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RESEARCH ARTICLE

Energy Aware Cross Layer Based Clustering and Congestion Control Using Mexican Axolotl Algorithm in VANET

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Abstract – In recent years, wireless communication networks have been developing rapidly, which causes many challenges to be faced in vehicular ad hoc networks (VANETs). Congestion is a degradation of the quality of service in which messages begin to be delivered less often to the recipient. So, in this paper, to optimize the energy efficiency of network cross layer based clustering protocol is presented. For clustering, Reputation based Weighted Clustering Protocol (RBWCP) is presented. To enhance the clustering performance of RBWCP, clustering parameters of the protocol are optimally chosen using Mexican Axolotl Algorithm (MAA). In this work, cluster head is selected in every cluster using the weight vehicle's reputation such as speed, direction and position. After the formation of cluster, mean value of vehicle density (MVVD) threshold is estimated depend on the received signal strength of the vehicles. This threshold value is compared with the density of each vehicle inside the cluster. If the density of the vehicle is greater than the threshold, then the cluster is divided into sub-clusters. It leads to control the congestion in the network. The execution of the proposed model is calculated in terms of cluster lifetime, delivery ratio, delay, overhead and throughput.

Index Terms – VANET, Congestion, Mexican Axolotl Algorithm, Energy-Efficient Clustering Algorithm, Vehicle Density, MVVD Threshold.

1. INTRODUCTION

Over the past few years, VANETs technology has emerged as an essential research area, which continues to provide many challenges and problems [1]. This system is designed to allow vehicles to communicate without using a central station or controller, making it easy to set up and maintain [2]. During critical medical emergencies, VANET is vital in saving human lives in areas where basic infrastructure is unavailable [3]. However, with these useful applications of VANET, new challenges and problems arise. Vehicles are given additional responsibilities due to the lack of infrastructure in VANET. Managing communication within the network with its communication requirements is one of the functions of each vehicle as part of the network. VANETs are responsible for communication between vehicles moving in a specific environment.

There are two types of vehicle communication, vehicle-to-vehicle communication (V2V) and vehicle-to-infrastructure (V2I) [4] [5]. In V2I, the vehicles communicate to infrastructure such as roadside units (RSU). Furthermore, the VANETs are used for various applications such as road traffic safety, reducing travelling time and congestion, dynamic topology, frequent disconnections, mobility modelling, predictable mobility pattern, etc [6] [7]. Congestion is a well-known problem resulting from the rapid expansion of the vehicular framework and the efficient use of wired as well as wireless networks [8]. The effect of congestion increases and causes network latency and packet loss [9] [10] [11] [12].

1.1. Problem Statement and Contributions

In an automotive environment, network congestion negatively impacts quality of service (QoS) [13] [14]. It occurs when a network node or link tries to receive too much data. Congestion takes place in the VANETs as a result. This problem can be solved by extending capacity or controlling packet data rates. This can be overcome by enhancing the hardware and developing the software carefully. When critical safety messages start to fail, the safety of drivers, passengers and other human beings on the roads becomes vulnerable. This is against the QoS of the VANET. Hence a congestion

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control framework is critical to keep the channel loose from congestion. When the traffic density on the street is high, spread messages are generated by nearby vehicles, which can cause channel overload. This causes channel congestion and hence packet loss. So, to overcome these issues, the following contributions are presented in this paper.

- To optimize the energy efficiency of network cross layer based clustering protocol is presented.
- For clustering, Reputation based Weighted Clustering Protocol (RBWCP) is presented.
- To enhance the clustering performance of RBWCP, clustering parameters of the protocol are optimally chosen using Mexican Axolotl Algorithm (MAA).
- Cluster head is selected in every cluster using the weight vehicle's reputation such as speed, direction and position.
- After the formation of cluster, mean value of vehicle density (MVVD) threshold is estimated depend on the received signal strength of the vehicles.
- This threshold value is compared with the density of each vehicle inside the cluster. If the density of the vehicle is greater than the threshold, then the cluster is divided into sub-clusters. It leads to control the congestion in the network.

The remaining section of the paper is shorted as follows: Section 2 relates some conventional work which concentrated research on congestion control in VANET. Section 3 provides proposed methodology of Mexican Axolotl Algorithm based Reputation based Weighted Clustering Protocol. The experimental results and performance analysis was conducted in section 4. Section 5 concludes the work.

2. LITERATURE REVIEW

Here, some recent works related to congestion control in VANET are discussed. Regine and Menakadevi [15] had developed a model for node density based congestion control in VANET using dynamic clustering mechanism. In this approach, the authors had used dynamic clustering devices based on density. This method was used to determine the node density of the precise location in a lane. Also, this method was provided best solution for congestion. Besides, the average vehicle density threshold computed using the trained dataset was used to trigger the congestion control process in the cluster. The dynamic clustering process was triggered based on the node density and threshold value. The results showed that the model was outperformed in terms of parameters. However, energy efficiency of the network is to be increased further.

