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COMPARISON BETWEEN AMGRP WITH FUZZY AMGRP

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Abstract- The Vehicular Ad hoc Networks (VANETs) has gained a lot of popularity in research field from last few years. Due to its various features like high mobility etc., it has preferred to deployed in different real time applications to analyze and operate the traffic on highways and urban areas. A large number of research has been conducted in this domain in order to develop the efficient and secure route selection approach for it. The present study also added a contribution to the research by developing the Fuzzy AMGRP (AHP based Multimetric Geographical Routing Protocol) for VANETs. The proposed work elects the nodes on the basis of evaluated weight function and the weight function is measured automatically by using the fuzzy inference system. The major factors like Mobility, Link Lifetime, Node Status, Node Density and PDR are consider as an input to the fuzzy inference system and then the node with the more effective weight value is selected. A comparative analysis of Fuzzy AMGRP and traditional AMGRP is also drawn in the terms of packet delivery ratio, end to end delay, average hop count and normalized routing overhead. On the basis of the simulated results and comparative analysis the fuzzy AMGRP is found to be more secure and reliable then the AMGRP routing approach.
Keywords—Wireless Sensor Network, Energy Efficient Clustering Protocol, Load Balancing.

1. INTRODUCTION

VANETs are the wireless communication networks with high node mobility[2]. Thus, to perform routing and data transmission in VANETs is one of the most tedious tasks. A large number of routing protocols are available to perform the data transmission and routing in an effective way. While performing routing, the nodes are selected to create a dedicated path from source to destination node[3]. The selection of the nodes should be done effectively and efficiently so that the data could be transferred successfully. The node selection criteria relies upon various factors such as energy of the nodes, distance from node to adjacent nodes, distance from node to base station, mobility of the nodes etc. Future scope of this system is visualized as there would be smart vehicles equipped with information collection devices (on-board sensors) [15], on-board display devices, information processing devices (on-board CPU) as well as wireless communication devices.The congestion is reduced by controlling the traffic flow with time[4]. The ad hoc network is the most popular sensor network based communication domain [21].

In [1], author had developed a novel and efficient routing protocol for VANETs and named as AHP based Multi geographical routing protocol (AMGRP). The existing work adopted the Analytical Hierarchical Process along with this the author had also considered the multiple routing factors like mobility, connection lifetime, node density and node status etc for better output quality of the network. The next hop selection was done on the basis of the single weight value function within the defined region to ensure the data forwarding process. The obtained simulated results of the existing work were compared to the GPSR and SLD-GEDIR protocol and the existing work was found to be more efficient and effective.

With inspiration from [1], of this study and research work had presented a novel routing approach. The present work is developed to overcome the flaws of traditional work. This protocol [1] basically works on the computed single weighing function to identify a next hop node within a defined range which can ensure an enhanced forwarding process. The major problem that is faced in this work[1] is to define the weight value. It is hard to define that which weight value will be best to achieve the best results. It is deriving good results in the scenario they are focusing but it was a hard problem to find best weight value so there is a need to update the weight value concept.

Thus in present work, the weight function is evaluated automatically by using the fuzzy inference system. The node selection is performed on the basis of the various factors such as node mobility, link lifetime, node status, node density and PDR. This study is the second part of the previous paper and is organized to analyze the efficiency of the proposed work over traditional AMGRP routing protocol.

The methodology of the present work is as follows;

The first step is to define the initial network parameters such as simulation time, data packet length, carrier frequency, propagation model, traffic type, physical layer etc. The work has the following initial parameters as the network setup[3].

Table 1 Simulation Setup of present work

Parameters	Value
Simulation Time	400

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Number of traffic	10
Data Packet Length	512 bytes
Carrier Frequency	5.8 GHz
Propagation Model	Two-Ray ground model
Physical Layer	IEE802.11p(11Mbps)
Transmission Power	10mW
Traffic Type	UDP

After defining the initial parameters, the network is deployed. The source node is elected from the deployed nodes in order to initiate the communication process in the network.

Apply the fuzzy AMGRP approach to elect the CH in the network. The CH is elected on the basis of the input parameters defined for the fuzzy system.

Next hop selection is performed for creating the route to the destination node in order to transfer the data. At last, the data transmission is performed and the performance of the present work is evaluated.

