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Optimal Geographical Cluster Based Routing Protocol in Vehicular Ad-Hoc Networks Using Hybrid Meta-Heuristic Algorithm for Network Lifetime Enhancement

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Abstract
VANET is a subdivision of mobile ad hoc network (MANET), that has many applications in the areas of vehicular communication. To establish VANET, Medium Access Control and Routing Protocol must be developed. Due to development of technologies, there are several technical challenges in forming the network due to data congestion and poor network lifetime issues. To overcome these limitations, Optimal Geographical Cluster-based Routing (OGCR) protocol for VANET is proposed. In OGCR protocol, the clustering process will divide into two stages, first, the multi-hop cluster formation is performed by a Chaotic Ant Swarm optimization (CAS) algorithm, and then Cluster Head (CH) selection is performed by the degree of optimal cluster member's metrics. CAS algorithm inspired from the conventional ant colony system, and it reduces the number of clusters, that ends with CH changes. In cluster routing, intra cluster communication aims to forward data from cluster members to CH. The mimic Differential Search (DS) algorithm utilized to perform the inter cluster communication i.e., data transfer between one CH to neighboring CHs, which reduce the unwanted communication overhead. Moreover, the optimal pathfinder algorithm used to reduce the extra time of exchange control packets (i.e., control overhead reduction). SUMO traffic generator and Network Simulator (NS-3) tool evaluate the performance of proposed OGCR protocol. Simulation result shows the effectiveness of proposed OGCR protocol compared to existing state-of-art routing protocols.

Keywords — Chaotic ant swarm optimization (CAS) algorithm, Cluster Head (CH), mimic differential search (DS), Optimal Geographical Cluster based Routing (OGCR) protocol, Optimal pathfinder algorithm, VANET

1. Introduction

Vehicular ad-hoc networks (VANETs) are sub class of mobile ad-hoc networks (MANETs) that are formed between moving vehicles under different circumstances. VANET, expanding its research to greater heights, which enables a wide extent in automobile industry, by using map it easily locates the destination by finding the shortest path, communication with other vehicles, traveller convenience and insightful transportation [1]. It helps to protect lanes by scattering information about the road conditions, traffic and weather information among the intrigue vehicles in a favourable manner [2]. VANETs spread huge, consistent information to the customers, for instance, travel information, climatic information, and media applications. VANETs enable automated expressway applications, where the vehicles can journey without the help of their drivers, regardless of the way that such applications have not yet become sensible [3]. VANETs has a segment of the characteristics, like flexible central coordinator, self-routing information through different nodes, partitioned framework and dynamically advancing topology. [4]. It is challenging to address the security issues, traffic management in VANET among the moving vehicles [5].

In MANET, unicast routing is a primary method for vehicle to forward the information from source-to-destination node [6]. In Fuzzy based Multicast routing, multiple senders can forward the messages to multiple receivers with the help of intelligent intermediate nodes [7]. Geocast routing is to send or receive information based on specific geographic territory [8]. In general, source vehicle sends messages to each other vehicle in the framework [9]. Regardless, of MANETs, VANETs which is the sub levels of MANETs, is a kind of traffic model and frequently changed topology. As it is known that in MANET the central coordinator is fixed, but in VANET it keeps on moving that causes MANETs characteristics can't be truly applied to VANETs. Routing in VANETs is a key issue. A steady state routing described in [10] used to control the traffic significantly in VANET flexible frameworks. Flooding of multiple requests is reduced by extending the association range of the selected path. Dynamic source routing (DSR) and Ad-hoc On-demand Distance Vector routing (AODV) won't work with long time recovery [11]. A border node-based routing protocol (BBR) [12] continue through the framework portion on account of low centre point thickness and high centre flexibility. A two-phase controlling protocol (TOPO) [13] for long scale VANETs is an outline of high traffic lanes. A Greedy Traffic Aware routing protocol (GyTAR) [14] is an integrated land route aimed at finding urban conditions. The fundamental guideline behind GyTAR is the dynamic and selection of nodes through which the information is sent to the target. A Road based vehicular traffic (RBVT) routing protocol [15] mainly used in city based VANETs. RBVT protocol influences static vehicular traffic data with greater potential, organizes the network between them to create road-based routes. The Intersection based Geographical routing protocol (IGRP) [16] possibly select the right path to send the packets to reach the gateway of internet. Location based routing protocol [17] consolidates the highlights of received packets through area based geographic routing especially to address the breakage of connections. Street and Traffic Aware Routing (STAR) effectively limit the signs of traffic lights on the junction, along with traffic designs, and decide the routes to send the packets. Distributive adaptive distance with channel quality (DADCQ) protocol [18] uses distance method to send packets.

A Greedy perimeter stateless routing protocol [19] shows the route with the base number of moderate intermediate nodes while thinking over availability and the master node key job is sharing the network status information in routing table. Junction based multipath source routing (JMSR) [20] is a geographic routing protocol, it retrieves even the street location of the nodes with the help of satellite maps. It transfers the information simultaneously two ways through various intermediate nodes.

2. Related works

There are lots of research have been presented in Optimal Geographical Cluster-based Routing protocol in Vehicular Ad-hoc Networks. Some of the existing research relevant to OGCR in VANET using various techniques are listed below,

Bhoi et al. [21] have proposed a safe and clever routing protocol to give better transportation system to the passengers and drivers. This protocol encourages the vehicles to send their information in a protected and neat way. Secure and Intelligent Routing protocol (SIR) recognizes the intermediate vehicles with quickest path after getting authentication to forward the information. In this paper, with Network Gap Encounter (NGE) the early network gap junction is detected. Also, the path length decreases while ignoring the malignant vehicles in the path.

Chang et al. [22] have proposed the improved separation-based routing protocol mirroring these VANET qualities. The protocol conquers urban vehicular situations with less systems overhead and applied two fundamental methodologies which are a convergence-based course disclosure and a steady transfer hub choice plan. The intersection point-based course disclosure is structured dependent on the Intersection Waiting Time (IWT) system to take action because of something surround to have uniformity. It empowers to scatter messages towards all intersection point. The steady state node is planned on the adaptive waiting time (AWT) organized with a relative distance and a relative speed between a sender and neighbouring nodes.