Joshua et al. [16] had developed multi objective firefly algorithm based reputation based weighted clustering protocol in VANET. In this method, the authors had used RWCP for VANET. This method was mainly enhance the clustering time, improve packet delivery ratio and reduce cluster head. Besides, the parameters of the RWCP were optimized by using evolutionary algorithm such as MOFA. The effectiveness of the method was compared with the other existing Particle swarm optimization (PSO) and Multi-objective PSO methods. The obtained simulation results demonstrate that MOFA performs better than the next two standardized approaches. However, convergence speed of the algorithm is to be improved further for optimizing the parameters of RWCP.

Fan et al. [17] had developed a model using dynamic clustering algorithm based on mobility metrics in VANET. In this approach, the authors had used DCA based mobility metrics for VANET to create stable clusters, enhance lifetime of the cluster and decrease clustering reaffiliation times. Besides, the spatial dependence was used to determine the cluster structure, which described as the mobility similarity relationship between different nodes and after that, the effectiveness of the model was compared with the other existing algorithms such as lowest ID and Max-degree algorithm. From the results, the proposed algorithm cloud achieved the cluster stability with longer cluster life time and less reaffiliation time. Nevertheless, delivery ratio of the network is to be improved.

Ramamoorthy and Thangavelu [18] had developed a model for VANET by using an improved residual energy and distance based congestion aware ant colony optimization routing. This EESPWC approach produced high packet delivery rate and high throughput with low latency and overhead. In EDR-CAACO, roulette wheel EESPWC was selected based on fitness values of the link. In addition, pheromone level was used to calculate fitness value. The roulette wheel selects paths based on links with the highest fitness values. A combination of high fitness value links provided an energy-efficient congestion-free shortest path. From the results, EDR-CAACO method was achieved better results compared to the other methods based on various evaluation metrics. However, congestion in the network is to be controlled efficiently by presenting sub-clustering techniques.

Ji et al. [19] had developed a model to data transmission using efficient and reliable cluster for VANET. In this approach, a link reliability clustering algorithm was used. Besides, a link lifetime based neighbour sampling strategy was used before clustering. This approach has three stages such as cluster head selection, cluster formation, and cluster maintenance. After that, LRCA routing protocol was used to provide infotainment applications over VANET. To make appropriate routing decisions, they recommend special nodes at intersections to estimate network status. A data forwarding route that has the

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lowest weight is then selected as the optimal one. From the results, in this approach was outperformed in both cluster stability and data transmission. Nevertheless, energy efficiency is to be enhanced further.

Pastor and Chaturvedi [20] had introduced a model for congestion control in VANET by using an enhanced clustering based algorithm. To avoid collision in the VANET channels, a clustering based technique was utilized. The cluster nodes performed to data transmission operation. The performance of the model was enhanced by using this strategy. The performance of the model was evaluated using the packet delivery ration and throughput and the performance of the model was compared with other existing techniques. From the results, the proposed approach provided better results compared to the existing techniques. The authors need to focus on the throughput of the network.

Above reviewed articles in this section presented efficient techniques to control the congestion in the network. Although these techniques output the better results, energy efficiency is to be enhanced further. Thus, this work focuses on to present sub-clustering technique along with the optimized clustering model.

3. PROPOSED METHODOLOGY

3.1. Overview

Figure 1 illustrates the overall workflow of the proposed scheme. As illustrated in the figure, number of vehicles in the VANET is grouped using clustering protocol. To optimize the energy efficiency of network cross layer based clustering protocol is presented. For clustering, Reputation based Weighted Clustering Protocol (RBWCP) is presented. To enhance the clustering performance of RBWCP, clustering parameters of the protocol are optimally chosen using Mexican Axolotl Algorithm (MAA). Cluster head is selected in every cluster using the weight vehicle’s reputation such as speed, direction and position. After the formation of cluster, mean value of vehicle density (MVVD) threshold is estimated depend on the received signal strength of the vehicles. This threshold value is compared with the density of each vehicle inside the cluster. If the density of the vehicle is greater than the threshold, then the cluster is divided into sub-clusters. It leads to control the congestion in the network.