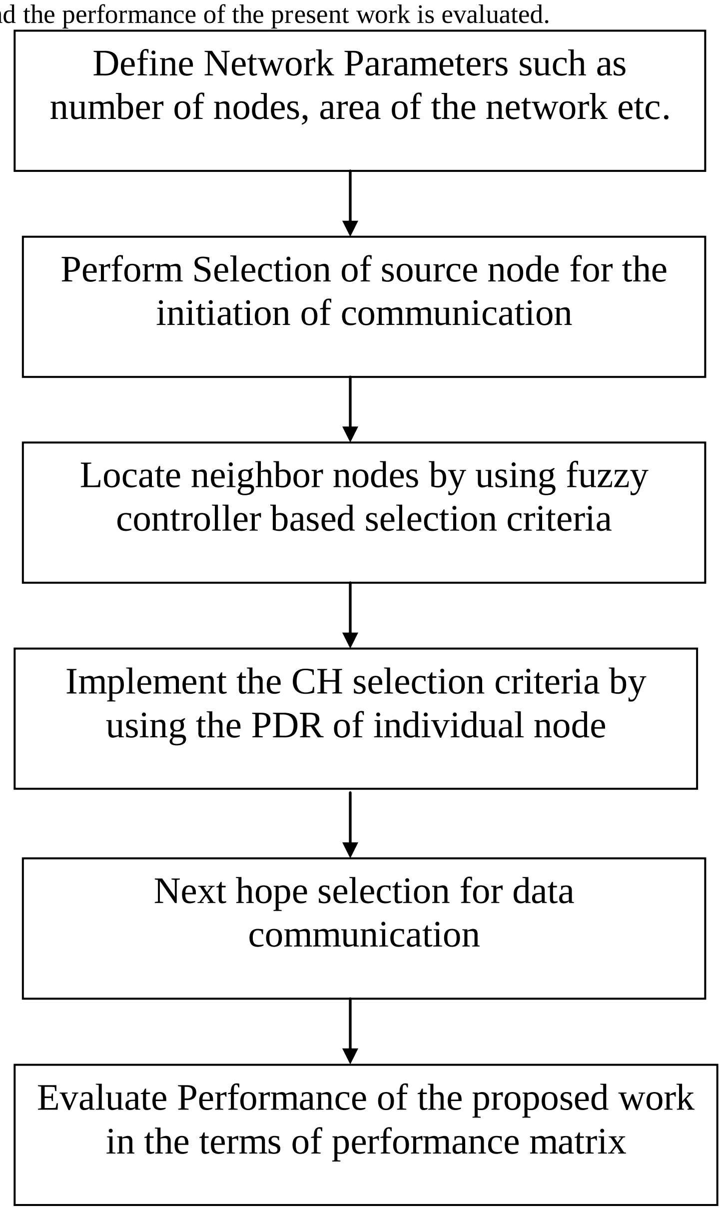

Figure 1 Framework of Fuzzy AMGRP

The work implements the Fuzzy-AMGRP routing protocol for VANETs. The fuzzy inference system is implemented for electing the CH nodes and the CH is elected on the basis of the major factors as follows:

Mobility

Link Lifetime

Node Status

Node Density
PDR
This section of the study is organized to represent the simulated results of the work. The MATLAB simulation platform is used for experimental analysis. The performance of the work is evaluated in the terms of following factors.
Packet Delivery ratio: the packet delivery ratio is a performance evaluation metrics that is specifically used to measure the rate of data packets delivered to the destination successfully. It is evaluated as follows:

$$PDR = \sum_{i=1}^{n} \frac{R_i}{S_i} \dots\dots\dots (1)$$

Where, n defines the number of source nodes, depicts the number of data packets received at the destination node, is used to define the number of data packets transmitted by the source node.
End to End Delay: this parameter is used to measure the average delay taken by the data packets to reach the destination node. The end to end delay in the work is evaluated as follows:

$$End\ to\ End\ Delay = \frac{1}{\sum_{i=1}^{n} R_i} \left(\sum_{i=1}^{n} \sum_{j=1}^{R_i} TR_{ij} - TS_{ij} \right) \dots\dots..(2)$$

