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Data Dissemination Scheme for VANET using Genetic Algorithm and Particle Swarm Optimization

Tahera Mahmood, Tulika

***Abstract:** A vehicular ad hoc network (VANET) consist of moving vehicles connected via wireless technology e.g., Wireless Access in Vehicular Environment (WAVE) for the aim of exchanging information. Therefore data dissemination in VANET has become issue of debate for researcher. In VANET broadcasting play an important role. The aim of VANET is to ensure passenger safety through emergency message. With multiple objectives broadcast storm is assumed to be an NP-Hard problem. In this paper we propose DDV algorithm to solve broadcast storm problem. Fitness function has used to optimize the objective of proposed algorithm. The proposed algorithm producing better optimization results. We are considering a highway scenario in city with dynamic rotation, to evaluate the performance of the DDV algorithm we compare the result with Smart flooding techniques, MOGA (Multi Objective Genetic algorithm) [1] and EEADP. Our result show the better performance in terms of reduce the number of retransmission, increase the packet delivery ratio and provide better throughput.*

***Keywords:** VANET, Broadcasting, Genetic Algorithm GA, Partial Swarm Optimization (PSO), Geographical Area, Rate of Evaluation, Smart flooding, MOGA*

I. INTRODUCTION

In the Vehicular Ad Hoc Network (VANETs), vehicles form a self-organised network without the help of a permanent infrastructure network. Data dissemination should be established efficiently between the communicating nodes for safety applications. Data dissemination is a process of broadcasting data packets over a distributed wireless network. While during broadcasting, the number of vehicles equipped with computing technologies and wireless communication devices is going to increase dramatically. VANETs are distributed, self-organizing communication networks built up by dynamics moving vehicles. Broadcasting in a VANETs is defined as the dissemination of information from vehicle to all neighbor vehicle in network for specific task such as safety, security or advertisement. In specific VANET scenario, vehicle may not be able to receive the broadcast data in a single hop, due to the limited range of radio communication. Hence, we need multi hop because source vehicle not able to cover the entire network.

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In multi hope uncontrolled or blind retransmission will cause congestion and delays in a network. This problem is referred as broadcasting storm problem. The mobile ad hoc networks (MANETs) having very high mobility in which every vehicle node is acting as a host as well as router and forwarding packets to other mobile nodes [2, 3, 4] and changing their topology very fast.

Therefore, the protocols used for MANETs are not necessarily be suits to VANETs and can be optimized for providing better results. VANETs forms decentralized networks. VANETs perform the communication between the vehicle-to-vehicle (V2V) and vehicle-to-roadside (V2R), which not only enhances traffic safety but can also enable infotainment applications via multihop communication, between vehicles [5, 6]. Many data dissemination protocols [7] have been proposed to disseminate information about obstacles information, traffic conditions and mishap on the roads.

II. MAIN CONTRIBUTIONS

Following are the main contribution in this paper:

- To develop an efficient data dissemination technique for broadcasting in VANET.
- To formulate a new appliance for decrease the amounts of retransmission and increase the packet delivery ratio for VANET broadcasting.
- To improve the fitness function and enhance the selection of better optimized solution by using genetic algorithm and Particle Swarm optimization technique in VANET broadcasting.

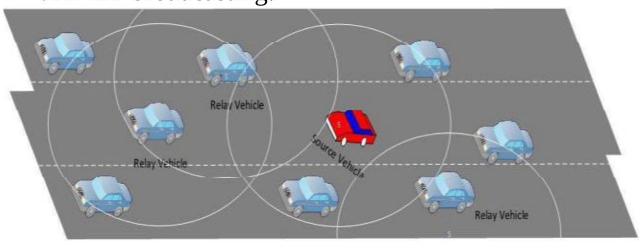

Fig 1. Data Dissemination in a Vehicular Network

III. RELATED WORK

Generally, there are different authors who suggest many techniques to explain the idea of data dissemination in VANET relying on diffusion schemes such as multicast, unicast and broadcast [8–13]. Some techniques designed for V2I communication and some for V2V architecture. In data dissemination, the most important technique is data broadcasting.

