Design of a New CBR Protocol in VANET using Fuzzy Particle Swarm Optimization

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Abstract— Vehicular Ad-hoc Network is the trending technology which can provide solutions for vehicular traffic and safety. Design of new hybrid routing protocol can solve the various problems for packet routing in VANET. This protocol is designed for routing which is useful for various applications where these applications require reliable and scalable routing in network. The system enables us to make routing more efficient and flexible when used with Fuzzy Particle Swarm Optimization technique where the link is selected by using Fuzzy Logic and PSO provide proper direction for the packet. FPSO provide reliable communication between nodes that improved the PDR, packet-delay, energy level and makes packet routing more efficient in VANET.

Key words: Vehicular Ad Hoc Network, CBR, fuzzy logic, PSO, Fuzzy Particle Swarm Optimization

I. INTRODUCTION

The Vehicular Ad-hoc Network is one of the trending networks for improvement in transportation systems which provide the solutions for the vehicle traffic and its safety. VANET is a kind of network where vehicles communicate with each other to create a wireless network to obtain the communication between them. The advance nature of new technology for vehicles has made it more responsibility towards safety of vehicles and their drivers. To provide safety to the vehicles the communication must be established between vehicles so that they can find reliable route for travelling. In this network, the vehicles which are moving on road needed to be within each other's range to make communication between them even without base station [13]. According to the mobile network they require a base station to communicate with each node within its range, but in VANET only the communicating vehicles wants to be within a particular range of each other.

Real-time apps and performance related applications demand strict time delay during communication [14]. The VANET provides a more effective and flexible way for vehicle to vehicle communication, vehicle to other interaction, sharing of data within their range, etc [1]. It is a challenge to ensure continuous and stable communication in the presence of high speeding vehicles. There are various routing protocols that have been defined to make routing more efficient and reliable in VANET. In-order to make routing more reliable in VANET an efficient routing protocol needs to be designed according to the requirement of the system. The current routing protocols cannot fulfil the requirements of the safe routing due to advancement in VANET which require more compatible routing protocols.

Routing protocol [10][11] must be able to provide more advanced features with more flexibility and when implemented in VANET there will be lesser complication in communication. The CBR [4] provides us more efficient way of communication between nodes with better efficiency. The CBR in VANET is useful for various applications where these applications require reliable and scalable routing in network. In CBR clustering of nodes is the most important aspect which makes the overall system more stable. Particle swarm optimization provides nature inspired intelligence for effective packet routing in VANET. Fuzzy provides the logical way for selecting an efficient route from source to destination and to detect conjunction between nodes. The system has designed a hybrid routing protocol that is more suitable for CBR in VANET to improve the communication performance in VANET. The proposed system efficiently route the packets in VANET to other locations. The main objective to implement FPSO technique is to improve the routing performance in VANET.

II. RELATED WORK

Large amount of work been done on Vehicular Ad Hoc Network with various routing techniques to improve the communication performance which provide the solution for the vehicles.

In paper [1] an author proposed a new model for the improvement in routing performance and design of clustering in VANET.

In paper [3] an author proposed a new protocol which is very useful and provides a reliable solution for routing in Vehicular Ad Hoc Network and also shows the proper efficiency.

An author of paper [4] proposed a new routing protocol which is designed for VANET and has lots of improvement in the routing efficiency and packet delay.

An author of paper [6] proposed the architecture which combined the three different techniques which provide high PDR and provide low delay for the performance level.

An author of paper [7] proposed a new technique in Vehicular Ad Hoc Network in which selection of Cluster Head and a clustering-algorithm for the VANET is introduced for effective CBR in VANET.

In paper [8] an author proposed a new concept based on Fuzzy Particle Swarm Optimization is introduced which decreases the networks cost in VANET.

Currently very few useful solutions for routing in VANET are implemented. The system shows the efficiency of the proposed protocol by using the simulations.

III. PROPOSED SYSTEM

Vehicular Ad-Hoc Network is known as the network which provides solutions for vehicle traffic and also provide safety for the vehicles. The system must design such a routing protocol that should be more suitable for CBR in VANET and will efficiently route packets to distant locations.

