Performance evaluation of Fuzzy logic based AODV and OLSR in MANET

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Abstract- Mobile Ad-hoc network (MANET) is a type of wireless network in which different wireless nodes connected in random manner. In this paper performances of AODV and OLSR have been analyzed using fuzzy logic controller. Fuzzy controller decided the value of Hello interval using two input parameters speed and battery power which is used in AODV and OLSR protocol. The performance of fuzzy based AODV and OLSR compared with conventional AODV & OLSR in terms of Average jitter, Average Throughput and End to End delay.

Keyword- MANET, AODV, Fuzzy logic controller, HI (Hello Interval), Fuzzy Based AODV (FBAODV),OLSR,Fuzzy based OLSR(FBOLSR), Qualnet 6.1

I. Introduction

MANET is a set of mobile nodes which communicate with each other. They do not require any infrastructure [1]. In MANET, nodes are free to move randomly and they can organize themselves in a random manner. MANET is useful in emergency situations like disasters, military activities, emergency medical situations [3]. Routing protocols in MANET are broadly classified in three different categories such as proactive, reactive and hybrid protocols.

The regular reception and broadcasting of Hello message indicates that the presence of a node in a route is active. Hello interval may be defined as the time interval between the transmissions of two successive Hello messages. Allowed Hello loss may be defined as the maximum number of periods of Hello interval to wait without receiving a Hello message before detecting the failure of connectivity.. If a node is unable to receive Hello message or any other packet for the time in seconds more than Allowed Hello Loss*hello interval, the link of the node to its neighbor is considered as failed [9]. The broadcasting of hello messages is commonly used method to provide the adapting capabilities to high variability and also provide uncertainty for MANET. Increase in the number of hello messages may lead more bandwidth and interference. Whereas decreasing the number of hello messages can cause of missing information which generally occurs due to failure of link [7].

In this paper fuzzy reasoning has been used to decide the optimized value of hello interval. Fuzzy reasoning totally works as the thinking of human. Performance of the network has been compared with and without fuzzy logic controller using AODV and OLSR.

II. Conventional AODV Protocol

AODV is a reactive routing protocol. In AODV routes are established whenever required. The working of AODV protocol may be described in two phases. First is the process of route discovery and second is route maintenance [1]. Route discovery process is started by creating RREQ (Route request) packet through the source node and send it to the neighboring nodes. Through these intermediate nodes the RREQ message finally reaches to the destination node. Destination node creates RREP (Route reply) packet and send it in the direction of source. These RREP messages also numbered by the neighboring nodes to avoid the duplicity of RREP packets [1]. Source changes its route information when it receives only up- to-date route information. In this way a route is established [3].

In the route maintenance phase each node of the route periodically transmits hello messages it indicates the presence of node in the active route [2]. If a node does not receive hello message from its neighbor in predetermined time interval then the node assumes that the link from its neighbor is failed. Then the node generates route error message (RERR) and send it to all the predecessors nodes which are still using the failed link for transmitting data. The intermediate nodes receive RERR message and pass it towards the source. When the source receives this information it reinitiate the route discovery process [1].

III. Conventional OLSR Protocol

The Optimized Link State Routing (OLSR) is a proactive routing protocol developed for MANETs[4]. It is an optimization of link state proactive routing protocols in that it reduces the number of control packets as well as size of control packet transmission required[8]**.** OLSR is developed to work independently from other protocols. OLSR is well suitable for networks, where the traffic is sporadic and random between a larger set of nodes rather than being almost exclusively between a small specific set of nodes. OLSR (Optimized Link State Routing Protocol), as a widely used and well tested protocol, is one of the main two Internet standards for wireless networks.

OLSR uses three types of control messages: HELLO, Multiple Interface Declaration (MID), and Topology Information (TC). A Hello message is sent periodically to all of the node's neighbors. Hello messages contain specific information about a node's neighbors. HELLO messages are broadcasted periodically for neighbor sensing. When a node receives a HELLO message in which it's address is found, it registers the link to the source node as symmetric.

IV. Fuzzy Based Aodv With Hello Interval (Fbaodv)

Fuzzy logic is based on the set of rules which is design by human experience. Fuzzy logic is based on the uncertain and approximate reasoning. fuzzy based reasoning is applied in many automated machines like washing machine, refrigerator etc. Fuzzy logic inference system (FIS) are of two type . One is Mamdani type and the other is Sugeno type FIS. Mamdani type system is very popular and is mostly used. These two systems are very similar in their function but the main difference between these two is: in Mamdani inference system the fuzzy output is neither linear nor constant and in Sugeno type inference system the fuzzy output is linear or constantIn this paper, mamdani type FIS has been used because it gives non linear and variable fuzzy output.