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However, this technique suffers from the "broadcast storm problem" where numbers of un-control and blind retransmission causes the congestion. Many researchers have recommended different methods to overcome the broadcast storm problem. In [1], a novel and improved fitness function for MOGA by using GA to solve the broadcasting problem in VANET. The proposed fitness function is to enhance the rate of evolution resulting in more generations and producing better optimization result. The result of proposed algorithm compares with previous approaches in State-Of-Art (Smart Flooding Technique) and found that the algorithm improved in reduction of the propagation time and the no. of retransmission. In [14], a protocol Particle Swarm Optimization Contention based Broadcast (PCBB) has proposed for fast and effective dissemination of emergency messages within the geographical area by utilizing contention window, position based forwarding scheme and PSO intelligent technique, which help to make more accurate analysis and performance, and increasing the percentage of the emergency message reception without affecting the channel collision. In [15] Genetic Algorithm based Network Routing (GANER) to solve the dynamic multicasting routing problem in VANET and increase the efficiency and performance in the packet delivery. The Proposed protocol GANER performed better in term of energy consumption than COPE used in VANET. In [16] guarantee the quality of service (QoS) influenced by broken links between vehicles and the failure of packets transmission in a vehicular ad hoc network (VANET). The results validated that GABR protocol is superior to the IBR and CAR protocols in terms of packets transmission delay and the packet loss rate. In [17] new approach for information dissemination in VANETs where the structure of the communications is configured using a model based on Covering Location Problems (CLP) that it is optimized by Genetic Algorithm. The results obtained show that the new approach can provide good solutions for very demanding response times. In [18] an algorithm based on Genetic Algorithm for preventing as well as detection of the attacks. The genetic algorithm will work on the fitness function to prevent the prankster attacks and the whole simulation done in MATLAB. The proposed algorithm is better in term of comparison between GA and without GA.

IV. SYSTEM MODEL

We consider a VANET model comprising of N number of vehicles such that r = 1... N, and they are communication with each other. We consider a highway scenario where multiple vehicles are moving with dynamic speed and dynamic direction. we consider each vehicle as dynamic with respect to each other. This assumption corresponds well with the argument that vehicle are running with a dynamic speed with respect to each other. We also assume that vehicles in VANETs have on board units (OBUs) containing wireless communication system [2]. Embedded wireless communication system in OBUs aids a vehicle to establish communication with other vehicles or roadside units in immediate vicinity due to limited radio signal. The radio range of a vehicle in VANET is approximate about around 1000m [19]. Dedicated Short-Range Communication (DSRC) technology is explicitly designed to support limited range of radio communication networks containing dynamic nodes like VANETs. As dedicated wireless communication channels are required to implement DSRC, hence authorities governing communication infrastructure have started to issue special and dedicated spectrum to support establishing the vehicular network. In US, the Federal Communication Commission (FCC) has allocated 75 MHz of spectrum in the 5.9 GHz band for VANETs which is further sub divided into seven channels [19].

Furthermore, there are many standard protocols governing DSRC that are being used for the implementation of VANET such as IEEE-WAVE, CALIM and C2CNet [20]. IEEE 802.11 family contains set of protocol suites for implementation of different types of wireless communication. This family also includes IEEE 802.11p, which is designed to support Wireless Access in Vehicular Environment (WAVE) [21], [22]. IEEE 802.Ilp contains many salient features that have given it an edge over other protocols and has become the de facto protocol for VANET communication framework governing both Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communications. In this paper we assume that all the vehicles use IEE802.11p for inter vehicle communication and we are considering V2V and V2I communication. Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) as well as beaconing system is some of the salient features of IEEE802.11p that are important with respect to this research [22]. The functionality of collision management, which helps in avoiding data packet collisions, is performed by CSMA/CA. Data packet collisions may transpire in the system when more than one vehicle in the same neighborhood attempts to transmit at the same time. In a system under CSMA/CA, when a vehicle decides to transmit something it has to check the channel for the possibility of any other transmission being carried out currently. If there is a transmission, the vehicle will assign it a random wait time after which it will check again to see if the channel is free to transmit. On the other hand, if there is no transmission, a vehicle may go ahead and transmit information. However, this situation may cause collision due to multiple vehicles following the same process with a desire to transmit some information. Hence, CSMA/CA allocates random wait time (also known as back-off interval) to each of the prospective vehicles. The random wait time is inside a contention window already defined in IEEE 802.11p. Additionally, packet acknowledgement (ACK) is also used by CSMA/CA to help in reducing collision. The ACK is sent by the receiver to notify the source about successful transmission of information. If the source does not receive ACK, it retransmits the original information. The lack of packet acknowledgement may be due to information not received by the receiver or ACK was not received intact [24]. We will take advantage of IEEE 802.l1 protocol in our proposed system to implement the network packet collision avoidance and will not consider any other collision avoidance system. One of the main implementation of our proposed system is that each vehicle must have an updated database of its neighboring vehicles. This information can be shared between vehicles by inter-vehicle communication.