The proposed system has design a new hybrid routing protocol for CBR in VANET to improve the performance of communication and to make packet routing

more reliable. The proposed protocol also provides the effective solution for routing which improves the transmission link quality and congestion occurred in packet transmission in network.

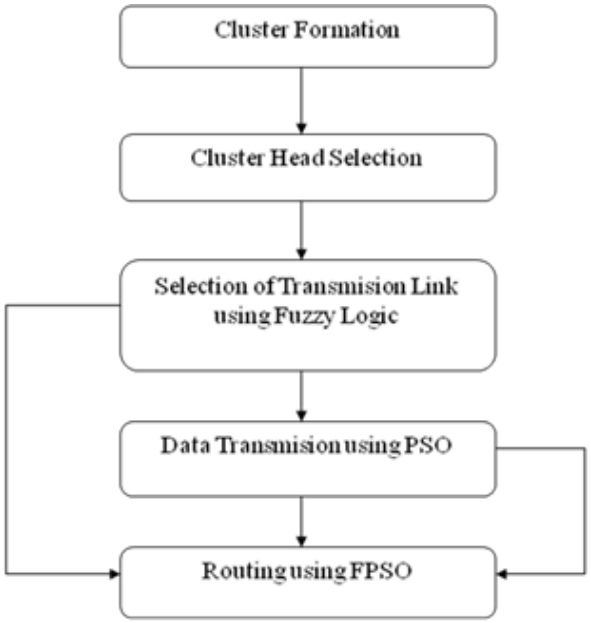

Fig. 1: Flow Diagram

A. Cluster Based Routing

In this routing, VANET is useful for various applications where these applications require reliability of routing and scalability of routing in the network. In CBR [2], clustering of nodes is the most important aspect which makes the overall system more stable. CBR provides effective way of communication between nodes by generating clusters through these wireless nodes which makes them more stable to maintain the proper level of communication between nodes. CBR can be performed on the basis of various factors such as which clustering technique to be used for clustering of nodes and the energy level of clusters during clustering and the location of access point through which clusters interact with each other. CBR [9] makes the interaction between nodes more efficient.

In proposed system clustering of nodes is done by using CAND algorithm by considering some factors such as energy level of nodes, large number of neighbor nodes and smallest distance from base station. In this algorithm one Cluster Head is selected for each cluster and that Cluster Head always convey the message of its cluster members to another Cluster Head of other cluster and then the Cluster Head of that cluster convey the message to its cluster members in this way the communication is performed between them.

B. Link Selection using Fuzzy

In a VANET, a link is good or not depends on the various performance metrics such as vehicle movement, the quality of link and the bandwidth. Therefore, in the process of link selection [3], these metrics considered collectively. The model for link selection is difficult to design and gives unstable solution. The system used Fuzzy Logic to solve this problem. In a proper way, Fuzzy Logic can process data by using Linguistic Variables which express the facts. Fuzzy Membership Functions are used to represent the level of a numerber value related to these variables. Fuzzy Rules are defined to create the proper fuzzy-value.

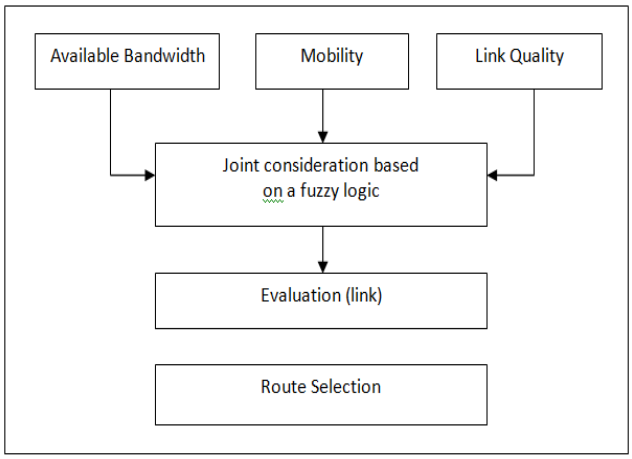

Fig. 2: Fuzzy Approach for Link-Selection

The following is the procedure for calculating a link status for a transmission link.

