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Optimum Route Selection using Improved FF-AOMDV to Increase Network Lifetime in MANET

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***Abstract*– Mobile Ad Hoc Network (MANET) is a collection of wireless mobile nodes that dynamically form a temporary network without the reliance on any infrastructure or central administration. Energy consumption is considered as one of the major limitations in MANET, as the mobile nodes do not possess permanent power supply and have to rely on batteries, thus reducing network lifetime as batteries get exhausted very quickly as nodes move and change their positions rapidly across MANET. The researches performed till date highlights this very specific disadvantage of energy consumption in MANETs and by applying the protocol named Ad-hoc on Demand Multipath Distance Vector with the Fitness perform (FF-AOMDV) and dragonfly topology to reduced it. The fitness function is employed to find the best path from the availability to the destination to scale back the energy consumption in multipath routing by using dragonfly topology. The performance of the planned FF-AOMDV protocol with sewing needle topology was evaluated using Network simulator Version two (NS-2), wherever the performance was compared with AOMDV and Ad-hoc on Demand Multipath Routing with Life Maximization (AOMR-LM) protocols, the two preferred protocols of this area. In proposed work Implemented FFAOMDV with Dragonfly algorithm and gives improvement of Energy consumption, Network lifetime, Packet Delivery Ratio, Throughput, End to End delay and Routing overhead ratio, which gives percentage of improvement as 10.7, 33.33, 5.9 13.47, 10.86, 8.47 percent respectively with respect to time.**

Keywords: **Mobile Ad-hoc network, multipath routing, fitness function, Dragonfly topology, AOMDV and FF-AOMDV.**

I. INTRODUCTION

Today, wireless networks have been very popular in the computing industry. Wireless networks can be categorized into two classes.Mobile Ad-hoc Networks (MANETs) are assortment of self routing enabled devices that communicate among themselves with none specific network infrastructure. Obviously, these networks are decentralized and believe neighbors for communication [1]. The topology of the networks isn't fixed and is subjected to alter over time because of the mobile nature of the devices.

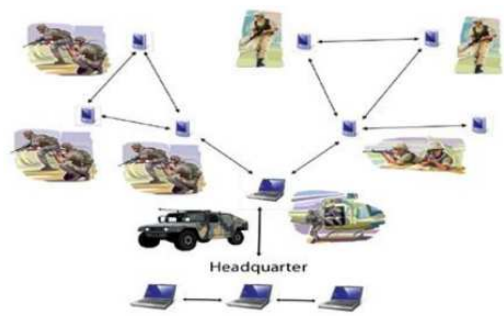

Fig.1.1 MANET architecture and components

The below figure 1.1 represents various mobile nodes general structure for the MANET by considering the military application. Headquarters mobile nodes access the information from other mobile nodes that are located at different positions. Using the routing protocol communications between mobile nodes is done. While working with the wireless networks, the network layer receives most of the researcher's attention. Due to this there are many routing protocols proposed by various authors for MANET with their different aims and objectives by targeting the specific application needs. They communicate with each other by using on peer-to-peer routing Mobile Ad hoc Networks (MANETs). It can be defined as autonomous system of mobile nodes connected with each other via wireless. Every node in MANETs works as a router as well as a host and forwards packets to each other to activate the communication between nodes not directly connected by wireless links. The main challenge on wireless MANETs is a development of dynamic protocols that can efficiently find routes between communication mobile nodes. This type of routing protocol should be able to keep up with the high degree of node mobility that is frequently changed into the network topology. The combination for the quality of the links differs with the use of broadcasting nature of the Wireless channels [2].