In order to obtain the identities of neighboring vehicles within the transmission range of a given vehicle, we use the beaconing mechanism as defined in IEEE 802.11p protocol [25], [26]. Upon receiving the transmitted beacon from various vehicles, the database of each vehicle is updated to include those particular vehicles.

V. SMART FLOODING (SF)

Smart flooding technique utilize the optimize the algorithm and categories into three main components: evolutionary algorithm, real time simulator and log analyzer. Evolutionary algorithm makes some random initial population to process the algorithm. Initial population has error in population so that utilizing of the fitness evolutionary process can reduces the error. Fitness evaluate categories into two step process, where in first step, each individual of the population evaluated on the real time simulator i.e. NS-2 and this real time simulator provides the log files. And in second step, we need to log files extractor i.e. known as log analyzer. Log analyzer can extract the log files and convert it into each individual of the fitness function analyze the all value of the population. Fitness function categories information the element using evolutionary algorithm.

VI. PROPOSED DATA DISSEMINATION OF VANET

The broadcasting storm problem is considered to be Non deterministic polynomial hard. In this paper we use multi objective genetic algorithms (MOGA) and PSO to solve the problem. MOGA is used fast searching because it is heuristic based search algorithms and PSO is Meta heuristic use for optimization. This paper focus for metrics such as propagation time Tp , numbers of retransmission Nr, throughput,packet delivery ratio, network life time. Multi objective genetic algorithm consist three function. These function defined as fitness, reproduction and termination function and denoted by f(x), z(x) and t(x). Table I consist of symbols and notation that are used to describe the model.

In this paper Genetic algorithm and partial swarm optimization technique is used for fast and accurate searching and optimization. Broadcasting swarm has transmitted the data/information but many times it sends as blind message. DDV algorithm reduced the blind message so that in this paper retransmission is less than MOGA and State of the arts (Smart flooding). Particle Swarm Optimization (PSO) is a relatively recent heuristic search method whose mechanics are inspired by the swarming or collaborative behavior of biological populations.

A solution in the search domain consists of the wait time, Twr and Time to Live (TTL). Wait Time always take a time before sending the retransmission packets of the data to the vehicle (v). While TTL is the time after sending the retransmission packet data of the vehicle (v). The probability of the neighborhood courage is based on two important elements wait time and time to live (TTL). And it can be determining total transmitted data received by total of the number of neighboring vehicles (Nvh) and number of vehicles that receive total transmitted (Nnp). It can be determining in mathematically:

$$P_{ne} := \begin{cases} 0, & if\ N_{np} = 0 \\ 1, & if\ N_{vh} = 0 \\ \frac{N_{np}}{N_{vh}}, & otherwise \end{cases} \quad (1)$$

The DDA will be get solution of the population that will have fitness function f(x) and fitness value (x) is based on fitness function. The fitness value x can be defined as the quality of that individual which generate from the best global position Gp of the parent position. The fitness function f(x) has been determined through MATLAB Simulator software. We have determined the analytical approach of the fitness function f(x). This approach helps in iterative evaluation of packet transmission on the highway scenario in the city with all direction and dynamic speed. The fitness function f(x) equation is represented in mathematically:

$$f(x) := [\, N_R \;\; T_P \,] \quad (2)$$

Where

$$N_R := \sum_{i=1}^{N_V} \alpha_i \quad (3)$$

$$\alpha := \begin{cases} \sum_{i=1}^{N_V} \alpha_i & if\ TTL - TI > 0 \\ N_R & if\ TTL - TI = 0 \end{cases} \quad (4)$$

Where

$$\alpha = V(N_R, P_{nc}, T_{wR}, TTL, TI, L_v) \quad (5)$$

The fitness function f(x) is a mainly focus on two parameters retransmission NR and propagation time TP that are to be optimized. Hence, we optimized the best fitness value of the system and its always ones so that minimized the value of the parameters retransmission NR and propagation time TP. Initial parameters can random generate and reproduction variable check the best generation Gn with previous and current generation. And its generate best fitness value of x. the reproduction are referred as next generation for parents.