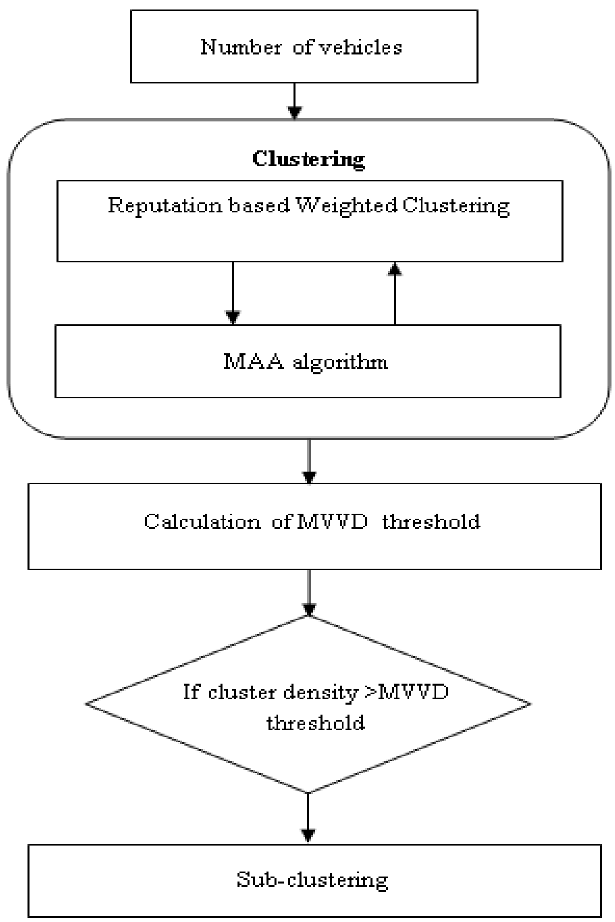

Figure 1 Overall Workflow of the Proposed Scheme

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3.2. Clustering using RBWCP Protocol

RBWCP algorithm is the extension of weight clustering algorithm (WCA). In this algorithm, each vehicle is identified by its highway ID, reputation, direction, time and speed of each vehicle are attained via the Global Positioning System (GPS). In this work, reputation of each vehicle is considered as the major factor to select the CH. The reputation is defined as the number of times a node has become a CH. After the selection of CH, the cluster will be maintained by the following phases: registering in a cluster, leaving a cluster and joining clusters.

3.2.1. CH Selection

In the initial state, each vehicle forwards HELLO message to its one hop neighbour vehicles within the predefined HELLO interval. This message includes reputation details of each vehicle such as speed, direction and position. After receiving the message, each vehicle *v* estimates the weight (W_v). The weight value can be defined using (1),

$$W_v = L_v * w_1 + S_v * w_2 - (H_v * w_3) - (R_v * w_4) \tag{1}$$

Here, L_v denotes the mean distance between the vehicle v and its one hop neighbours, H_v denotes the number of one hop neighbours, R_v denotes the reputation of vehicle v (it is considered as 0 at initial state) and s_v denotes the vehicle's speed, thus S_v can be calculated using (2),

$$S_v = \left| s_v - \frac{\sum H_v s_v}{H_v} \right| \tag{2}$$

Besides, w_1, w_2, w_3 and w_4 denote the weight factors and these represented in (3),

$$\sum_{v=1}^{4} w_v = 1 \tag{3}$$

Then the vehicle sorts the weights of each vehicle that is included in the message. From the sorted list, the vehicle with least W_v will be chosen as the CH within the election interval.

3.2.2. Registering in a Cluster

The selected CH forwards the invite to join (ITJ) message to the one hop neighbours at regular time intervals. After receiving the ITJ message, the one hop vehicle replies as Request-To-Join (RTJ) if it wants to register in the cluster. This RTJ message includes vehicle ID, highway ID, speed, direction and reputation. After getting the RTJ message, the CH checks the highway ID as well as vehicle's direction. Then, the CH forwards the acknowledgement (ACK) if the direction and highway ID of the vehicle match with that of CH. At final, the vehicle is jointed as cluster member to the cluster.

3.2.3. Leaving a Cluster

A vehicle exists inside the cluster until it is receiving the ITJ message from the corresponding CH. If the vehicle stops getting ITJ message from the CH within the CH_Timeout_interval, it understands that the communication is terminated with the CH. The CH keeps timestamps list for Pre_Interval (existence of cluster member to the CH) message attained from the corresponding cluster members. If RTJ is not received from any cluster members by the CH during cluster member_Timeout_interval, it perceives that all cluster members are left away the cluster. The reputation of CH will be decreased by -1 if the CH leaves the cluster without selecting another CH.

3.2.4. Joining Clusters

The CHs of all clusters which move in same highway ID as well as same direction receive ITJ message from each other. Among the CHs, the one which is having greater signal strength than the threshold value is considered as the only one CH and other CHs are considered as the cluster members. For the joining clusters, CH will be chosen based on W_v.

3.3. Optimization of RBWCP using MAA

In general, each protocol can be performed depend on the appropriate parameters configuration. In this work, for enhancing the performance of RBWCP protocol, parameters of the protocol are optimized using MAA algorithm.

