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Performance Evaluation of Zigbee Network Using AD-HOC On-Demand Distance Vector Routing Protocol

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Abstract

IEEE 802.11 standard for wireless local area network is more popular as it has a very high throughput as well as high data rate but there are fields where one need to have a different set of necessities like low cost, less power consumption, more reliability, low data rate and the less throughput. In order to full fill these requirements, IEEE 802.15.4 standard was developed for LR-WPAN providing a low cost and less complicated solution. Routing protocols plays a very important role in the direction of utilizing the limited network resources. Routing protocols is responsible for recognizing, creating and sustaining multi hop routes between sending node and destination node when there is no possibility of direct communication between them. This paper takes the reference from the previous work done by the author where he has implemented the AODV routing protocol in True Time 2.0 which is a Simulink based software used in MATLAB. A Path loss is the most important element that effects the design and the analysis of the wireless communication system. Here author has studied the impact of path loss exponent on transmission range and the hop count. Also soft computing technique named Fuzzy logic is used for deciding the optimum path loss exponent.

Keywords: IEEE 802.11, IEEE 802.15.4, LR-WPAN, routing protocol, AODV and Fuzzy logic.

INTRODUCTION

In wireless communication system, the power dissipation occurs due to the transmitter and the propagation channel. Path loss is the most important element that effects the design and the analysis of the wireless communication system. The transmitted signal is not able to reach to the destination directly due to various obstacles that blocks the line of sight path. There are various mechanisms which effect the propagation are Reflection, diffraction, scattering and the Doppler effect [1, 2] leading to the fluctuations in the amplitude and the phase of received signal.

The propagation models actually predicts the losses taking place between in the signal while travelling from transmitter to receiver. It also decides the coverage area. Propagation models can be used a mathematical tool used by the scientists and the engineers to plan and do the optimization of wireless communication system.

A mobile node in a network establishes route from source to destination through route discovery process and keep the track of change in network topology, if any using route maintenance mechanism. These two mechanisms depend upon the radio wave propagation which places a fundamental limitation on the performance of the ad hoc network [3, 4].

A wireless Ad Hoc network is a distributed type of wireless network with no central controlling node. The network is called ad hoc because it does not rely on a pre-existing infrastructure, all nodes have equal status on a network and the nodes are permitted to associate with any other ad hoc network node in the link range.

Routing protocols plays a very important role in the direction of utilizing the limited network resources. An intelligent routing strategy manages with the limited network resources and adaptable to the changing conditions like network size, traffic density and network partitioning. Routing protocols is responsible for recognizing, creating and sustaining multi hop routes between sending node and destination node when there is no possibility of direct communication between them. Thus, how well the protocols perform in the present state depends on how well they can distinguish between a good link and bad link during active communication [3, 4]. A complete literature survey on the types of routing protocols used in Zigbee network is well explained in [5, 6, 7].

IEEE 802.11 standard for wireless local area network is more popular as it have got a very high throughput as well as data rate, but there are applications where we need to have a different set of requirements like low cost, less power consumption, more reliability, low data rate and the less throughput. In order to full fill these requirements, IEEE 802.15.4 standard was developed for LR-WPAN providing a low cost and less complicated solution [8]. Zigbee protocol [7,8,9] is based on based on IEEE 802.15.4 standard, defines a specifications for low rate WPAN (LR-WPAN) which supports simple devices that the Zigbee Alliance [10] is an association of companies working together to develop standards (and products) for reliable, cost-effective, low-

power wireless networking. Zigbee technology is used in a wide range of products and applications across consumer, commercial, industrial and government markets worldwide. [11]. There are various parameters associated with the Zigbee network. People have done tremendous research in the field of the improvement of network performance by studying the performance metric. In [12] author has emphasized on the Ad Hoc routing protocol generally used in Zigbee network called On-Demand Distance Vector (AODV) routing protocol [13,14]. Author has done a comparison between the simplified versions of AODV called AODV-Junior [15] with the proposed Energy Aware routing algorithm (EA-AODV). It has been found that the proposed algorithm has better Packet delivery ratio, less end to end delay. The proposed algorithm has better energy consumption balance leading to increased network lifetime. [16] Proposes a region based priority technique for the evaluation of overall performance of Zigbee network. Author has made a comparison between priority based and no priority based model based on performance metrics like packet delivery ratio, no. of retransmission attempt, media access delay, queue size, hop count etc. In [17], Author has emphasized on the critical problems of AODV used in large Zigbee mesh network such as high packet loss, high packet collisions, data loss, packet collisions, energy consumption etc. making AODV inappropriate in a fast and efficient application. Author proposes a metric based on fuzzy logic used in the decision making process of AODV. The experiments shows that the proposed method leads to reduction in the communication delay, no of packet collision and the packet loss.

