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Improving the Performance of Antnet Protocol using Performance Measures Modeling in Mobile Ad Hoc Networks

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Abstract: ***A mobile ad hoc network (MANET) forms self-autonomous networks which mean nodes are communicated without the aid of any access point. This network forms an ad hoc (provisional) network which is node are random moves in the simulation area. AntNet is a bio-inspired routing protocol based on real Ant behaviour. Nowadays, Swarm Intelligence (SI) techniques are widely used in various domains. In mobility, nodes are taken seldom position and moving randomly. In this work, we have used standard mobility models like Random Way Point (RWP) model. Also, AntNet routing protocol has been used with well-known wireless routing protocols such as Ad-hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR). The Performance measures modeling (PMM) used to increase the QoS (Quality of Service) results. Therefore, the performance results of the proposed AntNet-PMM model revealed that better results when compared with other models. The Simulation work was made in Network Simulator (NS2). The obtained NS2 output will be given input to Curve fitting tool in MATLAB. In this work, Packet Delivery Ratio (PDR), Average Delay and Throughput are considered as QoS parameters. Moreover, curve fitting expressions are used to enhance better accuracy such as polynomial expression, rational expression, and power expression.***

Keywords: PMM; AntNet; Mobility; Routing Protocol.

I. INTRODUCTION

In recent days, wireless networks are one of the growing fields in networking. MANET is configured as an infrastructure-less network i.e., mobile nodes (MN) are connected directly without base station while in a cellular network is configured as an infrastructure-based network i.e., MNs are connected through the base station. The main advantage of this decentralized network is that robust than centralized network due to due to the multi-hop manner. However, the chance of single node failure in MANETs the data can take multiple paths. The drawback of this network is high mobility i.e., one location to another location, due to high mobility the data transmission met high packet loss and delay. This network can be used in various applications such as the defence side, emergency rescue operations, and robots etc.,

The PMM model is a mathematical form to assess the metrics of the wireless network. This model gives better results than other simulation metrics results. In this paper used some mathematical expressions namely Rational, Power and Polynomial Expressions to increase the MANET metrics.

A. Contributions

- AntNet-PMM model is proposed to increase the network performances.
- Existing authors examined only limited mobility models, here we have used three mobility models such as RWP, RD and RW models.
- Used two on-Demand routing protocols.

The review of work explained in section 2. An overview of mobility models and reactive routing protocols were explained in section 3. Section 4 addressed the shortest path problem in Dynamic topology using the AntNet algorithm. The simulation work and experimental results discussion has been explained in section 5. Conclusion and future direction of the work are discussed in section 6.

II. RELATED WORKS

Table 1 explains the review of work and various authors proposed their works.

Table- I: Review of works

Sno	Year	Author's name	Techniques	Drawbacks
1	2004	Vikrant Saigal et al., [1]	Load Balancing routing	DSR does not consider the load condition in route setup
2	2005	Mohammad Shahidul Hasan et al., [2]	Network Control System	Packet delay and Packet Drop
3	2009	Chenn-Jung Huang et al., [3]	Particle Swarm Optimization	-
4	2010	Michael Meisel et al., [4]	Social Insect wired AntNet Routing	Review the Biological routing algorithm
5	2011	Binod Kumar Pattanayak et al., [5]	Power-aware AODV	Considered only reactive routing algorithm
6	2011	Jyoti Jain at al., [6]	Ant Colony Algorithm	No routing protocols were evaluated and compared

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7	2012	Pankaj Sharma and Ashok Kumar Sinha [7]	Performance measures modelling	Single reactive protocol
8	2014	Gurpreet Singh et al., [8]	An Innovative ACO	Not compared with any existing protocol
9	2014	B. Nancharaiah and B. Chandra Mohan [9]	Hybrid Routing Protocol PSO with ACO	Considered only two NAMET Parameters
10	2016	V.V. Mandhare et al., [10]	QoS routing enhancement using metaheuristic approaches	A single metric is considered for route determination

III. OVERVIEW OF ROUTING PROTOCOLS

A. Ad hoc routing protocols

In MANET [11], nodes are keeps on moving from one position to another position in a real-world scenario. It was a tedious process to design an effective protocol for a protocol in MANET and it was an active study region. Several protocols were proposed for routing and widely classified as table-driven and on-demand protocols. Mobile nodes update their routing information periodically between themselves in table-driven protocols. The drawback of a proactive routing protocol is generating a large number of control messages due to exchanging information periodically [12].