Table 1 Optimized Parameters

Parameters	**Solution representation**	**Range**
w_1	P_1	[0, 1]
w_2	P_2	[0, 1- w_1]
w_3	P_3	[0, 1-($w_1 + w_2$)]
w_4	P_4	[0, 1-($w_1 + w_2$ + w_3)]
cluster_size	P_5	[1, $\frac{2}{(le+sd)} * (z * Tr)$]

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Hello_interval	P_6	[0.5, 15]
Election_interval	P_7	[0.5, 15]
Cluster member_Time out_interval	P_8	[3, 45]
CH_Timeout_interval	P_9	[2, 45]
ITJ_interval	P_{10}	[1, 15]
Pre_Interval	P_{11}	[1, 15]

Table 1 illustrates the parameters which are to be optimized. All the parameters illustrated in the table are continuous type except cluster size which is the upper limit for the cluster can manage. This cluster size can be defined using (4),

$$cluster\_size < \frac{2}{(le + sd)} * (z * Tr) \quad (4)$$

Here, z denotes the lanes count, Tr denotes the range of transmission, le denotes the vehicles' standard length and sd denotes the standard.

The MAA algorithm is introduced by Yenny Villuendas-Rey et al [21]. It is inspired by the life of the axolotl such as the birth, reproduction and regeneration of axolotl cells, as well as how they live in the aquatic environment. Since axolotls are sexual creatures, the population is split into males and females.

This algorithm takes into account the ability of axolotls to change their color as well as they change their body color to hide and avoid predators. The following phases of MAA explain the optimization of RBWCP parameters.

3.3.1. Initialization

In MAA, each solution represents the axolotl. In this work RBWCP parameters which listed in the table 1 are considered axolotl. The population of this algorithm is defined using (5),

$$Pop = \{A_1, A_1, ..., A_{np}\} \quad A_n \in Pop, 1 \le n \le np \quad (5)$$

Here, np denotes the size of population. A denotes the solution or axolotl and it can be defined using (6),

$$A_n = \{p_1, p_2, ... p_{11}\}_n \quad (6)$$

3.3.2. Fitness

In this phase, fitness is calculated for each solution. The fitness is calculated depend on the distance (D) between clusters, vehicle speed (S_v) and reputation (R) of the CH. It can be defined using (7),

$$F_n = \min(C_1 * D + C_2 * S_v - C_3 * R(CH)) \quad (7)$$

Here, C_1, C_2 and C_3 are the variables within the range [0, 1]. According to (7), the solution with minimum fitness is chosen as optimal parameters. Else, the solution is updated as per the following phase.

3.3.3. Update the Solution

The solution of this algorithm is updated by following the four phases such as transition, injury & restoration, reproduction and assortment.

3.3.3.1. Transition

The initial population of axolotls is randomly initialized. Each individual is then selected as male or female as the axolotl matures according to its sex, resulting in two subgroups. Transition from larvae to adults then begins. Males will metamorphose from larvae to adults in the water, changing body part color depending on the male that best matches the environment.

The well-adapted individuals may good camouflage, and that other individuals change their coloration accordingly. However, the ability of axolotls to change color is limited, and the authors didn't want everyone to be able to perfectly match the best, so they introduced an inversion probability. Based on such probability, the axolotl would be chosen to jump to the best.

Consider the solution with best fitness as the best adapted male denoted as X_{best} and the transition parameter γ within the range [0, 1]. The male axolotl denoted as X_n alters its colour of the body parts using (8),

$$X_{nm} \leftarrow X_{nm} + (X_{best,m} - X_{nm}) \bullet \gamma \quad (8)$$

Likewise, female axolotls denoted as Y_{best} evolve from larvae to adults to highly adapted females by equation (9). The current female axolotl is denoted as Y_n.

$$Y_{nm} \leftarrow Y_{nm} + (Y_{best,n} - Y_{nm}) \bullet \gamma \quad (9)$$

To select the individuals for random transition, a random number is *rand* is considered within the range [0, 1]. Besides, the inverse probabilities of transition for male and female axolotls are determined using (10) and (11) respectively,

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$$pX_n = \frac{F(X_n)}{\sum F(X_n)} \quad (10)$$

$$pY_n = \frac{F(Y_n)}{\sum F(Y_n)} \quad (11)$$

Here, $F(X_n)$ and $F(Y_n)$ denote the fitness value of male and female axolotls respectively.

Random transition of individuals will be occurred as (12) and (13) only if the value of *rand* is lower than the inverse probabilities of transition.

$$X_{nm} \leftarrow \min_m + (\max_m - \min_m) \times rand_m \quad (12)$$

$$Y_{nm} \leftarrow \min_m + (\max_m - \min_m) \times rand_m \quad (13)$$

3.3.3.2. Injury & Restoration

Walking across water can cause accidents and injuries to axolotls. This process has been considered in the injury and restoration phases. For every A_n in the population, some parts of axolotls body lose if damage probability (p_d) is satisfied. Besides, m^th body part of axolotls will be lost with the probability of regeneration (p_{re}) and it will be replaces using (14),

$$p'_{nm} \leftarrow \min_m + (\max_m - \min_m) \times rand_m \quad (14)$$

3.3.3.3. Reproduction and Assortment

For every female axolotl in the population, a male was chosen to produce the offspring. For this, selection of tournament is used. The male then deposits the sperm and the female uses the coat and deposits it into the sperm. An egg is created with genetic information from both parents. Each pair of male and female maids has two eggs. The female lays eggs and waits for them to hatch. Once released, the various processes begin. Newly formed individuals will compete with their parents for survival in the population. If, according to the fitness function, the young is good, they will be replaced by the young.