Where, the is used for receiving time of data packet transmitted by the source at the destination and denotes the data packet sending time of the packet by the ith source node.
Normalized Routing Overhead: it depicts the ratio of total control packets corresponding to the total delivered packets in the network. It is measured by using the following formulation:

$$NRL = \frac{1}{n} \left(\sum_{i=1}^{n} \frac{1}{R_i} \left(\sum_{j=1}^{R_i} \sum_{k=1}^{P_{ij}} C_{ijk} \right) \right) \dots\dots\dots\dots.(3)$$

The variable denotes the count of control bytes at hop by packet sent at source node.
Average Hope Count: It is average number of hops required to transmit the data to the base station.

$$AHC = \frac{1}{n} \left(\sum_{i=1}^{n} \frac{1}{R_i} \left(\sum_{j=1}^{R_i} \sum_{k=1}^{P_{ij}} H_{ijk} \right) \right) \dots\dots.\dots.(4)$$

Where, denotes the number of hop traversed by the data packet to reach the source.

2. COMPARISON ANALYSIS

The comparison of work is done with the traditional AMGRP routing protocol. The comparison is also drawn on the basis of above defined parameters.
The graph in figure 2 depicts the comparison analysis of PDR in case of present and traditional work. The bar in blue depicts the PDR of traditional AMGRP mechanism and the bar in red defines the PDR of Fuzzy-AMGRP protocol. The comparison analysis of PDR is drawn on the basis variable number of nodes in the network. On the basis of the comparison graph, it is observed that the PDR of present work in each and every case is efficient and higher than the PDR of traditional AMGRP routing protocol. The facts and figures observed from the comparison graph is represented in table 2.

Table 2 Analysis of PDR for AMGRP and Fuzzy-AMGRP protocol

Number of Nodes	AMGRP	Fuzzy AMGRP
1	0.48	0.5
2	0.52	0.56
3	0.55	0.67
4	0.6	0.69
5	0.65	0.78
6	0.67	0.80
7	0.69	0.80
8	0.71	0.81
9	0.73	0.91

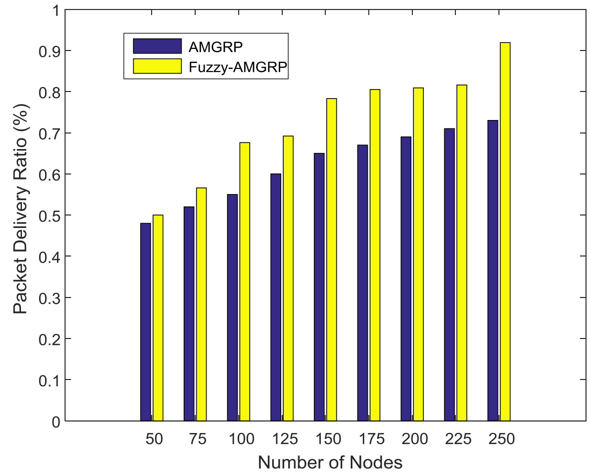

Figure 2 Comparison Analysis of AMGRP and Fuzzy AMGRP with respect to the PDR

Similarly, the comparison analysis for end to end delay is shown in graph 3. The graph proves that the end to end delay of the work done is lesser than the end to end delay of traditional AMGRP routing protocol for each and every defined scenarios. The observed facts corresponding to the end to end delay for AMGRP and Fuzzy AMGRP is calibrated in table 3.

Table 3 Analysis of End to End Delay for AMGRP and Fuzzy-AMGRP protocol

Number of Nodes	AMGRP	Fuzzy AMGRP
1	1.05	0.6259
2	0.9	0.4358
3	0.81	0.3188
4	0.72	0.2834
5	0.62	0.2218
6	0.50	0.1717
7	0.48	0.1691
8	0.45	0.1608
9	0.35	0.0710

Figure 3 Comparison Analysis of AMGRP and Fuzzy AMGRP with respect to the End to End Delay

The comparison graph shown in figure 4 depicts the comparison of AMGRP and Fuzzy AMGRP on the basis of the normalized Routing Overhead. The Normalized routing overhead in case of fuzzy AMGRP is higher in contrast to the normalized routing overhead of traditional AMGRP protocol. The minimum NRL in case of Fuzzy AMGRP is 0.9440 and the maximum is 5.0526.

