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A novel energy aware cluster based routing protocol for emergency message dissemination in vehicular adhoc networks

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Abstract---In Vehicular Adhoc Network (VANET), the typical topology variations produced by the highly mobile nature of vehicle poses major issues in data transmission. The mobility and location based data dissemination techniques could satisfy the requirements of emergency message (EM) dissemination. It faces several issues in highway as well as urban roadways like minimum latency, highly secure, and scalable, which needs to be resolved. Generally, broadcasting protocols for VANET make use of beacon signals, which are distributed amongst the vehicles to attain information about the neighboring vehicles. With this motivation, this paper presents an energy aware cluster based routing protocol for the critical message dissemination (EAC-RPCMD) technique for VANET. The goal of the EAC-RPCMD technique aims to disseminate the EMs in the cluster based VANET environment. The EAC-RPCMD technique primarily designs an equilibrium optimizer based clustering (EOC) technique for the organization of vehicles into clusters. Besides, the manta ray foraging optimization (MRFO) algorithm based route selection (RS) technique, named MRFO-RS technique for optimal choice of routes to destination. Moreover, the EM dissemination scheme is also employed in the VANET. The performance validation of the EAC-RPCMD technique takes place and the results are inspected under several

aspects. The simulation results reported the betterment of the EAC-RPCMD technique compared to recent state of art approaches.

Keywords---Vehicular Adhoc networks, Emergency dissemination, Equilibrium optimizer, MRFO algorithm, Route selection.

1. Introduction

Vehicular Adhoc Network (VANET) has considerably improved transport system and assisted in decreasing many redundant situations which cause irreversible accidents on road. VANET makes it possible for vehicles to interact with each other in parking areas or on roads [1]. Each communication that takes place amongst vehicles is named vehicle-to-vehicle (V2V) transmission whereas the exchanging of data among roadside units (RSUs) and vehicles is named as vehicle-to-infrastructure (V2I) transmission. The control channel (CC) and Service channel (SCH) are utilized to transmit security alerts about crashes, accidents, dangerous events, and normal data messages except safety messages. The VANET is combined with several problems, transmission of data is a vital one [2]. Generally, normal messages aren't time critical, on the other hand, emergency or safety messages are time critical and need effective communication as quickly as possible [3]. There are various methods for distribution of emergency messages (EMs), but almost all of them are developed to work under certain situations. Still, there is room for considerable improvement as the technique has not reached its maturity yet and is still in the development stage. Fig. 1 illustrates the architecture of VANET [4].

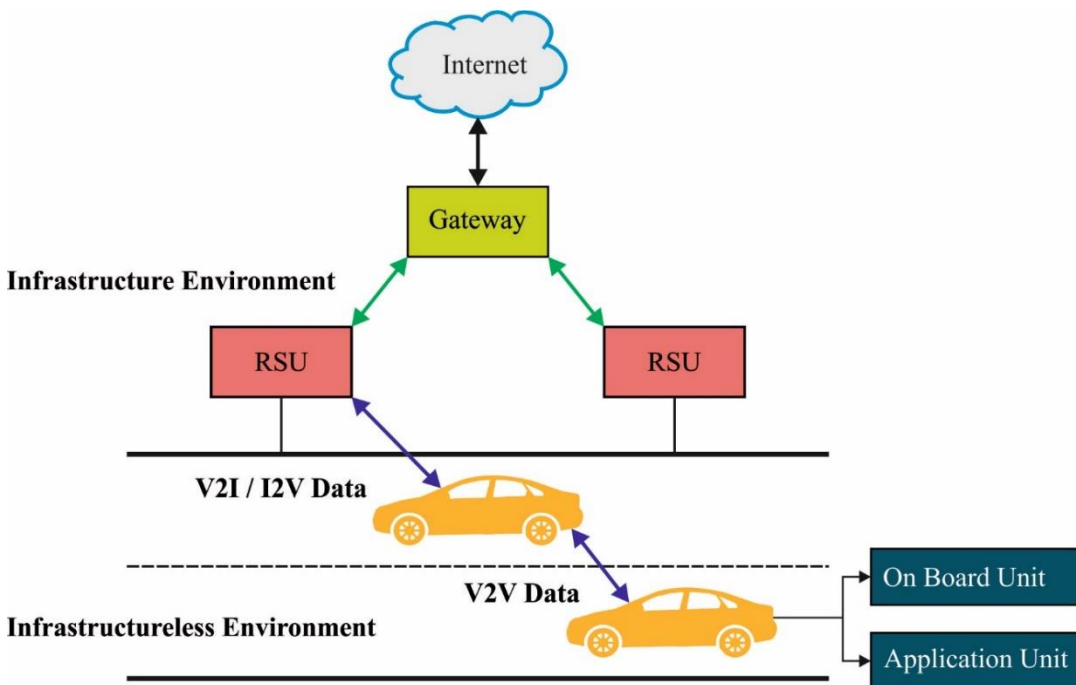


Fig. 1. The basic structure of VANET

A main problem of mechanism discussed previously is the credibility of transmission messages [5]. Any vehicle could falsely transmit an incident that has not taken place. Especially, autonomous cars are targeted with this attack [6]. In order to prevent this problem, clustering based dissemination of data is employed. The vehicle forms a cluster based on the feature computed for vehicle intends to combine. A cluster head (CH) is designated with administrative privilege of that specific cluster [7]. Another major benefit of the model is that it deals with the transmission storm problems [8] – in which all the vehicles getting the same messages further rebroadcast it, then, cause main network congestion. The usage of this clustering algorithm is to extend lifetime of the network of vehicles traveling on the same road. The fundamental vehicular network can be purely Adhoc in nature with vehicle interacts with RSU in V2I or vehicle interacts with other vehicles in V2V or hybrid using these two kinds of transmission [9]. Recently, EMs distribution in VANET has received significant interest. Drivers could avoid accidents by broadcasting EMs at the right time. Hence, broadcasting speed, especially for time critical EMs, is an important factor [10]. It is extremely difficult to develop this system for dynamic vehicular networks. Therefore, timely EM broadcasting and computational effective solutions are needed for EM broadcasting in VANET [11].

Lenin and Tamilarasan [12] proposed a Spotted Hyena and Simulated Annealing Optimization Algorithm (SHSAOA)-based deployment system for accurate approximation of NLOS node. It includes the advantage of SA combined with SHOA to establish good balance among the procedure of exploitation and exploration in the searching space. This method generates a candidate solution by deriving the advantages of the trajectory-based characteristics of SA all over the development phase for improving the local optimization method.

Paranjothi et al. [13] presented a hybrid method-based fog computing named Hybrid-Vehfog to broadcast messages in obstacle shadowing region and a multihop method to broadcast messages in non-obstacle shadowing region. The presented technique dynamically adapts to the environment changes and strong drone positioning ability is required. Shah et al. [14] developed a data broadcasting method with time barrier mechanisms to decrease the message overhead that could clutter the networks. The presented method is depending on the concepts of a super-node to accurately distribute the message. Furthermore, to prevent unwanted transmission that could create transmission storm problems, the time barrier method is adopted for handling these problems.