1) Firstly the various elements which considered for fuzzy processing such as BWF, MF and LQF are calculated. These elements calculated as following:

a) BWF is calculated in following manner

$$BWF = \min(CITR(c), CITR(x))$$

Where CITR is the channel idle time ratio and $CITR(c)$ denotes CITR at the current node, $CITR(x)$ denotes the CITR at node x.

b) MF is calculated in following manner

$$MF_i(c,x) = \begin{cases} \sqrt{\frac{|AC_i(c,x) \cap AC_{i-1}(c,x)|}{|AC_i(c.x) \cup AC_{i-1}(c,x)|}}, & AC_i(c,x) \cup AC_{i-1}(c,x) \neq \varphi \\ 0, & \text{otherwise} \end{cases}$$

Where, AC is the additional coverage where $AC_i(c,x)$ indicate the current value and $AC_{i-1}(c,x)$ indicate the previous value, respectively.

c) LQF is calculated as

$$HRR_i(c,x) = \begin{cases} \frac{NUM_r(c,x)}{NUM_s(x)}, & NUM_s(x) \geq 10 \\ \frac{NUM_r(c,x)}{NUM_s(x)} \cdot \left(1 - \left(\frac{1}{2}\right)^{NUM_s(x)}\right), & \text{otherwise} \end{cases}$$

Where, NUM r(c, x) denotes the number of hello messages received a c from x, and NUMs(x) is the number of hello messages sent from x. As shown in the equation, we discount those nodes who are only neighbors for less than 10 s (when NUMs(x) < 10).

Once the HRR is calculated then LQF is calculated as:

$$LQF(c,x) \leftarrow (1 - \alpha)LQF_{i-1}(c,x) + \alpha \times HRR_i(c,x)$$

After calculation of the LQF, LQF$i-1$(c, x) is updated as

$$LQF_{i-1}(c,x) = \begin{cases} 0, & NUM_s(x) < 10 \\ LQF(c,x), & \text{otherwise} \end{cases}$$

2) In the next process where a numerical-value is converted to a fuzzy-value using a Fuzzy Membership Function. The triangular functions are compatible for the proposed protocol because it required the perfect link from other links. A node used the BW Membership Function to calculate at what level the BWF (Large,

Medium or Small). And also calculate at what level the MF (Slow, Medium or Fast) and at what level the LQF (Good, Medium or Bad).

Rules	Bandwidth	Mobility	Link Quality	Rank
Rule 1	Large	Slow	Good	Perfect
Rule 2	Large	Slow	Medium	Good
Rule 3	Large	Slow	Bad	Un-preferable
Rule 4	Large	Medium	Good	Good
Rule 5	Large	Medium	Medium	Acceptable
Rule 6	Large	Medium	Bad	Bad
Rule 7	Large	Fast	Good	Un-preferable
Rule 8	Large	Fast	Medium	Bad
Rule 9	Large	Fast	Bad	Very Bad
Rule 10	Medium	Slow	Good	Good
Rule 11	Medium	Slow	Medium	Acceptable
Rule 12	Medium	Slow	Bad	Bad
Rule 13	Medium	Medium	Good	Acceptable
Rule 14	Medium	Medium	Medium	Un-preferable
Rule 15	Medium	Medium	Bad	Bad
Rule 16	Medium	Fast	Good	Bad
Rule 17	Medium	Fast	Medium	Bad
Rule 18	Medium	Fast	Bad	Very Bad
Rule 19	Small	Slow	Good	Un-preferable
Rule 20	Small	Slow	Medium	Bad
Rule 21	Small	Slow	Bad	Very Bad
Rule 22	Small	Medium	Good	Bad
Rule 23	Small	Medium	Medium	Bad
Rule 24	Small	Medium	Bad	Very Bad
Rule 25	Small	Fast	Good	Bad
Rule 26	Small	Fast	Medium	Very Bad
Rule 27	Small	Fast	Bad	Very Bad

Table 1: Rule Base

3) The IF–THEN rules are applied based on the fuzzy-values of the parameters BWF, MF, and LQF. The IF–THEN rules defined in given table helps for the calculation of the rank of the link. The LinguisticVariables for the proper rank selection defined as {Perfect, Good, Acceptable, Un-preferable, Bad, Very Bad}. As shown in given table, first rule is defined in following manner:

IF Bandwidth is Large, Mobility is Slow, and Link quality is good, THEN Rank is perfect.