A reproduction function z(x) is replacement the parameters which is based on crossover function c(x), and mutation function m(x). A crossover is process that can improve its parameters. A crossover function c(x) category into two part and separate them and best one is children of the parents. When two individuals selected as parents who take from the previous generation, the crossover function c(x) is separate them at new locations as parents. A mutation function m(x) is new offspring formed and it occurs to maintain diversity within the population and prevent premature convergence. Mutation function m(x) randomly selected 20 percent diversity of the population and changing the location. The selected value of the mutation rate created acceptable individuals. As above we discuss two parameters who utilize in the chromosomes is probability of neighborhood coverage Pnc and wait time Twr.

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Time Interval (TI) is a count the receive packets data of the vehicle and TI subtracted with the TTL and this time known as actual time Tact. Actual Time categories: (1) Tact=0, it means a vehicle v dispose off the packets. (2) A vehicle v transmitted packets whose forwards by Tact.

Chromosomes are normally encoded in binary values. But here, the decimal number can be use in Simulator Software. V is a no. of vehicles such as v=1,2,3….V, the fitness function f(x) has created best fitness value optimized and x have the best fitness value of the all individual optimized to the global position G(x) and here we generate the best fitness value among the 1000 local current generation

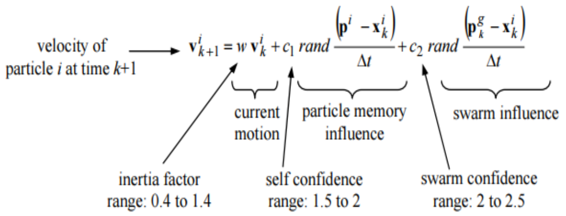
$$T(x) := \begin{cases} True & if\ G_{gn} = 1000, P(x) > G(x) \\ False & else \end{cases} \quad (6)$$

Where

$$G_{gn} := \begin{cases} G_{gn}, & if\ \ G_{gn} \le 1000 \\ 1, & if\ \ G_{gn} > 1000 \end{cases} \quad (7)$$

Genetic Algorithm has nearest local position find but Particle Swarm Optimization has ability find minimum error present in the current position to global position. PSO is a heuristic method which find the best location of the particles in each iteration. We are receiving some parameters from genetic algorithm as: fitness function f(x), fitness value x, best global fitness value Gx and PSO has some parameters initialize as: maximum iteration, initial position, acceleration coefficient, upper bound, lower bound, etc. Consider the global optimum of an n-dimensional function defined by:

$$f(x_i)=f(x_1, x_2, x_3, x_4, \ldots x_n,) \quad (8)$$



where x_i is the fitness variable.

$$x_0^i = x_{min} + rand(x_{max} - x_{min}) \quad (9)$$

$$v_0^i = \frac{x_{min}+rand(x_{max}-x_{min})}{\Delta t} = \frac{position}{time} \quad (10)$$

The positions and velocities are given in a vector format with the superscript and subscript denoting the i particle at time t. In Equations, rand is a uniformly distributed random variable that can take any value between 0 and 1. This initialization process allows the swarm particles to be randomly distributed across the design space. The second step is to update the velocities of all particles at time k+1 using the particles objective or fitness values which are functions of the particle's current positions in the design space at time k. The fitness function value of a particle determines which particle has the best global value in the current swarm, gkp, and also determines the best position of each particle over time, ip, i.e. in current and all previous moves. The velocity update formula uses these two pieces of information for each particle in the swarm along with the effect of current motion, v_k^i, to provide a search direction, v_{k+1}^i , for the next iteration. The velocity update formula includes some random parameters, represented by the uniformly distributed variables, rand, to ensure good coverage of the design space and avoid entrapment in local optima. The three values that effect the new search direction, namely. The original PSO algorithm uses the values of 1, 2 and 2 for w, c1 and c2 respectively, and suggests upper and lower bounds on these values as shown in Equation above. However, the research presented in this paper found out that setting the three weight factors w, c1, and c2 at 0.5,1.5, and 1.5 respectively provides the best convergence rate for all test problems considered. Other combinations of values usually lead to much slower convergence or sometimes non-convergence at all. The tuning of the PSO algorithm weight factors is a topic that warrants proper investigation but is outside the scope of this work. For all the problems investigated in this work, the weight factors use the values of 0.5, 1.5 and 1.5 for w, c1, and c2 respectively. Position update is the last step in each iteration. The Position of current motion, particle own memory, and swarm influence, are incorporated via a summation approach as shown in Equation 12 with three weight factors, namely, inertia factor, w, self-confidence factor and swarm confidence factor, respectively. Each particle is updated using its velocity vector as shown in Equation 13.