B. The AODV protocol

AODV [12] is a reactive protocol that involves the creation of paths when requested. It has the discovery of the path and maintenance of the path. Normally, each routing protocol has these 2 stages, but each protocol has its own way of sending and receiving packets. The route discovery comprises of route request and route reply. The request for the path can be made by broadcasting, i.e. node sends a request to its neighbouring nodes until the destination is reached. The response to the route is unicast because once the target reaches the shortest distance instead of just sending it to the shortest path. If a node wishes to send requests to another node, first check the routeing table if the path is accessible to continue broadcasting otherwise initiates the request for the route. The aid of the sequence ID is to identify the freshness of a route. Fig. 1 describes that the route request format of the AODV routing protocol.

S_node addr	Rq_id	S_node (Seq_no)	D_node addr	D_node (Seq_no)	H_ct

Fig. 1.AODV header format (RReq)

C. The DSR protocol

The route request format of DSR [12] is different from the AODV protocol. Also, it has 2 major mechanisms such as route discovery (RREP) and route maintenance (RREP) and one more additional feature is route error (RERR). In DSR, the source node contains a sequence of neighbourhood nodes ID which is an aid to find the destination node. AODV [13] uses a forward learning method to find a source node whereas DSR doesn't use. The target node (D_node) gets a route request packet from the S_node, through the reverse path already stored in the RReq_header, sends an RRply message to the corresponding source node. The advantage of DSR protocol is low latency. The limitation of DSR protocol is route overhead problem because of entire path information sent along with data packets. Also, an expired path information stored in the cache is may affect the overall network performances [13]. Fig. 2 describes the route request format of the DSR routing protocol.

Req_id	D_node (IP_ad)	D_node (Seq_no)	S_node addr	S_node (Seq_no)	H_ct

Fig. 2.DSR header format (RReq)

IV. ANTNET-PMM MODEL

A. AntNet algorithm

An antnet routing protocol is inspired by the real behaviour of ants. This is the first swarm intelligence routing protocol that developed for finding the optimal route in the middle of the source (S_node) and target nodes (D_node). In this work, took simulation results of Ant net, AODV and DSR apply path measures modelling techniques. Swarm intelligence is a promising area to solve optimization problems in the field of research. Most of the authors have concentrate to solve real-time problems like shortest path and optimizing bandwidth with the help of swarm intelligence techniques. This work presents an Ant net routing algorithm described based on ant swarm [14].

There are two kinds of the agent in an AntNet algorithm, such as backward and forward ants. The behaviour forward ant uses the collection of topology status data from a S_node to a group of D_node. The information and updates of the routing table handle by backward ant [15]. An ant colony algorithm, following a repetitive process to give better solutions to a problem [16]. The central parts of this technique are

1. To generate a new population solution to the given problem, use artificial agents called ants.
2. To create better future solutions use the information collected during the past.

An AntNet algorithm can be described in the following steps. The antnet algorithm has been described by individual ants perception model [16]. The described AntNet algorithm is not original to authors took from [16].

//AntNet Pseudo code

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Input: Available paths from S_Node to D_Node
Output: Shortest route using AntNet

Step1. Phase I start: Initialize node properties ()
Fixing node size () // total nodes
Creation of a mobility model using bonnmotion ()
Fix initial position of node ()
Step2. Phase I end.
Step3. Phase II: start main ()
t = C_Time;
t_{end} = Simulation Duration length;
δt = Time interval between ant node generations
for each (Node)
M = Local traffic model;
T = routing table;
While (t <= t_{end})
If (t mod δt = 0)
D_Node = Select Destination node (Data_traffic_distribution);
Forward ant (S_Node, D_Node);
Backward Ant (S_Node, D_Node, St_Data);
End if
End foreach
Step 4. Phase II end main()

B. PMM model

After completion of the AntNet algorithm, the resultant output is shown in table 2. This table describes the performance measure of Delay, PDR, and Routing overhead.

Table- II: Reactive protocol performance measures model

DSR performance measures model			
Pause Time	**Delay**	**Throughput**	**PDR (%)**
10.00	0.735	0.909	0.974
20.00	0.773	0.857	0.936
30.00	0.594	0.878	0.819
40.00	0.951	0.791	0.829
50.00	0.731	0.556	0.9005
AODV performance measures model			
Pause Time	**Delay**	**Throughput**	**PDR (%)**
10.00	0.529	0.945	0.927
20.00	0.986	0.694	0.94
30.00	0.605	0.8774	0.722
40.00	1	0.79	0.737
50.00	0.739	0.56	0.89
AntNet performance measures model			
Pause Time	**Delay**	**Throughput**	**PDR (%)**
10.00	0.545	1	1
20.00	0.706	0.9145	0.96
30.00	0.729	0.763	0.878
40.00	0.861	0.832	0.898
50.00	0.727	0.636	0.989

