Cluster Based Multi Hop Data Dissemination Protocol in V2V Networks using Whale Optimization Technique

Bhoopendra Dwivedy
Department of CSE
G. L. Bajaj Institute of Technology & Management
Greater Noida, India
bhoopendra.dwivedi@glbitm.org

Anoop Kumar Bhola
Department of Computer Science
Banasthali Vidyapith
Rajasthan, India
anupbhola@gmail.com

Sachin Yadav
Department of CSE
G. L. Bajaj Institute of Technology & Management
Greater Noida, India
sachin.yadav@glbitm.org

Abstract—In vehicular ad-hoc network (VANET), the dissemination of traffic information and road conditions from source vehicle to many destination vehicles on the road plays an important role in VANET. The multiple messages are needed to provide the requirement of safety and non-safety applications. This paper investigates the congestion problem due to the control overhead messages and proposes an optimal adaptive data dissemination protocol (OAddP). The proposed protocol (OAddP) utilizes the optimal clustering and control overhead reduction algorithms to maximize the data dissemination efficiency and Success rate with different traffic flows. The Whale optimization Algorithm (WOA) is used for clustering and cluster head (CH) selection. Then, a predictor-based decision making (PDM) algorithm is used to minimize the control overhead messages in network. The proposed algorithm is simulated & compared with adaptive data dissemination protocol (AddP) for varying traffic flow & vehicle density. The simulation results show better performance in terms of higher success rate and data dissemination efficiency.

Keywords—Data dissemination, VANET, Cluster head, Whale optimization Algorithm.

I. INTRODUCTION

In India, more than lakhs of individuals are killed in car crashes each year and this proportion is expanding every year. More than 60-70 % of mischances can be straightforwardly or by implication related to human blunders, for example, carelessness, trouble, poor choices, street condition, crossing point impact and climate condition, for example, haze, drizzling and so on. Mishap alert data can be utilized adequately to avoid impacts if there is a dependable and snappy technique to transmit this sort of message between vehicles or amongst vehicle and framework [1]. In this way, interfacing vehicles remotely before the beginning of crashes and blockage is critical. VANET is a mobile ad-hoc network (MANET) that concerns about the communication among different vehicles and infrastructure. Dedicated short range communications (DSPC) [2] is an RF technology-based standard has been designed exclusively for automotive communications. VANET differed from MANET because it establishes a directional way for message stream [3]. The necessity for transmitting the data in an effective way with minimal delay is highly demanded in recent days.

The problem of data dissemination is hence concerned with propagating data not within but beyond the transmission range of the sender. An intuitively simple way to disseminate data beyond the transmission range is through flooding. In flooding each node receiving the message would simply rebroadcast the message without any regard to its current position or any other factors [4, 5]. Thus, data is propagated beyond the transmission range when a node verging on to the transmission range rebroadcasts the message. For effective broadcasting, each vehicle upon receiving a message would make a decision to rebroadcast the message depending on whether or not it is the farthest node in the transmission range [6]. Thus, the decision-making ability of each vehicle on participating in the message propagation is dependent on its awareness of vehicles around it [7].

II. RELATED WORKS

Liu et al. [11] have proposed two 1- D lattice networks for two-way roads using network coding technique with encountering phase and separated phase. During the encountering phase, there is a cover between the telecom inclusion regions of the two disseminators and the vehicles in two ways can get the packets from the two disseminators at the same time. Liu et al. [12] have proposed a cloud-helped security message scattering plan (CMDS) for a coordinated framework that comprises of both cloud foundation and VANET– cell systems. An incorporated VANET– cellular network considers with the transports go about as portable portals. Ucar et al. [13] have introduced VMaSC-LTE hybrid architecture with the blend of 3GPP/LTE system which is based on IEEE 802.11p. The vehicles are grouped with the highlight of multi-hop with the highlights of cluster head selection utilizing the relative portability metric figured as the normal relative speed as for the neighboring vehicles. Kim et al. [14] have presented a prefetch-based data dissemination method which consisting of roadside wireless access points with local data storages. Lin et al. [15] have proposed a mutually enhanced company wise spatial TDMA plan.

