Performance Evaluation of Intelligent Ant sense and AODV Routing Protocols for Personal Area Network in Different Motilities

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***Abstract*-Mobile ad hoc networks (MANET) have emerged as an important field in the wireless area. Due to its dynamic nature, a primary challenge of MANET is the design of effective routing algorithm that can adapt its behavior to frequent and rapid changes in the network. This paper presents a novel scheme for MANET routing enhancement called Intelligent Ant sense (INTANTSENSE) protocol based on ant colony optimization. It utilizes a collection of mobile agents to perform optimal routing activities. By combining the capability of reactive routing with distributed and multipath routing mechanism, Intelligent Ant Sense routing compared with AODV protocol using network simulator-2 (NS-2).INTANTSENSE protocol utilizing the benefits of pheromones, third party reply model and ring search model, to enable optimal path routing, fast route discovery and effective Sense routing route failure handling.**

Keywords- MANET; AODV; INTANTSENSE Ring Search Model; Third Party Reply

I. INTRODUCTION

Mobile Ad-Hoc Network (MANET) is a recent developed part of wireless communication and expected to become an important part of the future generation architecture [1]. One of the major issues that affect the performance of an ad hoc network is the way of routing implemented in a network governed by mobility and dynamic network size.

Generally, routing is the process of discovery, selecting, and maintaining paths from a source node to another destination node and using this path to deliver data packets. The goal of every routing algorithm is to direct traffic from sources to destinations, maximizing network performance with minimizing costs; routing overhead and delay.

II. INTANTSENSE AND AODV PROTOCOLS

Routing in mobile ad-hoc network is used to provide routes to the packet from source to destination in a proper way [2].Reactive routing protocols take the approach of only building a route when there is a need for it. The goal of a reactive protocol is to reduce the control traffic overhead by only sending control traffic when needed, if no traffic is sent, there is no control overhead [3,4].The most commonly adopted routing protocols have been chosen for analysis and comparison are AODV and Intelligent Ant Sense protocols.

A. Aodv

Ad hoc On-demand Distance Vector (AODV) is a proactive protocol. In this protocol, the nodes use the sequence numbers to avoid loops and take the path information as updated as possible. When a source node wants to transmit information to a destination node, it sends a RREQ (Route Request) packet in broadcast mode to request a route. If a node sees that it is in the destination field of a RREQ, first it checks that this packet has not been received yet by means of a RREQ register. If it was not registered, it sends the message back and increases the number of hops and creates the route reverse replying with a RREP (Route Reply) packet to confirm the path. For the maintenance HELLO messages are used for detecting and monitoring links to neighbors. The disadvantages of AODV are; the route request flood all network until reach destination. HELLO Message updating process sends to all network nodes even to nodes they are not associated to the initiated path which leads to adding more overhead on the network. Also AODV not allow multipath routing, new request always must be discovered on route failure situation [5, 6].

B. Intantsense

Intelligent Mobile Ad-hoc routing protocol is a new protocol uses the same mechanisms of pervious Ad-Hoc on demand distance vector (AODV) routing protocol, the same features of reactive routing algorithm route discovery and route maintenance based on Ant Colony Optimization named Intelligent Ant Sense, and it depends on pheromone value which is used to control

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routing process for route discovery, during route maintenance and failure handling. For Intelligent Ant Sense protocol, each route in nodes routing table is assigned a pheromone value to represent the quality of the route, measuring the cost and efficiency of chosen path from source to destination. Ants agent collect the path's information as they travel from node to another, at each node, the initial pheromone value calculated based on the information collected by the ant. This value then assigned to the route entry in the nodes routing table. The pheromone value depending on the number of hops the forward ant needed to reach the node. Initiate pheromone value for all nodes route table calculated by Equation (1).

$$\text{Pheromone (p)} = \frac{\alpha}{N_h} \tag{1}$$

N_h = number of hops for ant to travel from source to next node.