Zhu et al. [23] have researched the geographic routing protocol for the multilevel environment VANET and proposed a Multilevel scenario Greedy opportunity routing protocol (M-GOR). This type of routing protocol measure the connectivity and greedy forwarding packets. The computation technique for the availability likelihood and a GOF calculation is utilized to react these effects. The reproductions from both the system layer and framework level have confirmed the precision of this investigation and showed that M-GOR picked up to 20% expansion on the conveyance proportion and 10% lessening on the normal jump tally.

Togou et al. [24] have proposed stable CDS-based routing protocol (SCRP) is a dispersed routing protocol that processes end to end delay for the whole routing way before sending information messages. SCRP maintains good connectivity on roadside units and ensure the connection with all intermediate nodes. Based on delay and connectivity this routing protocol assigns weight to roadside units. Roadside unit with least weights are used to forward the information.

3. Problem methodology and System model

This part expresses an optimal geographical cluster-based routing protocol in vehicular ad-hoc networks using hybrid meta-heuristic algorithm (OGCR). This, paper describes about chaotic ant swarm optimization (CAS) algorithm, mimic differential search (DS) algorithm, optimal pathfinder algorithm.

3.1. *Problem methodology*

Kumari et al. [25] have exhibited an effective routing protocol for example AHP based Multimeric Geographical Routing Protocol (AMGRP) as it receives an Analytical

Hierarchical Process (AHP) while considering numerous routing criteria. The protocol executes the figured single-gauging capacity to recognize a next jump node inside a characterized run which can guarantee an improved sending process. An AHP instrument is utilized to join different choice criteria into a existing gauging capacity accordingly upgrading the routing protocol over various measurements. The reproduction is completed in a sensible urban situation with impediment displaying to show the enhancements of AMGRP routing instrument when contrasted and existing routing protocols. Some routing protocols [21]-[31] utilize a few variations in routing support methodology or metric calculation assembles least impedance ways on a jump by-jump premise. The route determination with end-to-end delay (E2ED) is issue of non-security applications in urban VANETs. The fundamental disadvantage is the lifetime of system, which respects diminish the exhibition of the system. Moreover, the nearby most extreme issue and information blockage issues give some negative weight on thought about system. Various routing plans have been proposed to address these difficulties. In any case, building up and keeping up stable cluster is getting one of huge testing issues. To overcome these limitations, this paper proposes optimal geographical cluster-based routing (OGCR) protocol for VANET. In OGCR protocol, the clustering process will divide into two stages, and contributions of this paper is summarized as follows:

- First, the multi-hop cluster formation is performed by a chaotic ant swarm optimization (CAS) algorithm, and then CH selection is performed by the degree of optimal cluster member's metrics. CAS algorithm inspired from the protocol ant colony system (ACS) [26] and it reduces the number of clusters, CH changes. In OCB routing, intra cluster communication aims to forward data from cluster members to CH.
- The mimic differential search (DS) algorithm utilized to perform the inter cluster communication i.e., data transfer between one CH to neighbouring CHs, which reduce the unwanted communication overhead.
- Moreover, the optimal pathfinder algorithm used to reduce the extra time of exchange control packets (i.e., control overhead reduction). Here SUMO traffic generator simulators and Network Simulator (NS-3) tool is used to evaluate the performance of proposed OGCR protocol. The simulation result shows the effectiveness of proposed OGCR protocol compared to existing state-of-art routing protocols.

3.2. *System model for proposed OGCR protocol*

In the proposed OGCR protocol, the clustering process is dividing the two processes. Initially, the cluster formation is done proposed chaotic ant swarm optimization. Then selected the cluster head (CH) based on the performance of cluster members metrics. The multi-hop cluster formation process is finished by CAS algorithm. This CAS algorithm is combination of ant colony algorithm. Then performed the inter cluster routing by using differential search algorithm. This proposed algorithm is reducing the unwanted communication during data transformation between the cluster head and neighbouring cluster head. To reduce the packet loss and overhead reduction, the optimal path finder algorithm is used, and it chooses the paths between nodes and reduces the shortest path problems. The system model of proposed routing protocol is shown in **Figure 1**.

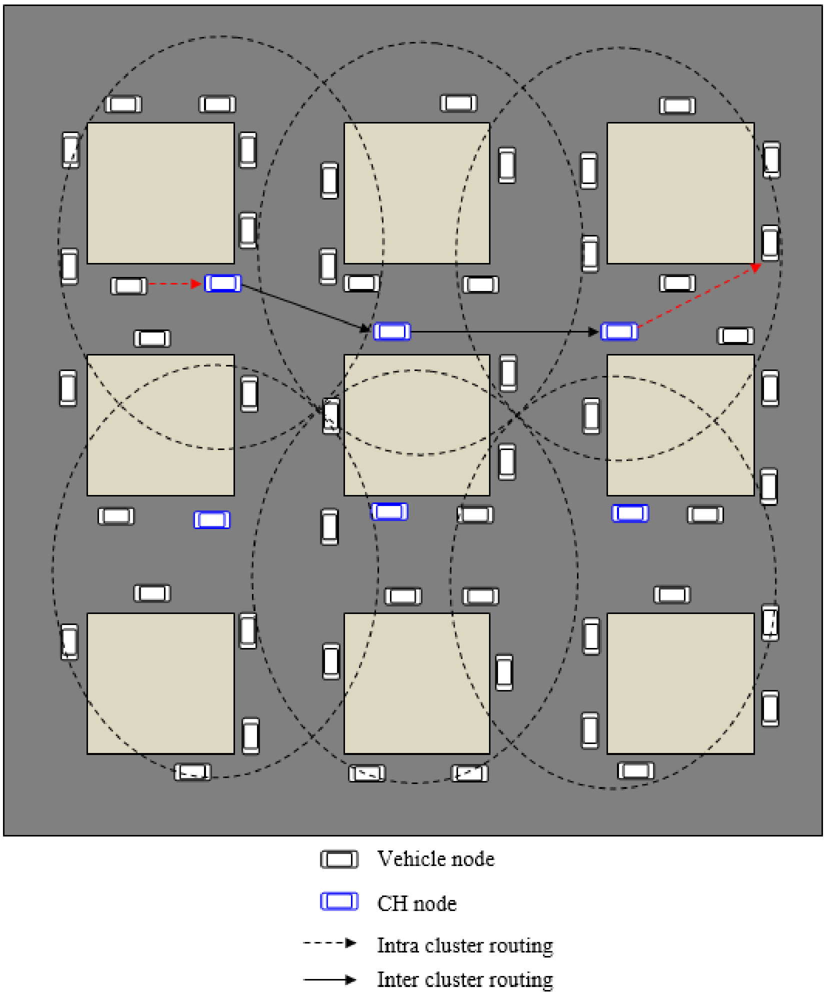

Fig. 1 System model of proposed routing protocol

4. Optimal Geographical Cluster based Routing protocol

4.1. *Multi-hop cluster formations using chaotic ant swarm optimization (CAS) algorithm*