Prathiba et al. [15] proposed an SDN enabled continuous clustering method named Migrating Consignment Region (MiCR) based Federated K-means method to disseminate SCM to the AV through 5G-V2X transmission. Different from other methodologies that generate cluster for all the instances, MiCR continue to hold moving cluster for broadcasting SCM to AV with low latency and ultra-higher reliability. Benrhaïem et al. [16] introduced a system, named reliable emergency message dissemination system (REMD) that attains predetermined reliability for message broadcasting when fulfilling the delay requirement, for different channel conditions. The primary objective is to assurance higher reliability in all the hops, with lower control over-head when keeping lower end-to-end latency for time-critical applications.

Benkerdagh et al. [17] presented a system that comprises data management beforehand broadcasting method as the initial phase of this technique. In this process, the original message is enhanced for reducing the amount of exchanged packets. Next, the proposition contains creating stable and fast clusters to enhance the message dissemination time and to obtain effective bandwidth utilization. This method is depending on a Fitness function that considered various parameters namely link lifetime validity, broadcast time, relative velocity, and connectivity degree.

This paper presents an energy aware cluster based routing protocol for critical message dissemination (EAC-RPCMD) technique for VANET. The EAC-RPCMD technique primarily designs an equilibrium optimizer based clustering (EOC) technique for the organization of vehicles into clusters. In addition, the MRFO approach based route selection (RS) technique, named MRFO-RS technique for optimal choice of routes to destination. Furthermore, the EM dissemination scheme is also employed in the VANET. The performance validation of the EAC-RPCMD technique takes place and the results are inspected under several aspects.

2. The Proposed Model

This paper has established a novel EAC-RPCMD technique to disseminate the EMs in the cluster based VANET environment. The EAC-RPCMD technique initially selects the CHs and organizes clusters using the EOC technique. Followed by, the optimal choice of routes taking place using the MRFO-RS technique. Fig. 2 demonstrates the overall working process of the proposed EAC-RPCMD technique.

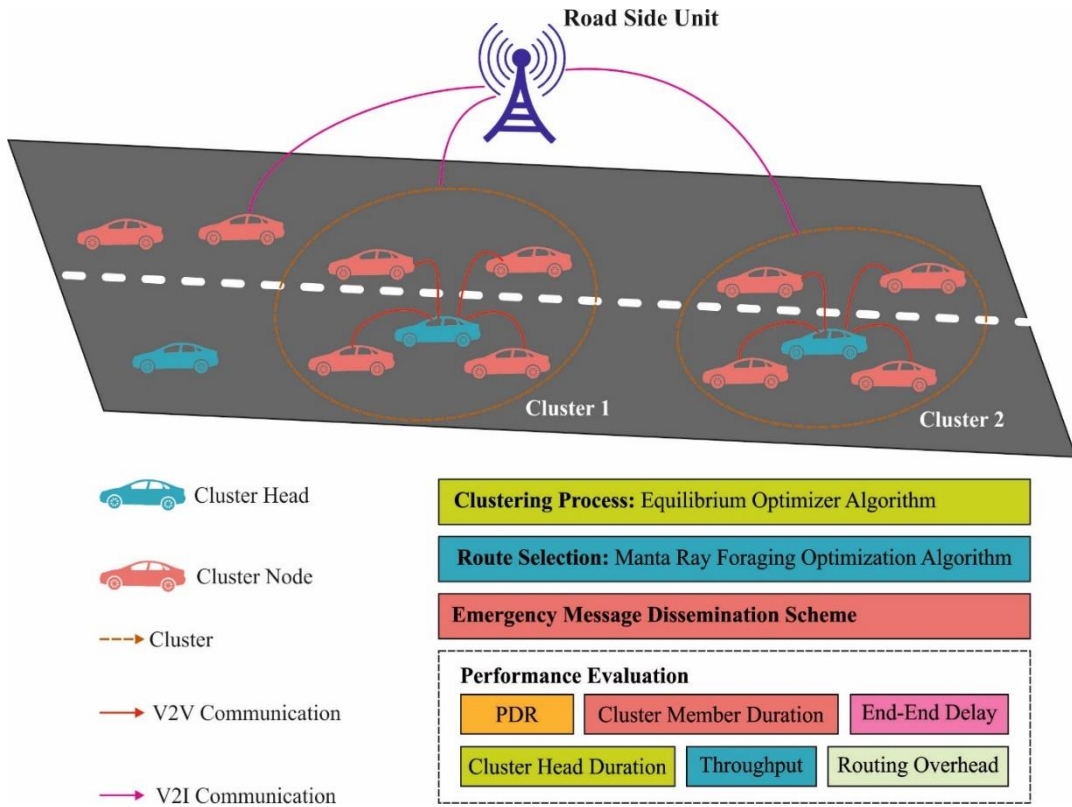


Fig. 2. Overall process of EAC-RPCMD technique

2.1. Process involved in EOC technique

At the initial stage, the vehicles are placed in the target environment and the information collection phase gets initiated. Then, the EOC gets executed to elect the proficient set of CHs. The EO method is initially presented by Faramarzi et al. [18]. The EO is stimulated by the control volume mass balance method that is used for the assessment of equilibrium and dynamic states. In EO, every individual in the population is analogous to solutions and single concentration is analogous to a particle location in the PSO method.

$$C = C_e + (C - C_e) \cdot F + \frac{G}{\lambda V} (1 - F), \quad (1)$$

Whereas V is determined as unit, C_e denotes the equilibrium candidate, F and G indicates exponential term and generation rate, correspondingly. $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_n)^T$ represent a random vector within $[0, 1]$ n signifies the amount of parameters of the single concentration C . The equilibrium state shows the last convergence state of EO. The equilibrium pool contains five individuals.

$$C_{e,pool} = \{C_{e(1)}, C_{e(2)}, C_{e(3)}, C_{e(4)}, C_{e(ave)}\}. \quad (2)$$

But, for multi-objective optimization issues, usually, there is a group of alternative trade-offs among this objective. They could not arrange the solution

according to their fitness values. Solution in the external repository is considered as equilibrium candidate. It can be expressed in the following equation:

$$C_{e,pool} = \{Rep\}, \quad (3)$$

In Eq. (3) Rep signifies the external repository, and the Rep is employed to save previous records of non-dominated solutions found along with the entire searching method. All the individuals in every iteration upgrade its concentration C (location) with roulette wheel selections amongst equilibrium candidates C_e [19]. The abovementioned selection process is capable of maintaining the variety of the solutions attained in the searching method. The concentration upgrading rules are controlled by the F exponential term,

$$F = e^{-\lambda(t-t_0)}, \quad (4)$$

$$t = \left(1 - \frac{iter}{IT}\right)^{a_2(iter/IT)}, \quad (5)$$

While t indicates the function of iteration, t reduces with the iteration count, $iter$ and IT represent the present iteration and the maximal iteration, correspondingly. a_2 denotes constant values that control the exploitation capability of EO. In order to achieve higher convergence by reducing the searching speed, t_0 is determined by:

$$t_0 = \frac{1}{\lambda} \ln(-a_1 \text{sign}(r_0 - 0.5)[1 - e^{-\lambda t}]) + t, \quad (6)$$