METHODOLOGY

There are various parameters associated with the Zigbee network which are:

- Packet delivery ratio: It ii defined as the ratio of number of packets received successfully to the number of packets transmitted in Medium Access sub layer.
- Packet loss (%): Packet loss is the ratio of lost packets while transmission to the transmitted in MAC sub layer.
- Hop count: Number of hops required for the message to reach to the destination.
- Throughput: It measures how fast the data message can pass through a network.
- Media Access Delay: It is the time, a node takes to access media for starting the packet transmissions [5].
- Network Lifetime: This is defined as the minimum time at which maximum numbers of nodes are dead or shut down during a long run of simulations [5].
- Transmission power: It is the strength by which the signal is sent. It is an important parameter that determines the number of neighbors for nodes in ad hoc network.
- Receiver signal threshold power: decides whether the medium is busy or free.
- Signal transmission range: signal transmission range is how long the signal can reach. It depend on the transmitting power, path loss and the minimum threshold power.

This paper uses the Ad Hoc routing protocol known as AODV routing protocol [13,14] for Zigbee network in True Time 2.0 [18,19], which is a Simulink based simulator in MATLAB. Full information on the implementation of AODV in True Time is explained in [7, 8]. This paper focuses on the impact of variable path loss exponent on the performance metrics like the transmission range and the number of hops. Also authors have implemented the fuzzy logic for finding the optimum value of path loss in the network. Simulation scenario used is given in Table 1.

Table 1: Simulation Scenario parameters

Parameters	**Description**
MAC protocol	802.15.4(Zigbee)
No. of nodes	30
Nodes placement	Random
Area of region	30x30
Data rate (bits/seconds)	200kbps
No. of packets send	60
Transmitting power (dBm)	-1
Threshold power (dBm)	-48
Path loss exponent	2 to 5
Minimum frame size (bits)	248
ACK timeout (seconds)	0.00004
Retry Transmission limit (numbers)	5
Hello Interval	1 second
Active Route Timeout	3 seconds
Delete period	2 seconds

Path loss plays an important role in the transmission range. Figure 1 to 2 show the membership function for the input and the output respectively. Figure 3 and 4 shows the rule viewer and the surface viewer for the input and output variation using fuzzy logic.

