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Speed Performance of Intelligent Ant Sense Routing Protocol for Mobile Ad-Hoc Personal Area Network

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***Abstract*– Now days the Mobile Ad-Hoc Networks (MANET) become an important field in the wireless area for user applications. Due to its dynamic nature of this networks the main problem is how to design an effective routing algorithm that can adapt its behavior to frequent and rapid changes in the network due to high speed of each mobile in the network. The paper presents a new idea for MANET routing enhancement named an Intelligent Ant Sense (INTANTSENSE) routing protocol based on ant colony optimization. It utilizes a collection of mobile agents to perform optimal routing activities. The idea of this routing protocol is based on capability of reactive routing with distributed and multipath routing mechanism with utilizing the benefits of pheromones concept of ants in its nature to perform optimal path, fast route discovery and effective Sense routing failure handling. Intelligent Ant Sense Routing Protocol (INTANTSENSE) compared with AODV protocol using network simulator-2.34 (NS-2.34) in case of different speeds to show the performance of Intelligent Ant Sense routing protocol in dynamic network with many cases of speeds and two cases number of nodes.**

***Index Terms*– MANET, AODV, INTANTSENSE, Ring Search Model, Speed and NS-2.34**

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 a dynamic network with high speed. 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. REACTIVE ROUTING PROTOCOLS

Routing in mobile ad-hoc network is used to provide route the packets from source to destination in a proper way [2]. Reactive routing protocols only building a route when there is a need for it if no traffic required then no rout established. The goal of a reactive protocol is to reduce the control traffic overhead in proactive protocols in which route established always even that there is no need route 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 with Intelligent Ant Sense protocols is AODV routing protocols.

A. AODV

Ad hoc On-demand Distance Vector (AODV) is a reactive 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 known as an Intelligent Ant Sense, and it depends on pheromone value which is used to control 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).

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

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:

$$Pn = P - 0.1 * P \qquad (2)$$

Pn= 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:

$$Pn = P - 0.8 * P \qquad (3)$$

Pn 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. 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.

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

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

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

- 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:

Table 1: Simulation Environments

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
Speeds	1.5 , 2.5 , 3.5 , 4.5 , 5.5 ,6.5 m/s
Communication Range	15 m

A. First Scenarios

A speed scenario of 15 nodes for the two protocols Intelligent Ant Sense and AODV was simulated under several speeds from 1.5 sec to 6.5 m/s with total simulation time of 100 sec.The performance analysis graphics were obtained by the following metrics.