Here a_1 represent a constant value that impacts the exploration capability, $\text{sign}(r_0 - 0.5)$ is used for controlling the direction of exploitation and exploration, r_0 signifies an arbitrary value within $[0, 1]$. In the study, the value of a_1 and a_2 are fixed to 2 and 1, correspondingly. The election of both values is reliable with the original EO method. Hence, the F exponential term is expressed by:

$$F = a_1 \text{sign}(r_0 - 0.5)(e^{-\lambda t} - 1). \quad (7)$$

Generation rates play a significant part in the equilibrium model. It is applied to enhance the exploitation capability of EO.

$$G = G_0 e^{-\kappa(t-t_0)},$$

$$G_0 = GCP(C_e - \lambda C), \quad (8)$$

$$GCP = \begin{cases} 0.5r_1, & r_2 \geq GP, \\ 0, & r_2 < GP, \end{cases}$$

In which G_0 signifies the first value. GCP denotes the generation rate control possibility. GP denotes the generation possibility that is fixed to 0.5 based on the original EO method. r_1 and r_2 denotes arbitrary value within $[0,1]$. κ shows the decay vector. This work considers $\kappa = \lambda$. Therefore, the generation rate is expressed by:

$$G = G_0 F. \quad (9)$$

The proposed EOC technique intends to group n sensors to a certain number of clusters C_{opt} . At the time of the CH selection process, the nearby vehicles are chosen as CHs using the Euclidean distance measure which reduces the transmission distance and energy utilization. But it is difficult to determine the distance of the vehicles in mobility. For resolving this issue, the distance to the nearby vehicles can be represented. In order to choose the CHs and construct clusters, the proposed model derived a fitness function with distinct variables such as residual energy (RSE), average distance to nearby vehicles (ADNV), and vehicle degree (VD). The FF can be represented using Eq. (20):

$$F(i) = \alpha \times RSE + \beta \times ADNV + \gamma \times VD, \quad (20)$$

where $\alpha + \beta + \gamma = 1$. Principally, the RSE of vehicles at the data transmission of k bit data to vehicle located at a distance d can be equated as follows:

$$REL = E - (E_T(k, d) + E_{R(k)}) \quad (21)$$

where E denotes the present energy of vehicle and E_T indicates the energy dissipated by the vehicle at the time of data transmission.

$$E_T(k, d) = kE_e + KE_a d^2 \quad (22)$$

where E_e describes the energy of electrons and E_a indicates the dynamic amplified energy, $E_{R(k)}$ specifies the energy consumed on receiving data, as given below.

$$E_{R(k)} = kE_e \quad (23)$$

Moreover, the ADNV defines the mean value of the DNV in single hop communication. It can be equated as follows.

$$ADTN = \frac{\sum_{j=1}^{NB_i} dist(i, nb_j)}{NB_i}, \quad (24)$$

where $dist(i, nb_j)$ mentions the distance between two nearby vehicles. Moreover, VD indicates the number of vehicles that exist in the single hop communication distance, as given in Eq. (25):

$$DEG = |N(x)| \quad (25)$$

where $N(x) = \{n_y / dist(x, y) < trans_{range}\} x \neq y$, and $dist(x, y)$ exhibits the distance amongst a pair of vehicles n_x and n_y , $trans_{range}$ infers the communication range of the vehicles.

2.2. Design of MRFO-RS Technique

MRFO technique was projected by [20]. It simulates the Manta ray performances. The MRFO was expressed by reproducing the important foraging approaches namely somersault, chaining, and cyclone. But, the MRFO is same as many

meta-heuristic techniques, their initialized step was determined arbitrarily in Eq. (26).

$$X_{ij}(\cdot) = Lb_{ij} + r(\cdot) \cdot (Hb_{ij} - Lb_{ij}) \forall i \in N_{pop}, j \in N_{var} \quad (26)$$

The Manta ray performance was changed to optimum foodstuffs from the chaining approaches utilizing the mathematical formulation provided in Eq. (27) for changing its places ($X_{i,j}$).

$$X_{i,j}(t+1) = \begin{cases} X_{i,j}(t) + (X_{best,j}(t) - X_{i,j}(t)) \cdot (r(\cdot) - \lambda) \Lambda \forall i = 1, j \in N_{var} \\ X_{i,j}(t) + (X_{i-1,j}(t) - X_{i,j}(t)) \cdot (r(\cdot) - \lambda) \Lambda \forall i > 1: N_{pop} \end{cases} \quad (27)$$

$$\phi = 2 \cdot r(\cdot) \cdot \sqrt{|\log(r(\cdot))|} \quad (28)$$

Conversely, swarm is swimming in spiral same as cyclones then detecting the foodstuff. Eventually, the latest Manta ray places were modified about the optimum place in this operator technique utilizing the equation written as in Eq. (29).

$$X_{i,j}(t+1) = X_{i,j}(t) + SF \cdot (r_2 X_{best,j} - r_3 X_{i,j}(t)) \Lambda \forall i \in N_{pop} \quad (29)$$

$X_{best,j}$ is determined as showcased in Eq. (30) that determines an optimum place with maximum food concentration [21]. When the minimum concentration was confirmed, an arbitrary place was fixed as demonstrated in Eq. (33).

$$X_{i,j}(t+1) = \begin{cases} X_{best,j} + \Lambda X_{i,j} \cdot (r - \beta) \Lambda \forall i = 1, j \in N_{va} \\ X_{best,j} + r \cdot (X_{i-1,j}(t) - X_{i,j}(t)) + \beta \cdot \Lambda X_{i,j} \Lambda \forall i > 1: N_{pop} \end{cases} \quad (30)$$

$$\text{where } \Lambda X_{i,j} = X_{best,j}(t) - X_{i,j}(t) \quad (30)$$

$$\beta = 2 \cdot \exp\left(r_1 \frac{T_{max} - t + 1}{T_{max}}\right) \cdot \sin(2\pi r_1) \quad (31)$$

$$X_{i,j}(t+1) = \begin{cases} X_{rand} + \Lambda X_{i,j} \cdot (r - \beta) \Lambda \forall i = 1, j \in N_{var} \\ X_{best,j} + r \cdot (X_{i-1,j}(t) - X_{i,j}(t)) + \beta \cdot \Lambda X_{i,j} \Lambda \forall i > 1: N_{pop} \end{cases} \quad (32)$$

$$\text{where } \Lambda X_{i,j} = X_{rand} - X_{i,j}(t) \quad (32)$$

$$X_{rand}(\cdot) = Lb + r(\cdot) \cdot (Hb - Lb) \quad (33)$$

Meta-heuristic techniques share 2 particular performances, exploration and exploitation. According to these 2 performances, meta-heuristic techniques are superior to another approach. In MRFO, once t/T_{max} is lesser than $rand$, the cycle of exploitation was implemented, else search spaces are implemented. N_{pop} , T_{max} , and SF defines the MRFO control system that is carefully monitored for ensuring their optimum efficiency.