III. PROPOSED APPROACH

Adaptive data dissemination protocol (AddP) is proposed by Oliveria [16] that is an effective multi hop broadcasting protocol. This (AddP) technique deals with beacon congestion problem especially the scenarios like beacon load in high density area. In addition, with the help of this technique the reliability can be maximized and possibly tackle the real-time constraints at the time of managing the overhead low data dissemination. Moreover, this technique utilized a received based approach for achieving relay selection with the design metrics of local density and distance from neighboring nodes. The performance of AddP compared with the other beaconless and beacon assisted protocols therefore, the result demonstrates that it keeps up its high delivery ratio and low average delay even under outrageous conditions. The methodology is summarized as:

1. Cluster is achieved by position and velocity of vehicles; CH is selected by the vehicle information's energy consumption and congestion rate. The parameters are time varying constraints which are optimized by the WOA algorithm.
2. Cluster head (CH) is a candidate node which able to transfer the traffic related information form V2V communication.
3. Finally, a collection of simulations was utilized to predict the effectiveness of OAddP mechanism, by AddP.

Each vehicle in our model consists of on-board units (OBUs) and roadside units (RSUs) as shown in Fig. 1. In the network, the vehicles are incorporated with some components such as sensors, storage units, GPS and a user interface to alert the driver by delivering messages and the location of the reported events. The network consists of high-density vehicles, CH vehicles, base stations (BS), intra cluster and inters cluster routing.

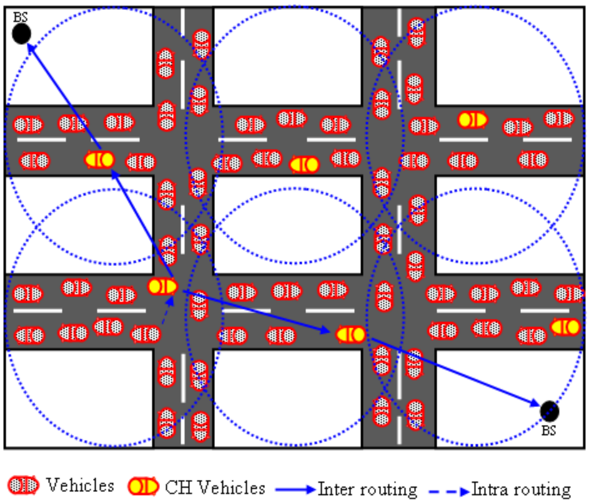

Fig. 1. Network model

Here the detailed description of proposed clustering and control OH message reduction techniques are presented as follows:

Cluster formation: The clustering algorithm is beginning with a gathering of arbitrary particles and after that search for optimal by refreshing generation, every particle is updated by the given two best values.

The initial best solution is represents as P_{best} another best value is global best i.e. g_{best} is traced and acquired so far by any particle in the population.

$$p_{\text{best}_k} = \begin{cases} p_k, \text{If}\left(\text{fitness}(p_k)\text{fitness}\left(p_{\text{best}_k^i}\right)\right) \\ \quad p_{\text{best}_k}, \text{otherwise} \end{cases} \quad (1)$$

$$g_{\text{best}_k} = \begin{cases} p_k, \text{If}\left(\text{fitness}(p_k)\text{fitness}\left(g_{\text{best}_k^i}\right)\right) \\ \quad g_{\text{best}_k}, \text{otherwise} \end{cases} \quad (2)$$

A particle utilizes a portion of the population as its topological neighbors and the best value is a local best and is called l_{best} .In mathematically, the particles are initialized randomly over the search space and move through dimensional space to determine new solution. Here, P_K^i implies vehicle location/position.

V_k^i Implies the velocity of i^{th} vehicle/particle on k^{th} iteration, so for $(K+1)^{\text{th}}$ iteration the P_{k+1}^i and V_{k+1}^i can be calculated as:

$$V_{k+1}^i = \omega.V_k^i + c_1.\text{rand}_1.\left(p_{\text{best}_k^i} - P_k^i\right) + c_2.\text{rand}_2.(g_{\text{best}_k} - P_k^i) \quad (3)$$

$$P_{k+1}^i = P_K^i + V_{k+1}^i \quad (4)$$

Where ω is inertia weight, constant C_1, C_2 representing the learning factors, which is 2 in this case, and rand_1 and rand_2 are random numbers ($0< n< 1$).