The disorganized insect swarm advancement (CAS) calculation expects the accompanying systems to accomplish the structure objectives expressed:

- Every node can utilize power control to set the transmit control and assess the separation by the transmitter.
- Every node is outfitted with directional reception apparatuses, which can assess direction data from the accepting signal.
- Every node can perform information accumulation and pressure to meld the accepting information packets and its own information parcel into a steady information packet.

The activity of multi-jump grouping calculation is likewise separated into adjusts. Each round incorporates three stages: cluster head determination stage, group definition stage, and consistent state stage. Considering the correspondence separation and the system thickness necessities, the system structures guaranteeing direct correspondence between any part hub and CHs may not be functional for huge scale sensor systems. Thus, for a huge scale remote sensor organizes there is a requirement for multi-jump correspondence structure which doesn't restrict the group size and its zone inclusion. CAS calculation is a compelling multi-jump protocol broadly received in remote sensor arrange. It comprises of transmitting information by utilizing different hubs that go about as switches alongside condition detecting. The middle hubs among the groups course other sensor's information that are bound for cluster heads. The switches hubs are picked to such an extent that the transmit enhancer vitality is limited. In each cluster, source hubs compute the separation to the group heads by embracing CAS calculation. //The optimal multi-hop data information transmission way for every node is appeared in **Figure 2**. At the point when a hub picks hub as its next-jump hub, the picked hub must fulfil two requests. Right off the bat, the picked hub must have a closer separation to the group head. Also, the point making by the first hub, the first hub's next-jump hub, and the first hub's optional jump hub or group head must be a heartless edge. On the off chance that the following jump hub doesn't fulfil the auxiliary interest, the first hub will pick the optional jump hub as its next-jump hub and figure whether fulfil the requests. Therefore, the reason node R_i choosing node C_i as its next-hop node in Figure 2.

$$D^2_{R_i-C_j} + D^2_{C_j-M_k} < D^2_{R_i-M_k} \qquad (1)$$

The distance between the choosing C_i and reason R_i nodes are $D_{R_i-C_j}, D_{C_j-M_k}, D_{R_i-M_k}$ respectively. Once the cluster head has calculated the optimal multi-hop paths, by broadcasts the remaining message and TDMA code to the cluster.

Initialize each ant/node on the process, In the search space, values are assigned to the process and the initialization process and modelling of search space is represented as following equation (1),

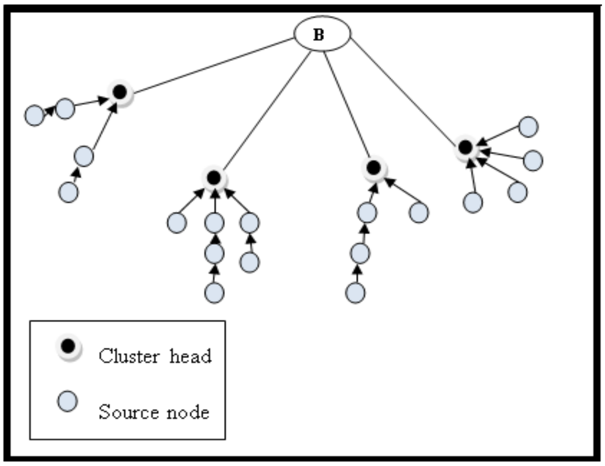

Fig. 2 Multi -hop cluster-based routing architecture

$$T_d = \frac{V}{D_{front}} + D_{back}.NL * 100 \qquad (2)$$

Where, the number of network nodes are V and distance between the vehicles, and it is furthest neighbour in front is represented D_{front}. and traffic density is T_d.The distance between the vehicles and its furthest neighbour behind is D_{back}.The network of roads lanes is represented as NL.

$$l_d = \left[\frac{(1-T_d)}{\lambda'} + 1\right]^{-1} \qquad (3)$$

$$Tr = Tr_{max} \qquad (4)$$

$$Tr = Tr(1 - l_d)_{max} \qquad (5)$$

$$Tr = \sqrt{\frac{Tr_{\max}.\ln Tr_{\max}}{l_d}} + \alpha.\ Tr_{\max} \qquad (6)$$

$$\tau_{C_iR_j}(iter = 1) = \frac{1}{|V_{total}|} \qquad (7)$$

Here, the maximum transmission range between the nodes are represented as Tr_{max}. The nodes transmission range depends defined range in standard is represented as Tr . The local vehicle density is l_d.

4.1.1. Cluster head selection

Each time a node is chosen as a cluster head, its entire network structure is refreshed. Hence, the quality of a node is chosen as group head based on the slow movement of that node and close to base station. The likelihood of every node, chosen as group head is determined dependent on these two qualities.

$$CH_i = \frac{V_{n_{ij}} * \alpha + [\tau_{C_iR_j}(iter)] * \beta}{\sum_{R_i}^{n} CH_i * \alpha + [\tau_{C_iR_j}(iter)] * \beta} \qquad (8)$$

The equation (8) gives the probability of each node to be selected as a cluster head. It is represented by CH_i. $V_n$is the vehicles of each node n. De_{hi} is dependent on the degree associated with each node.

$$De_{hi} = Degree_{vn} + 1 \qquad (9)$$

$\tau_{C_iR_j}(iter)$ is the pheromone concentration associated with each node for an iteration. Process of CAS algorithm using clustering and cluster head is shown in Figure 3.