In the MRFO-RS technique, the route selection process for EM dissemination can be considered as an NP hard problem, which aims to determine the shortest route with the least latency and cost. The optimal route needs to pass a fixed set of sojourn points where every point needs to be stopped at only once. The MRFO-RS technique aims at the minimalization of the cost, latency, and distance. Consider Let ξ indicates a sojourn point and S denotes a collection of ξ ($i, j = 1, 2, \dots, m$), $C_{i,j}$

is the cost of shifting from ξ_i to ξ_j , $d_{i,j}$ is the distance from ξ_i to ξ_j , and $\tau_{i,j}$ is the traveling latency from ξ_i to ξ_j . The decision parameter can be defined using Eq. (34). As the objective function aimed to minimize the cost, latency, and distance, it is defined as follows.

$$\Gamma_{i,j} = \begin{cases} 1 & \text{if } \xi_j \text{ is visited from } \xi_i \\ 0 & \text{otherwise} \end{cases} \quad (34)$$

$$\mathbb{C}: \text{Min} \sum_i^m \sum_j^m C_{i,j} \Gamma_{i,j} \quad (35)$$

$$\mathbb{D}: \text{Min} \sum_i^m \sum_j^m d_{i,j} \Gamma_{i,j} \quad (36)$$

$$\mathbb{T}: \text{Min} \sum_i^m \sum_j^m \tau_{i,j} \Gamma_{i,j} \quad (37)$$

But the optimized constraints are $\sum_i^m \Gamma_{i,j} = 1$ for every i and j , the estimated route could not be selected many times ($\Gamma_{i,j} + \Gamma_{j,i} \leq 1$) and $\Gamma_{i,j} \geq 1$.

2.3. Emergency Message Dissemination Phase

The primary goal is to minimize time delay and enhance complete coverage for successful EM broadcasting, along with, non-time-critical message is obtained with a delay. Moreover, forwarding EM via transmission could create network congestion degrades the entire efficiency of the networks. The presented method in Algorithm 2 deals with CH selection and cluster formation, along with, manage UNreg vehicles. When receiving an EM, the vehicles initially check their status. When the vehicle is CH, the obtained EM is disseminated directly to each CM. After receiving, a CM vehicle sets a barrier to transmit the messages. Hence, only distant vehicles transmit the EM. In a conventional situation, a CM broadcasts the received messages to its CH that disseminate the messages to each CM. This hop could add a delay in broadcasting the EM. In order to decrease the delay, in the presented method, any vehicle could raise its privilege to transmit the EM itself afterward its time barrier terminates. Furthermore, the gateway vehicles behave in the same way after receiving EM while broadcasting the EM through clusters. Moreover, it has no explicit acknowledgment utilized in the presented method. This implies distant vehicles have received the same messages and it is not necessary to transmit the message.

3. Performance Validation

The experimental validation of the EAC-RPCMD technique takes place under varying number of vehicles and vehicle speed [22, 23]. Table 1 provides a detailed comparative study of the EAC-RPCMD technique with recent methods under the distinct number of vehicles. The PDR analysis of the EAC-RPCMD technique and existing methods under various vehicles are performed in Fig. 3. From the figure, it is noticed that the GPSR technique has attained poor performance with the lower PDR values. At the same time, the QADD technique has gained slightly enhanced PDR value whereas the DPSO-VANET technique has accomplished even

better outcomes. However, the EAC-RPCMD technique has reached maximum performance over the other methods with the PDR of 93.53%, 94.88%, 92.55%, 87.62%, and 79.69% under vehicles 100-500 respectively.

Table 1 Result analysis of EAC-RPCMD technique with different count of vehicles

No. of Vehicles	EAC-RPCMD	DPSO-VANET	QADD	GPSR
PDR (%)				
100	93.53	76.19	60.03	42.23
200	94.88	83.59	73.45	64.42
300	92.55	80.85	55.65	55.38
400	87.62	71.26	43.32	58.39
500	79.69	63.87	40.04	58.94
Average Throughput (kbps)				
100	222.61	200.56	143.28	87.44
200	211.27	164.05	123.96	106.06
300	191.70	112.50	103.19	107.49
400	185.38	137.56	99.61	93.89
500	179.03	121.09	99.61	95.32
Routing Overhead (%)				
100	12.59	23.62	35.31	37.76
200	16.86	34.77	33.41	37.22
300	15.74	31.78	37.49	49.19
400	18.51	36.40	48.10	50.00
500	22.43	39.67	53.27	53.81
End to End Delay (ms)				
100	72.02	105.73	109.14	127.88
200	121.71	161.95	182.39	190.91
300	185.65	228.39	245.43	270.98
400	252.50	303.35	347.64	374.90
500	376.96	439.63	456.67	519.70

The ATT analysis of the EAC-RPCMD method and current approaches under many vehicles are executed in Fig. 4. From the figure, it is noted that the GPSR system has accomplished poor performance with the lesser ATT values. Simultaneously, the QADD procedure has received slightly enhanced ATT value whereas the DPSO-VANET technique has accomplished even better outcomes. However, the EAC-RPCMD technique has reached maximal performance over the other systems with the ATT of 222.61kbps, 211.27kbps, 191.70kbps, 185.38kbps, and 179.03kbps under vehicles 100-500 correspondingly.