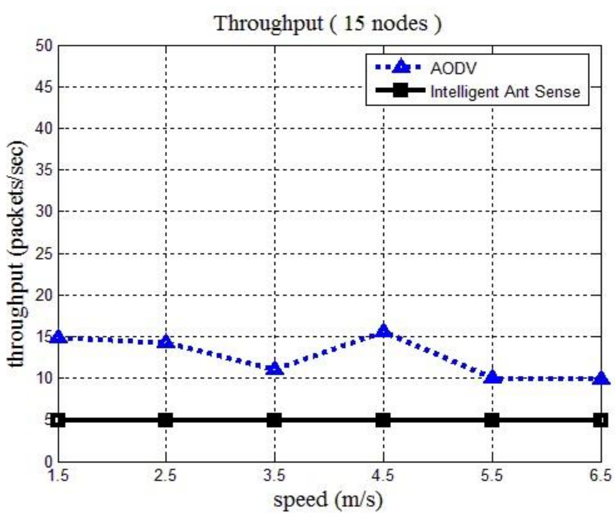

Fig. 1: 15 nodes throughput performances

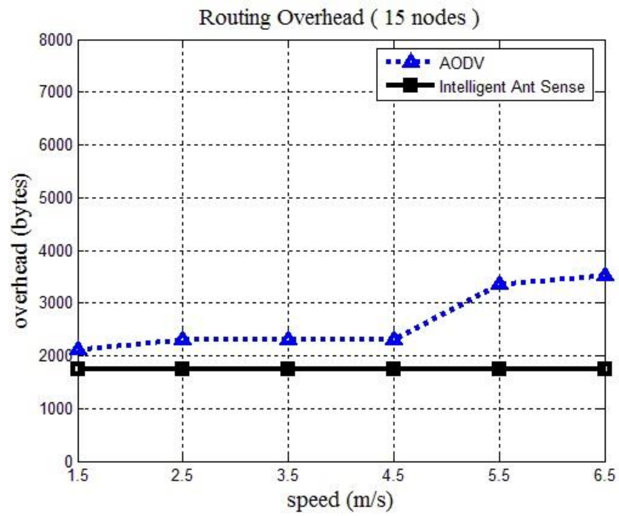

Fig. 2: 15 nodes overhead performances

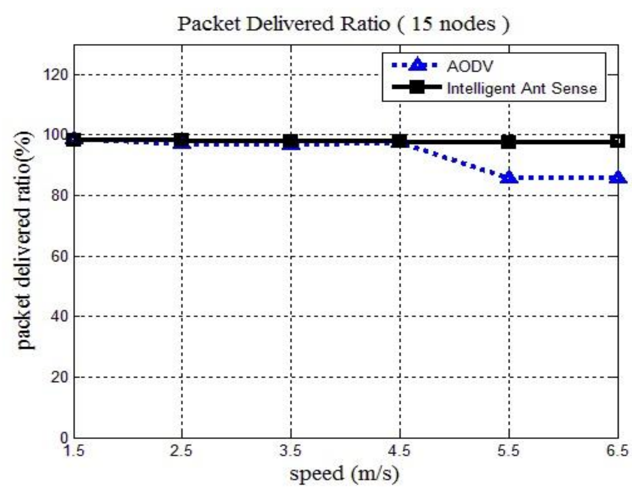

Fig. 3: 15 nodes PDR performances

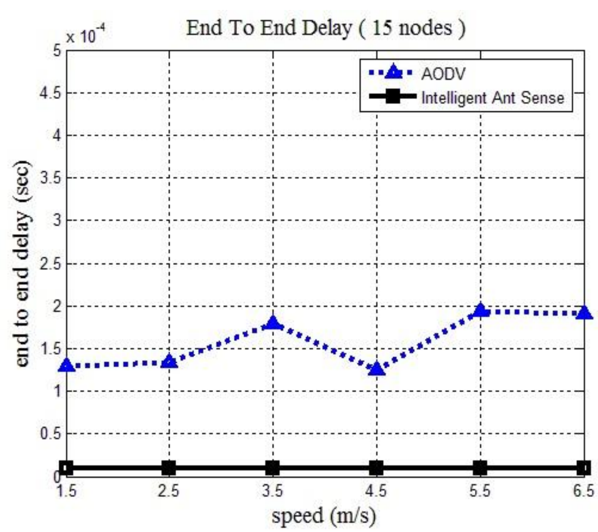

Fig. 4: 15 nodes end delay performances

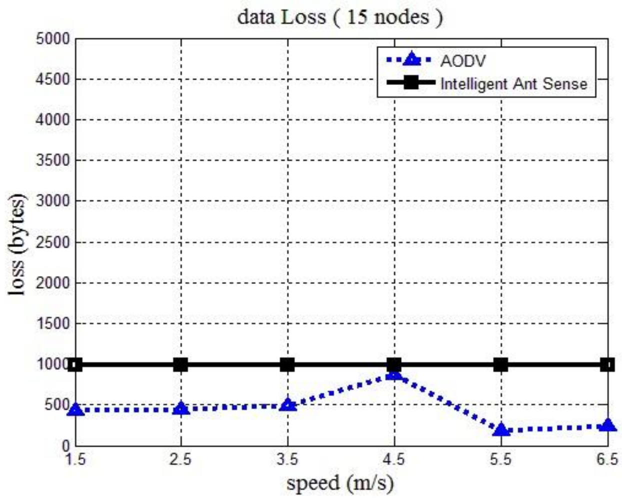

Fig. 5: 15 nodes loss performances

B. Second Scenario

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

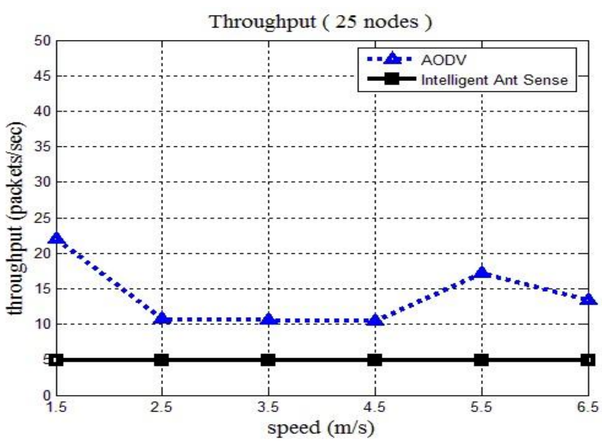

Fig. 6: 25 nodes throughput performances

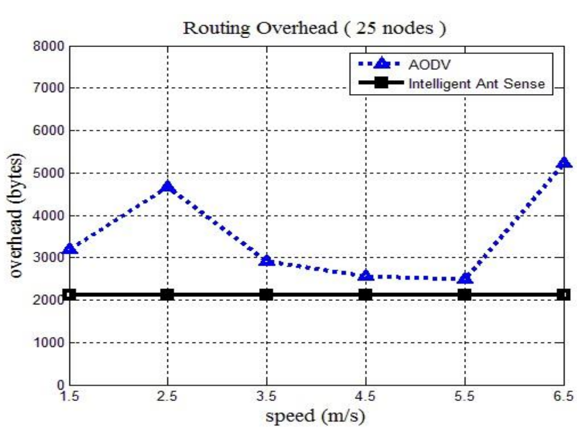

