Improving Geographic Routing for Vehicular AD-HOC Networks Based on Fuzzy System

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Abstract- In recent years, a new technology known as Vehicular Ad-hoc Networks (VANET) has received a lot of attention in smart cities, particularly in Intelligent Transportation Systems (ITS). By establishing a wireless network between the nodes, the VANET technology allows them to function like automobiles without needing a controller or central base station. It allows vehicles to communicate with their surroundings along with sending and receiving data. The routing protocol in VANET systems is a critical feature for efficient networking. Therefore, various existing protocols are being used for routing in VANET. As most VANETs have a Global positioning system (GPS) device, geography-based routing protocols are well suited for VANETs. The traditional geographic routing protocol selects the next hop which is closest to the destination to establish a route from the source to the destination. However, selecting the next hope without considering its available bandwidth and link quality leads to packet loss. In order to overcome this problem, a fuzzy logic-aided technique is incorporated into the routing algorithm. The intelligent fuzzy-based Greedy Perimeter Stateless Routing (GPSR) routing protocol is both effective and efficient. The routing protocol uses link quality, bandwidth, and mobility to find the optimum next neighbor node for packet forwarding.
Index- GPSR, Bandwidth, Link Quality, Mobility.

I. INTRODUCTION

Ad-hoc networks are self-organizing, decentralized networks in which nodes communicate without the need of wires. The nodes communicate with each other in their same radio range or outside their radio range. In wireless Ad-hoc networks, infrastructure is not permanent. The topology of the network changes very quickly. All network nodes participate in the forwarding packet for routing purposes from source to destination. Ad-hoc networks are a new wireless communication prototype for mobile hosts. It is used for many purposes like military communication, automated battlefields, rescue operations, entertainment and many more. The wireless networks have advantages over the wired networks, as mentioned below.

- Wireless network installation is easier and faster than wired networks.
- Wireless networks are easily adaptable to changes and are more flexible.
- It can be extended to those places where wired communication is not possible.

There are two types of wireless networks.

1. Infrastructure networks
2. Infrastructure-less networks

MANET is an infrastructure-less in nature. In MANET wireless technique is used for connecting the nodes. To move data from one point to another point controller is not required. Topology is maintained by all the nodes in the network. In MANET node employed as routers and hosts, all nodes have the ability to connect or depart the network in this adequate bandwidth, and node mobility is entailed. It issued different types of protocols and benefits in power battery consumption and routing traffic. The route is discovered with the help of routing protocols, and changing topology causes link failure in the network.

A vehicular ad-hoc network (VANET) is a self-organizing network, and it is an infrastructure-less network. It is a MANET application in which all vehicles are linked together via wireless links. The automobiles function as network nodes. The VANET is the most significant component of an intelligent transportation system (ITS), including vehicles equipped with short and medium range wireless communication. Each engaged car becomes a wireless router in a VANET, allowing vehicles to join within the same range. The main objective of VANET is to improve road safety, the transportation system, and vehicle safety. This vehicle functions as a sensor, providing drivers with early warnings in dangerous situations such as collisions and traffic congestion. It gives simple functions to all road users instead of safety applications. Internet connectivity, e-commerce, and multimedia apps are all examples. Users can download music, send e-mails, and play online games. ADASE, CAMP, CARTRACK 2000, and Fleet Net are some of the applications that have been expanded with the help of various governments and automobile manufacturers.

Topology-based routing, Position-based routing/Geographic routing, Cluster-based routing, Broadcast routing, and Geocast routing are some of the numerous types of routing protocols using in VANET. GPSR is one of the position-based routing protocols. In this protocol beacon message is broadcast to its entire neighbours. The position of neighbour is found by means of a hello message and the position of destination is found with the help of location service. If the node does not receive the message, then it assumes that it failed and it deleted from the table. GPSR uses two methods of forwarding packets.

Greedy Forwarding – In this technique source node selects the node that is closest to the destination node as an intermediate node. Fig. 1.1 shows that node Y is considered as an intermediate node because its node is closest to the destination node.