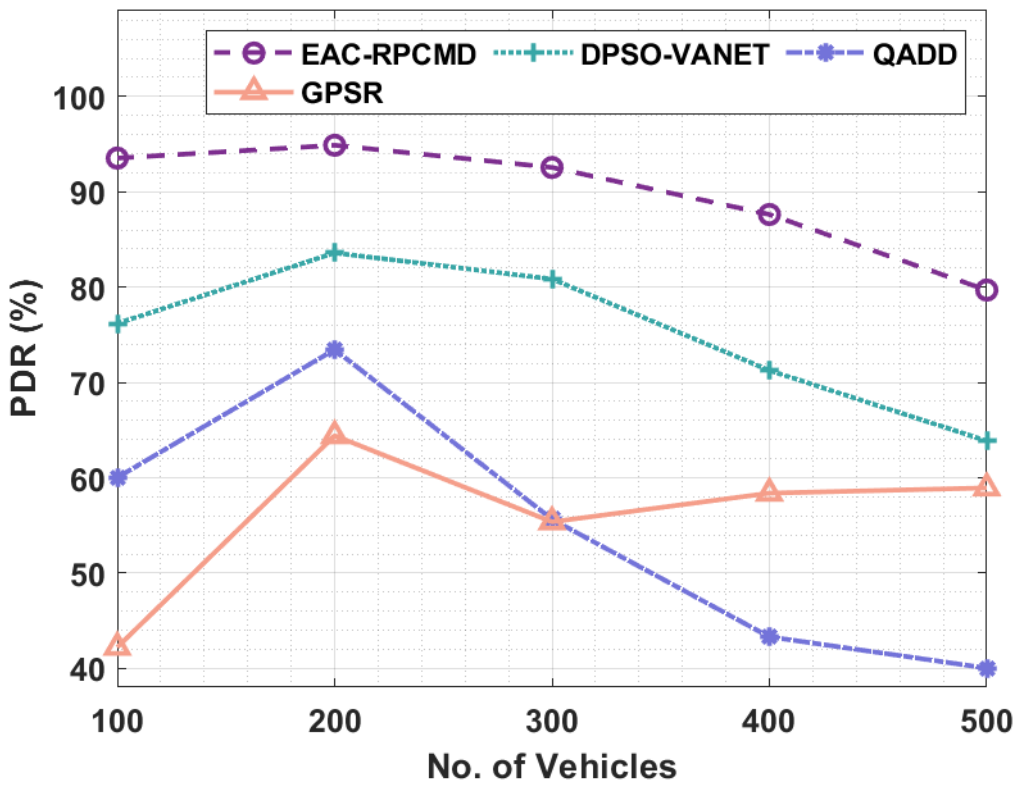


Fig. 3. PDR analysis of EAC-RPCMD technique with count of vehicles

Next, a clear routing overhead (ROH) analysis of the EAC-RPCMD approach with other technologies takes place in Fig. 5. The result described that the QADD and GPSR techniques have reached ineffectual outcomes with the minimal values of ROH. Followed by, the DPSO-VANET technique has accomplished near optimal outcomes with the reasonable ROH. But the EAC-RPCMD technique has demonstrated its superior outcome with the least ROH of 12.59%, 16.86%, 15.74%, 18.51%, and 22.43% respectively.

Subsequently, an End-to-End Delay (ETED) analysis of the EAC-RPCMD procedure with other methods takes place in Fig. 6. The outcomes described that the QADD and GPSR approaches have attained ineffective outcomes with the slight values of ETED. Next, the DPSO-VANET process has achieved near optimum outcomes with the reasonable ETED. However, the EAC-RPCMD system has proved its higher result with the minimum ETED of 72.02ms, 121.71ms, 185.65ms, 252.50ms, and 376.96ms correspondingly.