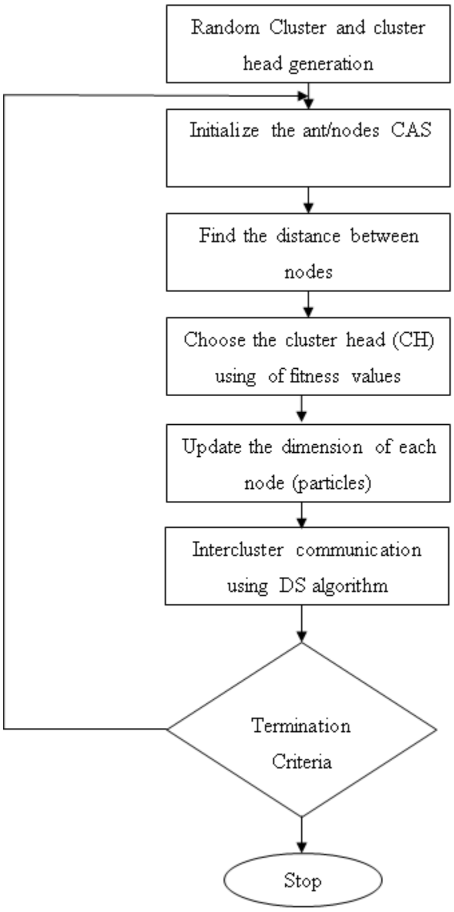

Fig. 3 Process of CAS algorithm using clustering head

4.2. Inter cluster communication using Differential Search (DS) algorithm

The DS algorithm is propelled of differential evaluation and search algorithm. It tackles the beginning stage issue by testing the target works at numerous and arbitrary starting focuses. In investigating the hunt space, the DS calculation exploits the places of individuals to give important data about the wellness scene. The separation between people likewise gives a sign of decent variety in the present populace. A bigger separation between two people implies it has an enormous inquiry space to investigate. Therefore, it can accomplish more extensive investigation. The DS calculation applies this idea through changing and recombining the present populace. Change creates a preliminary vector by transforming an objective vector with a weighted contrast vector. It have two individual, $Y_i^t$and X_i^t in the present populace, which are chosen haphazardly. The equation (10) tells about the generation of preliminary vector V_i^t,

$$V_i^t = X_i^t + F(Y_i^t - Z_i^t) \qquad (10)$$

Where F is a learning rate predefined subjectively. The learning rate is a positive real number controlling the rate at which the population evolves. An effective value for the learning rate is greater than one. The trial vector is employed to produce an offspring Z_i^{t+1} via crossover. The crossover is represented as,

$$Z_{ij}^{t+1} = \begin{cases} V_{ij}^t, & if \quad j \in J \\ Z_{ij}^t, & otherwise \end{cases} \qquad (11)$$

Where J is a condition set to determine which element is inherited from the trial vector. However, the crossover Scheme may differ in some applications. Binomial crossover using one-point, or two-point crossover can also be employed, as well as exponential crossover. And the new solution is generated both neighborhood and best solution. A trial vector V_i^t is generated equation (12),

$$V_i^t = Z_i^t + F(P_b - Z_j^t) \qquad (12)$$

The solution among the population is $P_b$among the populations and random neighborhood selected vector is Z_j^t and scale vector is F.

4.2.1. Initialization of cluster using DS algorithm.

Multi-hop inter cluster communication using DS algorithm. The nodes consists of three parts. The first part is to estimate the scale factor and crossover rate. The second part is to fix the threshold to activate cluster. Based on the active number of clusters, the route is established for maximum time period. $C_{Max}$is active or inactive. Each bit in this part represents whether the corresponding cluster is active or inactive. Multi-hop inter cluster communication using DS algorithm is shown in **Figure. 4**

In this study, a value of less than 0.5 represents an active cluster; otherwise, it is an inactive cluster. Furthermore, the last part represents the centroids of each cluster notated by

$$M_{ijd}^t, d = 1, \ldots\ldots, dandj = 1, \ldots., C_{Max} \qquad (13)$$

The length of this part is $C_{Max}D$.

The fitness value is the group legitimacy esteem. Right now, legitimacy is basically estimated. Fundamentally, improves the standard proportion between the intra-and between clusters by means of mix with a multiplier work. The intra-group is characterized as cluster conservativeness estimation and must be limited. Between group separation is the separation between cluster centroids. It is characterized as the base separation between two groups rather than the normal separation among cluster. Discovered that the standard proportion between the intra-and between group separations may prompt few clusters. The algorithm for inter cluster communication using DS algorithm is

Algorithm 1: Inter cluster communication using DS algorithm

Set $C_{Max} = 0$
For every nodes i=1,..,M
Set $C_i = 1$
While dataset $S \neq \varphi$
From dataset S, Determine an instance i,$i \in S$randomly.
Find its neighbors with the radius r to instance i.
Record the founded neighbors in small clusterC_{k_i}.$S = S - C_{k_i}$
End while
If $C_i > C_{max}$
Update the Ci_{max}
End if
End nodes
For every node
Generates the first part of cluster
For j=1 to C_{max}
If $j \leq C_i$
Set $C_{ij}^0 = 1$
The is Cl_{ij}^0average of the data in cluster C_i
Else
Set $C_{ij}^0 = 0$
Generate Cl_{ij}^0 randomly
End if
End for
End for

Thus, a penalty should be added for too small number of clusters:

$$\text{intra}= \frac{1}{S} \sum_{i \in N_p} \sum_{D_j \in Z_{pi}^t} D_j - C_i^2 \quad (14)$$

$$\text{inter}= \min_{i,j \in N_p, i \neq j} \left\{ \sum_{i \in N_p} \sum_{D_j \in Z_{pj}^t} C_i - C_j^2 \right\} \quad (15)$$

$$VI = (\alpha . N(\lambda, \sigma) + 1) \text{ (intra/inter)} \quad (16)$$

Were, λ the constant number. π is 3.14 and $N(\lambda, \sigma)$is Gaussian function with mead and standard deviation is σ. This above equation (16) is specified as number of clusters is$|N_P|$.