Fig. 3: Processing of Fuzzy Rules

C. Routing using FPSO

In proposed system two machine learning techniques implemented a new Fuzzy Particle Swarm Optimization protocol to solve various routing problems in VANET. In proposed system, fuzzy [5] is used detect the link-stability which helps in avoiding the link-failure which makes system reliable and stable in route selection for reliable packet routing in network. Particle Swarm Optimization is a naturr related technique used for finding the solution in network. In Particle Swarm Optimization, the behavior of natural entities is followed for finding the solution for various problems. In proposed system CAND algorithm of particle swarm optimization is used to efficiently route packets in VANET to different locations.

IV. SIMULATION

To verify the simulation result various parameters of performance metrics are required in order to make the routing more reliable and stable. The simulation is carried out on some of these parameters in initial phase of the proposed system. According to these parameters the various factors such as total number of nodes to be needed for routing, the functioning capacity of nodes, the size of packet and their delivery ratio, the rate at which data will be transmitted, delay in packet delivery all these will improve the routing performance in VANET.

Sr. No.	Parameters	Values
1	Number of Nodes	71
2	Simulation area	2121*438
3	Transmission range	1 mbps
5	Simulation time	15 s
6	Packet size	32 bit

Table 2: List of performance-metrics related to routing

The evaluation of the proposed protocol is based on the following simulation parameters:

Sr. No.	Parameters
1	Packet Delivery Ratio
2	Energy level of Nodes
3	End-to-End Delay
4	Throughput

Table 3: Simulation Parameters

V. EXPERIMENTAL RESULTS

Proposed system used a trending VANET to enhance the performance of proposed protocol. It was implemented in Linux. Here, how the routing was performed for CBR in VANET by using FPSO is shown with various screen-shots.

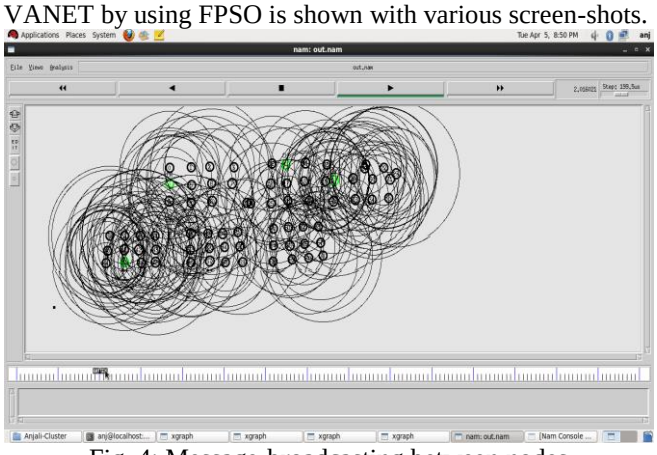

Fig. 4: Message-broadcasting between nodes

The Fig 6.1.2 shows that the message was transfer to each and every node in the network. Once the broadcasting of the messages is completed, the clustering of nodes performed in the network.