3.4. Termination

The algorithm is continued until attaining the optimal parameters. Else the algorithm will be terminated. Steps of selection of RBWCP parameters are described in algorithm 1. At final, compact clusters will be formed with optimal number of vehicles for each CH using the optimal RBWCP parameters.

Input: $P_1, \ldots, P_{11}$, np, population of X, population of Y,

Output: Optimal parameters

1. Initialize the population of solutions
2. Split the population of solution and opposite solution as male (X) and female (Y)
3. Calculate fitness for each solution using (7).

Transition

4. Choose X_{best} and Y_{best} based on the fitness.
5. Calculate pX_n and pY_n using (10) and (11).
6. **If** $pX_n < rand$

   $X_{nm} \leftarrow X_{nm} + (X_{best,m} - X_{nm}) \bullet \gamma$
7. **Else**

   $X_{nm} \leftarrow \min_m + (\max_m - \min_m) \times rand_m$
8. **End If**
9. Update X_{best}
10. **If** $pY_n < rand$

    $Y_{nm} \leftarrow Y_{nm} + (Y_{best,n} - Y_{nm}) \bullet \gamma$
11. **Else**

    $Y_{nm} \leftarrow \min_m + (\max_m - \min_m) \times rand_m$
12. **End If**
13. Update Y_{best}

Injury & Restoration

14. For each X_n
15. **If** $rand \le p_d$
16. **If** $rand \le p_{re}$

    $X_{nm} \leftarrow \min_m + (\max_m - \min_m) \times rand_m$
17. Update X_{best}
18. For each Y_n
19. **If** $rand \le p_d$
20. **If** $rand \le p_{re}$

    $Y_{nm} \leftarrow \min_m + (\max_m - \min_m) \times rand_m$
21. Update Y_{best}

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Reproduction and Assortment

22. For each Y_n
23. Choose a X_n from the population using tournament selection.
24. Attain two eggs egg_1 and egg_2
25. Calculate fitness for egg_1 and egg_2
26. Sort X_n, Y_n, egg_1 and egg_2 based on their fitness values
27. Consider the first best individual as Y_n and second best as X_n.
28. **If** F(X_{best}) < F (Y_{best})

$$Best\ solution \leftarrow X_{best}$$

29. **Else**

$$Best\ solution \leftarrow Y_{best}$$

30. **End if**

Algorithm 1 Optimal Selection of RBWCP using MAA Algorithm

3.5. Density of Cluster and MVVD Calculation for Sub-Clustering

After the formation of clusters, density of each cluster is monitored. In the situation of high traffic, a cluster may congest with more number of vehicles. To control the congestion in the cluster, sub-clustering technique is used in this work. Figure 2 illustrates the workflow of sub-clustering. As illustrated in the figure, speed of each vehicle inside the cluster is monitored. If the speed of the vehicle (S_v) is lesser than the minimum vehicle speed, the vehicle will be included in the calculation of cluster density. Density of the cluster (k) is estimated using (15),

$$k = \frac{1}{L(v_r)} \tag{15}$$

Here, $L(v_r)$ denotes the distance among the vehicles on the segment of road *r*. The calculation of MVVD is described using (16),

$$Mean\ \min imum\ value(k_{\min}) = \sum_{i-1}^{t} \min imum(k_i)/t \tag{16}$$

According to (16), $k_{\min}$ is estimated by summing the ratio of minimum density of each cluster and total count to monitor the density.

$$Mean\ \max imum\ value(k_{\max}) = \sum_{i-1}^{t} \max imum(k_i)/t \tag{17}$$

According to (17), $k_{\max}$ is estimated by summing the ratio of maximum density of each cluster and total count to monitor the density.

The MVVD is estimated using (18),

$$MVVD = \frac{(k_{\min} + k_{\max})}{2} \tag{18}$$

According to (18), MVVD threshold value is estimated by calculating the mean of $k_{\min}$ and $k_{\max}$.