$$N(\lambda, \sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} exp\left(-\frac{(|N_P| - \lambda)^2}{2\sigma^2}\right) \quad (17)$$

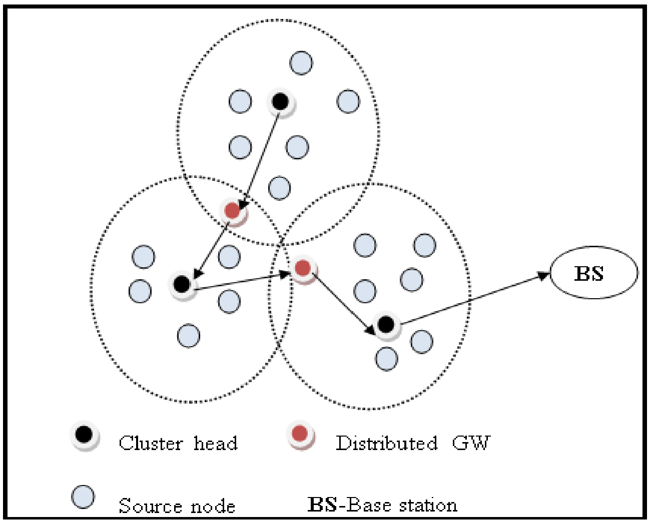

Fig. 4 Multi-hop inter cluster communication using DS algorithm

4.3. *Reducing the extra time of exchange control packets using optimal pathfinder algorithm*

Optimal Path Finder Algorithm (OPFA) utilizes antecedent data to extricate verifiable ways from its separation and routing tables without inordinate overhead. It significantly decreases the quantity of cases where routing circles can happen. The shortest path problem issue is a problem that is begging to be addressed in numerous fields, beginning with route frameworks, man-made consciousness and consummation with PC recreations and games. Albeit these fields have their own calculations, there are many universally useful ways discovering calculations which can be effectively applied. In any case, it isn't in every case clear what point of interest certain calculation has in contrast with its other options. Right now, Manhattan separation was picked as heuristic capacity since it is reasonable for finds the cluster-based separation.

$$D_h = |C_{H1} - C_{H2}| + |C_1 - C_2| \qquad (18)$$

Here, the distance between two cluster head is $|C_{H1} - C_{H2}|$ and distance between the two clusters is$|C_1 - C_2|$ the cluster Manhattan distance is D_h.

*4.3.1. Algorithm**

A* is a path finding calculation utilized for finding ideal way between two focuses called hubs. Calculation A* utilizes best-first hunt to locate the most minimal cost way among start and objective hubs. Calculation utilizes heuristic capacity, to decide the request wherein to cross hubs. This heuristic is aggregate of two capacities:

$$F = G + H \qquad (19)$$

G is exact cost of the path from initial node to the current node; H is admissible (not overestimated) cost of reaching the goal from current node; and mainly equation (19) is cost to reach goal, if the current node is chosen as next node in the path

The algorithms complexity in time can be expressed as,

$$0(|E| + |V|) \qquad (20)$$

The above equation (20) is worst case scenario every cluster and every node are visited. $0(|E| + |V|)$ can fluctuate between $0(|V|)$ and$0(|V|^2)$ depending on path evaluation.

4.3.2. Path finding

For solving the path problems, control packets problems and reducing the traffic collision between the clustering of nodes, a path should be found between the nodes. The path starts from the start node N_{start} and goal nodes N_{goal}. This process is represented in following equation (21),

$$A^{*}(N)=\begin{cases}0 & if\, N=N_{start}\\ \min_{s\in pred(s)'}(A^{*}(N')+C(N',N)) & otherwise\end{cases} \tag{21}$$

The start distance to node is $A^{*}(N)$and the nodes are represented is N.

5. Results and Discussion

The proposed optimal geographical cluster-based routing protocol in vehicular ad-hoc networks (OGCR) is simulated using SUMO traffic generator and Network Simulator (NS-3) tool. Here, the area considered for simulation is 500m x 500m, with bidirectional road scenario. The proposed optimal geographical cluster-based routing (OGCR) protocol for VANET. In OGCR protocol, the clustering process will divide into two stages, first, the multi-hop cluster formation is performed by a chaotic ant swarm optimization (CAS) algorithm, and then CH selection is performed by the degree of optimal cluster member's metrics. In OCB routing, intra cluster communication aims to forward data from cluster members to CH. The mimic differential search (DS) algorithm utilized to perform the inter cluster communication i.e., data transfer between one CH to neighboring CHs, which reduce the unwanted communication overhead. Moreover, the optimal pathfinder algorithm used to reduce the extra time of exchange control packets (i.e., control overhead reduction).

Table 1. Simulation parameters

Parameter	**Value**
Transmission power	10 m W
Number of nodes	50-200
Number of traffic source	10
Data packet length	512 bytes
Carrier frequency	5.8 GHz
Propagation Model	Two-ray ground model
Simulation time	400s
Traffic Type	UDP
Physical layer	IEEE 802.11p (11 Mbps)

5.1. *Performance analysis-Nodes*

In this process the proposed OGCR is compares with other existing methods AMGRP and GPSR. During this process, the constraints of sensor nodes parameters PDR, Normalized routing overhead and hops, delay performances are analysis the following graphs,

5.1.1. Packet Delivery Ratio

This result shows when the road consists of about 17–34 vehicles per km^2 with the average packet delivery ratio of OGCR. In this test scenario, the PDR is increased 5.8% to 6.9% higher than existing scheme AMGRP. The **Figure. 5** clearly explains the PDR is slightly increases.

5.1.2. Normalized routing overhead (NRH)

This represents the ratio of the total number of control packets against the data packet delivered to the destination during the complete simulation. From the **Figure.6**, the Normalized Routing Overhead (NRL) is increased. In a traffic of about 17–34 vehicles per km^2 the routing overhead of the OGCR is increased to be between 11.2% and 15.3% when compared with other existing methods are AMGRP and GPSR.

