Adaptive AODV Hello Messages based on Fuzzy Distance and Neighbors Changes

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ABSTRACT
In Ad hoc network such as WSN, nodes are mobile and continuously change its location and velocity, nodes need to send and receive data continuously, so each node must be aware of its neighbors, and to do this it periodically broadcast a HELLO message to its neighbors on fixed intervals, to announce its existence and to keep track of available nodes with direct link. But this hello messages add an overhead and increase congestion in the network. So it's important to reduce this effect for efficient use of AODV in WSN network. This paper propose a new scheme to reduce the number of hello messages in AODV routing protocol to increase the packet delivery ratio and reduce the congestion on the network.

General Terms
Algorithms, Performance, Design.

Keywords
Ad-hoc, WSN networks, hello message, hello interval, fuzzy logic, AODV

1. INTRODUCTION
In WSN network, the main purpose is to gather information from many locations and forward it to the base station. To achieve this functionality it require routing protocol which consume node resources and network bandwidth, this is a critical and sensitive issue that has to be take care of it due to the limitation of the WSN nodes like energy, storage capacity, bandwidth, and computing power. More over the nodes are always moving and changing their positions, therefore the topology of the network are changed frequently, so the process of find the route and maintain it is very important for maintain connectivity between nodes in network.

1.1 Overview of Ad-hoc On-Demand Distance Vector (AODV)
One of the first routing protocol is Ad hoc On-Demand Distance Vector (AODV). This protocol is a reactive protocol, that's mean that the route is established when it's needed. AODV use route discovery and route maintenance to find routes between nodes, more over it use hello message between node and its neighbors to announce its existence on fixed intervals to keep track of available nodes with direct link. Sending hello message is costly and consume network resources in sending and processing it.

AODV routing table is a time based for each entry, route entry that is not recently used considered as expired route. Route entry is added based on route discovery, the intermediate node maintain information for each route as route entry. AODV use many control packet to establish and maintain the route entry in routing table. One of the control packet is the hello packet which each node send it to its neighbor to maintain links to its neighbor.

1.1.1 HELLO Messages.
Each nodes send a local broadcast message to its neighborhood, neighbor node means that the node that can communicate with it directly. Although AODV is a reactive protocol it use periodic hello message to inform the neighbor that the link is still exist and alive[1], and that hello message never broadcast to other nodes because it send with TTL = 1. When a node receive a hello message it update routing table with the corresponding node with its lifetime. If a node didn't receive hello message from that node with the lifetime it's removed from routing table.

1.1.2 Adjusted Hello Message Time.
Each time a node receive a hello message it need to be processed. The node have to check for the routing table entry (update the expire timer or add the entry to the routing table) even if the node didn't changed its position in the network.

The periodic hello message is send based on hello timer interval (HI), this time determine when the next hello message will be send. When the timer expire each node broadcast a hello message to all its neighbors and that message use network bandwidth and can effect on the data packet that send over the network. the HI is predefine, each time the node broadcast the hello message to its neighbor its reset the time based on that interval and the timer start again.

1.2 Motivation
AODV is one of the earliest routing algorithm of ad hoc network that have been introduced. It's using hello message for keep track of node neighbor. Although hello message it's a control message and it size is small it's still consume node resources and network bandwidth and in some active network its will be a noticed problem and can affect the overall network performance.

Little approach have been proposed to improve the hello message like increase the HI but that was lead to poor performance of the network due to the high activity of the network[2].

This paper propose to use adaptive hello message in AODV based on information that collected from nodes neighbors. Then propose a fuzzy HI which is used with AODV based on some information collected from the node neighbor. This paper study the effect of the changed in routing table entry as clue to the mobility of the network, more changed in routing table mean high changes in the mobility. And then study the average distance between node and its neighbors. The tow factor (the mobility and average distance) was used in fuzzy logic to determine the next hello message.

2. RELATED WORK

Shaily Mittal et al [3], show the performance comparison between AODV, DSR and ZRP in MANNET's, the paper shows the AODV has given the best result against other protocol in packet delivery ratio and end to end delay.

Perkins et al. [4], creators of AODV protocol, present the reason for applying the hello message in AODV and give some of disadvantage of this message, more over they said they will do more research to eliminate the drawback of using hello message.

Ian D.Chakeres et al. [5],have investigate the effectiveness of hello message for link monitor status and found some influencing factors on the utility of these messages.