where f(x) is the fitness function. The global best position Gbest at time step t is calculated as

$G_{best} = min\{P_{best,i}^t\}$, where i = [1,2,.. n] and n>1 (11)

$$P_{best,i}^{t+1} = \begin{cases} P_{best,i}^{t+1} & if\ f_i^{t+1} > P_{best,i}^t \\ x_i^{t+1} & if\ f_i^{t+1} \le P_{best,i}^t \end{cases} \quad (12)$$

Therefore, the personal best Pbest,i is the best position that the individual particle has visited since the first time step. On the other hand, the global best position Gbest is the best position discovered by any of the particles in the entire swarm.

$$X_{k+1}^i = X_k^i + V_{k+1}^i . \Delta t \quad (13)$$

The three steps of velocity update, position update, and fitness calculations are repeated until a desired convergence criterion is met. In the PSO algorithm implemented in this study, the stopping criteria is that the maximum change in best fitness should be smaller than specified tolerance.

The broadcasting storm problem solved to utilize the computable technique of the real time simulator i.e. MATLAB software. Genetic algorithm and partial swarm optimization technique is used in this paper for fast searching and optimization. Broadcasting swarm has transmitted the data/information but many times it sends as blind message. DDV algorithm reduced the blind message so that in this paper retransmission is less than MOGA and State of the arts (Smart flooding).

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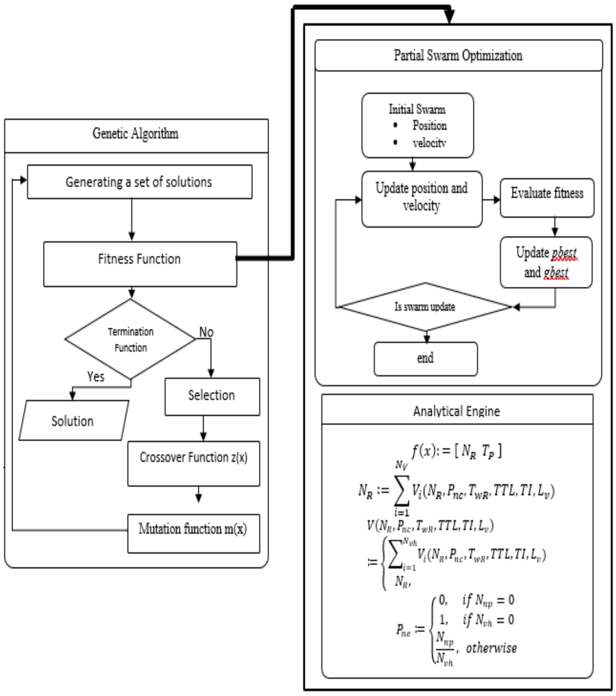

Fig 2. Flowchart of Genetic Algorithm and Partial Swarm Optimization in the Broadcasting Swarm

Here, DDV has focused on some specific term as throughput, return loss, network lifetime, total energy consumption.

Distance can measure:

$$distnc(ii) = \sqrt{((node(nodtble(i),3) - node(nodtble(i+1),3))^2 + (node(nodtble(i),4) - node(nodtble(i+1),4))^2)} \quad (14)$$

Vehicle can be transmitted specific rate of data to other vehicles and its consumption of the energy can find as Jules and shown in below:

$$e(f) = 8 * alpha1 * pktsize * datarate(f) + 8 * alpha2 * pktsize * datarate(f) * totaldist^{alpha} \quad (15)$$

And last vehicle received maximum transmitted data i.e. throughput. Throughput can require some basic component as packet ratio and its size, data transmission rate, and total time consumed between transmitted area/nodes.

$$thrgput = \frac{pktsize*datarate}{timeconsumed} \quad (16)$$

Broadcast swarm has sent all data to nearest all vehicle and before broadcasting the message to the vehicles, it can store the velocity, position and distance of the vehicles. This equation can find nearest point of the source vehicle and it can find all nearest vehicles/nodes.

$$dist = \sqrt{\left(node(p,3) - node(q,3)\right)^2 + \left(node(p,4) - node(q,4)\right)^2} \quad (17)$$

VII. RESULT AND DISCUSSION

A. Simulation Environment

Simulation can be done on MATLAB r2016 a software and machine configuration is 4 GB ram, Intel(R) core i3 CPU- 1.7 GHz and system type 64-bit operating system. with no. of Nodes. And this simulation is design for dynamic routing. This section deals with the network parameters used in the research work that is being shown in the Table1. The simulation parameters are listed in Table 1.