α = constant value parameter $1 > \alpha > 0$

Due to the fact that all ants' travel along the created path by the agent, each ant deposits a pheromone causing a high intensity of the pheromone along that path. All ants in colony would follow that optimal path. In Intelligent Ad-hoc routing protocol, as data packet is transmitted over the path from source node to destination node, source node would increase the pheromone value from that route entry using the increment function:

$$P_n = P - 0.1*P \tag{2}$$

P_n= new deposition pheromone value.

P= pheromone value calculated using Equation (1)

The established path does not maintain their initial pheromone values forever. All pheromone values in routing table decrease over time. As the pheromone entry decreased until reaches a minimum threshold value it's considered stale route and will be discarded from the routing table. The benefit is to remove any unused routes that will consume memory space. The evaporation function is calculated by:

$$P_n = P - 0.8*P\ldots\ldots\ldots\ldots\ldots\ldots \ldots\ldots\ldots\ldots \tag{3}$$

P_n is the new evaporation pheromone value.

P is pheromone value calculated using Equation (1)

Since the size of the network can by increased dynamically, a strategy needed for gain efficient distribution of forward ants to allow spreading of forward ants to each node without adding high overhead or excessive flooding as in AODV protocol. In intelligent Ant Sense protocol, forward ant is flooded taking a new routing decision at each intermediate node and sends depends on hop count [7].

When no route information available, route setup calculation initialed. Forward ant broadcasted hop by hop depending on hop count, if forward hop count exceed the max hop or forward ant received by destination, the forward packet dropped after built backward ant, if forward ant hop count is max hop and arrived node not a destination, the max hop count increased until forward ant delivered by the destination as shown in Figure 3.5.This strategy is known as ring search model [7].The benefits of this strategy are to reduce flooding and extra overhead controlled by number of hops, during that the forward ants hop increased, the route table will updated to the new maximum hop account with new pheromone value which allows immediately increasing searching scale [7].

To quick the process of the route discovery and reduce flooding, Intelligent Ant Sense adopts third party reply model. Any visited intermediate nodes that have a route in its routing table to the same destination can generate backward ant as a route reply. There is no need for the forward ants to continue traveling in search for destination [8].

Intelligent Ant Sense ensures that the routing paths are free from loops. For each node visited by the forward ant, the node's unique address would be appended to the ant stack. Nodes receiving the forward with same address would make sure it has never seen this particular agent before, by checking whether its own address is appended to the ant stack before or not. If node's address is found, forward ant will be discarded. For Intelligent Ant Sense, ants establish multipath routed to same destination .This strategy is useful to have access to many alternate routes to avoid the need of initiation a new route discovery when a current route is broken.

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III. SYSTEM MODEL

The simulation methodology that we have used to simulate ad-hoc network is Network Simulator- 2 (ns-2.34 version). The Distributed Coordination Function of IEEE 802.15.4 for wireless PANs is used as the MAC layer protocol. Traffic and mobility model based on Continuous bit rate (CBR) traffic sources are used. Only 70 bytes data packets are used. The numbers of traffics used were three between Sources 19, 10 and 3 to Destinations 6, 4 and 2 .The mobility models uses the random waypoint model in a rectangular field. The field configurations used is: 50m x 50 m field with two scenarios 15 and 25 nodes. The pause time, which affects the relative speeds of the mobiles, is also varied. Simulations are running for 100 simulated seconds.

The following four important performance metrics are considered for evaluation of these two on demand routing protocols [9, 10]:

- Throughput = $\sum \frac{\text{Number of all packets delivered}}{\text{Receiving time interval length}}$

- PDR= $\frac{\sum \text{Number of all packets received}}{\text{Number of all packets sent}} * 100$

- Data Loss = Σ Number of dropped data packets at all nodes

- End to End Delay =$\sum \frac{E}{\text{Number of packets delivered}}$

E: time when packet was sent by the source-time when packet was received at destination.

- Routing Overhead = Σ Number of routing packets sent

IV. SIMULATION SCENARIOS

The simulation parameters which have been considered for doing the performance comparison of two on-demand routing protocols are given in Table 1 below.