Lundgren et al. [6], present a strong evidence that unreliable implementation of hello message can give a systematic mismatch between the route state and the actual connectivity state which is called "communication gray areas" In such areas, data messages cannot be exchanged although the hello messages indicate neighbor reachability.

R.Gokila et al. [7], used an efficient secure data transition for adaptive hello message and he used design to decrease energy and delay without affecting the performance of the protocol.

Divya1 et al.[8], introduce an adaptive hello message and multi path route maintenance in MANET by decrease the battery drain by suppression of unnecessary hello message, he used a table to record all network changes, according to this changes the announcement rate is calculated.

Essam Natsheh et al. [9], Adaptive of hello messages in wireless ad Hoc networks. They used fuzzy logic system based on the transitions power of the node as the first factor and the speed of the node as a second factor to determine the next HI message.

Priyanka Thakkar and Prasanna Shete et al. [10], propose an approach to adaptive hello message by modifying the Hello message broadcast interval of AODV by making it directly proportional to event interval thereby suppressing unnecessary hello messages and breakage of links to the destination without adversely affecting the network performance.

3. IMPLEMENTATION

To implement HI fuzzy function (which will be called Fuzzy AODV) a good knowledge about the network and the node neighbor must be known.

change_neighbors Variable was defined to count the changed in node routing table every time changed had been made in the period of the HI. That count have been used accordance of the overall node in the network and that was used as input for the Fuzzy AODV.

The average distance between node and all its neighbor was calculated and the have been used according to the node transition range and that was used as a second input for the Fuzzy AODV.

3.1 Effect of the Mobility of the Network in HI

The mobility of the network is first factor that define the HI, the mobility was define as the change of neighbors, which can be calculated as the number of new neighbors plus the number of lost neighbors

$$change\_neighbors = New\_neighbor + Lost\_neighbors$$

If the changed was high then the node is in high mobility environment, which means it should broadcast hello messages more frequently to keep accurate record of available nodes, If not then the environment is not highly mobile and hello message can be broadcast less frequently.

3.2 Effect of the AVG distance between nodes

The average distance is define as the average distance between the node and all its neighbors. The distance was calculated based on the following equation

$$d = \sqrt{\frac{P_t G_t G_r \lambda^2}{(4\pi)^2 P_r L}}$$

Where P_t and P_r are the transition and receive power in watts, G_t, G_r are the transition and receive antenna gain L is the loss factor (assume 1) and λ is the wave length in meters.

If the average distance between a node and its neighbors is low then the neighbors is too close to the node and there is a low probability that they will be lost soon, so the HI should be increased. And if the average distance is too high then there is a high probability that the nodes will be lost soon so the HI should be decreased.

3.3 Rule-Based for Fuzzy AODV

The mobility of the network and the average distance was used to fill the fuzzy AODV set. It was combined with a 2-dimentional rule to control the HI. Each factor was classify as three category: Low, Medium and High, where high HI is set to 5 sec, medium is set to 3 sec and low is set to 1 sec and this values were chosen heuristically The following table (Table 1) show the fuzzy function, table 2 shows the corresponding HI for the fuzzy function:

Table 1- rule for HI fuzzy function

AVG distance	Mobility of the network		
	Low	**Medium**	**High**
Low	High HI	High HI	Medium HI
Medium	High HI	Medium HI	Low HI
High	Medium HI	Low HI	Low HI

4. SIMULATION ENVIROMENT

The proposed approach was tested using NS2 simulator version 2.34 running under Ubuntu Linux operating system.

5. SIMULATION PARAMETERS

The simulation layer in NS2 was as the following:-

A. Application layer. TCP connection between nodes was generated randomly using ns2 tool with a max connection to 10 connections at the same time with 512 KB packet size.

B. Routing Layer: The routing protocol is AODV with all its function and parameters.

C. MAC Layer: IEEE 802.11 MAC protocol.

D. Physical Layer: IEEE 8.2.11a with 11MB/s.

The test was divided into three parts:

- Part 1- The number of node 25, 50,100,150 and 200 nodes.

- Part 2- The Speed of node was 4,8,12,16 and 20 m/s with area 1000*1000 and 100 nodes for each test.
- Part 3- the area was 250×250 m, 500×500 m, 750×750 m and 1000×1000 m with 100 nodes.

In order to test our approach several scenarios have been generated to represent different simulation parameters, each point at the simulation was tested by using minimum 20 deferent scenarios to ensure an acceptable degree of confidence.