Fig. 7: 25 nodes overhead performances

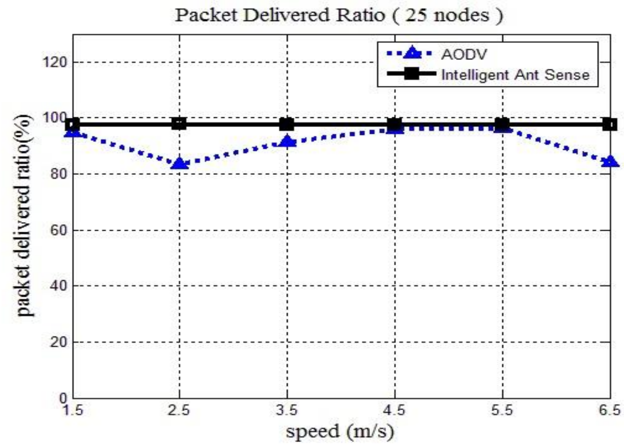

Fig. 8: 25 nodes PDR performances

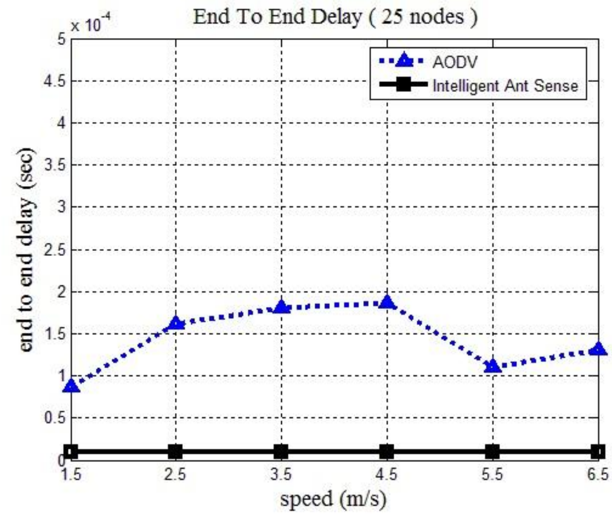

Fig. 9: 25 nodes end delay performances

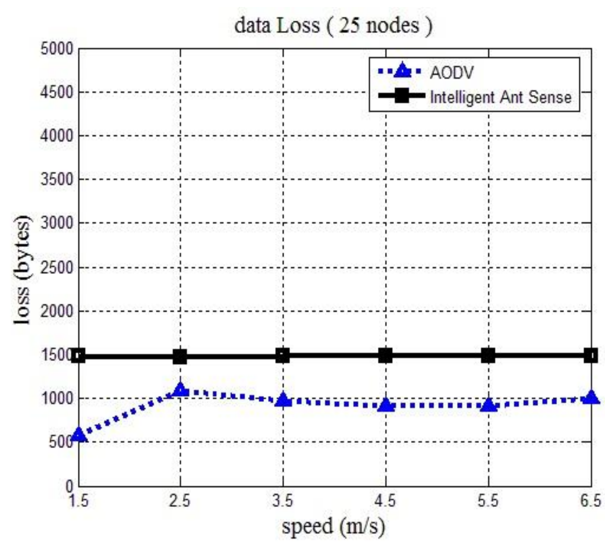

Fig. 10: 25 nodes loss performances

V. RESULTS AND DISCUSSION

As illustrated in Fig. 1 and Fig. 6 AODV gives a higher throughput than Intelligent Ant Sense in low and high speeds, the Intelligent ant sense suffer from the mobility of nodes with all speeds because of the updating the active routes many times due to pheromone value to ensure the shortest path.