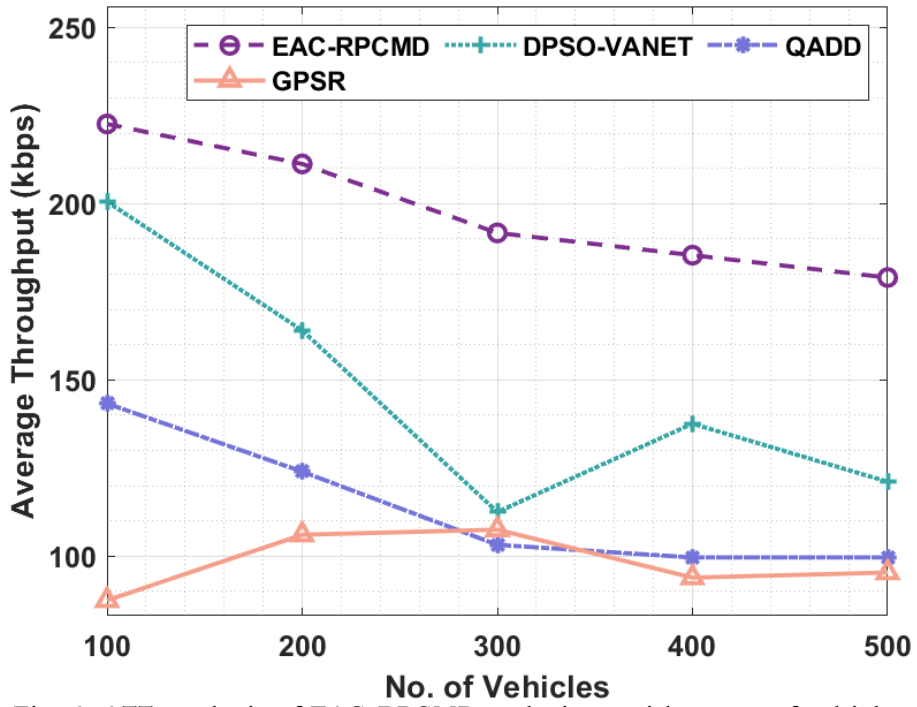


Fig. 4. ATT analysis of EAC-RPCMD technique with count of vehicles

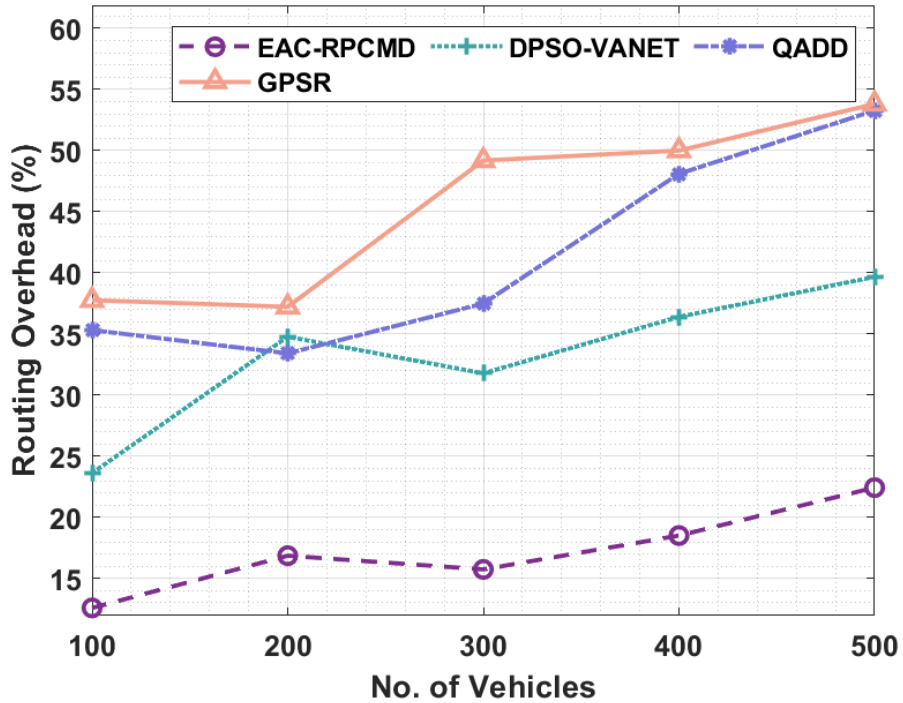


Fig. 5. ROH analysis of EAC-RPCMD technique with count of vehicles

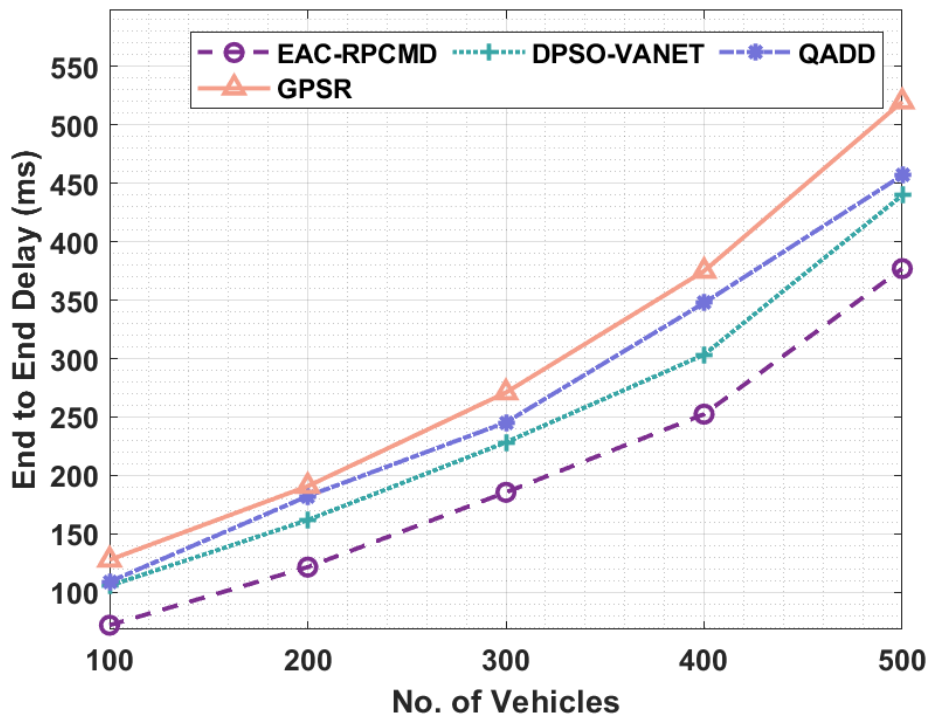


Fig. 6. ETED analysis of EAC-RPCMD technique with count of vehicles

Table 2 provides a detailed study of the EAC-RPCMD method with recent methodologies under distinct speeds of vehicles. The PDR analysis of the EAC-RPCMD method and current approaches under different vehicles speed is carried out in Fig. 7. From the figure, it is noted that the GPSR system has accomplished poor performance with the subordinate PDR values. Simultaneously, the QADD method has obtained slightly improved PDR value while the DPSO-VANET procedure has reached even better results. But, the EAC-RPCMD system has attained maximal performance over the other methodologies with the PDR of 98.84%, 98.36%, 96.42%, 91.12%, and 84.34% under vehicles speed 20-100 correspondingly.

Table 2 Result analysis of EAC-RPCMD technique with different vehicles speed

Speed of Vehicles	EAC-RPCMD	DPSO-VANET	QADD	GPSR
PDR (%)				
20	98.84	96.92	81.51	71.99
40	98.36	84.31	73.11	64.43
60	96.42	84.03	66.95	61.91
80	91.12	82.35	64.43	52.11
100	84.34	80.67	63.59	50.15
Average Throughput (kbps)				
20	236.31	183.64	133.07	130.93
40	222.57	165.12	125.24	106.00

60	207.32	96.74	128.80	73.24
80	194.78	104.58	97.46	64.69
100	191.63	86.06	74.66	54.72
Routing Overhead (%)				
20	9.01	26.92	33.29	41.99
40	13.25	33.29	35.03	36.77
60	11.11	34.16	37.35	41.12
80	14.67	32.13	38.22	56.49
100	19.01	36.48	39.67	59.10
End to End Delay (ms)				
20	52.32	114.23	126.07	139.88
40	107.31	171.46	185.28	210.93
60	168.65	232.64	291.85	317.51
80	232.00	323.43	394.48	430.00
100	351.06	463.55	518.81	597.76

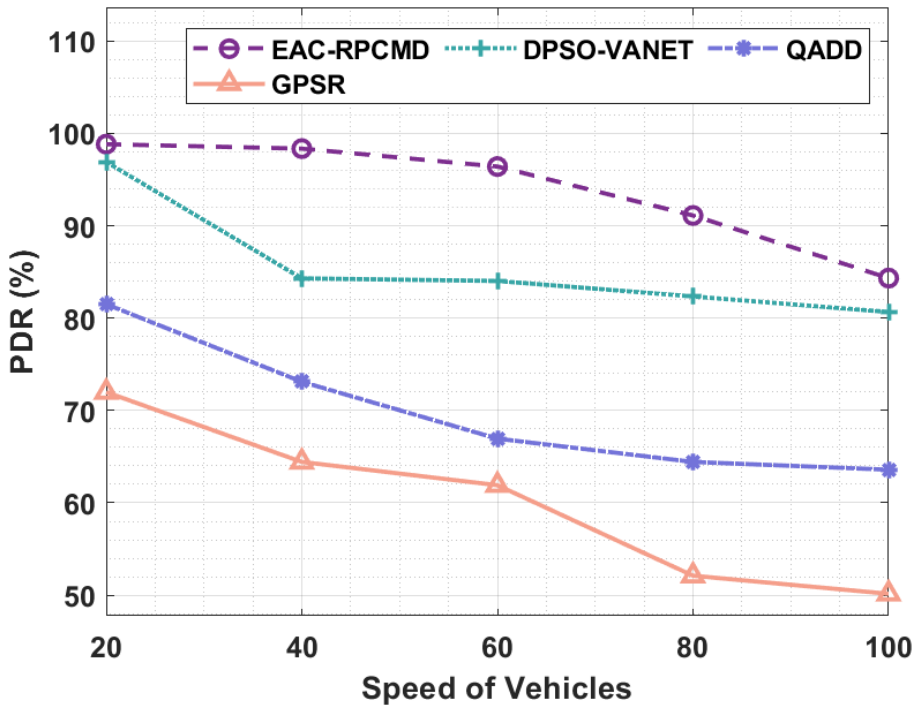


Fig. 7. PDR analysis of EAC-RPCMD technique with varying vehicles speed

The ATT analysis of the EAC-RPCMD model and current methodologies under multiple vehicles speed is executed in Fig. 8. From the figure, it is stated that the GPSR technique has achieved poor performance with the minimum ATT values. Simultaneously, the QADD algorithm has obtained slightly higher ATT value while the DPSO-VANET system has reached improved outcomes. But, the EAC-RPCMD

system has gained to highest performance over the other methods with the ATT of 236.31kbps, 222.57kbps, 207.32kbps, 194.78kbps, and 191.63kbps under vehicles speed 20-100 correspondingly.