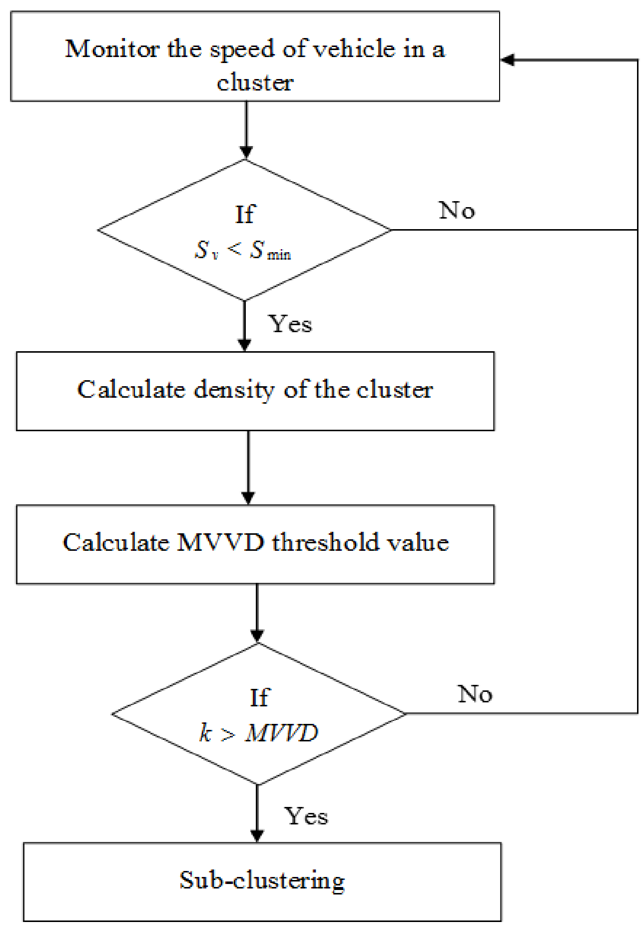

Figure 2 Workflow of Sub-Clustering

Then the estimated density of the cluster is compared with the MVVD threshold value. If the density of the cluster exceeds the threshold, then the cluster region is divided into sub-clusters to control the congestion. Figure 3 illustrates the two cluster regions in the network. As depicted in the figure 3, density of cluster 1 is greater than that of cluster 2. Figure 4 depicts the sub-clusters of cluster 1. As the density of cluster 1 exceeds the threshold, the cluster 1 is divided into sub-

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clusters with sub-cluster length one and two. Then the cluster members of each sub-cluster region are found depend on the members who belong to the corresponding region. Then the CH selection phase is initiated for each sub-cluster region.

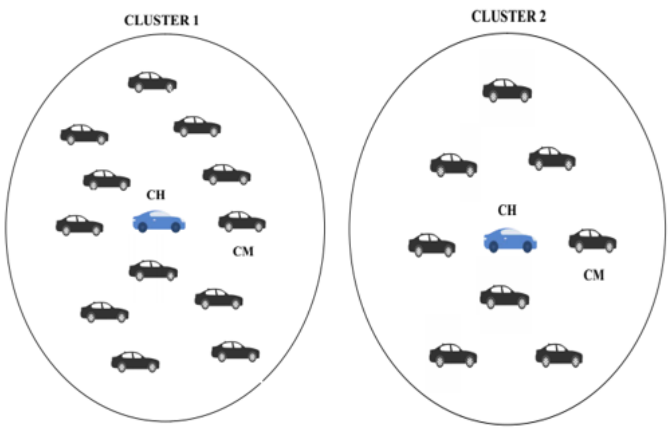

Figure 3 Cluster Regions in the Network

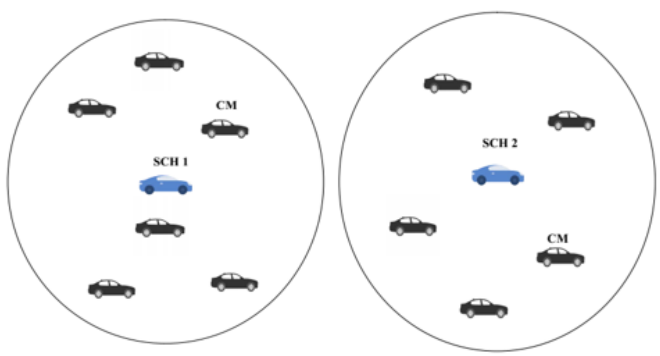

Figure 4 Sub-Cluster of Cluster 1

4. RESULTS AND DISCUSSION

This cross layer based optimal routing and MAC scheduling is executed in NS2. Table 2 shows the simulation parameter and its values. In this simulation 250 nodes or vehicles are used. These nodes are simulated in the simulation area 1000m×1000m. For routing, AODV routing protocol is used and 802_11 standard medium access control is utilized. Also, in this simulation, the data packet with the size of 512bytes is transmitted with the rate of 500kb/s. Initial transmitting power of each node is 0.66W, initial receiving power is 0.395W and initial energy is 10.3J.