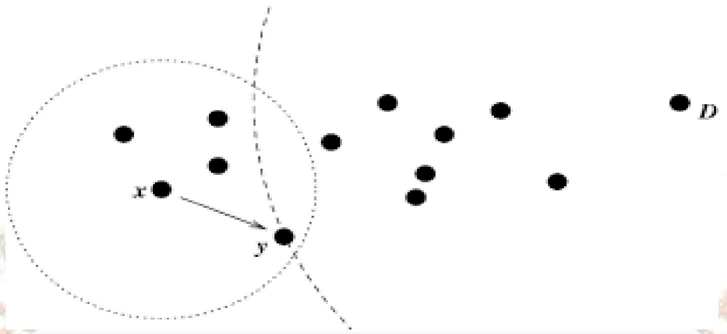

Fig. 1.1: Greedy Forwarding

When there is no closest neighbour in the network, then the problem of local maxima is arising in the network. As in the Fig. 1.2 given below there are two nodes W and Y that are equidistant from node X this is local maxima problem in which node is not able to decide which node is considered as the neighbour node for broadcasting the message to destination node.

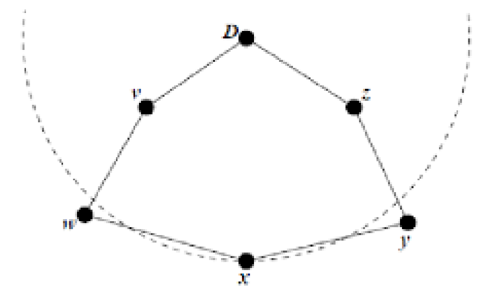

Fig. 1.2: Failure of Greedy Forwarding

Perimeter Forwarding- This technique is used when the above technique is failed. It uses the right-hand thumb rule. In Fig 1.3 the node Y send packet to node X then node X forward packet to node Z.

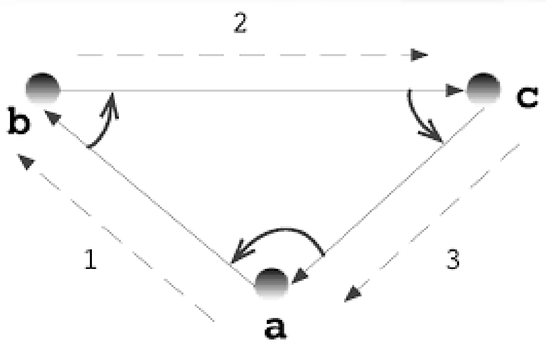

Fig. 1.3: Right hand thumb rule

II. RELATED WORK

In[15] authors described GPSRJ+ uses the road segments near to destination nodes in these decisions takes place at junctions. When local maxima arise, the node goes to recovery mode in which right hand rule is used and packet is come back to junction. The prediction of forwarding node is based upon junctions. If the next-hop contains the same coordinates as the forwarding node, then that node is considered as the next hop. GPSRJ+ will contain the lesser number of hops as compared to GPSR. The author takes four assumptions firstly edge is made by two or more points. Secondly because of obstacles nodes are not able to detect each other. Thirdly every node knows about its position. Lastly there is no diagonal straight road. At the end author concluded that GPSRJ+ gives better result as compared to other protocols.

By implementing a fuzzy logic controller, in [16] the authors offer a valuable method for improving the interval of active route time in the AODV protocol. In terms of average throughput, average end-to-end latency, and average jitter, the network's performance is compared using normal AODV and AODV with fuzzy-based ART. The performance of the AODV protocol with a fuzzy active route timeout length is superior, according to simulation results, in terms of average throughput, average jitter, and average end-to-end latency. As a result, a fuzzy logic controller may be used to calculate the value of ART precisely and dynamically, producing results that are superior to those of using the default value.

A fuzzy logic-based system is suggested in [17]. These applications demand precise localisation algorithms in order to locate the car in the network. A smart fuzzy logic and weighted centroid localisation method. The distance between nearby vehicles and heading information are the two input parameters for the fuzzy logic system. Periodic communications are used to exchange this information. The fuzzy logic system generates weight values. Each neighbouring car will receive a weight value from WCL. Then, a position estimate for the car is made using the weighted coordinates of surrounding vehicles. Our method performs better than CL at reducing location mistakes as density increases. However, the performance of the fuzzy logic system can be improved by adding more inputs.

The effectiveness of VANET communication depends on how efficiently the network's routing is controlled. In [18] the authors presented a modification to the GPSR protocol that uses a fuzzy logic controller (FLC) to intelligently select the appropriate next-hop based on connection quality and neighbour node in order to reduce latency and improve packet delivery ratio. A new "direction field" has been included in the beacon message to improve effectiveness. Depending on the link quality and the neighbouring node, the Fuzzy Logic Decision System is in charge of generating the fuzzy score for each nomination forwarding. Combining these two criteria, the 25 best next-hop is chosen, one close to the destination and has strong connectivity. Fig. 2.1 shows the system architecture of the proposed protocol.

