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ROUTING ANALYSIS USING FUZZY LOGIC SYSTEMS IN WIRELESS MESH NETWORKS

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1. INTRODUCTION

In a WMN, each router forwards packets on behalf of other nodes (that may not be within direct wireless transmission range of their destinations). Moreover, the gateway functionalities enable the integration of WMNs with various existing wireless networks such as Wi-Fi, cellular networks, Wi-Max, among others [2].

A WMN is self-organized, self-configured and redundant (if one node fails, the other ones are still able to communicate). This brings many advantages, such as low up-front cost, easy network maintenance, robustness, resilient and reliable service coverage. Moreover, and comparing meshes with traditional ad hoc networks, routers in meshes are not limited in terms of resources, and thus can be exploited to perform more resource intensive functions [3, 4]. When considering route creation process, routing protocols can be classified in three main categories: proactive, reactive and hybrid, as described below.

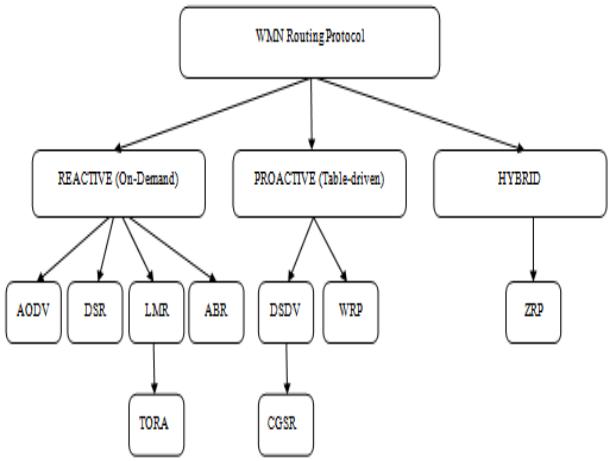

Figure 1: Routing Protocols

AODV is a reactive protocol or on-demand protocol [41]. Ad-hoc on demand distance vector routing protocol uses destination sequence number to offer loop free routing and fresh route to the destination. Unlike tables driven protocols it does not maintain

status of the network via continuous updates. This approached help in reducing the number of messages and the size of the routes tables.

AODV provides both multicast, and uni-cast connectivity in an ad-hoc environment. One of the main features of AODV is to respond quickly whenever a link breakage in active route is found.

AODV is a combination of both DSR and DSDV. It inherits the basic on-demand mechanism of route discovery and route maintenance from DSR plus the use of hop-by-hop routing sequence numbers and periodic beacons from DSDV.

AODV is simply an improvement of DSDV. However, AODV is a reactive routing protocol as opposed to proactive. This reduces the quantity of broadcasts by simply developing avenues dependant on requirement, and that is incorrect for DSDV.

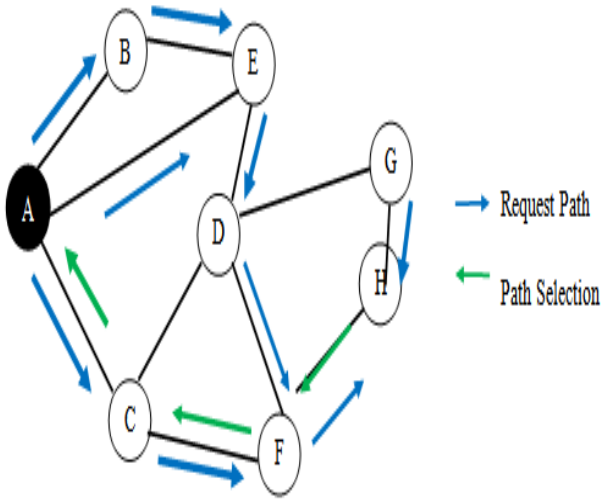

Figure 2: AODV protocol

AODV is one of reactive routing protocol means that only on demand it creates path to destination node. Pure AODV uses traditional routing tables and destination sequence number is used for identification of latest route to destination and formation of routing loops [13, 14, and 15]. There is growing age and there is important need of communication protocol over wireless system. Then AODV protocol came into existence. AODV is an on –Demand routing protocol which is confluence of DSDV as well as DSR. Route is computed on request, at the same time as it is in actual DSR by means of route detection process. That is why it is called reactive protocol. However, AODV maintains a routing table where it maintains one entry per destination unlike the DSR that maintains multiple route cache entries for each and every destination. AODV make available loop free routes even though mending link breakages but then again nothing like DSDV, it doesn't necessitate worldwide periodic routing advertisements.

