A Fuzzy GPSR Route Selection Based on Link Quality and Neighbor Node in VANET

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***Abstract*— Over recent years, a new technology named VANET (Vehicular Ad-hoc Networks) is highly recommended in smart cities and especially in Intelligent Transportation Systems (ITS). The VANET technology relies on the nodes acting like cars without the necessity for any controller or central base station by creating a wireless link among them. It enables cars to send and receive information between themselves and their environment. most VANETs utilize position-based routing protocols because they contain a GPS device. To deal with VANET problems, one solution is Geographic Perimeter Stateless Routing (GPSR) which has been broadly implemented. This paper suggests an effective intelligent fuzzy logic control system; called the FL-QN GPSR routing protocol. The proposed routing protocol incorporates two metrics link quality, and neighbor node to detect the best next-hop node for packet forwarding also updates the format of the Hello message by adding the direction field to be more suitable to our simulation. The OMNeT++ and SUMO simulation tools are both used in parallel to examine the VANET environment. The obtained results of the four simulation experiments in urban environments indicate substantial improvements in the network performance compared to the traditional GPSR and AODV concerning the QoS parameters.**

Keywords*— *FL-QN GPSR, Intelligent Systems, OMNeT++, SUMO, QoS, VANET.

I. INTRODUCTION

Even though VANET is a sub-class of MANET, but in the last ten years, VANET has drawn the attention of researchers all over the globe because of its diverse attribute such as the high mobility of vehicles compared to MANET, which is about 100m, and the frequent changes of topology. The vehicles can connect among each other in (V2V) mode or between a vehicle and infrastructure in (V2I) mode or by mixing the previous two-mode, which is a hybrid mode (V2X) [1]-[3].incorporating the applicable criteria that follow. In VANET, the routing protocol is divided into five categories: topology-based routing, position-based routing, cluster-based routing, geo-cast routing, and broadcast routing [4], [5].

Position-based routing (PBR) takes the geographical position of the nodes using GPS or any other device that can give the location of a node wirelessly, so the PBR doesn't have to establish a routing table for the entire network, it only requires to know the location of the neighbor node using a GPS, this is a great advantage which can save a lot of memory space. Position-based routing is a promise for large-scale wireless ad-hoc networks because of its simplicity, scalability, and use of node position information, making it advantageous for wireless networks. Geographical routing functions on the assumption that nodes are aware of their network positions [6], [7].

Geographical-based protocols are divided into three types (a) Non-delay tolerant networks (Non-DTN) which aim to send a packet as quickly as feasible from source to destination, for example, GPSR (Greedy Perimeter Stateless Routing), (b) Delay tolerant networks (DTN) method to improve network performance under frequent link breakage. DTN sends a packet based on the neighboring node's statistics. The transmission is carried out utilizing the Carry-and-Forward mechanism, for example, VADD (Vehicle-Assisted Data Delivery), and (c) Hybrid protocols in which the greedy forwarding and recovery modes are used for packet transmission, for example, GeoDTN+Nav (Geographic DTN Routing with Navigator) [8]. This paper is based on a very famous Non-DTN routing protocol that is (Greedy Perimeter Stateless Routing) GPSR. Since the traditional protocol has many disadvantages such as jumping into perimeter mode that makes the way to the destination very long, to lower the number of hops and chose the next-hop properly the traditional protocol must be enhanced in a way that the protocol performs well in different scenarios.

Many parameters can influence the GPSR performance, we focus here on two-parameter, namely the link quality and the neighbor node, the link quality is very important due to a weak link may lead to a link breakage and the data may be lost, this is happening as the neighbor node is moving far away from the source, and how close the neighbor node to the source is also very important as the node is close lead to a good delivery of the data.

These two parameters are implemented using a fuzzy logic system to obtain the best next-hop selection to improve the performance, it is done in I2V mode, the reason this mode is chosen is that it reduces the packet loss and delay the fuzzy logic controller is embedded in all vehicles and also the RUS to choose the best next-hop according to the two metrics. The simulation is applied in an urban environment where the speed of the vehicles is set to 40km/h.

The remainder of the paper is as follows, section II demonstrates the related work, Section III goes in the deep to show the process of enhancing the GPSR using fuzzy logic, while section IV shows the proposed FL-QN GPSR algorithm, meanwhile section V reveals the simulation tools and result. Finally, draw the conclusion in section VI.

II. RELATED WORK

Many researchers over the past years focused on investigating and improving the GPSR protocol and so many other protocols. In [9]-[11] in their analysis, they highlight several mathematical models to improve the GPSR protocol by offering extra details to establish a strong and stable path in the neighbor's table. Such analytical models can select the