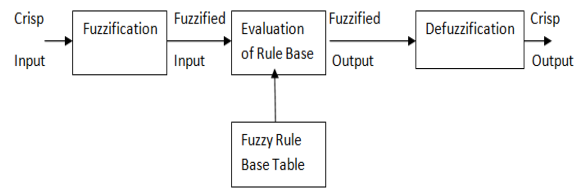

Figure 1: Fuzzy Logic Inference System

The FIS consist of four parts shown in Figure 1 which are fuzzifier, inference engine, fuzzy rule base, defuzzifier. The function of fuzzifier in FIS is to convert the crisp input data values to the fuzzy sets which are defined through fuzzy rule base. These rules can be made through human thinking and can be defined by their membership function. The role of defuzzifier is to convert the output fuzzy sets to a crisp output value.

For FBAODV and FBOLSR, a FIS through fuzzy logic toolbox in MATLAB has been designed. The Speed and Battery Power are input and hello interval has been taken as output variables as shown in Figure 2.

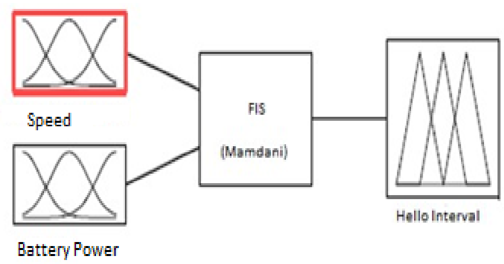

Figure 2: Proposed FIS for Improving AODV And OLSR Protocol.

If the speed is low, then the signal will reach to a few neighbors and the link with its neighbors will become weak and break easily. The hello interval must be small enough to get the update of the changes in neighbors rapidly. The high speed will reach the data to large number of neighbors and the life time of the link increases, so the hello interval should be long [8]

The high battery power of node may lead the high possibility to lose some current neighbors. Because of low battery power the life time of the link with the neighbors become less. So the hello interval should be small to send more hello messages to check the expected links break [8]. The fuzzy rules can be listed in tabulated form as

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Table 1- Fuzzy Rules for Hello Interval

Speed	Battery power		
	Low	**Medium**	**High**
Low	Low	High	High
Medium	Low	Medium	Medium
High	Low	Low	Low

For example, according to table1 the first rule is if speed is low and battery power is low then hello interval is low. The fuzzy membership functions of input and output parameters are divided into three sets namely: {low, medium, high}. Membership functions of all parameters are given below: Figure 3, 4, 5, shows fuzzy sets and membership functions for variables; speed, battery power and hello interval respectively.