CH selection: After cluster formation, BS collects design constraints from every node in the cluster such as energy consumption and congestion rate for CH selection process. The energy consumption of sensing region (E_S) defined as,

$$E_S = E_{\text{off-on}} + E_{\text{on-off}} + (E_s) \quad (5)$$

where $E_{\text{off-on}}$ is the changing energy utilization from the OFF to ON state, $E_{\text{on-off}}$ is the changing energy consumption from ON to OFF state and E_s is the energy utilization of the detecting activity. The energy utilization because of detecting region as,

$$E_s = E_\eta + E_{\text{AD}} + E_\varphi \quad (6)$$

where E_η denotes the energy utilization due to signal sampling, E_{AD} implies energy utilization (analog to digital conversion). The energy utilization of data handling region (E_S) defined as,

$$E_P = E_o + E_\vartheta \quad (7)$$

where E_o denotes the state energy utilization. The detailed description as follows:

$$E_P = \sum_{i=1}^{m}\sum_{j=1}^{n} P_o(i)T_o(i) + F_\vartheta(j)t_\vartheta(j) \quad (8)$$

where $P_o(i)$ is represented as the power consumption cost, $T_o(i)$ represented as the time interval, $F_\vartheta(j)$ implies state transition frequency, $t_\vartheta(j)$ implies energy utilization cost. The energy expense formula is defined as (when message is transmitted/received with distance d).

$$E_{T/R}(l,d) = \begin{cases} l(E_{\text{elec}} + \varepsilon_0 d^2) d < d_0 \\ l(E_{\text{elec}} + \varepsilon_1 d^4) d \geq d_0 \end{cases} \tag{9}$$

where ε_0 and ε_1 are the radio amplifier composes that rely upon sort of condition met and d_0 indicates the reference distance is

$$d_0 = \sqrt{\varepsilon_0/\varepsilon_1}$$

Finally, total energy consumption as follows,

$$E_{\text{total}} = E_S + E_P + E_C \tag{10}$$

Average BS distance (d_{BS}) is indicated as the ratio of distance among the CH and the BS to different vehicles.

$$d_{\text{BS}} = \frac{1}{I_x} \text{dis}(\text{CH}_x, \text{BS}) \tag{11}$$

In intra cluster and routing phase, vehicles are assumed to consume some energy for data sending to their CH. Here, to reduce the energy consumption, we lessen the intra-cluster distance and select CH which is near every one of the vehicles. The constraints are time varying factors, here, we consider as optimal problem. The problem is overcome by proposed Whale Optimization Algorithm (WOA) algorithm.

Whale optimization algorithm:

Step 1: Initialization

Arbitrarily generating weight value that communicates to the result in the search space.

Step 2: Fitness Calculation

Fitness value of solution is computed to get the best weight value.

Step 3: Update the position of current weight value Encircling prey

Humpback whales can identify the region of prey and encircle them. For the obscure position of the ideal outline in the hunt space, the present best competitor arrangement is the objective prey or is near the ideal in the WOA calculation. Once the best search agent is calculated, the other search agents will subsequently attempt to update their situation towards the best search agent.

Step 4: Termination criteria

Repeat process, until a better fitness or maximum number of iterations are met. The cluster metrics are separately collected from all CHs in the order of position and velocity. Then, average values of those parameters are stored in the log files with the separate locations. The two average values are compares in the relative attributes changes, and then the better result is taken for next operation. PDM algorithm predicts the CH change before it is action.