Table 2 Simulation Parameters

Parameters	**value**
Area size	1000m×1000m
Number of vehicles	1000
Protocol	AODV
MAC	802_1
Packet size	512 bytes
Initial transmitting power	0.66W
Initial receiving power	0.395
Rate	500kb/s
Initial energy	10.3J
Simulation time	50secs

4.1. Performance Analysis

The performance of the proposed MAA based RBWCP with sub clustering (RBWCP-MAA-WSC) is analysed by varying the number of vehicles. Besides, the performance of RBWCP-MAA-WSC is compared with that of MAA based RBWCP w/o sub clustering (RBWCP-MAA-WOS) and RBWCP with sub-cluster (RBWCP-WSC).

4.1.1. Cluster Lifetime

It is defined as the total time of cluster exists. Figure 5 illustrates the comparison of cluster lifetime of different approaches. As the RBWCP protocol is optimized using MAA algorithm, clustering is so efficient in the approach. Besides, the lifetime of the cluster is maintained because of the sub-clustering of high density cluster. Namely, compared to RBWCP-MAA-WOS and RBWCP-WSC, cluster lifetime is increased to 47% and 49% respectively by presenting RBWCP-MAA-WSC.

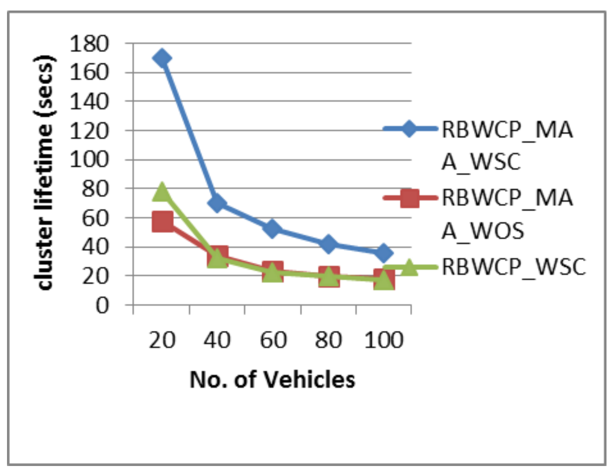

Figure 5 Performance Analysis of Cluster Lifetime

4.1.2. Delay

It is defined as the transmission time of a bit to reach the destination. The comparison of delay of different approaches is illustrated in figure 6. According to the figure, compared to

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RBWCP-MAA-WOS and RBWCP-WSC, the delay of proposed approach is decreased 42 % and 41% respectively by presenting RBWCP-MAA-WSC. Because of sub-clustering, the congestion in a region is reduced. Thus, the delay of packet delivery of the proposed model is reduced.

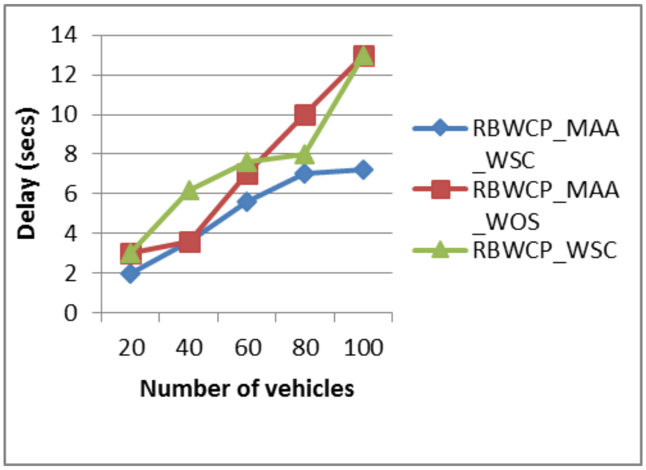

Figure 6 Comparison of Delay of Different Methods

4.1.3. Delivery Ratio

It is obtained by dividing the number of data packets arriving at the destination by the total number of data packets forwarded from the source vehicle. The comparison of delivery ratio of different approaches is illustrated in figure 7. When analysing figure 7, compared to RBWCP-MAA-WOS and RBWCP-WSC, the delivery ratio of proposed approach is increased 37% and 27% respectively by presenting the proposed approach because of sub-clustering scheme.

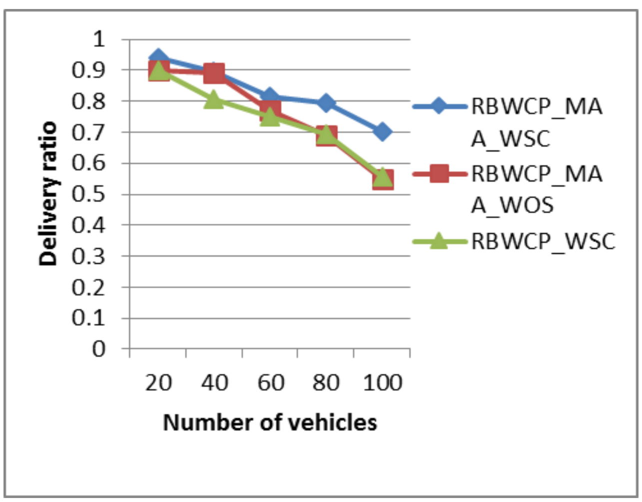

Figure 7 Comparison of Delivery Ratio Different Methods

4.1.4. Packet Drop

It is described as the failure of number of packets to reach their destination on a network. Figure 8 illustrates the comparative analysis of drop of different approaches. As depicted in the figure 8, the drop of the proposed approach is decreased 57% and 66% when compared to RBWCP-MAA-WOS and RBWCP-WSC approaches.