Fuzzy Logic

Fuzzy logic is a rigorous mathematical field, and it provides an effective vehicle for modeling the uncertainty in human reasoning. In fuzzy logic, the knowledge of experts is modeled by linguistic rules represented in the form of IF-THEN logic. A fuzzy set is uniquely determined by its membership function (MF), and it is also associated with a linguistically meaningful term. Fuzzy logic provides

a systematic tool to incorporate human experience. It is based on three core concepts, namely, fuzzy sets, linguistic variables, and possibility distributions.

The importance of fuzzy logic derives from the fact that most modes of human thinking and especially common sense reasoning are approximate in nature. The essential features of fuzzy logic are as follows:

- In fuzzy logic everything is a matter of degree.
- Any logical system can be fuzzified.
- In fuzzy logic, knowledge is interpreted as a collection of elastic or, equivalently, fuzzy constraint on a collection of variables.
- Inference is viewed as a process of propagation of elastic constraints.

This paper deals with building the network model to solve the routing problem in Wireless Mesh Network using Fuzzy Logic techniques along with various parameters like PDR, routing overhead, end delay and throughput.

2. RELATED WORK

Hetal Rana et.al, described **t**he area of Wireless Mesh Networks consists of small nodes with sense, compute and communicate wireless ability. This document present hierarchical routing protocol, Power Efficient Gathering in Mesh Information Systems and a comparative study on various versions of PEGASIS protocols. **Prabhat Kumar et.al,** extended the work done on WMN and explained more routing protocols in the field of wireless mesh network. The author has provided information that would be helpful for the future research workers. **Prabhat Kumar et.al,** extended the work done and he explained more routing protocols in the field of wireless mesh network. His provided information would be helpful for the future research workers. **M.M. Shurman et.al,** incorporate genetic algorithm (GA) with hierarchical clustering for the sake of reducing the long-distance communications. Simulation results are extremely promising and show significant improvements over heuristics and normal genetic algorithms. **Sadagopan et al,** proposed the ACQUIRE component utilized for effective questioning as a part of mesh systems. Secure perspectives the system as a disseminated database where complex inquiries can be further separated into a few 13 sub questions.

3. SIMULATION MODEL

The process of routing in network is shown in this section. This step includes getting the parameters like node id, no. of nodes, network width, network length etc. The simulations is carried out by using MATLAB 2010a as the language that is use to develop the proposed framework. The AODV protocol is used to modify the network parameters that are added to the simulator and evaluates the proposed framework based on it. Following steps are used in the simulation model:

1. Firstly, ENTER the number of nodes
2. Enter the length and width of the network.
3. Enter the number of rounds to run for the network.
4. Then, the cluster head should be plotted by the user.
5. After that the routing will takes place and QOS parameters of the network will be plotted by the simulator according to the code.
6. Evaluate various parameters like throughput, end delay, routing overhead and PDR.
7. Optimize network using fuzzy logic based on membership functions.
8. In the end, the parameters like throughput, end delay, routing overhead and PDR are evaluated.

The simulation is done with the following parameters:

- **Throughput**

Throughput is the rate of invention or the rate on which a bit can be processed. When used in the framework of communication networks.

- **End-to-End Delay**

The packet end-to-end delay is the average time in order to traverse the packet inside the network. This includes the time from generating the packet from sender up till the reception of the packet by receiver or destination and expressed in milli seconds (ms). This includes the overall delay of networks including buffer queues, transmission time and induced delay due to routing activities. Different application needs different packet delay level.

- **Packet Delivery ratio**

Packet delivery ratio is defined as the ratio of data packets expected by destinations to those generated through sources. It can be taken as:

$$PDR = S1 \div S2$$

Where, S1 is the sum of data packets received by the each destination and S2 is the sum of data packets generated by the each source

- **Routing overhead**

It is the ratio between the numbers of sent routing packets over the number of received data packets.

4. SIMULATION RESULTS

This section contains the simulation results evaluated in MATLAB 2010 and it has been seen that proposed algorithm based on fuzzy logic has good results w.r.t without optimization method.