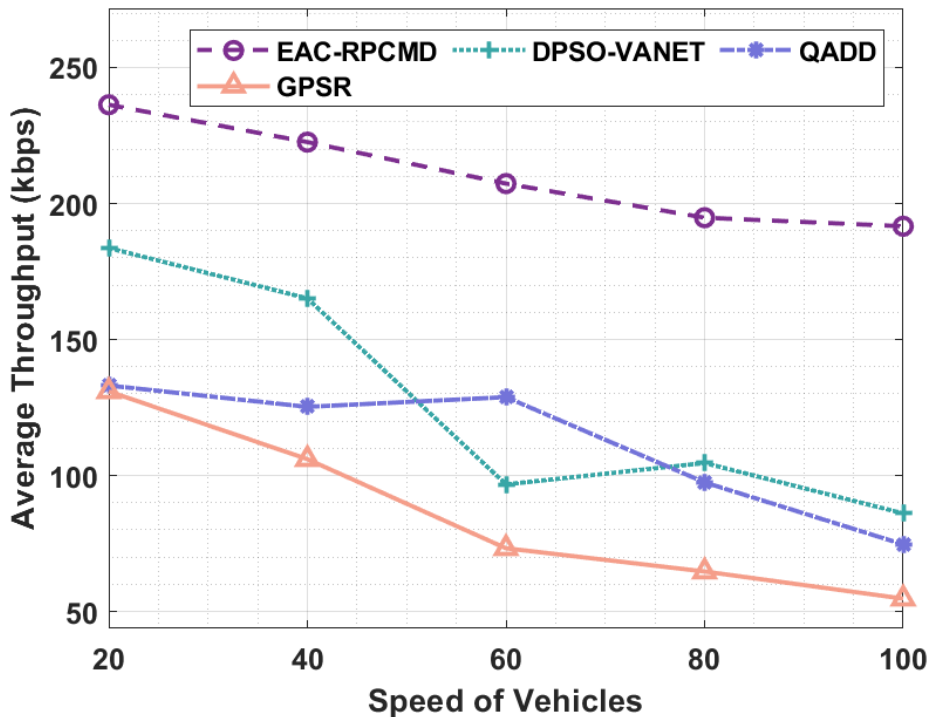


Fig. 8. ATT analysis of EAC-RPCMD technique with varying vehicles speed

Next, a ROH analysis of the EAC-RPCMD method with other models takes place in Fig. 9. The result described that the QADD and GPSR procedures have obtained ineffective outcomes with the slight values of ROH. Afterward, the DPSO-VANET procedure has attained near optimum results with the reasonable ROH. However, the EAC-RPCMD approach has proved its higher outcomes with the minimum ROH of 9.01%, 13.25%, 11.11%, 14.67%, and 19.01% correspondingly. Following, a ETED analysis of the EAC-RPCMD approach with other methodologies takes place in Fig. 10. The outcomes described that the QADD and GPSR methods have obtained ineffective results with the lesser values of ETED. After that, the DPSO-VANET methodology has attained near optimum outcomes with the reasonable ETED. But the EAC-RPCMD method has established its greater outcome with the minimum ETED of 52.32ms, 107.31ms, 168.65ms, 232.00ms, and 351.06ms correspondingly.

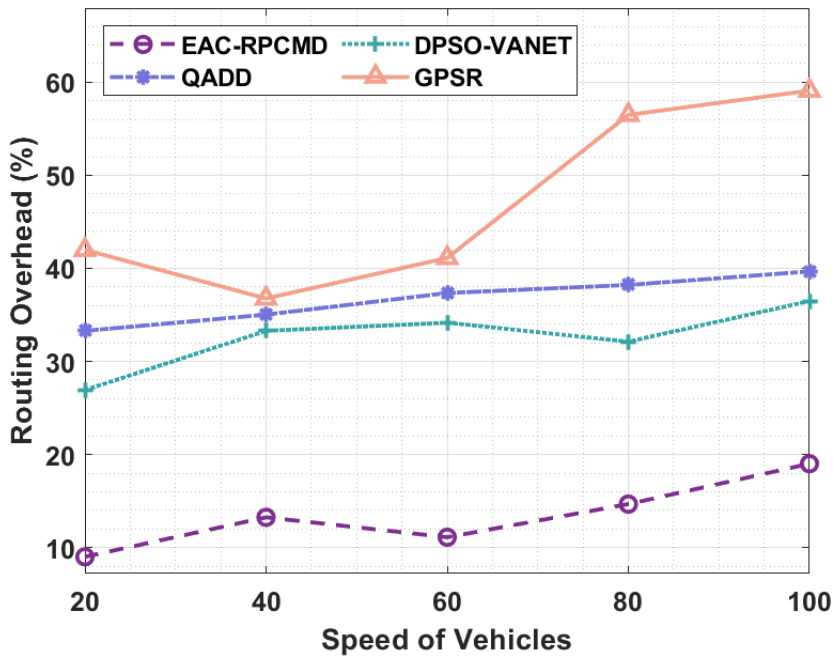


Fig. 9. ROH analysis of EAC-RPCMD technique with varying vehicles speed

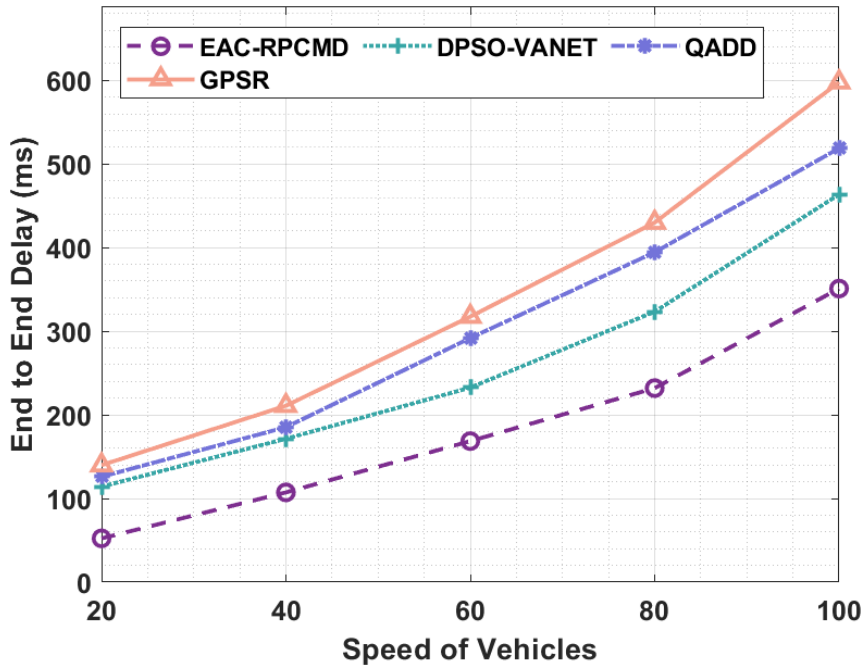


Fig. 10. ETED analysis of EAC-RPCMD technique with varying vehicles speed

Finally, a CHD and CMD analysis of the EAC-RPCMD technique with other methods are offered in Table 3. A brief CHD analysis of the EAC-RPCMD technique with compared methodologies is offered in Fig. 11. For an effective outcome, the value of the CHD needs to be maximum. The results demonstrated

that the GPSR can attain only lower CHD over the other techniques. In addition, the QADD and DPSO-VANET techniques have reached moderate CHD over the EAC-RPCMD technique. However, the EAC-RPCMD technique has ensured optimal performance with the maximum CHD of 73.52s under vehicle speed of 20.