5.1.3. End-to-End delay (E2ED)

This parameter is used to find the average delay taken by the received data packet to reach the destination. From the **Figure.7**, the delay is slightly increases than other methods. Using of 17–34 vehicles per km^2 on the simulated road topology the latency of OGCR is 3.2–5.7% less than AMGRP and 15.44% less than GPSR. The proposed OGCR is performs better than other existing methods.

5.1.4. Average Hop Count (AHC)

It is the average number of hops required for the packets to reach their destination. For the 16–35 vehicles per km^2 is simulated in NS3, the average hop count (AHC) is lesser by 3.4–5.41% than AMGRP and by 12.43% GPSR is shown in **Figure.8**

5.2. *Performance analysis-Vehicles*

In this process our proposed OGCR is compares with other existing methods AMGRP and GPSR. During this process, the constraints of vehicles parameters PDR, Normalized routing overhead and Average hop count (AHC), delay performances are analysis the following graphs,

5.2.1. Packet Delivery Ratio

While increasing the speed of the vehicles, the performance of all the three protocols degrades as nodes will remain within the communication for a really short period. This period of time is not sufficient to forward all the data packets. When the maximum node speed is about 85 km/h the average PDR of OGCR increases from 5.6% to 8.3% more than AMGRP and 27% to 32.44% more than GPSR is shown in **Figure.9**

5.2.2. Normalized routing overhead (NRH)

The performance metrics analysis of normalized routing overhead (NRL) is shown in **Figure.10**. From that fig.10, the proposed OGCR is increases than AMGRP and GPSR. Our proposed OGCR is increased from 5.6%-7.9% more than AMGRP and increased from 6.8%-10.5%.

5.2.3. End-to-End delay (E2ED)

Performance analysis of end-to-end delay is shown in **Figure.11**. When the vehicles are moving at a maximum speed of about 16 km/h, the average delay in OGCR is reduced from 5.7% to 8.3% less than the AMGRP.

5.2.4. Average Hop Count (AHC)

The average number of hops the protocols has taken using in our proposed OGCR and its performance analysis is shown in **Figure.12**. The average hop count in OGCR is from 6.10%

to 7.4% less than AMGRP and from 20.8% to 23.2% less than GPSR. From the above performance metrics analysis using our proposed OGCR protocols, it provides the better performance with high network lifetime. Comparing with the other existing methods are AMGRP and GPSR, our proposed OGCR is improves the performance of packet delivery ratio, Normalized routing overhead and Average hop count (AHC), delay with better efficiency when comparing other existing protocols. These all analysis shows that our OGCR technique can effectively handle challenges of VANET and provides enhanced traffic efficiency and passenger safety, reduces the collision problems compare to existing AMGRP and GPSR techniques.