4.1 Comparison With and Without Optimization

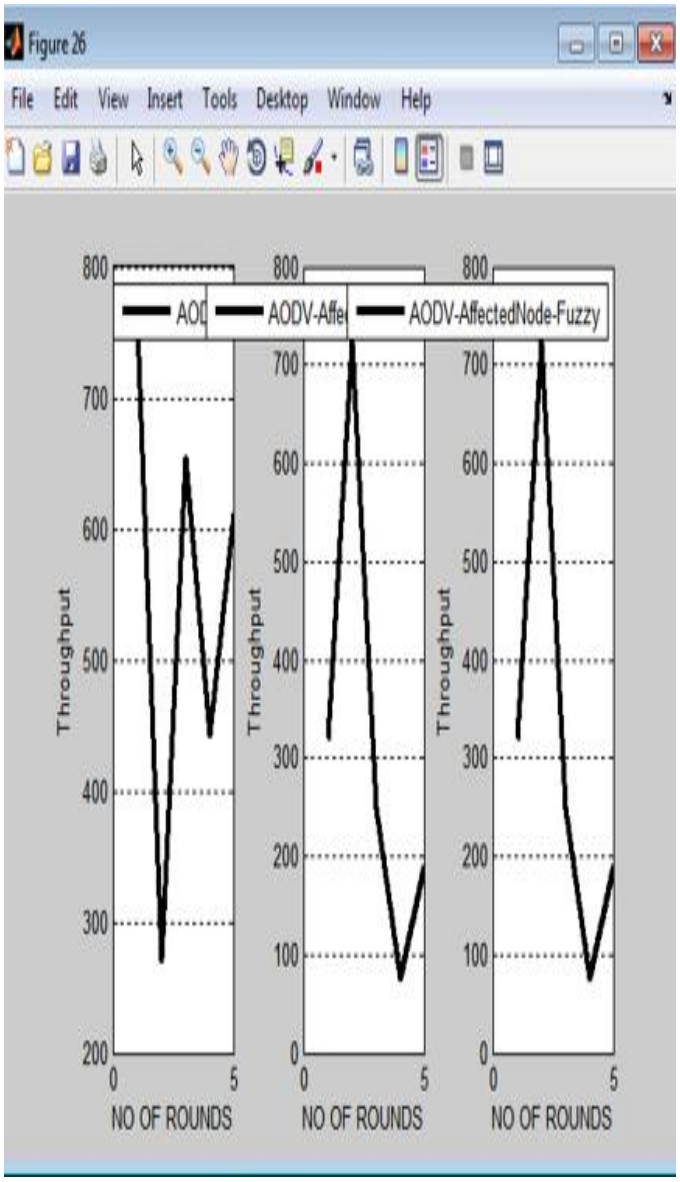

Figure 3: Throughput using normal nodes, affected nodes and using fuzzy logic

Above figure shows the difference between three scenarios like normal network, without optimization and with optimization using fuzzy logic. From graphical representation it has been seen that for normal network, the obtained value for throughput is 600, without optimization is 200 and with optimization is 230.

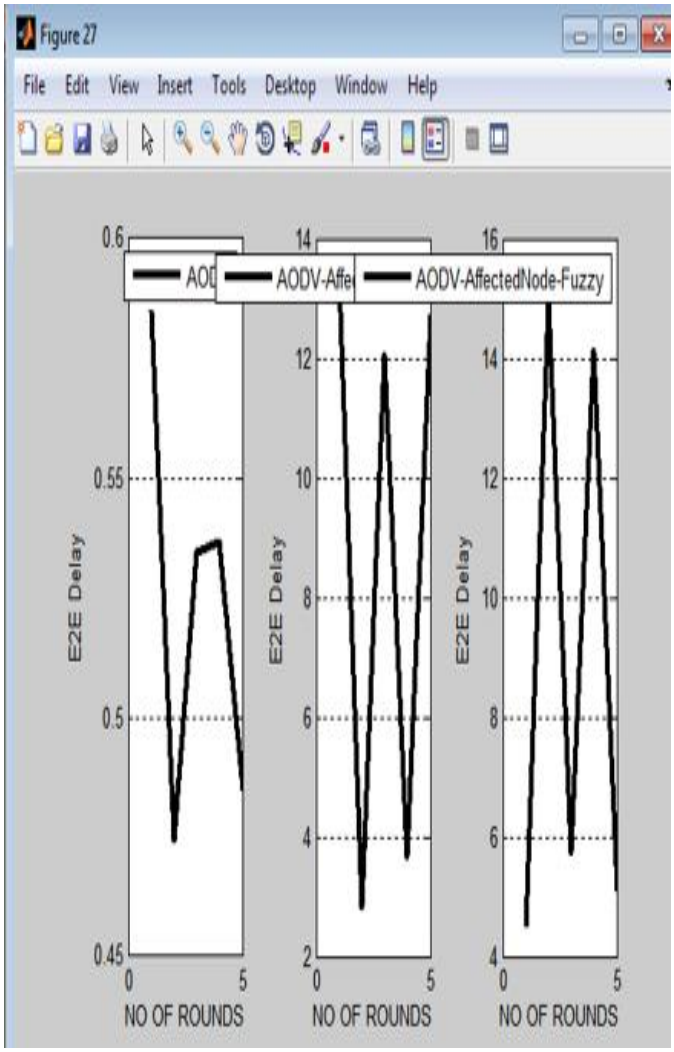

Figure Ошибка! Текст указанного стиля в документе отсутствует.**:** End delay using normal nodes, affected nodes and using fuzzy logic