TABEL 1 SIMULATION ENVIROMENT

Network Environment	Scenarios
Area Size	50m * 50m
Propagation Model	Two Ray Ground
MAC Protocol	IEEE 802.15.4
Traffic Protocol	CBR
Routing Protocol	INTANTSENSE , AODV
Mobile Nodes	15, 25 nodes
Pause Time (sec)	2 ,15 , 30 ,45 , 60 , 75 , 90
Communication Range	15 m

A. First Scenarios

A pause time scenario of 15 nodes for the two protocols Intelligent Ant Sense and AODV was simulated under several pause times from 2 sec to 90 sec with total simulation time of 100 sec.The performance analysis graphics were obtained by the following metrics.

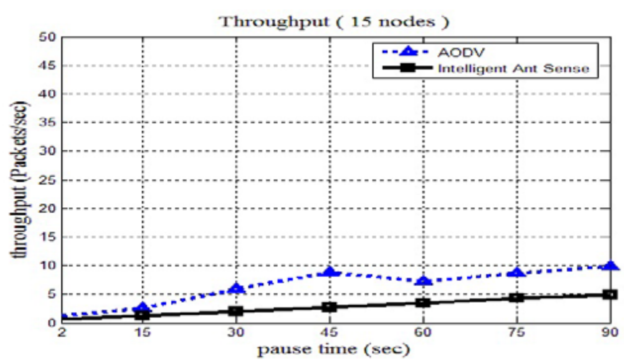

Figure A.1 15 nodes throughput performances

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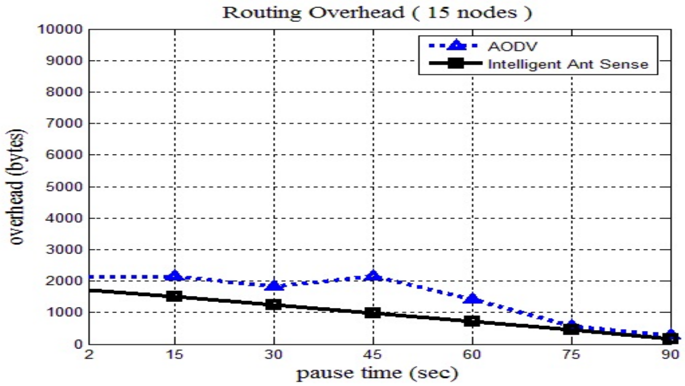