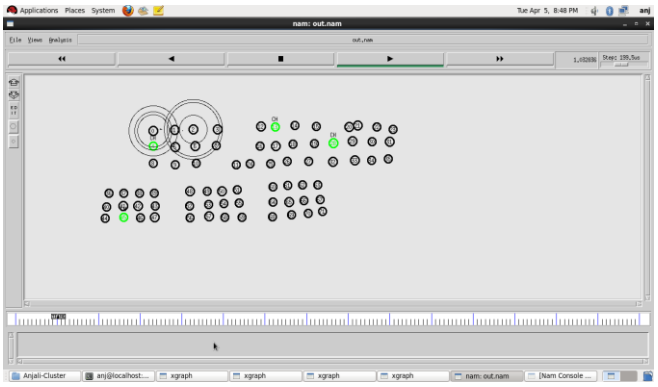

Fig. 5: Cluster Head Selection

The fig. 5 show the process of clustering, once the clusters are formed the Cluster Head was selected for each cluster according to the distance between nodes and the energy of the node.

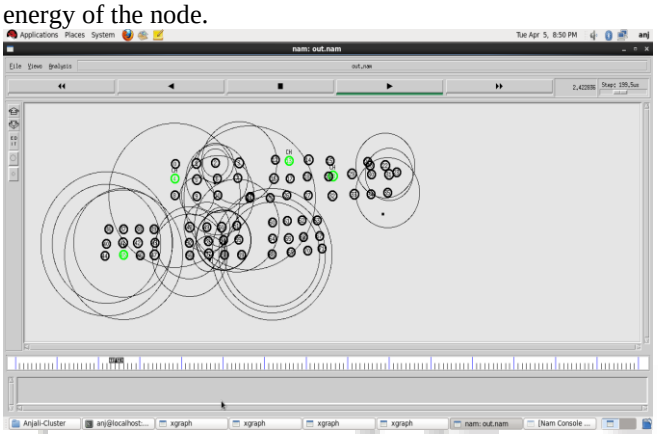

Fig. 6: Packet-routing between clusters

As shown in fig. 6 The routing was performed between clusters where each cluster sends the packet to another cluster to reach the destination node. In this process the link for sending the packet from source node to the destination node selected by using Fuzzy Logic. Once the link was selected the PSO provide the way that from which node the packet was arrived to the destination. In this way the packet routing was performed in the network by using proposed protocol.

Analysis of the experimental result is performed in following manner:

The screen-shots in the given section shows how the packet routing is performed using the proposed system. For proper result of proposed system, following analysis carried out. The proposed system observed in four different parameters:

- packet delivery ratio ;
- energy level of node;
- end-to-end delay;
- Throughput.

A. Packet Delivery Ratio

Fig. 6 shows the PDR in the network. The proposed protocol shows advantage for various protocols which are used for routing in VANET because the proposed protocol used the BW, MF, and LQF in the link-selection. The proposed protocol is useful than PSO because of the consideration of link-quality. PSO provides many packet losses in the network. The proposed protocol find the perfect link for routing, using Fuzzy Logic which provide improvement in the PDR.

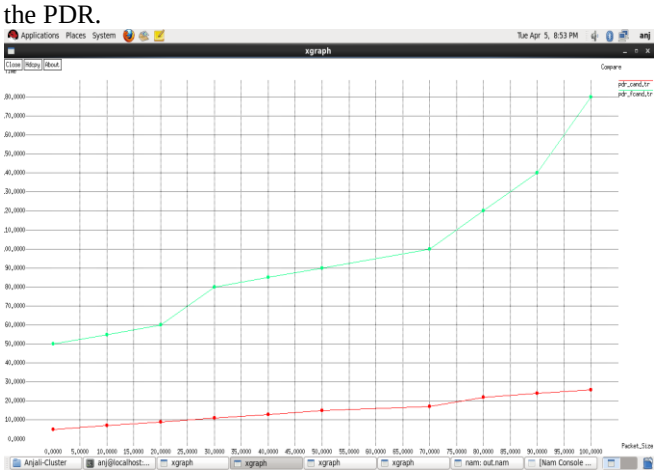

Fig. 7: Packet Delivery Ratio

B. Energy Level of Node

Fig. 8 shows the energy level of nodes in the network. The proposed protocol selects the perfect link for transmission in VANET. Therefore, the proposed protocol shows high-energy level of node.