6. EVALUATION CRITERIA

A. Normalized routing load: it is the ratio of routing packet transmitted to the data packet delivered through the simulation.

∑ Number of routing packets / ∑ Number data packets

B. Average End-to-End Delay: Average packet delivery time from a source to a destination. First, for each source-destination pair, average delay for packet delivery is calculated. Then the whole average delay is calculated from average delay of each pair. End-to-end delay includes the delay in the send buffer, the delay in the interface queue, the bandwidth contention delay at the MAC, and the propagation delay.

∑ (arrive time – send time) / ∑ Number of connections

C. Packet delivery ratio: the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

∑ Number of packet receive / ∑ Number of packet send

7. SIMULATION RESULTS

7.1 Evaluation Criteria against Number of Nodes

Effect of number of node is done by run the simulation one for original AODV base system and with Fuzzy AODV by changing of number of nudes from 25, 50, 100, 150 and 200. Where the area is 1000 m by 1000 m and the maximum speed is 10, maximum connection 10. Figure 1 show the normalized routing load against the number of node when the speed and the area are fixed. The result show the Fuzzy AODV reduces the routing load in the network due to increasing HI when the mobility is low, the figure shows an improvement made by the Fuzzy AODV at high number of nodes because at high number of nodes the Fuzzy AODV will operate in dense area for which it will perform better that Original AODV, but at low number of node where the Fuzzy AODV operate in a sparse area the performance will be close to original AODV.

Figure 2 show the packet delivery ratio for the same scenarios. The Fuzzy AODV shows an improvement in packet delivery ratio due to decrease in overhead caused by hello message as shown in figure 1.

Figure 3 shows the end to end to delay for the same scenarios and the Fuzzy AODV shows improvement in average delay due to decrease in the routing load in the networks.