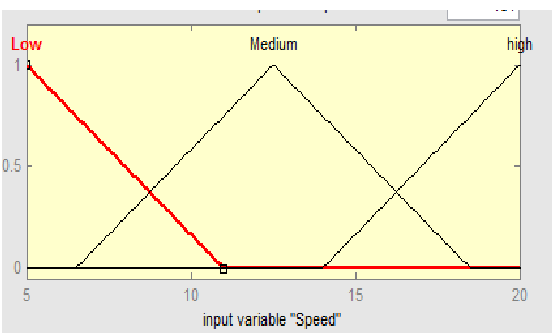

Figure 3: Membership function plot of Speed

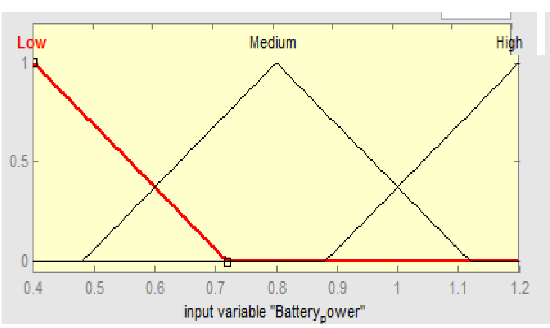

Figure 4: Membership Function Plot Of Battery Power

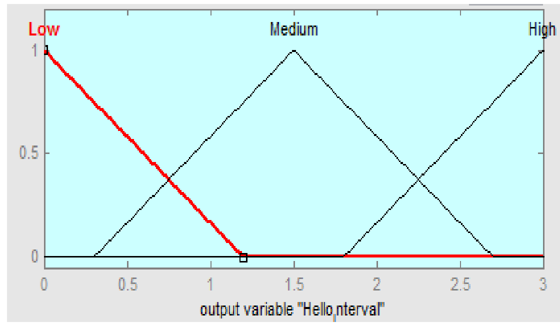

Figure 5: Membership Function Plot Of Hello Interval

V. SIMULATION SETUP

The simulation has been done through Qualnet Simulator 6.1 over 1500X1500 window platform by varying pause time. Qualnet simulator is a discrete event simulator which is capable of simulating wired or wireless scenarios from simple to complex conditions. In this simulation model 80 nodes have been used which are connected through wireless subnet. The simulation area of 1500m×1500m has been taken as flat area. The simulation time has been taken 300sec. There are 6 CBR connections, Random way point type mobility model and data rate of 2 Mbps have been used in this simulation. Omni directional antenna is used to transmit the signals in whole direction. The performance metrices like Average Throughput, Average Jitter, Average End to End Delay have been used for varying packet rate.

VI. Simulation Parameters

Simulation parameters are listed below:

Table 2- Simulation Parameters

Parameters	Value
Simulator	Qualnet 6.1
No. of node	80
Simulation time	300sec
Mobility model	Random way point
Pause time	5,10,15,20,25 sec
Data rate	2Mbps
Radio type	802.11b radio
Antenna model	Omni directional
Item size	512 bytes
End time	250sec
Channel frequency	2.4GHz
No. of CBR	6
Number of packets send	100
Simulation Area	1500m×1500m
Battery Model	Linear

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VII. Performance Metrics

In this paper following metrics for the evaluation of performance have been used:

- **Average End to End Delay:**
  This is the Average time taken by packets for travelling from source to destination including all the possible delay caused by buffering during the process of route discovery, retransmission delay, queuing delay, propagation and transfer times of data packets [2]. It is measured in seconds and should be as low as possible.
- **Average Jitter:**
  It is defined as the delay variation between each received data packet. Average Jitter should be as low as possible for better performance.
- **Average Throughput:**
  It is defined as the average rate of successfully received data packet at destination measured in (bit/sec)[10]. Throughput should be as high as possible

VIII. Result and Analysis

To analyze the performance of AODV and FBAODV, the following two cases of transmission power and mobility have been taken into consideration.

Case 1:

Parameters of conventional AODV and FBAODV for this case1 are given below.

Table 3- Parameters For AODV And FBAODV For Case1

Parameters	AODV	FBAODV	
Speed(m/sec)	10	10	
Battery Power(mAhr)	1200	1200	
Hello interval(sec)	1	1.59	

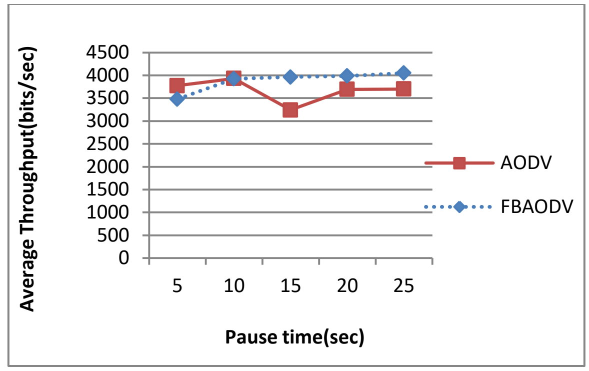

Figure 7: Average Throughput of AODV and FBAODV

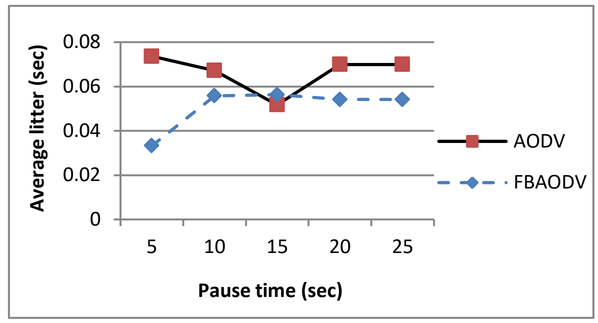

Figure 8: Average Jitter of AODV and FBAODV.

Figure 7 shows the average throughput for case 1. The values of throughput for AODV and FBAODV are shown in table 4. According to the table 4 the average throughput of FBAODV is slightly larger than conventional AODV.

Figure 8 shows the average Jitter for case 1. The values of average jitter for AODV and FBAODV are shown in table 4. According to the table 4 the average Jitter of FBAODV is much smaller than conventional AODV.