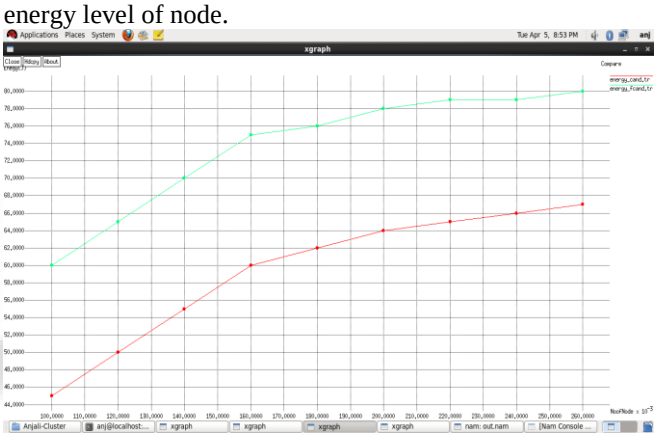

Fig. 8: Energy Level of node

C. End-To-End Packet Delay

Fig. 8 shows the End-to-end Packet Delay in the network. As shown in the given figure, the proposed protocol is very effective for Packet Delay, when the packet-rate is high and the packet reached very fast. PSO perform number of iterations in the link-selection and shows high-delay. By using the FPSO, the proposed protocol selects the best link which efficiently reduces the number of routes that are found.

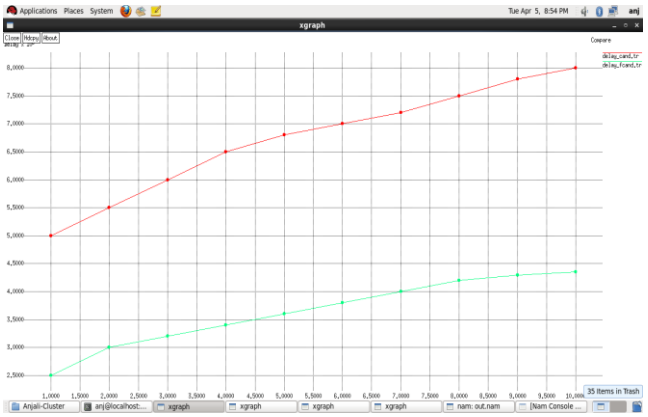

Fig. 9: End-to-End Packet Delay

D. Throughput

Fig. 9 shows the output level of the network. The proposed protocol used Fuzzy Logic for link-selection which provides perfect-link. Therefore, the proposed protocol shows high-level of throughput in the network and PSO shows low level of throughput.

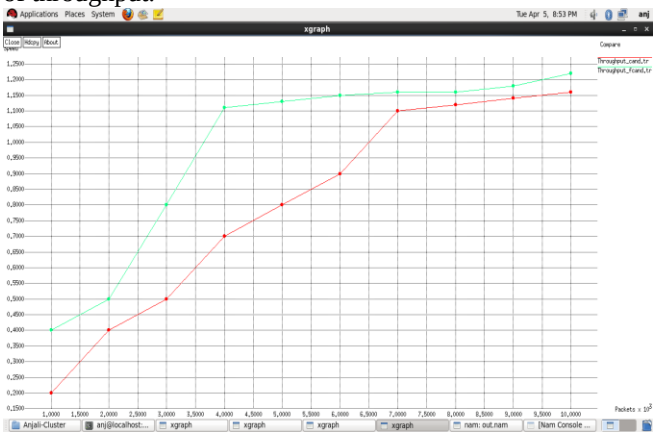

Fig. 10: Through-put

Through above experimental results we say that FPSO provide better results in the communication performance and improves the performance of routing in VANET.

VI. CONCLUSION

In this paper, a new hybrid routing protocol for CBR in VANET is introduced which improves the performance of packet routing and make it more reliable. Clustering of nodes by CAND algorithm makes system more stable. The CAND algorithm of particle swarm optimization is used for packet routing between wireless nodes. The implementation of Fuzzy Particle Swarm Optimization protocol provides more reliable communication between nodes and minimizes the conjunction between vehicles. The performance of routing can be improved by enhancing the required packet delivery ratio, throughput, packet delay and energy level of node.

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