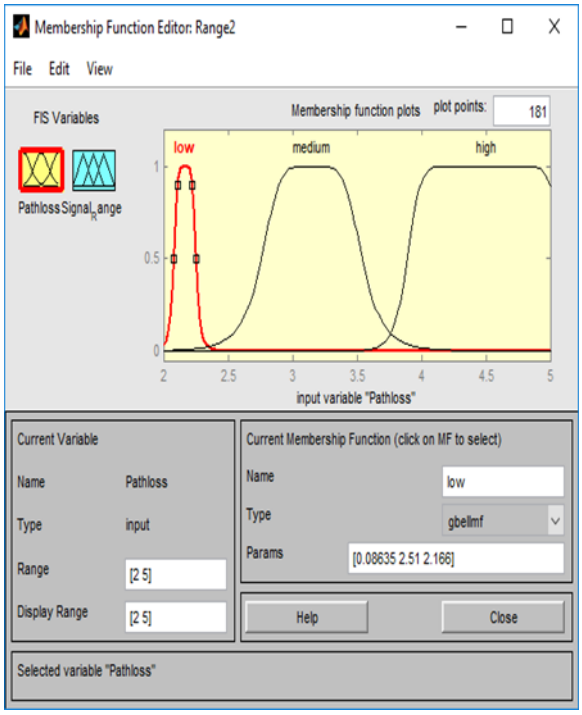

Figure 1: Membership function for path loss

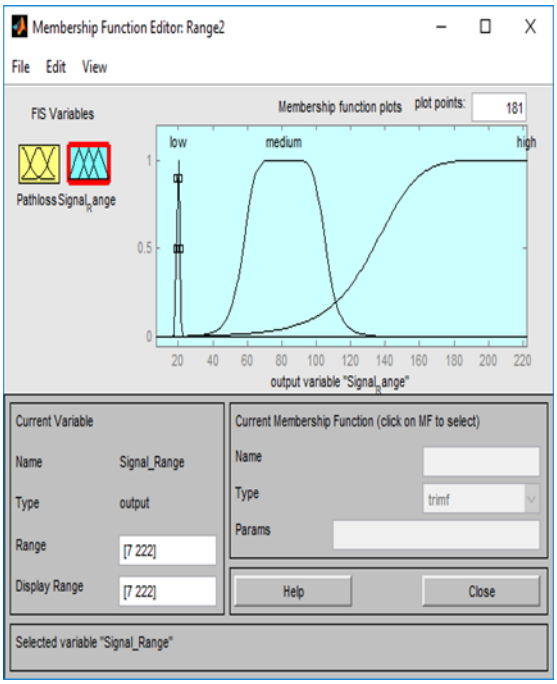

Figure 2: Membership function for transmission range

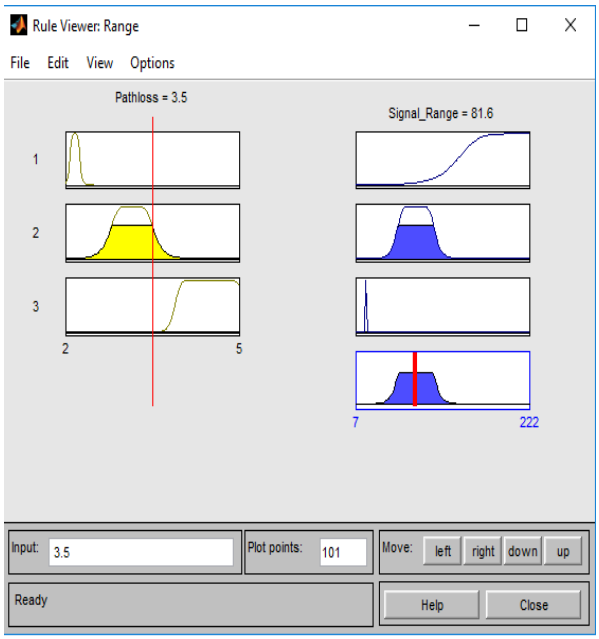

Figure 3: rule viewer for path loss

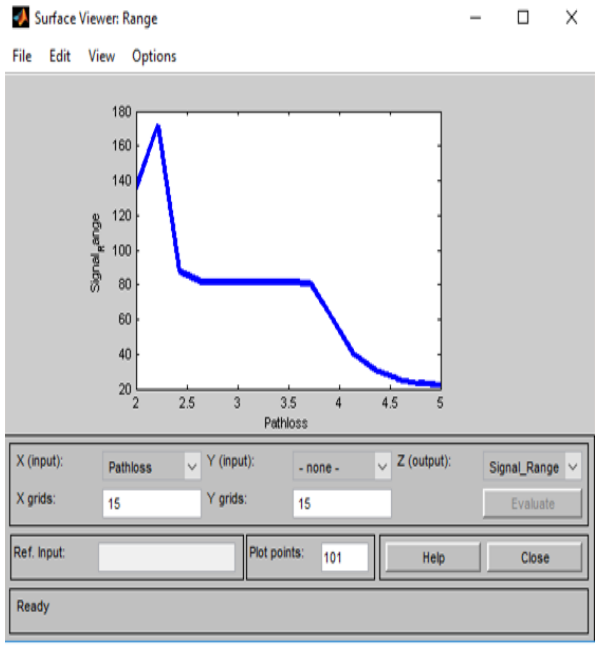

Figure 4: Surface viewer

RESULTS

Path loss is the most important element that effects the design and the analysis of the wireless communication system. Here free path propagation model is used and the parameters that get effected by the path loss exponent is presented. Figure 5 and 6 present the variation of no. of hops needed to make the data reach to the destination and the variation of transmission range vs. path loss exponent respectively.