Figure A.2 15 nodes overhead performances

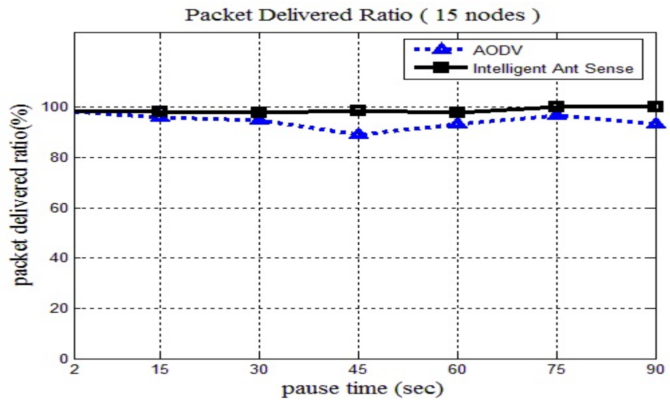

Figure A.3 15 nodes PDR performances

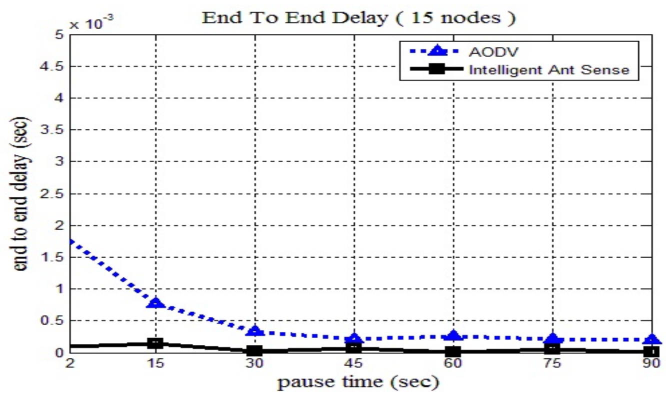

Figure A.4 15 nodes end delay performances

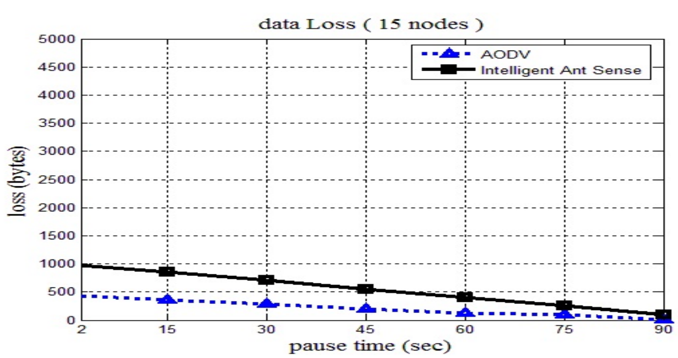

Figure A.5 15 nodes loss performances

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B. Second Scenario

A pause time scenario of 25 nodes for the two protocols Intelligent Ant Sense and AODV was simulated as the same like 15 nodes pause time scenario under the same conditions and same simulation times. The performance analysis graphics were obtained by the following metrics.