This strategy leads to receive low data packets by each node when compared to AODV. AODV does not update its route due to mobility of nodes, it kept a higher throughput, but this throughput will be reduced if the speed of the mobile nodes was increased because of low data delivered at each node due to link breaking during high speeds. In case of 15 nodes the throughput remains lower than 25 nodes because increasing in number of nodes with increase the throughput in the network in AODV but has the same value for Intelligent Ant sense.

For overhead as shown in Fig. 2 and Fig. 7 AODV have a high overhead than intelligent ant sense in low and high speeds too. The overhead of the AODV algorithm increases as the speeds of the moving nodes increased specially in 15 node scenario. The increasing of overhead is due to high speeds because of increasing the speeds of moving nodes leads to many link failure and more flooding network to discover a new route.

Intelligent Ant Sense demonstrates a lowest routing overhead compares to AODV with all speeds in 15 and 25 nodes scenarios, and gives a stable overhead at low and high speeds. This good performance obtained from the efficient route discovery and availability of alternates active route in the Intelligent Ant sense protocol which reduce the control overhead in the network. As observed that AODV has higher overhead in 25 nodes scenario than Intelligent Ant Sense when compared with 15 nodes scenario which remains close overhead for both protocols in low speeds that because a few number of nodes gives low overhead .

For Packet delivered ratio as shown in Fig. 3 and Fig. 8 both protocols AODV and Intelligent Ant Sense ensure a high packet delivered ratio in low speeds and slightly low packet delivered ratio when the speed was increased in 15 and 25 nodes scenarios. Intelligent Ant Sense ensures a 99% packet delivered ratio (PDR) in low speed and 97% in high speeds. In low and high speeds the tested algorithms show a perfect packet delivered ratio (PDR) of Intelligent Ant Sense than AODV. AODV have the same 99% packet delivered ratio like Intelligent Ant Sense in low speeds, but will reduce to 84% than Intelligent Ant sense because of poor route maintenance due to the link failure at high speeds of active nodes or due to the other purposes such as one of active nodes becomes not active (power off) . Intelligent Ant Sense ensures a good Packets delivered ratio because of a good route updating and availability of other routes due to the pheromone process.

As shown in Fig. 4 and Fig. 9 Intelligent Ant Sense has a lower end to end delay in low speeds. Even in high speeds, the end to end delay remains at a stable level, lower than AODV in both scenarios 15 and 25 nodes. AODV ensure low end to end delay at low speeds but gives high delay at high speeds that because of many times route suffer from breaks due to mobility of nodes with high speed, this high speed leads to a long time taken to discover a route when the link was failed many times frequently.

The Intelligent Ant Sense gives low delay because it have an alternate links available from the strategy of periored link pheromone values make it quickly discover a new route when failed is occurred. And another reason is using the third party reply which help to reduce the time of route discovery by reply the nodes that were already have a route to destination.

In Fig. 5 and Fig. 10 show that the number of dropped data packets for Intelligent Ant Sense is observed to be higher than that of AODV in 15 nodes and even in 25 nodes scenario. Intelligent Ant Sense shows stable dropped data throughout the simulation period at low and high speeds, that because of many times of link updating due to the nodes moves from place to another one. As motioned that the Intelligent Ant Sense update all active link periodically and make changes between routes depending on pheromone value priority , due to this updating the Intelligent Ant Sense suffered from speeds of nodes, because due to nodes movement, the route was alternated between active links depending on the goodness of the link controlled by the pheromone value which make the transmitted data suffered from many breaks lead to drop it, this is because the Intelligent Ant sense always ensure the highest pheromone value of route to ensure shortest route.

VI. CONCLUSION

Through the performance analysis conducted in the previous sections, Intelligent Ant Sense proved better routing performance compared with conventional routing method AODV at personal area network (WPAN) in case of packet delivered ratio, end to end delay and overhead. Intelligent Ant Sense shows lower overhead, lower end delay with high packet delivered ratio, but it offers low throughput and slightly high packet loss. Intelligent Ant Sense ensures reactive approach since the route always adapted and enables inactive nodes to be in sleep mode 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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