PMM model [7] is a mathematical model to increase the performance of delay, throughput and PDR with help of curve fitting tool in MATLAB. The simulation results shown in table2,3 and 4 will be used as data set in a curve fitting tool. In this experiment and scenarios, used three expressions namely polynomial expression, power expression and rational expression consider as fitting type. To find out Root means square rate (RMSE) and error rate (ER) to attaining best results. Also, used some constant values and set the different default values of different constant values which can be used by expressions. If the R-square value is near to 1.0 that expressions give a minimum error rate. Three types of curve fitting expression are used which are defined by equation (1), equation (2) and equation (3).

$$f(x) = (pole1*x^7 + pole\ 2*x^6 + pole\ 3*x^5 + pole\ 4*x^4 + pole\ 5*x^3 + pole\ 6*x^2 + pole\ 7*x^1 + pole\ 8) \quad (1)$$

$$f(x) = (powe1*x^5 + powe\ 2*x^4 + powe\ 3*x^3 + powe\ 4*x^2 + powe\ 5*x + powe\ 6)/(x^3 + q1*x^2 + q2*x + q3) \quad (2)$$

$$f(x)=(a*x^b+c) \quad (3)$$

V. SIMULATION ENVIRONMENT AND SETUP

In this section [9], we analyze and study in-depth of AntNet protocol and we evaluate its performance. The Network Simulator (NS2) [17] has been used to develop an AntNet protocol and carry out the simulation works. The simulation outcome demonstrates that under varying pause time, the PMM model increases the efficiency of routing protocols: AODV, DSR, and AntNet. The given table 3 explains the simulation parameter and its corresponding values such as total nodes, pause time variations, simulation area (in metres) [1]. The simulation atmosphere is a 500 * 500 m, the 50 number of nodes were used in this simulation work. The simulation start time and end time is 05.0s and 250.0s. The pause time of this simulation is variants of 10 to 50 ms and a propagation model is two ray ground models [8, 18]. As shown in Table 3 describes varies simulation parameters and configuration setup is listed.

Table- III: Simulation parameter values

Parameters	Values
Simulation initiate time	05.0s
Simulation ending time	250.0s
Propagation model	Two ray Ground
Channel type	Wireless
Routing protocols	DSR, AODV and AntNet
Mobility model	RWP
Variation of pause time	10, 20, 30, 40 and 50
Total no.of nodes	50
Total no.of connections	5
Network type	Wireless
MAC type	802.11

A. Simulation metrics

In this section, three simulation metrics were used to identify the performance outcomes. The metrics termed as throughput, PDR and Delay. The PMM model gains higher accuracy than normal simulation values. This work compared with DSR, AODV and AntNet respectively.

- ***Throughput***

  In this connection network, throughput is the successfully amount of data sent to the receiver over total simulation time and equation 4 is used to calculate the throughput of the path. Throughput is calculated using awk scripts which process the trace file and produce the results. Fig 4 shows the results of throughput along with variants of pause time.

  Throughput = Number of packets sent successfully / total simulation time (4)

- ***Delay***

  Delay is calculated using awk scripts which process the trace file and produce the results. Fig 3 shows the

  results of delay along with variants of pause time and Equation 5 is used to calculate the delay of the path.

  Delay = Time spent on hop1 + ……+ time spent on hop n (5)

- ***PDR***

  In this communication network, PDR is calculated using AWK scripts which process the trace file and produce the results. It is the measure of successfully delivered packets to the destination node. Fig 5 shows the results of PDR along with variants of pause time and Equation 6 is used to calculate the PDR of the path.

  *PDR = (Number of packets sent – packet lost) * 100) / Number of packets send* (6)

B. Results of the overall simulation

Table 6 shows that the overall simulation outcome of routing protocols along with PMM model. Tables 5 show the results of routing protocol without PMM model. The PMM model increases the result of simulation outcome, using three curve fitting expressions. The RWP mobility model is created with the aid of Bonnmotion with various parameters. As mentioned below, the AntNet algorithm is compared with existing well-known path finding protocols such as AODV and DSR protocols. The AntNet-PMM model attains the better result as we expected than other routing protocol when the Delay, PDR and throughput are used as simulation metrics.