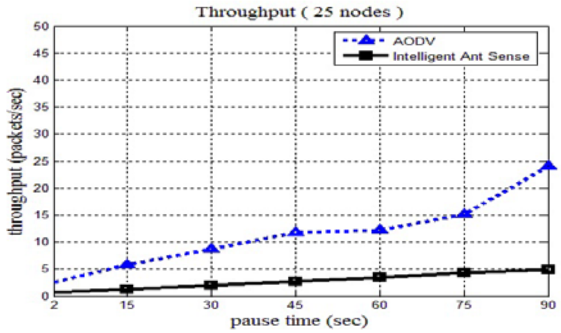

Figure B.1 25 nodes throughput performances

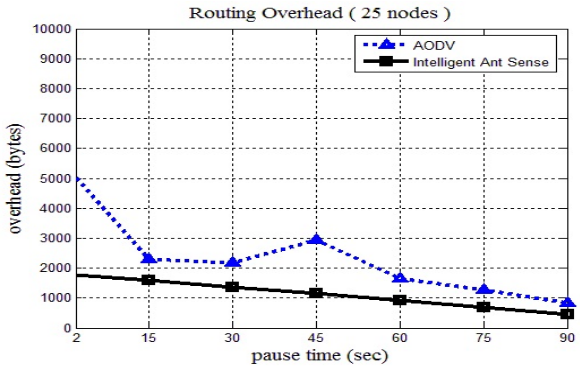

Figure B.2 25 nodes overhead performances

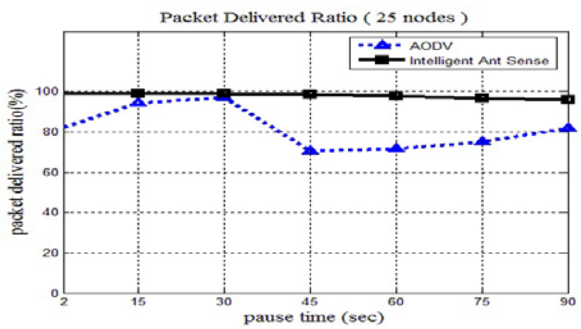

Figure B.3 25 nodes PDR performances

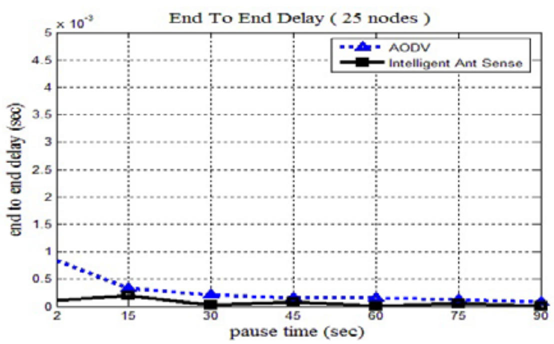

Figure B.4 25 nodes end delay performances

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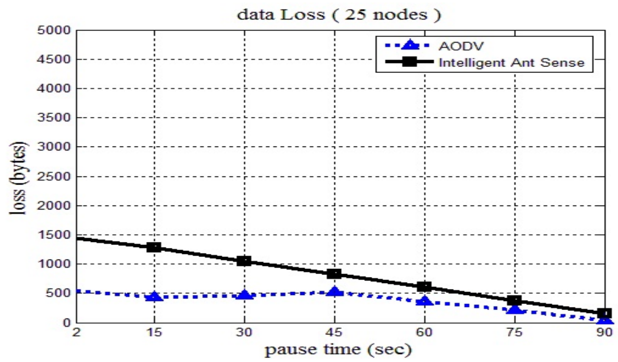

Figure B.5 25 nodes loss performances

V. RESULTS AND DISCUSSION

As illustrated in Figure A.1 the throughput comparison shows that the two algorithms performance margins are very close in high motilities. The two algorithms show almost a similar low level of initial throughput because of high movement of nodes in the network make the link between the Sources and Destinations suffer from many breakes and leads to low packets recivered by the nodes for both protocols. At low mobility, Intelligent Ant Sense gives a lower throughput than AODV, becouse due to route updating for active links many times to ensure shortest path and the sent packets buffered until the new link updated, this will make a low throughput of packets if the packets take a long time buffered in the sending nodes, for overhead as shown in Figure A.2. Overhead of both protocols is closed together at low mobililites becouse of stable path that not suffered from frequent like failure due to high mobility. Overhead of AODV algorithm increases as the network becomes more mobile. This is because the frequent link failure which requires new route discover by flooding the network by new route request packets and due to use the hello message update in AODV. Intelligent Ant Sense ensures lower routing overhead compared with AODV even in low mobility that is because it uses a good adapting routing discovery and maintenance. For Packet delivered ratio as shown in Figure A.3 both protocol ensure a close packet delivered ratio. An intelligent Ant Sense protocol has a ratio of 100 % packet delivered ratio (PDR) at low mobilities when the nodes are static and 98% at high mobilities. AODV have a sligthly small packet delivered ratio than Intellignet ant sense with 98% PDR. Even that the intelligent antsense have a low throughput becouse of buffering the packets sends due to many changes between available routes but it kept max packet delivered ratio becouse of use multipath stratery to ensure that all sent packets were recivered by sink due to simulation time. As shown in Figure A.4 Intelligent Ant Sense has a lower end to end delay in low mobilities. Even in high mobilities, the end to end delay remains at a stable level, and becomes lower than AODV. Intelligent Ant Sense also ensures low delay because it has an alternate links avaiable from the strategy of periored link phermone values make it quikly discover a new route when failure is occurred. And another reason is using the third party reply which helps to reduce the time of route discovery by reply the nodes that already have a route to destination. In Figure A.5 the number of dropped data for Intelligent Ant Sense is observed to be higher than that of AODV. Intelligent Ant Sense shows a more frequent event of dropped data throughout the simulation period at high nobilities that is because many times of link updating due to the nodes moves from place to another one.

VI. CONCLUSION

Through the performance analysis conducted in the previous chapter, Intelligent Ant Sense proved better routing performance compared with conventional routing method AODV at personal area network (WPAN). Intelligent Ant Sense shows lower overhead, lower end delay with high packet delivered ratio, but it offers low throughput and slightly high end to end delay. Intelligent Ant Sense ensures reactive approach since the route always adapted and enables inactive nodes to be in sleep mode to save battery energy, and ensure low power consumption when used with IEEE 802.15.4 MAC protocol at personal area networks (WPAN), Adapt rapidly to network changes, Effective route failure handling, Faster route discovery process, accepted packet delivered ratio, Distributed algorithm, Minimized flooding and overhead, Low delay, Loop free and Offers multipath.

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