Table 1 Properties of Parameters

Environment	MATLAB 2016a
Optimization algorithm	Genetic Algorithm And PSO
Network size	Dynamics
Type of Road	Highway with multiple lanes
Parameters	Throughput, energy, delay and error rate
Simulation Area	100 x 100 m^2
Commute Range	20
No. of Nodes	1000 Nodes

B. Discussion

We first present the obtained results in terms of dropped packet rate. After that, we analyze the performance of broadcasting methods in terms of throughput. Finally, we demonstrate the impact of nodes density transmit the data (broadcasting message) in the term of:

- It can be seen, the number of dropped packets in both approaches with low density (4 to 14) is nearly the same and slightly goes up with the increase in vehicles density. However, in medium and high density drops much more packets analyzed to the PSO and GA.
- Throughput: Throughput is a rate of transmit of the successful message data. Throughput of the network signal may be affected by various factors.
- Network lifetime: this criterion is often used interchangeably with the network lifetime. Due to limited energy resource in each vehicle, use this energy in efficient VANET to increase the network lifetime.
- Energy consumption: Each individual node needs some amount of energy for processing the information.

C. Comparative Analysis

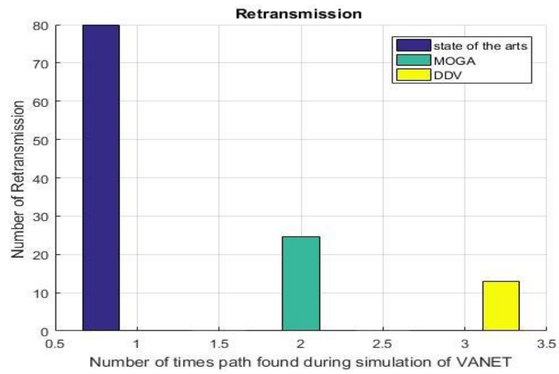

Fig 5. Comparative Analysis of Retransmission of DDV with State of the arts (Smart Flooding) and MOGA

The smart flooding and MOGA techniques require 80 and 24.7 retransmission for network coverage respectively [1]. And other hand DDV proposed, it requires 15 retransmissions for network coverage as shown in the figure 5. Retransmission oppose the efficiency of the throughput. If retransmission higher, it means efficiency of the throughput is low. And proposed broadcasting technique, i.e. improve the efficiency of the throughput as shown in figure 7.

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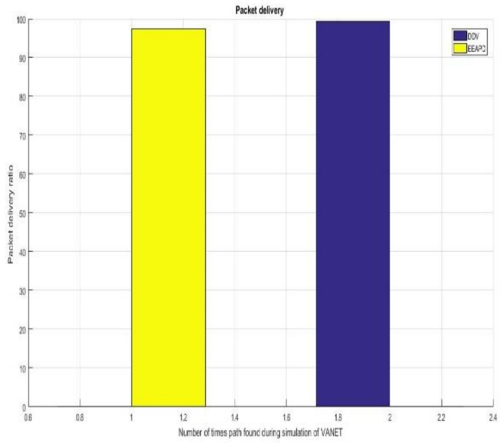

Fig-6 Comparative Analysis of Packet Delivery Ratio of DDV and EEAPD

In Figure 6 show that the DDV has high packet rate as compare to EEAPD, whereas EEAPD has outperformance as compare to S1PD, SEAD, AddP in term od packet delivery ratio. This show outperforms all protocols. Packet delivery ratio is the ratio of the number of packet received by the destination to the number of packet sent by the sender. It may affect by different crucial factor such as packet size, group size, action range and mobility of nodes. The robust message transmission is defined as the 100% packet delivery. Here 100% delivery means receiver receive all the packets send by sender node before time period expires