ALGORITHM I. OPTIMAL ADAPTIVE DATA DISSEMINATION PROTOCOL (OADDP)

Input: Number of populations, control variables, and termination level
Output: Cluster formation and CH selection

```
Begin
for each vehicle
initialize best and global best solution
end for
for each vehicle
calculate fitness value
compute vehicle with best fitness is add to the cluster
for each vehicle
calculate velocity
update position
end for
for each vehicle
initialize xi, Etotal
end
for each CH vehicle
initialize position, velocity
compute relative difference
end for
if check relative difference >> predefined threshold
pass signal FOR CH
else
no action
end if
end for
```

IV. RESULTS

The performance proposed OAddP is compared with the well-known data dissemination protocol AddP [16].using Network simulator (NS-2) and simulation of urban mobility (SUMO).

For both environments, the proposed OAddP mechanism implement in 5×5 network scenarios with the network size of 4000×4000 m^2. The number of vehicles is varied by 100, 200, 300, 400 500 and 600 with a maximum speed of 110 kmph. We set the vehicle speed within a range of 10kmph to 60kmph with the flow of 500, 1000, 1500, 2000, 2500 and 3000 vehicle/hours. The total simulation time of whole experiments are 15 minutes. The simulation parameters are given in Table 1.

TABLE I. SIMULATION PARAMETERS

Parameters	Values
Total vehicles	100, 200, 300, 400 500 and 600
Average vehicle speed	110 kmph
Simulation area	4000 X 4000 m^2
MAC layer	IEEE 802.11p
Transmission range of urban nment	200 meters
Transmission power of urban environment	0.98 mW
Transmission range of highway environment	256 meters
Transmission power of highway environment	2 mW
Packet size	2048 byte
Control OH message size	32 bytes
Simulation time	15 minutes

Performance analysis with varying traffic flow:

In experiment, the performance of proposed OAddP mechanism is compared with the existing AddP mechanism with several performance constraints under various traffic flows in urban environment. Fig. 2 presents the success rate of proposed and existing mechanism with different traffic flows. The plot clearly depicts the success rate of proposed OAddP mechanism is very higher than AddP mechanism for all traffic flows.

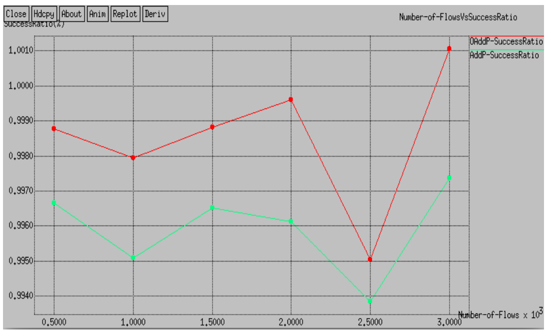

Fig. 2. Success rate with different traffic flows

Fig. 3 gives the data dissemination efficiency of both proposed and existing mechanism. The plot clearly depicts the dissemination efficiency of proposed OAddP mechanism is very higher than AddP mechanism for all traffic flows.

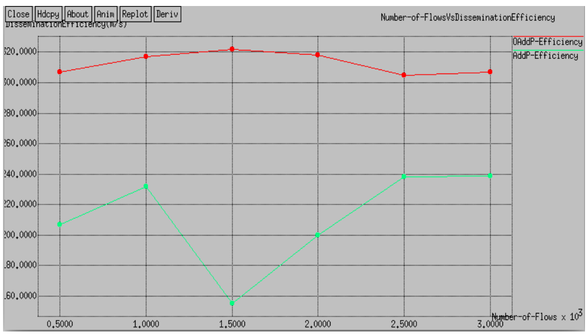

Fig. 3. Data dissemination efficiency with different traffic flows

V. CONCLUSION

One of the difficulties in VANET is the addition of new features to make the system increasingly sheltered and dependable, without the danger of reduced performance. This paper is concerned with the routing protocol to improve packet delivery ratio and success rate in different scenario. A relative examination of various routing algorithms in the field of VANET is introduced. It will additionally feature the primary issues in routing algorithms. The proposed optimal adaptive data dissemination protocol (OAddP) uses the Whale Optimization Algorithm (WOA) technique to perform the clustering and is based on effective multi hop broadcasting protocol. The extensive simulations have been conducted for urban and highway environments. This simulation result shows that the proposed OAddP mechanism increases the success rate and Data dissemination efficiency in different traffic flows with respect to Adaptive data dissemination protocol (AddP**).**