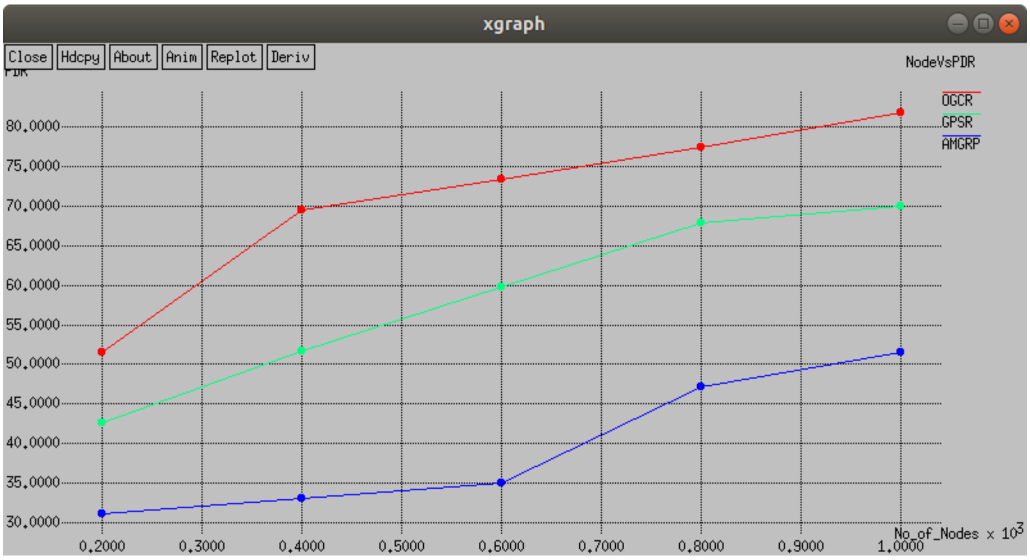

Fig.5 Number of nodes (n) Vs PDR

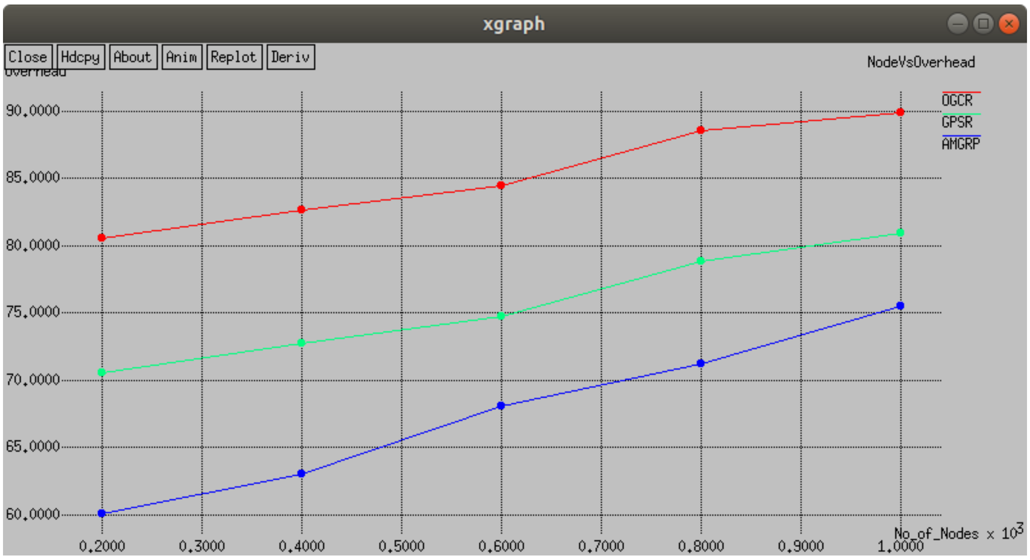

Fig.6 Number of nodes (n) Vs NRH

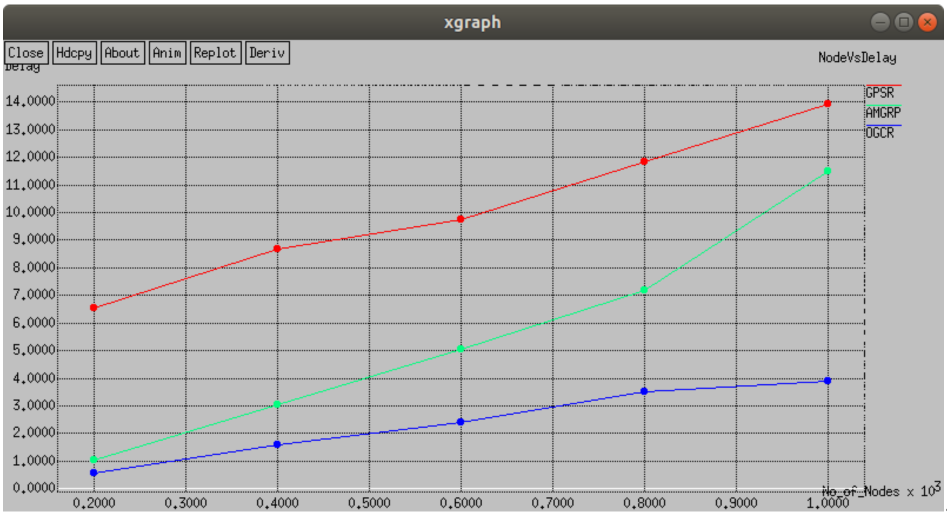

Fig.7 Number of nodes (n) Vs E2ED

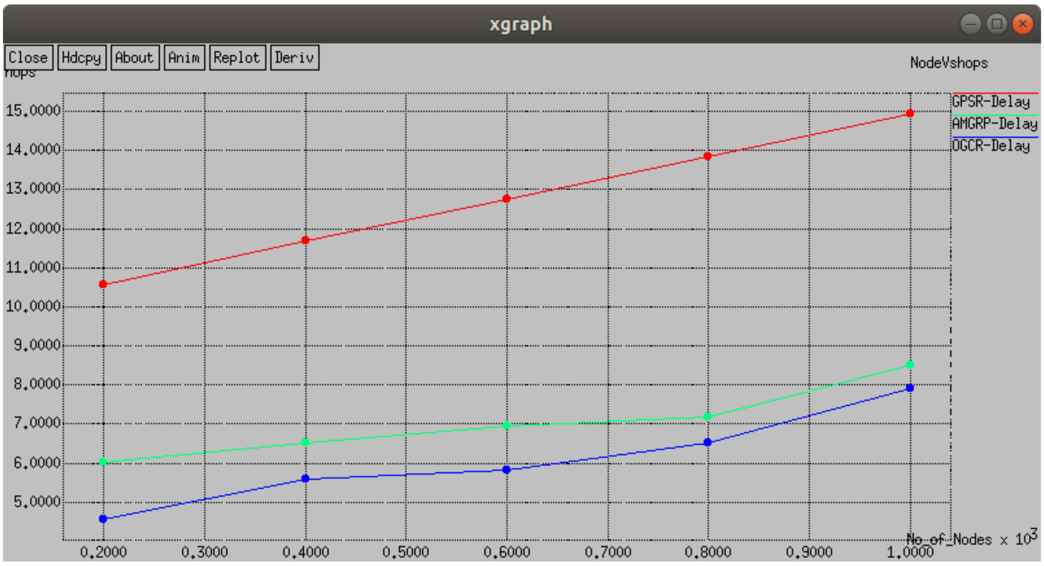

Fig.8 Number of nodes (n) Vs AHC

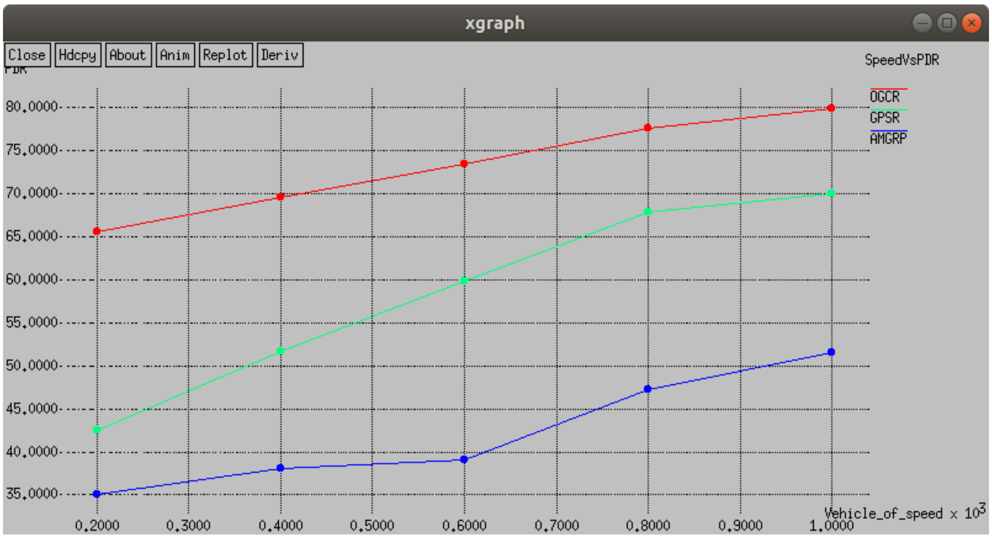

Fig.9 Number of vehicles (n) Vs PDR

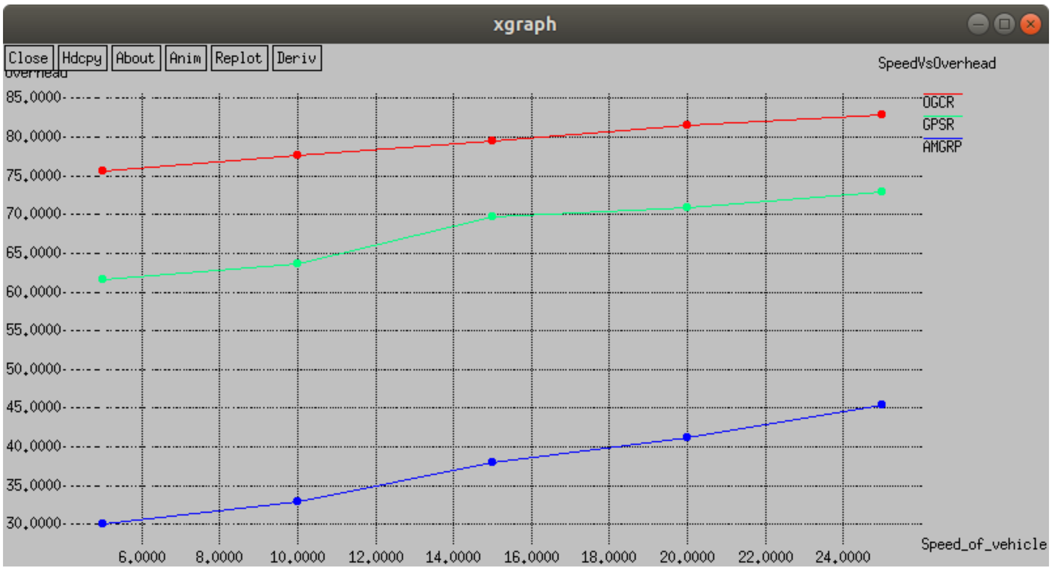

Fig.10 Number of vehicles (n) Vs NRH

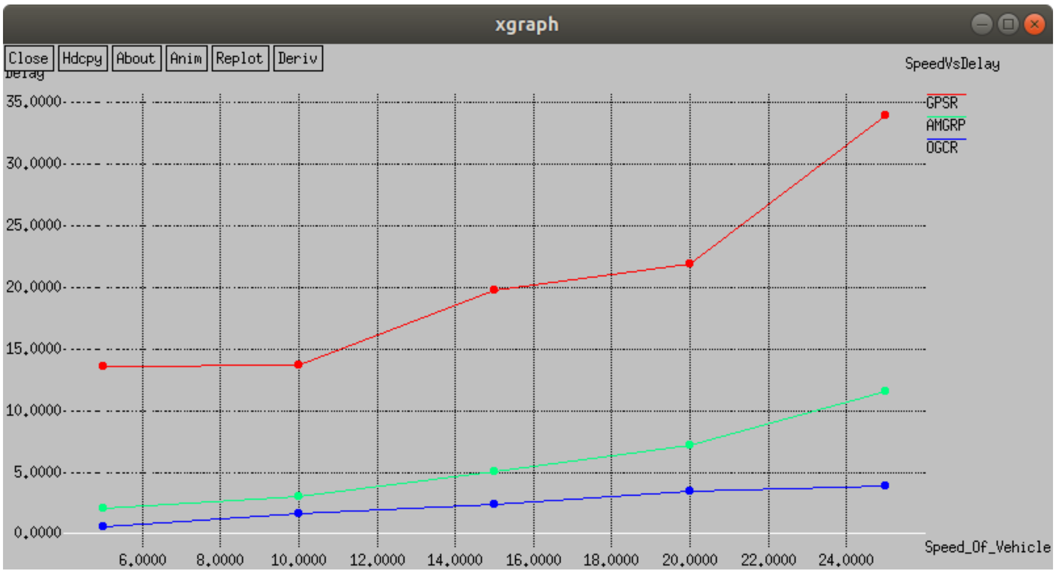

Fig.11 Number of vehicles (n) Vs E2ED

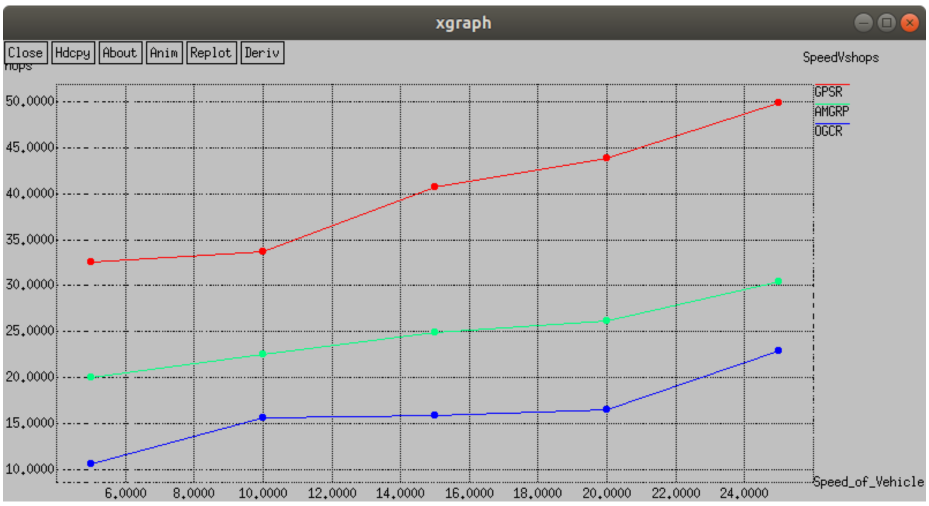

Fig.12 Number of vehicles (n) Vs AHC

6. Conclusion

The proposed optimal geographical cluster-based routing (OGCR) protocol for VANET. The clustering process will divide into two stages, initially, the multi-hop cluster formation is performed by a chaotic ant swarm optimization (CAS) algorithm, and then CH selection is performed by the degree of optimal cluster member's metrics. Then, forwarded the data from cluster members to cluster head with intra cluster communication using of CAS algorithm inspired from the protocol ant colony system and reduced the unwanted communication instead of inter cluster communication by utilized of mimic differential search (DS) algorithm. By using of optimal pathfinder algorithm, the control overhead reduction is reduced. Experimental results show that OGCR technique provides the better efficiency and improved performance when comparing with other existing techniques.

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