D. Performance Analysis

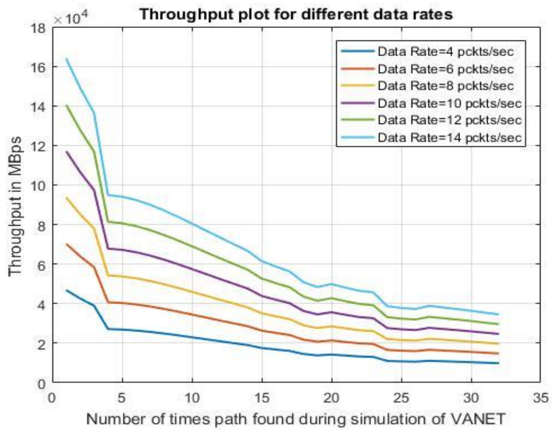

Fig 7. Throughput Plot for Different Data Rate

In addition, the best behavior of the PSO and GA are more noticeable when the number of vehicles grows. This is algorithm work successful process and it takes a lot of generation to come up with the best suited individuals for the prevailing environmental conditions. Broadcasting network completed the simulation on dynamics nodes. So that all nodes properly change the location as real time vehicle changes. Fig 6 shown as rate of flow of the data transmission in a different rate (4, 6, 8, 10, 12, 14 packet/sec). This simulation performance analysis on two nodes (Source and destination) whose situate nearly to the other nodes and its efficiency so high as shown. So that throughput is high.

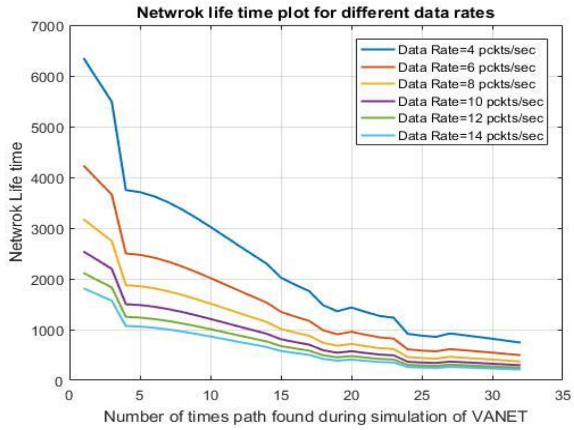

Fig 8. Network Life Time Plot for Different Data Rates

Fig 8 show as network life time operate during the number of times path found. Network lifetime can transmit the maximum energy as required the throughput at different data rate.

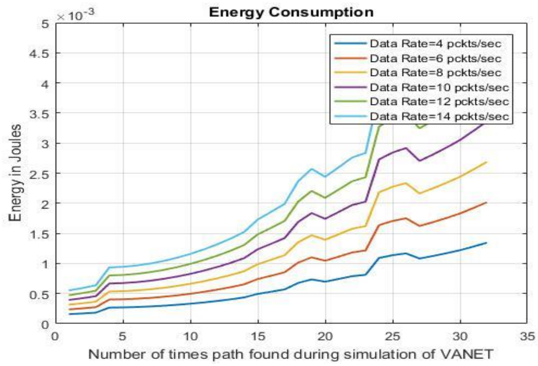

Fig 9. Energy Consumption

Fig 9. Show as energy consumption during the broadcasting period. When source and destination point near then energy loss very low and it provided maximum efficiency.

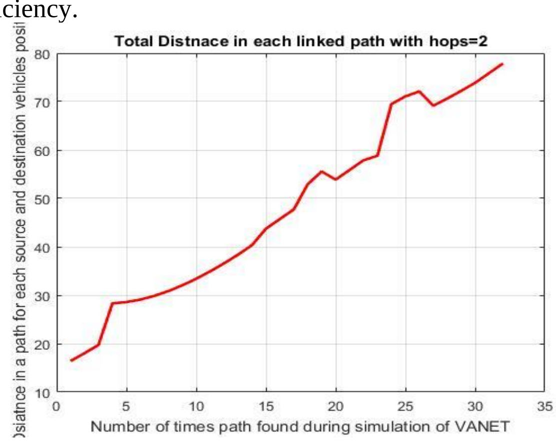

Fig 10. Total Distance in Each Linked Path

In fig 10 shows that total distance in each link path cover of number of times path found during the simulation with respect of each source to destination.

VIII. CONCLUSION

GA and PSO are most popular searching and optimization technique.

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In this paper, we have presented a novel fitness criteria, based on analytical approach to solve the issues of broadcasting storm in VANETs. The analytical approach helps in reducing the complexity of MOGA, increasing the rate of evolution and producing the better optimized solutions. The results showed that our approach produces better results in terms of propagation time, packet delivery ratio and number of retransmissions compared to the previous approaches adopted in smart flooding technique and EEAPD.

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