Table- IV: Overall performance comparison of routing protocols based on PMM model

Pause Time (ms)	Routing Protocols		
	AODV-PMM		
	Delay (ms)	Throughput (kbps)	PDR
10.00	0.429	0.974	0.942
20.00	0.742	0.747	0.95
30.00	0.574	0.874	0.794
40.00	0.724	0.826	0.781
50.00	0.604	0.594	0.927
DSR-PMM			
Pause Time (ms)	Delay (ms)	Throughput (kbps)	PDR
10.00	0.684	0.924	0.984
20.00	0.692	0.874	0.924
30.00	0.557	0.882	0.871
40.00	0.758	0.801	0.854
50.00	0.682	0.604	0.934
ANTNET-PMM			
Pause Time (ms)	Delay (ms)	Throughput (kbps)	PDR
10.00	0.502	1	1
20.00	0.702	0.942	0.97
30.00	0.624	0.793	0.884
40.00	0.741	0.874	0.872
50.00	0.604	0.706	0.9897

Delay is defined based on packet arrival variations in a given simulation study. Fig. 3 shows that the delay variations under different pause time. Furthermore, in these PMM model, when the pause time is 10 and 30 the delay of packets are less compare to 20, 40 and 50 respectively by considering performance measures method. Therefore, AntNet based PMM gives fewer delay variations than other methods like AODV and DSR.

Fig. 4 describes the reactive routing protocol performance under variants of pause time: 10, 20, 30, 40 and 50 in ms. In general, the DSR protocol gives better results than the AODV protocol because it is a multi-hop disciplinary protocol. The default DSR performance results mentioned in Table 4 after applying the PMM model the performance results increased as well as AntNet and AODV protocols mentioned in Table 4. When the pause time is 10, the throughput of the packet is higher than other variants of pause time and less number of packets dropped during pause time 40 and 50.

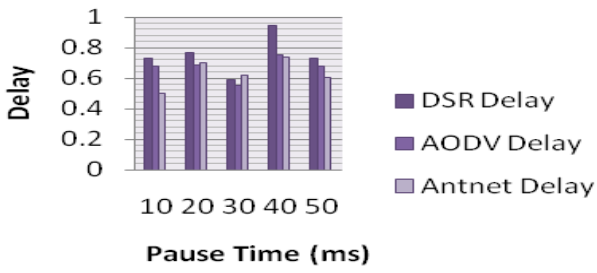

Fig. 3.PMM-Delay variations under pause time

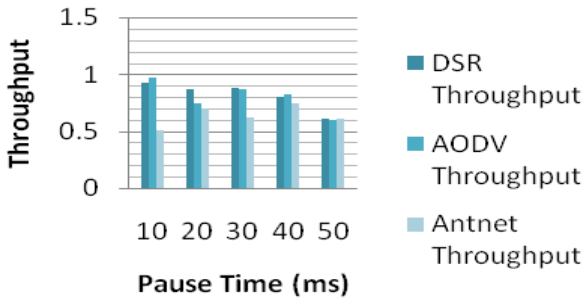

Fig. 4.PMM-Throughput variations under pause time

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Fig. 5 describes the reactive routing protocol performance under variants of pause time: 10, 20, 30, 40 and 50 in ms. In general, AODV protocol performance results mentioned in Table 4 after applying the PMM model the performance results increased respectively. When the pause time is 10, the delivery ratio of the packet is higher than other variants of pause time.

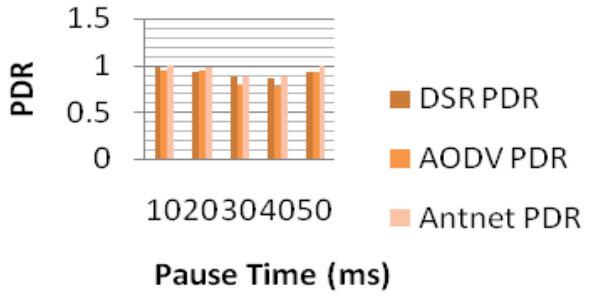

Fig. 5.PMM-PDR variations under pause time

VI. CONCLUSION

Eventually, AntNet-PMM model has been used to increase the performances. This work addresses the problems of routing and mobility models. Furthermore, the PMM model is used to increase routing protocol performances. The simulation experiments are validated and its average PDR achieved accuracy is 99.7 %. We compared the other two existing routing protocols with the proposed model. Finally, the proposed AntNet-PMM model gives better results than the other two models such as DSR-PMM and AODV-PMM. In the future, we will include other routing protocols and mobility models. Although, to increase the number of nodes because in this work we have considered only less number of nodes. Furthermore, other bio-inspired algorithms like Particle Swarm Optimization and Fire-fly optimization will be tested. A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

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