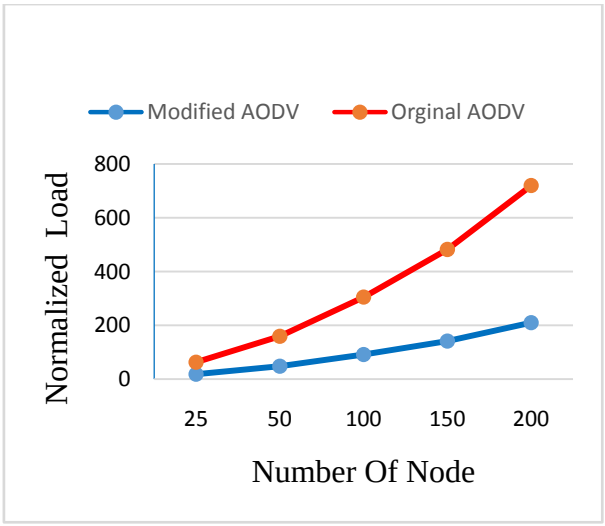

Figure 1

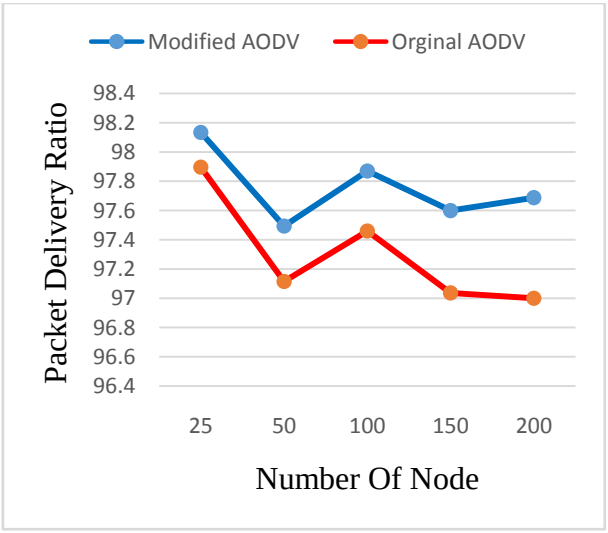

Figure 2

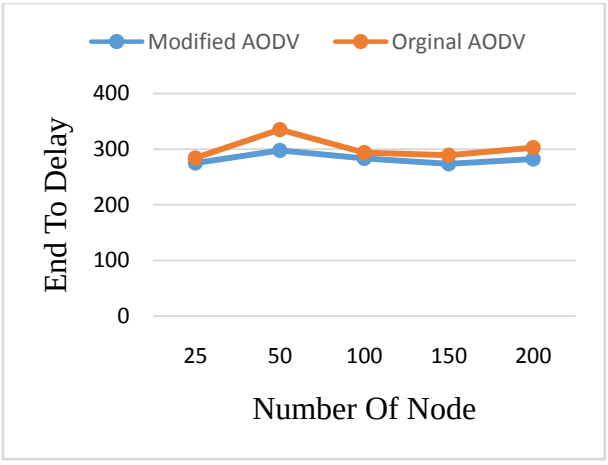

Figure 3

7.2 Evaluation Criteria against Speed of Nodes

Effect of the speed of the nodes in done by run the simulation one for original AODV and for Fuzzy AODV by changing the

speed of the nodes from 4, 8, 12, 16 and 20 m/s when the number of node are set to 100 node, area 1000 ×1000 m and maximum connection 10. Figure 4 shows the routing load against speed, the result shows that the Fuzzy AODV reduce the routing load for all scenario due to the decrease in the hello message and that's leads to a better result in packet delivery ratio figure 5 and shows decrease in end to end delay figure 6.