The method of routing in energy dependant networks has to meet stability and quality throughout the communication time. Simply, the link stability and flawless communication depends directly over the energy of the devices. Routing protocols are responsible for ensuring energy efficient path discovery and try to reduce energy consumption of the nodes within the network. Major routing protocols minimize energy consumption by choosing minimum hop distance nodes, so as to enhance transmission rates or to reduce delay in transmissions [3]. Recent approaches in energy efficient routing concentrate on choosing specific nodes according to their offered residual energy, by which the protocol technique insured to attain energy efficiency with different limited network performance. Researchers have found several improved solutions for achieving energy efficiency in these decentralized networks. A number of them provide routing with minimum energy utilization and aiding on lifetime maximization. Routing Protocols should uplift and retain network operations for longer time ensuring efficient ways between communicating nodes. Prolonged communication was achieved by minimizing node's energy consumption throughout its active and inactive states. Following are the ways used to achieve energy efficiency in mobile ad-hoc networks [4, 6, 7, 8].

II. METHOD

A. Dragonfly Topology

A novel intelligence optimization technique called Dragonfly Algorithm is used. This topology is basically design best network architecture.

In the traditional AOMDV, it builds multiple paths using RREQs. It does not take into account the energy for choosing the paths. Here the proposed protocol not only considers residual energy but also transmission power of nodes in paths selection to maximize the lifetime of networks.

The proposed system consists of three stages:

- Calculate residual energy in network
- design efficient network
- Calculate energy consumption in route discovery
- Find shortest route with higher residual energy

This algorithm is conscientious for deployment of nodes in an exacting area.

In dragonfly topology no. of network terminals is known as:

$N=a*p(ah+1)$

To steadiness channel load on load-balanced traffic, the network should have $a=2p=2h$. Each of the router topology is based on randomized placement of nodes using node deployment algorithm.

The following symbols are used in our description of the dragonfly topology.

N = number of network terminal.

p = Number of terminals connected to each router.

a = Number of routers in each group.

h = Number of channels within each router used to connect to other groups.

Within the event on route selection once the chosen route fails, the supply node can then select another route from its routing table that represents the shortest route with higher energy level and minimum energy consumption.

B. Fitness Function

The fitness function(FF) is an improved technique that comes as a part of the many optimization algorithmic rules like genetic algorithm, bee colony algorithmic rule, firefly algorithmic rule and particle swarm optimization rule. The fitness finds the most important factor of several factors necessary in the optimization method that counts on the aim of the analysis [9, 10, 11, 12]. In MANETs, the fitness factors are energy, distance, delay, bandwidth etc. This matches the reasons for designing any routing protocol, as they aim to enhance the full utilization of network resources. In this analysis, the fitness function used is Energy consumption in association with a type of Swarm Intelligence(SI) called Dragonfly Algorithm such as Particle Swarm optimization (PSO) rule. It had been used with wireless sensor networks to optimize the choice route in case the first route fails [13][14]. The factors that affect the selection of the optimum route are:

- The remaining energy functions for each node
- The distance functions of the links connecting the neighboring nodes
- Energy consumption of the nodes
- Communication delay of the nodes.

C. FF-AOMDV

In antraditional AOMDV, once a RREQ is broadcasted by a source node, more than one route to the destination are found and the data packets are forwarded through these routes without knowing the routes' quality. By implementing the above explained rule on an analogous scenario, the routes selection is entirely different. Once a RREQ is broadcasted and received, the provision node will have three (3) forms of information to realize the selection of the shortest and optimized route with reduced energy consumption [15][16][17]. This information includes:

- Information about network's each node's energy level
- The distance of every route
- The energy consumed in the process of route discovery.

The route, that consumes less energy, may probably be (a) the route that has the shortest distance; (b) the route with the very best level of energy, or (c) both. The supply node can then send the information packets via the route with highest energy state, to minimize its energy consumption. Unlike of different multipath routing protocols, this protocol also initiates new route discovery method once all routes to the destination are unsuccessful. Within the event once the chosen route fails, the supply node can then select another route from its routing table that represents the shortest route with higher energy level and minimum energy consumption. The best route with less distance to destination can consume less energy [18].