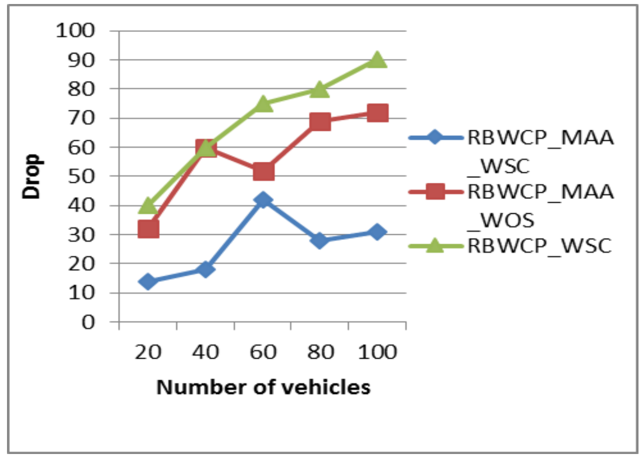

Figure 8 Comparison of Drop of Different Methods

4.1.5. Overhead

It is defined as the excess amount of packets used during the communication. The comparison of overhead of different approaches a depicted in figure 9. However, compared to RBWCP-MAA-WOS and RBWCP-WSC, the overhead of RBWCP-MAA-WSC is decreased 25% and 30 % respectively by presenting the proposed scheme.

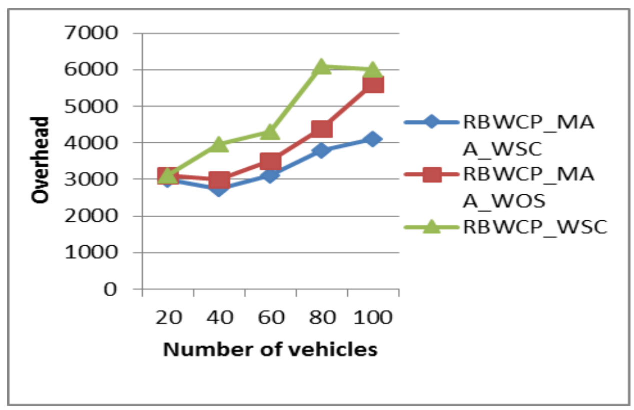

Figure 9 Comparison of Overhead of Different Methods

4.1.6. Throughput

The throughput is calculated based on the amount of data moved successfully from one vehicle to another in a given time period. Figure 10 depicts the comparative analysis of throughput of different approaches. As depicted in the figure, the throughput of the network is increased when the number of vehicles increases. However, compared to RBWCP-MAA-WOS and RBWCP-WSC, throughput of RBWCP-MAA-WSC is increased to 29% and 87% respectively.

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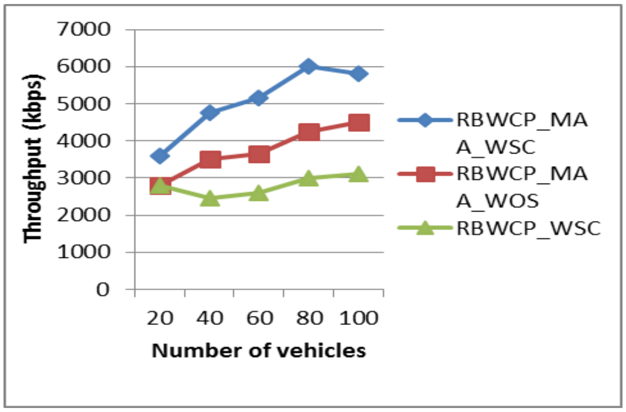

Figure 10 Comparison of Throughput of Different Methods

5. CONCLUSION

In this paper, to optimize the energy efficiency of network cross layer based clustering protocol has been presented. For clustering, Reputation based Weighted Clustering Protocol (RBWCP) has been presented. To enhance the clustering performance of RBWCP, clustering parameters of the protocol are optimally chosen using Mexican Axolotl Algorithm (MAA). In each cluster, cluster head has been selected using the weight vehicle's reputation such as speed, direction and position. This threshold value has been compared with the density of each vehicle inside the cluster. If the density of the vehicle has been greater than the threshold, then the cluster has been divided into sub-clusters. The proposed RBWCP-MAA-WSC model proved that to control congestion in the network has been improved. From the simulation results, the network lifetime and delivery ratio of the proposed model are increased 47% and 37% respectively.

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