Above figure shows the difference between three scenarios like normal network, without optimization and with optimization using fuzzy logic. From graphical representation it has been seen that for normal network obtained value for delay is .4,

without optimization is 13 and with optimization is 3.

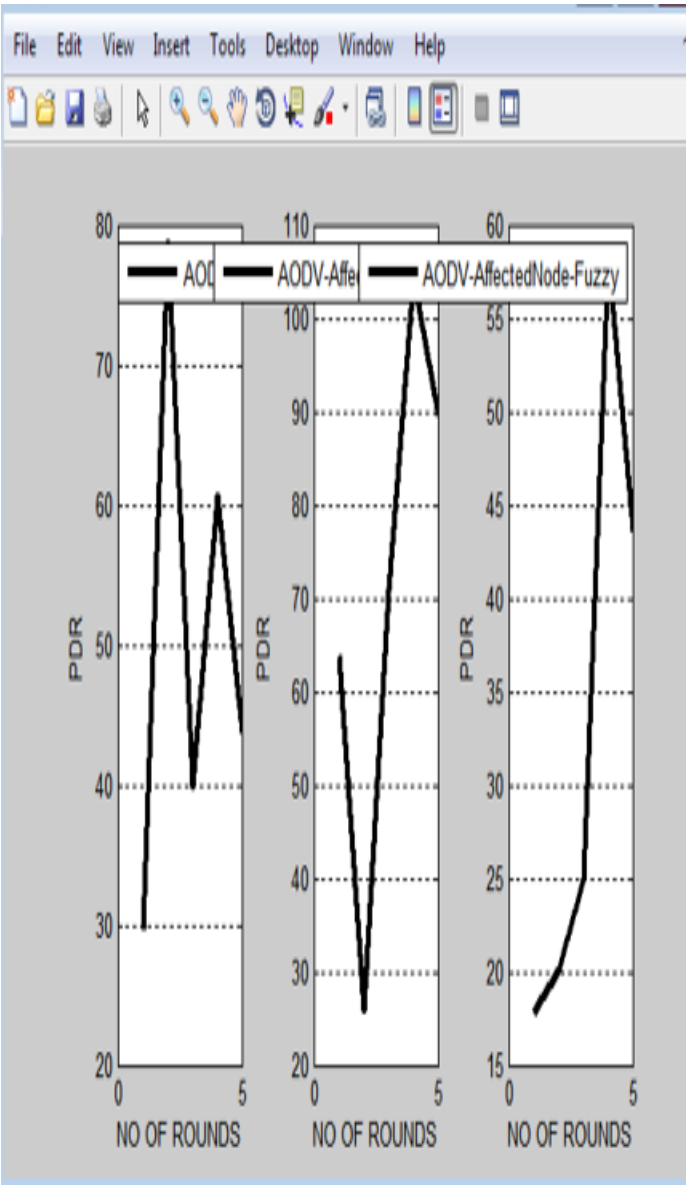

Figure 5: PDR using normal nodes, affected nodes and using fuzzy logic

Above figure shows the difference between three scenarios like normal network, without optimization and with optimization using fuzzy logic. From graphical representation it has been seen that for normal network, the obtained value for PDR is 45, without optimization is 90 and with optimization is 45.

5. CONCLUSIONS

Many routing protocols which are basically categorized into three main types such as reactive, proactive and hybrid routing protocols are studied. This work, all routing protocols for sensor network those are comes under these three types are discussed. Apart from the main routing protocols, there are many improved routing protocols presented by different researchers and still research is going on day by day, so AODV routing protocol has been utilized in proposed work. In mesh network, it is very tough task to predict the performance of routing protocol under varying network conditions and scenarios. So, this protocol has been analyzed using fuzzy logic based on various parameters like end delay, PDR, routing overhead and throughput. From simulation it has been concluded that proposed work based on fuzzy logic has best results than without optimization.

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