III. RELATED WORK

Many research papers have been studied based on performance evaluation, optimization, sizing techniques, efficiency improvement, and factors affecting system performance, economical and environmental aspects of Energy Efficient Multipath Routing Protocol for Mobile ad-hoc Network using different topologies.In [1] analysis, authors projected a new energy efficient multipath routing

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algorithmic rule referred to as FF-AOMDV (Fitness Function Ad Hoc On Demand Multipath Distance Vector) simulated using NS-2 under 3 completely different situations, variable node speed, packet size and simulation time.In [2] authors use fuzzy logic and a fitness operate as a soft computing technique for planning this projected protocol. The fuzzy logic is essentially wont to calculate fitness price of every route. This fitness price helps to outline the character of the route like that route is efficient with reference to energy. In [3], algorithmic rule supported reinforcement learning was projected that was supported local data. The obtained results illustrated through the figures indicated that reinforcement learning may be a promising conception in MANETs.A wide vary of fields, like business and military applications, use MANETs. Thus, establishing a path from supply to focus on is important to confirm that the information packet delivered meets the QoS needs. However, this paper projected a QoS-routing algorithmic rule applicable in MANETs that satisfies energy and delay constraints.In [7], authors planned an ant colony-based energy control routing protocol PSO-ACECR and evaluated the affect of various quality models to the performance of PSO-ACECR (ant colony-based energy control routing) in MANETs. In PSO-ACECR, the routing protocol can notice the higher route that has a lot of energy than different routes through the analysis of average energy and also the minimum energy of methods.

IV. PROPOSED METHODOLOGY

This paper proposed a new multipath routing protocol called the FF-AOMDV routing protocol with Dragonfly topology, which is a combination of Fitness Function and the AOMDV protocol and dragonfly topology. In a normal scenario, when a RREQ is broadcasted by a source node, more than one route to the destination will be found and the data packets will be forwarded through these routes without knowing the routes' quality. By implementing the proposedalgorithm on the same scenario, the route selection will be totally different. When a RREQ is broadcasted and received, the source node will have three (3) types of information in order to find the shortest and optimized route with minimized energy consumption.

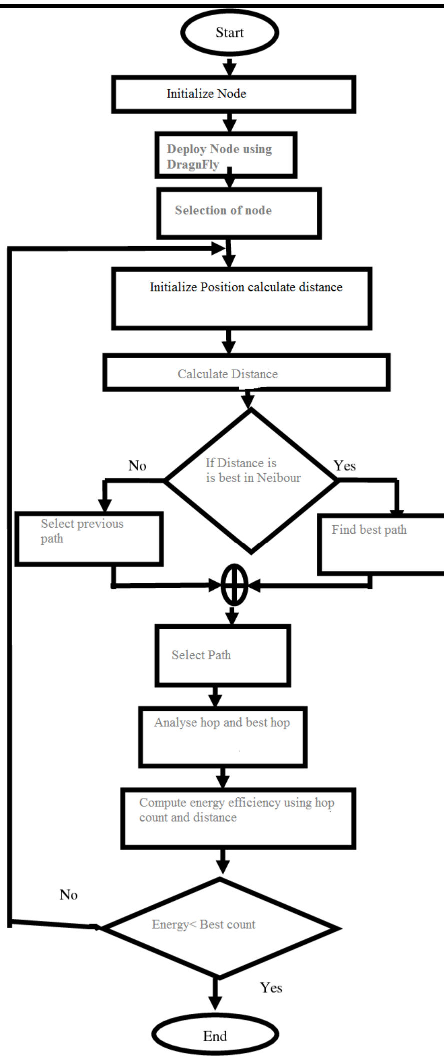

Fig.3 Flow diagram of proposed work

In the traditional AOMDV, it builds multiple paths using RREQs. It does not take into account the energy for choosing the paths. Here the proposed protocol not only considers residual energy but also transmission power of nodes in paths selection to maximize the lifetime of networks.