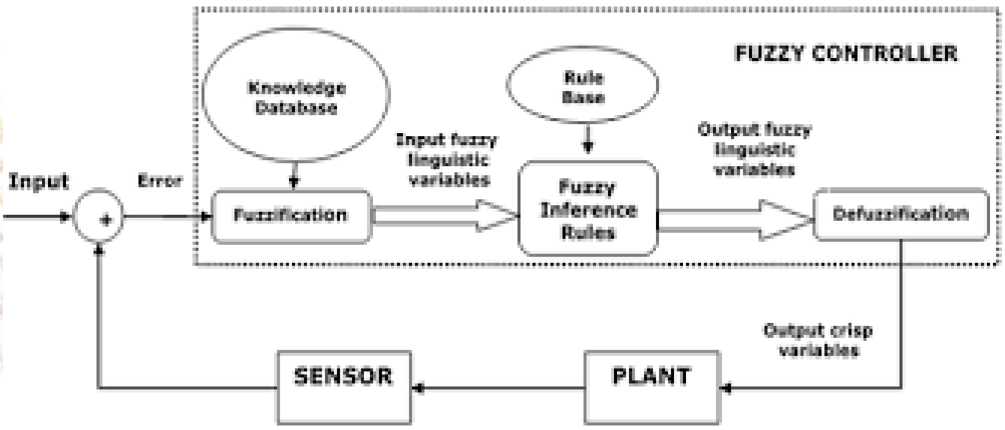

Fig. 2.1. System architecture

III. IDENTIFICATION OF OBJECTIVES

Problem Statement- To maximize distance progress, most geography-based routing systems employ a forwarding approach that picks nodes closest to the target. These nodes are more likely towards the communication range's boundary, when connection failure is more frequent. Furthermore, picking these nodes continuously without considering their available bandwidth might lead to increasing packet loss and delays. The fuzzy logic technique is used to pick the next optimal node based on numerous parameters such as link quality, bandwidth and mobility.

Objectives-

- To study existing geographic routing protocols and fuzzy improvements in VANETs.
- To design fuzzy based geographic routing protocols in VANETs.
- To simulate the proposed protocol using MATLAB.
- To perform comparative analysis of proposed protocol with other routing protocol.

IV. PROPOSED DESIGN AND METHODOLOGY

The GPSR can be improved with a fuzzy logic controller, as shown in this section. Three criteria are used to select the best next-hop node: link quality, bandwidth, and mobility. Because it has a solid academic base and can handle approximate, imprecise, and ambiguous data, the fuzzy logic method was chosen above other methods for augmentation. Fig. 3.1. depicts the fuzzy logic controller. Based on the link quality, bandwidth, and mobility, the Fuzzy Logic Decision System assigns a fuzzy score to each nominee forwarding. These three characteristics identify the next-hop with the best link quality, bandwidth, and mobility.

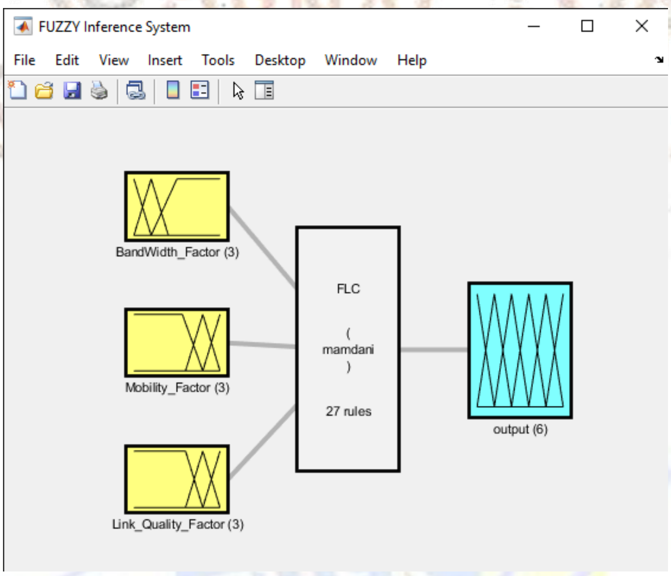

Fig. 3.1. Fuzzy Logic Controller

The fuzzy logic decision system in Fuzzy GPSR consists of four fundamental steps: fuzzification, rule base, inference engine, and defuzzification. The triangle membership is used for the following input/output because of its simplicity.