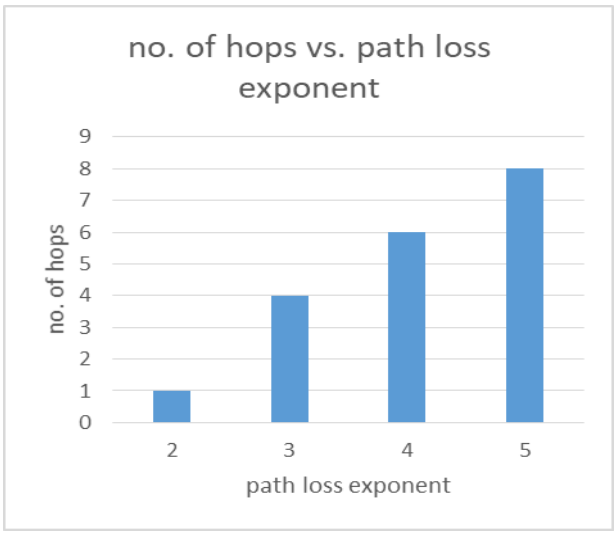

Figure 5: No. of hops vs. path loss exponent

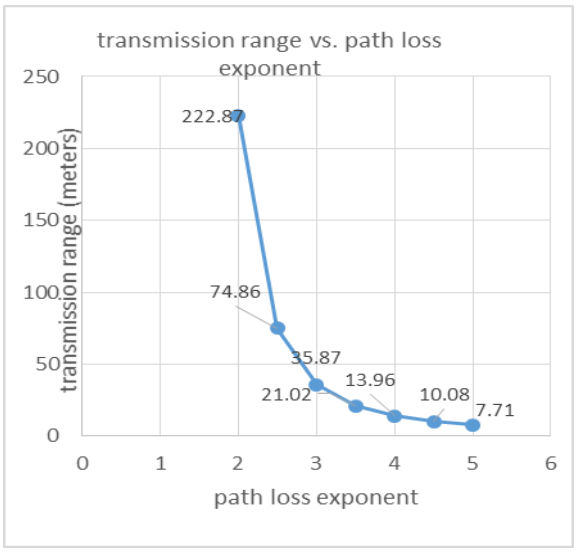

Figure 6: transmission range vs. path loss exponent

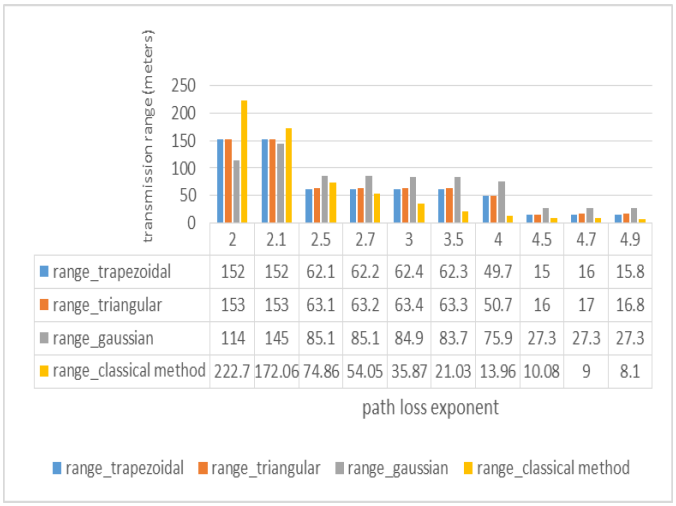

Figure 7: fuzzy logic based transmission range vs. path loss exponent

DISCUSSION

Figure 1 to 4 is showing the membership function for the path loss exponent as input and the membership function for the signal transmission range as output. Figure 4 shows the surface view. With the variation in path loss exponent ranging from 2 to 5, it can be seen in figure 5 that the number of nodes needed is also increasing. Figure 6 shows that the transmission range is inversely proportional to the path loss exponent. Authors have applied a soft computing technique called fuzzy logic in this paper. Figure 7 shows the variation of signal transmission range with the path loss exponent at -48dBm threshold power. It can be observed that the signal transmission range remains constant for 2.5 to 3.5 value of path loss exponent. It can also be seen that the Gaussian membership function is giving better result as compare to others.

CONCLUSION

The correct modelling of path loss is very important which determined the signal to noise ratio which is a determining factor in the transmission power control. At the medium access layer, the receiver power level is determined by the path loss exponent. The signal can be determined only if the receiver power level exceeds a certain value of threshold power. From the figures shown above, it can be concluded that the number of hops get increased with the increase in path loss exponent.

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