V. RESULTS

By using NS2 simulator and utilized the Constant Bit Rate (CBR) as a traffic source with 50 mobile nodes that are distributed randomly in a 1500 m* 1500 m network area; the network topology may therefore, undergo random change since the nodes' distribution and their movement are random. The transmission range of the nodes was set to 200 m, while, for each node, the initial energy level was set to 100 joules of the network. Initial design MANET architecture using dragonfly topology then random assign energy according to

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topology. After deployment of network architecture find optimum path using FF-AOMDV According to different parameter as below describe:-

A. ***Packet Delivery Ratio*** **(PDR):** Itis the ratio of the data packets that were delivered to the destination node to the data packets that were generated by the source. The higher the ratio, the better the performance of the routing protocol.

$$PDR = \frac{\text{number of packets received}}{\text{number of packets sent}} \times 100$$

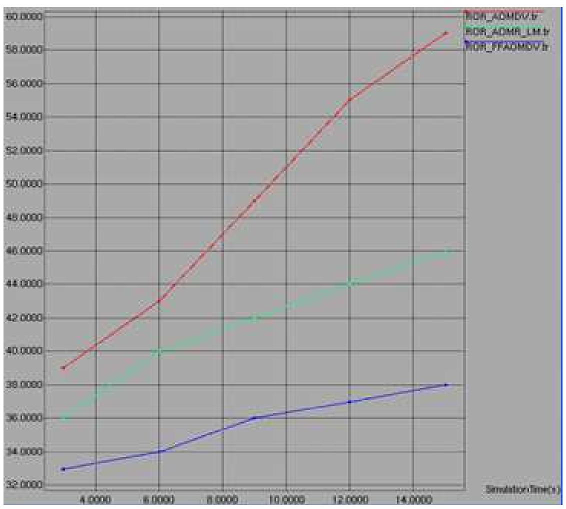

Fig.4 Graph of packet delivery ratio with simulation time

Fig.4 shows graph of packet delivery ratio with simulation time. The fig. shows the variation of packet delivery ratio on varying simulation time for FF-AOMDV with Dragonfly topology, AOMR-LM and AOMDV routing protocols. Simulation time is varied as 4, 6, 8, to 14 seconds.

When the simulation time increases, the packet delivery ratio also increases. The FF-AOMDV with Dragonfly topology has better performance in terms of packet delivery ratio than both AOMR-LM and AOMDV protocols. The FF-AOMDV protocol with Dragonfly topology achieved 76% of packet delivery ratio in 4 seconds of simulation time and 97% in 14 second of simulation, the AOMR-LM protocol achieved 70.23% of packet delivery ratio in 50 seconds simulation time and 76.2% in 14 seconds of simulation time and finally, the AOMDV achieved 74.8% in 4 seconds simulation time and 78.7% of 14 seconds simulation time. The FF-AOMDV with Dragonfly topology has higher PDR due to having multiple paths always available in case of any chance or case of route failure.

B. ***Throughput:*** Throughput is known as the number of bits that the destination has successfully received.

$$TP = (\text{number of bytes received} * 8 / \text{simulation time}) * 1000 \text{ kbps}$$

Fig.5 Graph of throughput

Fig.5 shows the comparison of throughput behalf of simulation time. In this figure x axis show the simulation time and y axis show the throughput. In this fig. shows the effect on the throughput on varying simulation time for FF-AOMDV with Dragonfly topology, AOMR-LM and AOMDV routing protocols. Simulation time is varied as 4-14 seconds. When the simulation time increases, the throughput also increases. The FF-AOMDV protocol with Dragonfly topology has better performance in terms of throughput than both AOMR-LM and AOMDV protocols. The FF-AOMDV with Dragonfly topology has 171.6 kbps throughput in 4 second simulation time and 1122 kbps in 14 second of

In FF-AOMDV with Dragonfly topology the packet-loss is nearly zero because of its unique property of storing the information about the various energy efficient paths available for flawless communication.

C. ***End-to-end delay:***End-to-End delay refers to theaverage time taken by data packets in successfully transmitting messages across the network from source to destination. This includes all types of delays, such as packet queuing at interface queue; propagation time and transfer time; and buffering during the route discovery latency [21].