Table 4 Analysis of Normalized Routing Overhead for AMGRP and Fuzzy-AMGRP protocol

Number of Nodes	AMGRP	Fuzzy AMGRP
1	0.32	0.9440
2	0.5	1.1152
3	0.52	1.2949
4	0.72	1.3202
5	0.88	1.6976
6	1.55	2.2603
7	1.65	2.3544
8	1.71	2.7989
9	2.1	5.0526

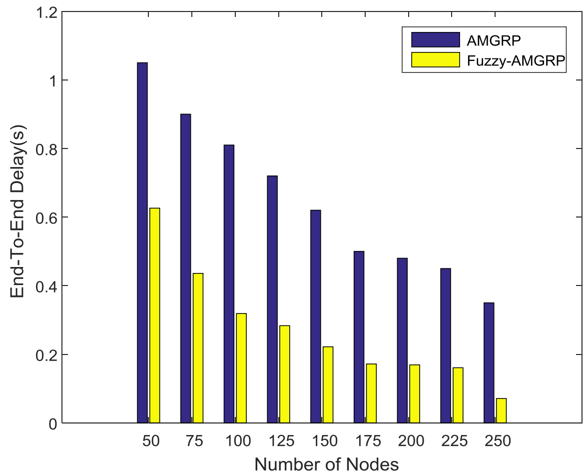

Figure 4 Comparison Analysis of AMGRP and Fuzzy AMGRP with respect to the Normalized Routing overhead (NRL)

The average hope count of fuzzy AMGRP is lower than the average hop count of traditional AMGRP protocol as shown in graph of figure 5. The network with lesser average hop count is considered to be an ideal network. The average hop count is also evaluated on the basis of the number of nodes in the network.

Table 5 Analysis of Average Hop Count for AMGRP and Fuzzy-AMGRP protocol

Number of Nodes	AMGRP	Fuzzy AMGRP
1	2.25	2.0000
2	2.1	0.9511
3	1.75	0.9392
4	1.55	0.8766
5	1.4	0.5090
6	1.3	0.3140
7	1	0.2243
8	0.95	0.1493
9	0.9	0.1029

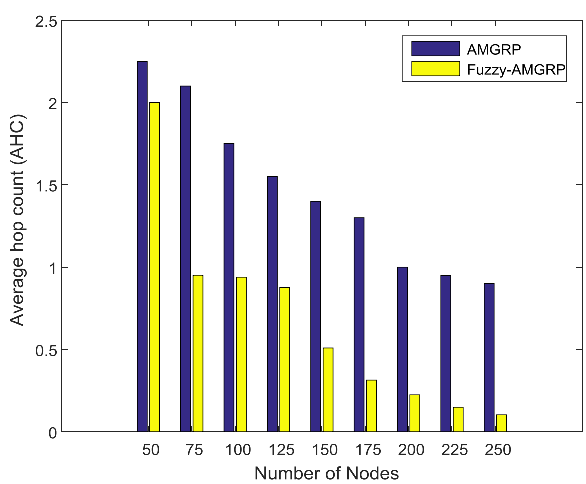

Figure 5 Comparison Analysis of AMGRP and Fuzzy AMGRP with respect to the Average Hop Count

3. CONCLUSION

On the basis of the simulated results, it is concluded that the fuzzy AMGRP approach has more enhanced and reliable outcome in comparison to the traditional AMGRP routing approach in terms of packet delivery ratio, normalized routing overhead, end to end delay and hop count. The packet delivery ratio of the fuzzy AMGRP is 10.2% higher than the traditional AMGRP approach, the average hop count and end to end delay is approximately 35% and 38% reduced than the AMGRP respectively. Thus on the basis of facts and figures obtained from the performance of the fuzzy AMGRP it is proved that it has more efficiency and reliability than the traditional AMGRP approach.

The performance of the presented work is found to be quite effective but still more amendments could be done in order to achieve the more accurate and appropriate outcomes. For this purpose, the type 2 fuzzy inference system could be considered to replace the currently employed fuzzy inference system. Following are the advantages of T2FL over T1FL:

T2FL is considered as an efficient and effective method for handling the high level of uncertainties that are available in real world based complex applications.

T2FL model is mostly preferred and suitable to process the applications where to determine the exact numeric membership functions is a tedious task and the evaluations are also uncertain.

T2FL rationalized that the fuzzy logic models can operate more accurately in comparison to other probabilistic models.

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