Figure 9 shows the average End to End delay for case 1.The values of average End to End delay for AODV and FBAODV are shown in table 4. According to the table 4 the average End to End delay of FBAODV is smaller than conventional AODV.

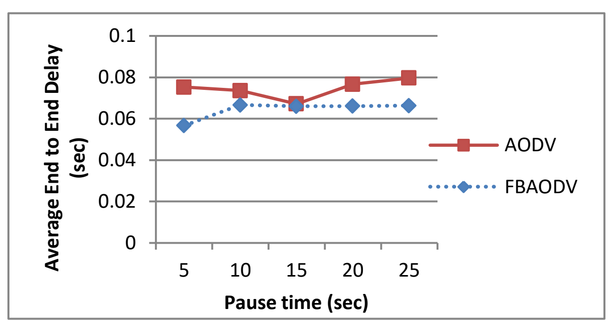

Figure 9: Average End to end delay of AODV and FBAODV

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Case2:

Parameters of conventional OLSR and FBOLSR for this case are given below:

Table 4- Parameters for OSLR and FBOSLR for case2

Parameters	**OSLR**	**FBOLSR**
Speed(m/sec)	10	10
Battery Power (mAhr)	1200	1200
Hello interval(sec)	1	1.59

he values of throughput for OLSR and FBOLSR are shown in table4. According to the table 6 the average throughput of FBOLSR is larger than conventional OLSR

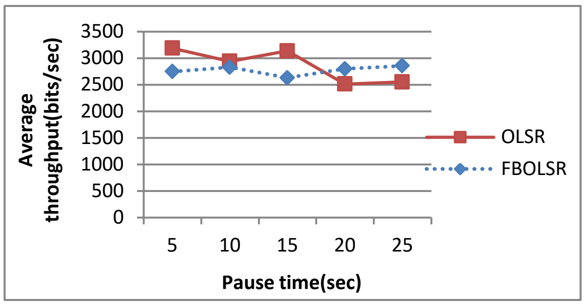

Figure 10: Average Throughput of OLSR and FBOLSR

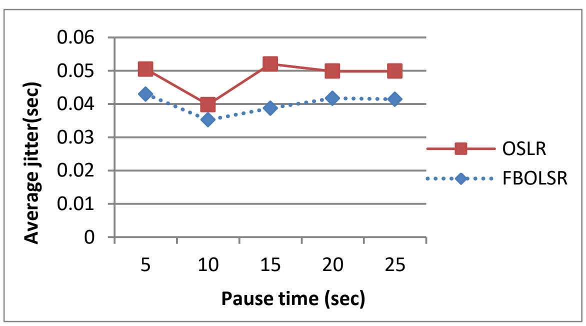

Figure 11: Average Jitter of OLSR and FBOLSR

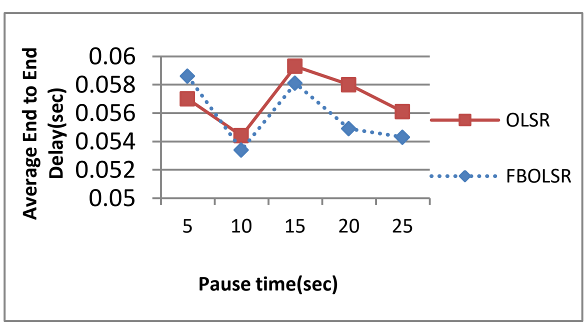

Figure 12: Average End to end Delay of OLSR and FBOLSR

Figure 11 shows the average Jitter for case 2 .The values of average Jitter for OLSR and FBOLSR are shown in table4. According to the table 6 the average Jitter of FBOLSR is much smaller than conventional OLSR.

Figure 12 shows the average End to End delay for case 2.The values of average End to End delay for OLSR and FBOLSR are shown in table6.
According to the table4 the average End to End delay of FBOLSR is much smaller than conventional OLSR. From all the results it has been found that for both the cases, fuzzy based OLSR gives better results than conventional OLSR.

IX. Conclusion

In this paper, an efficient approach to optimize the frequency of sending hello message has been proposed. The performance of network in terms of Average Throughput , Average End to End Delay and Average Jitter for conventional AODV and OLSR with fuzzy based have been compared. From the simulation results it can be concluded that FBAODV and FBOLSR performs better in terms of throughput, jitter and end to end delay. Althrough this work it can be said that instead of static value of hello interval, the value of hello interval can be determined accurately and dynamically through fuzzy logic and this gives better results.

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