Fig.6 shows the comparison of E2E delay w.r.t. packet size. The fig. shows the change of end-to-end delay for FF-AOMDV with Dragonfly topology, AOMR-LM and AOMDV. When the packet size increases as 64, 128, 256, 512, 1024 bytes, the end-to-end delay also increases. The E2E delay in FF-AOMDV routing protocol with Dragonfly topology increases from 14.8 ms to 25 ms, in the AOMR-LM protocol it increases from 18.64 ms to 44 ms and finally, in the AOMDV protocol it increases from 21.63 ms to 42 ms. The FF-AOMDV routing protocol with Dragonfly topology has better performance than both AOMR-LM and AOMDV in terms of end-to-end delay.

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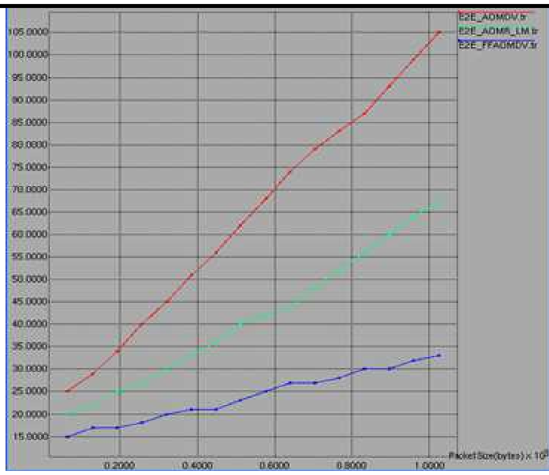

Fig.6 Graph of End to end delay

D. Energy Consumption: Energy consumption refers to the amount of energy that is spent by the network nodes within the simulation time. This is obtained by calculating each node's energy level at the end of the simulation, factoring in the initial energy of each one [22].

Fig.7 shows the comparison graph of energy consumption behalf of node speed. The variation in energy consumption for FF-AOMDVwith Dragonfly topology, AOMR-LM and AOMDV are shown. When the node speed increases as 2,4,6,8,10 m/s, the energy consumption also increases. In the FF-AOMDV with Dragonfly topology it increases from 60 joules to 98 joules as it is designed to select the path having higher energy levels and shortest route from source to destination, in AOMR-LM it increases from 61 joules to 112 joules and in AOMDV it increases from 72 joules to 158 joules.The FF-AOMDV with Dragonfly topology has least energy consumption because it has the information of most energy efficient paths stored.

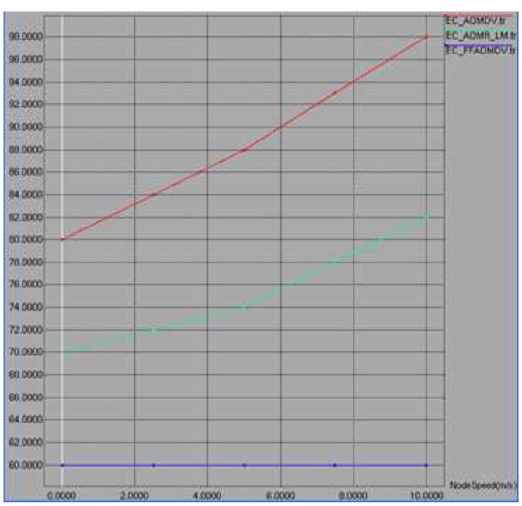

Fig.7 Graph of energy consumption behalf of node speed

E. Network Lifetime: The network lifetime refers to the required time for exhausting the battery of *n* mobile nodes.

F.