In VANETs for geographic routing, fuzzy logic algorithms can deal with erroneous and incomplete information about neighbours due to speed and wireless signal limitations. When a node needs to forward a packet, it uses a fuzzy logic controller to generate a fuzzy score for each neighbor to pick the best node for the job. All three-routing metrics are combined using the proposed fuzzy logic function; the three matrices are link quality, bandwidth and mobility.

Link Quality can be calculated as received beacon packets divided by the sent beacon packets.

Bandwidth - Choosing a next neighbor node without taking into account its bandwidth could result in significant packet losses and delays. The bandwidth can be calculated as a number of bits successfully transmitted divided by the total time spent transmitting by the node.

Mobility- The mobility is calculated from the velocity of the node. As a next-best neighbor node, the present forwarding node chooses the neighbor node with the best fuzzy score. The fuzzy logic decision system has three fundamental processes, fuzzifying, fuzzy inference, and de-fuzzifying. The initial stage is to translate numerical input values into linguistic variables, which are then mixed using fuzzy rules to get an output according to the rules. The final phase turns this output into a numerical value representing the next hop node’s fuzzy score.

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Fuzzification- The fuzzy set is mapped with crisp numerical input values. Fig. 3.2, 3.3 and 3.4 show the link quality, bandwidth, and mobility membership functions. The fuzzy membership function for link quality is shown in Fig. 3.3. The current forwarding node uses the membership function to assess whether each neighboring node's link quality metric fits in the Good, Medium, or Bad categories.

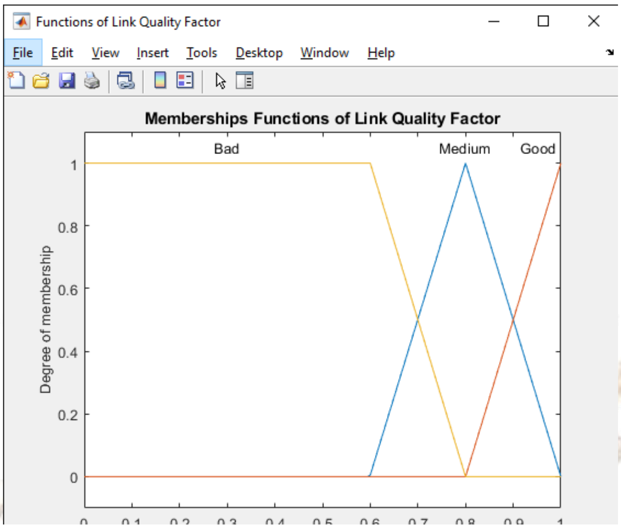

Fig.3.2. Membership function of Link Quality

Fig. 3.3 depicts the bandwidth's fuzzy membership function. The membership function is used by the forwarding node to determine whether a possible forwarder's bandwidth belongs to the Good, Medium, or Bad categories.

