **packet delivery fraction and energy consumption with optimized cluster forming and Residual energy based cluster forming**

In terms of throughput, latency, PDF, and energy consumption, Figure 3 depicts the performance evaluation findings of existing Residual energy based cluster forming and optimized cluster forming. The results clearly show that the proposed cluster technique improves performance [9][10]. In a VANET, simply examining the node's residual condition isn't enough to improve network performance; it's also necessary to evaluate the node's residual status in terms of packet processing ability [11][12].

V Conclusion

VANETs (Vehicular Ad Hoc Networks) are a type of mobile ad hoc network that allows users to move around freely. The network used to disseminate data among automobiles to aid with roadside traffic monitoring, navigation, and vehicle safety. Clustering on the VANET solves the scalability problem while also making the network more robust. To accomplish optimal resource usage, the article devised an energy efficient clustering technique. Cluster creation is based on the node's optimized energy processing ability. In a similar context, the suggested technique is validated using NS2, and its performance is compared to that of existing residual energy-based clustering. The proposed technique outperforms in terms of energy usage, packet delivery, and delay, according to the findings.

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