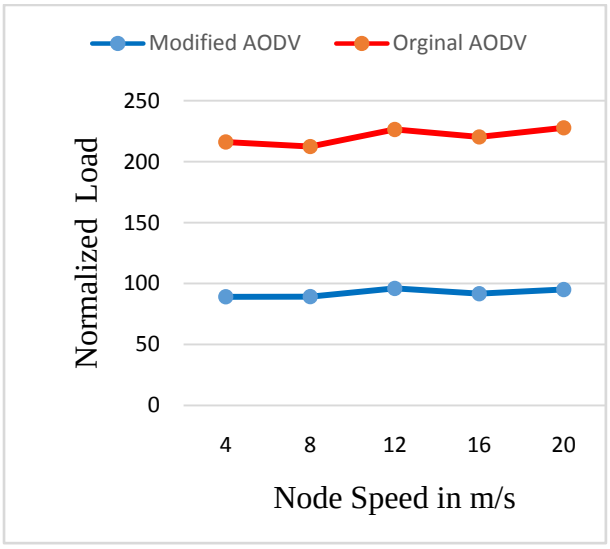

Figure 4

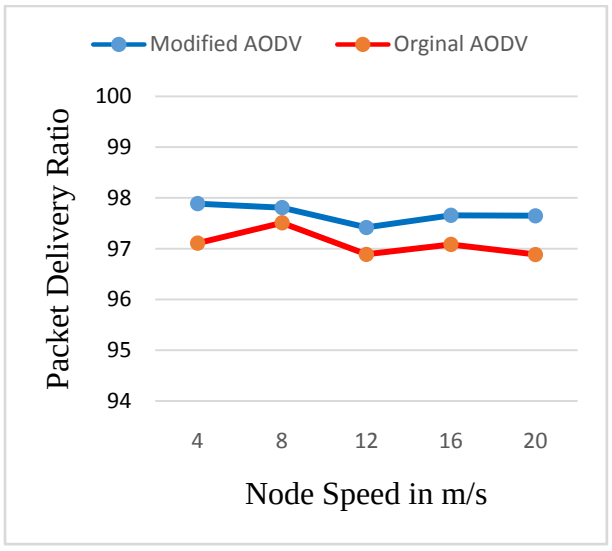

Figure 5

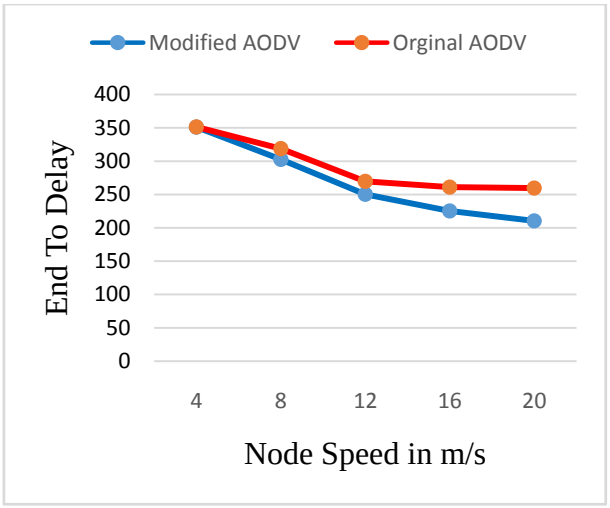

Figure 6

7.3 Evaluation Criteria against Area

Effect of the area of the simulation environment is done by run the simulation one for original AODV and for Fuzzy AODV by changing the area of the simulation from 250×250, 500×500, 750×750 and 1000×1000 when the number of node are set to 100 nodes, speed is set to maximum 10 m/s and maximum connection 10. Figure 7 shows the routing load against area, the result shows that the Fuzzy AODV reduce the routing load for all scenario due to the decrease in the hello message and that's leads to a better result in packet delivery ratio in figure 8, figure 8 shows that the packet delivery ratio is better at small area because it works in a dense area, Figure 9 shows the end to end delay against area which shows improvement of Fuzzy AODV and shows improvement for Fuzzy AODV in end to end delay because it decrease the congestion on the network.

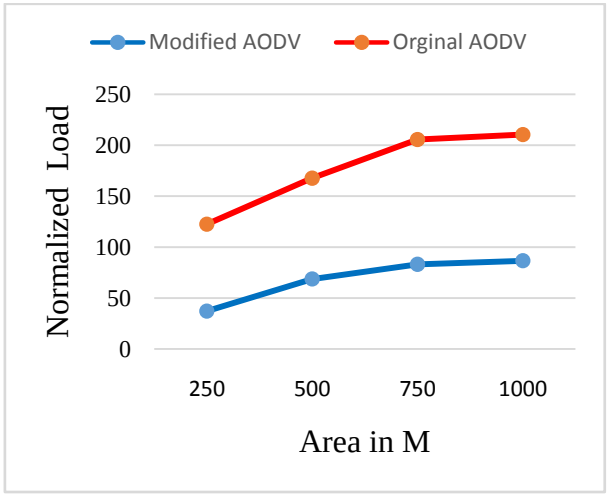

Figure 7

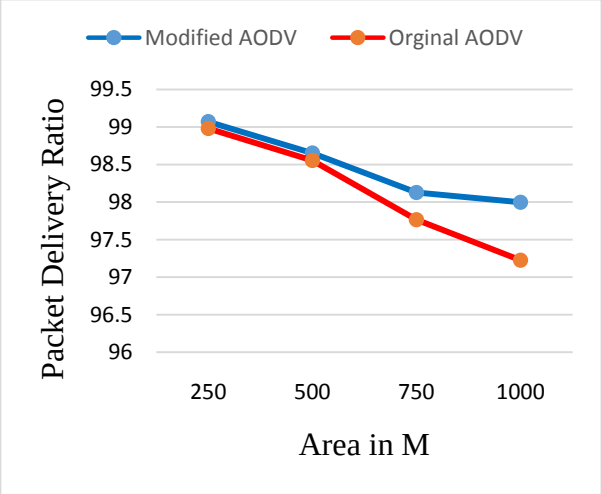

Figure 8

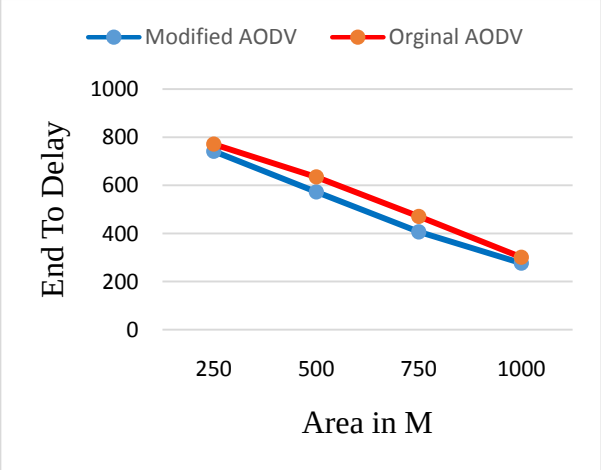

Figure 9

8. CONCLUSION

This paper present a performance evaluation of using fuzzy HI in AODV routing protocol to optimize the frequency of sending the hello message. The fuzzy function was developed based on the mobility of the network and the average distance between nodes, it is noticeable that the performance of fuzzy HI is better than the original AODV protocol in all field, that because the fuzzy function reduce the number of hello message without affecting the performance of the network, reducing the hello message lead to reduce the congestion on the network so it's give a better packet delivery ratio and a less end to end delay.

The work presented here has given us an insight that the ad hoc routing protocols configuration parameters might be determined more accurately and dynamically by fuzzy logic system, instead of static values.

9. REFERENCES

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