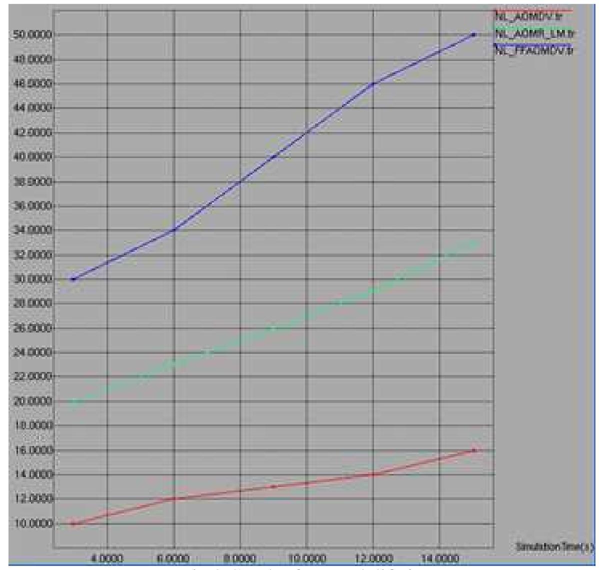

Fig.8 Graph of network lifetime

Fig.8 shows the comparison of network lifetime behalf of simulation time. In this figure x axis show the simulation time and y axis shows the number of exhausted nodes for FF-AOMDV with Dragonfly topology, AOMR-LM and AOMDV when varying the simulation time. The FF-AOMDV with Dragonfly topology exhausts 0 nodes in 50 seconds and 2 nodes in 250 seconds, the AOMR-LM exhausts 0 nodes in 50 seconds and 3 nodes in 250 seconds, while, the AOMDV exhausts 2 nodes in 50 seconds but 6 nodes in 250 seconds. The FF-AOMDV with Dragonfly topology enhances its network lifetime as it routes the traffic to the nodes having higher energy in the network. In the case, when the energy of these nodes get exhausted the topology has the property of storing information about various energy efficient routes and hence it transfers the traffic to next energy efficient shortest path, thus enhancing the network lifetime. case of any route failure and hence reducing the overhead due to control packets and queuing of data packets, thus improving Routing overhead ratio. Now that we have seen all the improvements in performance parameters in graphical form, we can easily take the data values from the graphs and can compare them in tabular form. The following are the tables in which we have compared the performance metrics on varying simulation scenarios. All the tables show the comparison of various existing protocols (single run) with the proposed FF-AOMDV with Dragonfly topology (three runs) over each value of varying simulation values to show the justified values of the proposed algorithm.

Table 1 Comparison of performance parameters and percentage improvement w.r.t. Simulation Time

S. No.	PARAMETERS COMPARED	EXISTING FFAOMDV	IMPLEMENTED FFAOMDV WITH DRAGONFLY ALGORITHM
1.	ENERGY CONSUMPTION(in joules)	68	61
2.	NETWORK LIFETIME (nodes exhausted)	3	2
3.	PACKET DELIVERY RATIO(PDR)	76.46%	81%
4.	THROUGH PUT (in kbps)	400.78	454.68
5.	END-TO-END DELAY (in mS)	26.74	24.12
6.	ROUTING OVERHEAD RATIO	0.3468	0.3197

VI. CONCLUSION

In this research paper, proposed a new energy efficient multipath routing algorithm called FF-AOMDV with Dragonfly topology simulated using NS-2 under three different scenarios, varying node speed, packet size and simulation time. These scenarios were tested by six performance metrics Packet delivery ratio, Throughput, End-to-end-delay, Routing overhead ratio, Energy consumption and Network lifetime. Simulation results showed that the proposed FF-AOMDV with Dragonfly topology has performed better than the existing FF-AOMDV and the other two protocols AOMR-LM and AOMDV in throughput, packet delivery ratio, routing overhead ratio and end-to-end delay. It also performed well against FF-AOMDV for conserving more energy and enhancing the network lifetime. In proposed work Implemented FFAOMDV with Dragonfly algorithm and gives improvement of Energy consumption, Network lifetime, Packet Delivery Ratio, Throughput, End to End delay and Routing overhead ratio, which gives percentage of improvement as 10.7, 33.33, 5.9 13.47, 10.86, 8.47 percent respectively.

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