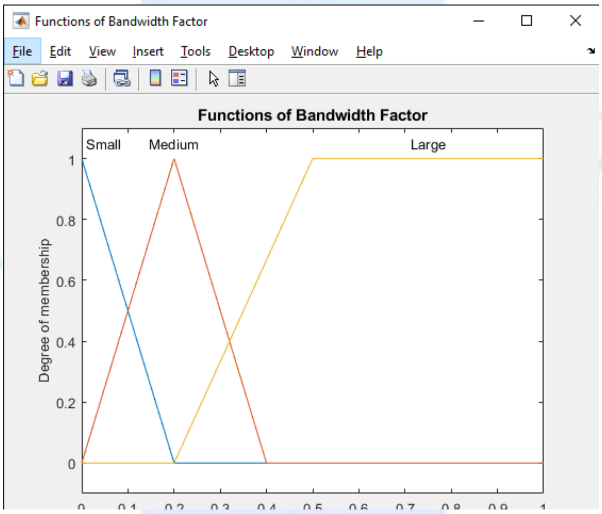

Fig.3.3. Membership Function of Bandwidth

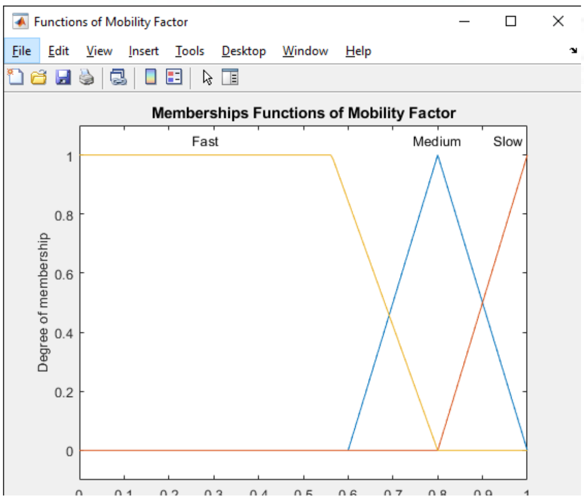

Fig.3.4. Membership function of mobility

The fuzzy membership function of the mobility is shown in Fig. 3.4. The mobility membership function is used by the present forwarding node to determine which degree candidate forwarder belongs to Slow, Medium, or Fast.

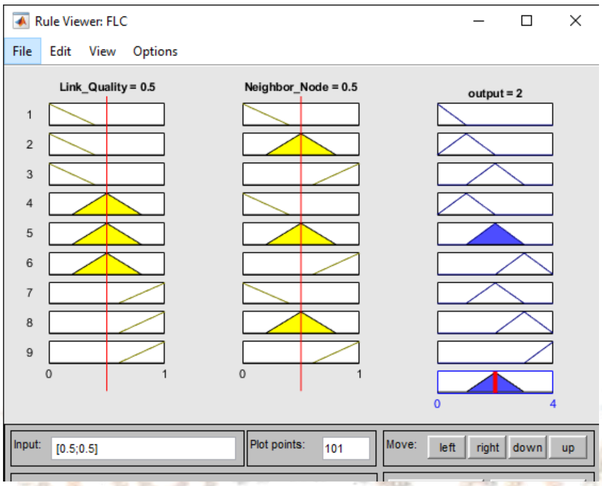

Fig.3.5. Rule View

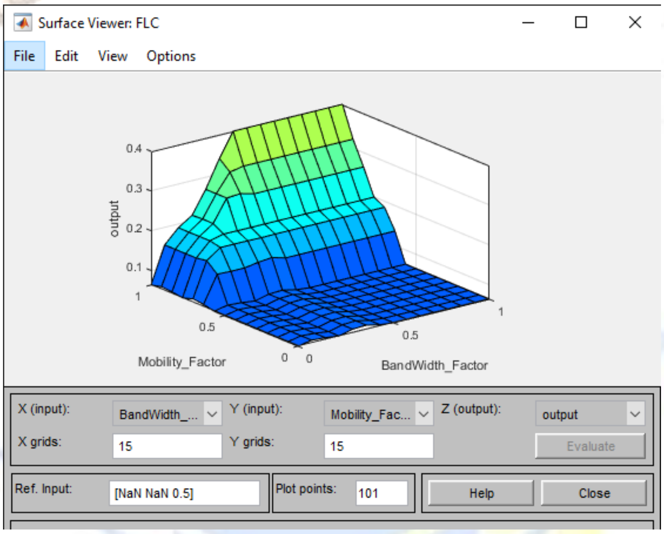

Fig.3.6. Surface view of FLC

Defuzzification is the process of extracting a value from the output of an aggregated fuzzy set. And it will convert the results of fuzzy inference into a crisp value. Fig. 3.7 depicts the fuzzy output membership function. It ranges from 0 to 1, with 0 being the worst neighbor weight and 1 representing the best neighbor weight. If multiple neighboring nodes have the same fuzzy score, the node having a minimum distance to the destination is chosen as the next forwarding node.

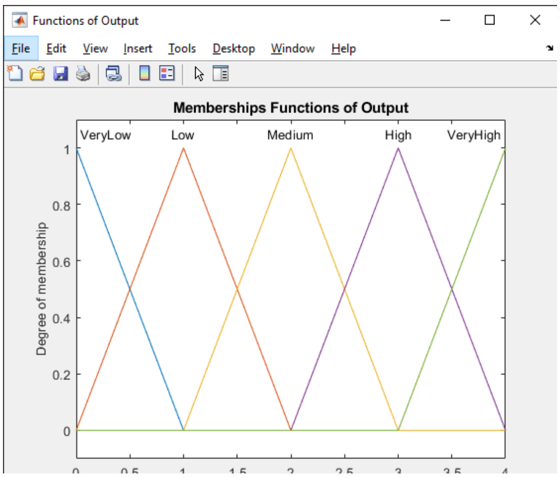

Fig.3.7. membership Function of Fuzzy Output

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