REFERENCES

[1] E. Schoch, F. Kargl and M. Weber, "Communication patterns in VANETs", IEEE Communications Magazine, vol. 46, no. 11, pp. 119-125, 2008.
[2] J. Jang, "Outlier filtering algorithm for travel time estimation using dedicated short-range communications probes on rural highways", IET Intelligent Transport Systems, vol. 10, no. 6, pp. 453-460, 2016.
[3] X. Lin, P. McKinley and L. Ni, "The message flow model for routing in wormhole-routed networks", IEEE Transactions on Parallel and Distributed Systems, vol. 6, no. 7, pp. 755-760, 1995.
[4] C. Hu and M. Chen, "Adaptive Multichannel Data Dissemination: Support of Dynamic Traffic Awareness and Push–Pull Time Balance", IEEE Transactions on Vehicular Technology, vol. 54, no. 2, pp. 673-686, 2005.
[5] J. Misener, "EDITORIAL: Intelligent Transportation Systems and Safety: Innovation and Directions", Journal of Intelligent Transportation Systems, vol. 11, no. 3, pp. 105-106, 2007.
[6] Wisitpongphan, "Broadcast storm mitigation techniques in vehicular ad hoc networks", IEEE Wireless Communications, vol. 14, no. 6, pp. 84-94, 2007.
[7] A. Vinel, C. Campolo, J. Petit and Y. Koucheryavy, "Trustworthy Broadcasting in IEEE 802.11p/WAVE Vehicular Networks: Delay Analysis", IEEE Communications Letters, vol. 15, no. 9, pp. 1010-1012, 2011.
[8] F. Tseng, Y. Liu, J. Hwu and R. Chen, "A Secure Reed–Solomon Code Incentive Scheme for Commercial Ad Dissemination Over VANETs", IEEE Transactions on Vehicular Technology, vol. 60, no. 9, pp. 4598-4608, 2011.
[9] N. Cenerario, T. Delot and S. Ilarri, "A Content-Based Dissemination Protocol for VANETs: Exploiting the Encounter Probability", IEEE Transactions on Intelligent Transportation Systems, vol. 12, no. 3, pp. 771-782, 2011.
[10] P. Ruiz, B. Dorronsoro, P. Bouvry and L. Tardón, "Information dissemination in VANETs based upon a tree topology", Ad Hoc Networks, vol. 10, no. 1, pp. 111-127, 2012.
[11] F. Liu, Z. Chen and B. Xia, "Data Dissemination With Network Coding in Two-Way Vehicle-to-Vehicle Networks", IEEE Transactions on Vehicular Technology, vol. 65, no. 4, pp. 2445-2456, 2016.
[12] B. Liu, D. Jia, J. Wang, K. Lu and L. Wu, "Cloud-Assisted Safety Message Dissemination in VANET–Cellular Heterogeneous Wireless Network", IEEE Systems Journal, vol. 11, no. 1, pp. 128-139, 2017.
[13] S. Ucar, S. Ergen and O. Ozkasap, "Multihop-Cluster-Based IEEE 802.11p and LTE Hybrid Architecture for VANET Safety Message Dissemination", IEEE Transactions on Vehicular Technology, vol. 65, no. 4, pp. 2621-2636, 2016.
[14] R. Kim, H. Lim and B. Krishnamachari, "Prefetching-Based Data Dissemination in Vehicular Cloud Systems", IEEE Transactions on Vehicular Technology, vol. 65, no. 1, pp. 292-306, 2016.
[15] Y. Lin and I. Rubin, "Integrated Message Dissemination and Traffic Regulation for Autonomous VANETs", IEEE Transactions on Vehicular Technology, vol. 66, no. 10, pp. 8644-8658, 2017.
[16] R. Oliveira, C. Montez, A. Boukerche and M. Wangham, "Reliable data dissemination protocol for VANET traffic safety applications", Ad Hoc Networks, vol. 63, pp. 30-44, 2017.