Table 3 Comparative analysis of EAC-RPCMD technique with respect to CHD and CMD

Speed of Vehicles	EAC-RPCMD	DPSO-VANET	QADD	GPSR
Cluster Head Duration (s)				
20	73.52	66.44	63.30	55.99
40	71.44	63.93	58.49	53.90
60	69.67	62.47	58.08	52.23
80	65.22	57.24	52.85	47.63
100	63.80	55.15	48.88	39.69
Cluster Member Duration (s)				
20	93.88	80.82	68.39	56.77
40	91.69	76.50	68.39	57.31
60	87.88	72.45	66.77	55.96
80	83.74	68.12	62.45	52.18
100	84.17	64.34	56.50	47.58

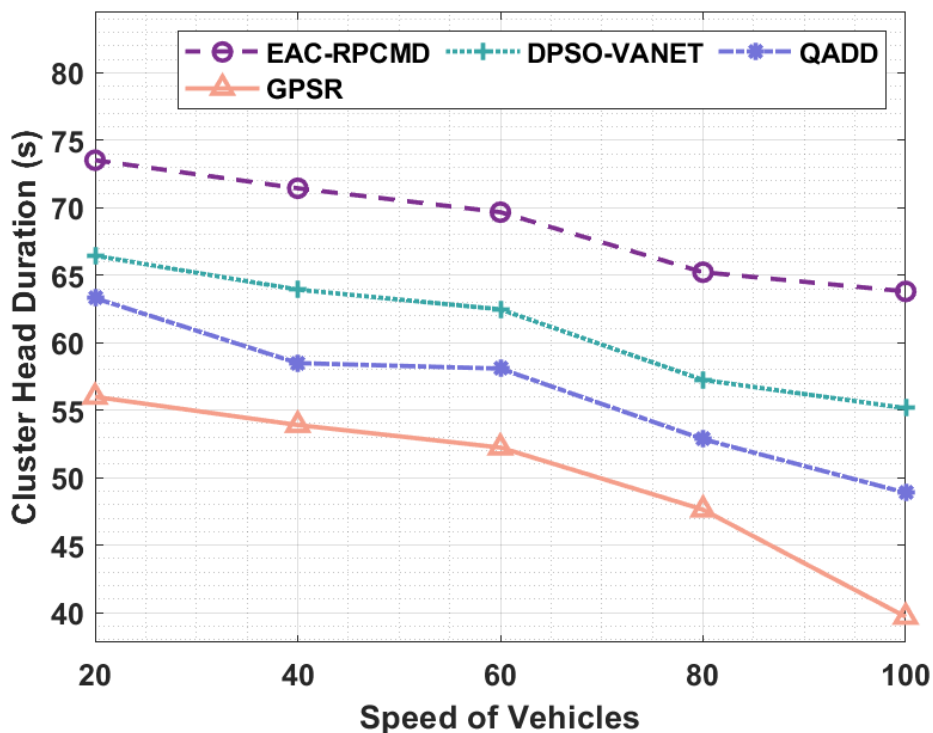


Fig. 11. CHD analysis of EAC-RPCMD technique with existing approaches

A brief CMD analysis of the EAC-RPCMD methodology with compared methodologies is presented in Fig. 12. For efficient outcomes, the value of the CMD needs to be maximal. The results proved that the GPSR has the capability of achieving only lesser CMD over the other systems. Moreover, the QADD and DPSO-VANET methodologies have gained to moderate CMD over the EAC-RPCMD method. But, the EAC-RPCMD approach has guaranteed optimum performance with the maximal CMD of 93.88s under vehicle speed of 20.

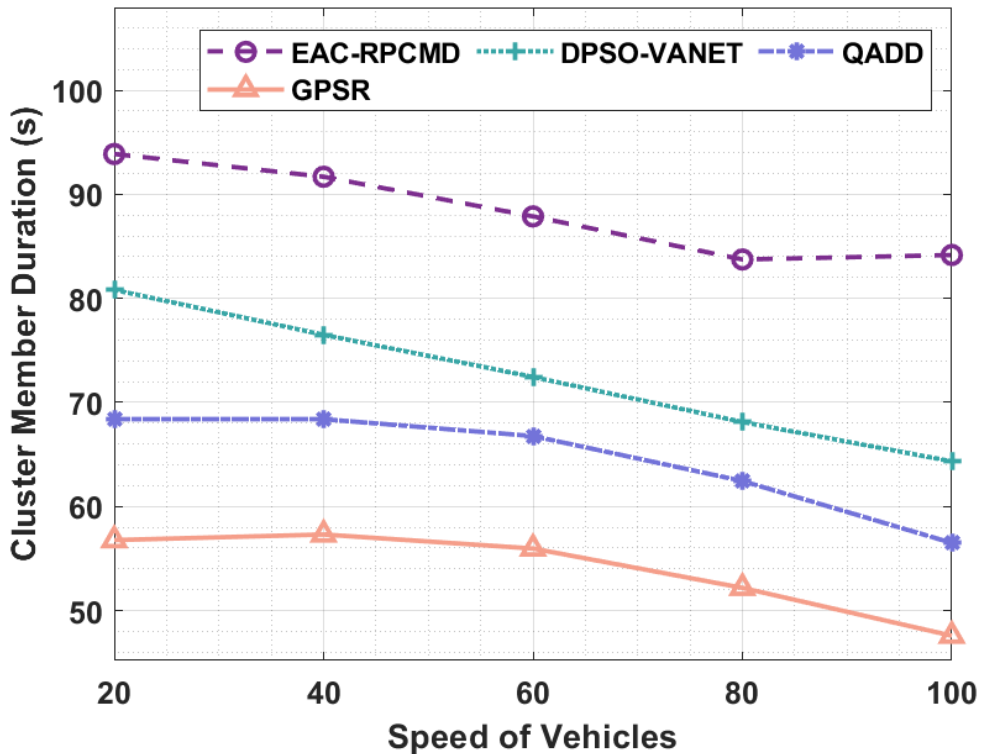


Fig. 12. CMD analysis of EAC-RPCMD technique with existing approaches

4. Conclusion

This paper has established a novel EAC-RPCMD methodology to disseminate the EMs in the cluster based VANET environment. The EAC-RPCMD technique initially selects the CHs and organizes clusters using the EOC technique. Followed by, the optimal choice of routes taking place using the MRFO-RS technique. Finally, the EM dissemination scheme is also employed in the VANET. The performance validation of the EAC-RPCMD technique takes place and the results are inspected under several aspects. The simulation results reported the betterment of the EAC-RPCMD technique compared to recent state of art approaches. Therefore, the EAC-RPCMD technique can be utilized as an efficient approach for EM dissemination in VANET environment.

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