Energy Conservation in Mobile Ad-Hoc Network using the Enhanced Fitness Function

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Abstract— In MANET, a collection of mobile nodes forms a wireless network. MANET forms a temporary network without the aid of any fixed infrastructure or centralized administration. A MANET is referred as an infrastructure-less network. The mobile nodes in this network dynamically sets up paths among themselves to transmit packets temporarily. Though MANET possess attractive advantages, it faces some challenges due to their particular characteristics. One of the important challenges is the limited energy resource, as the mobile nodes do not possess permanent power supply and have to rely on batteries. It reduces the network lifetime as batteries get exhausted very quickly as nodes involves the transmitting and receiving of packets and mobility of nodes. In existing system, the energy in MANET is conserved by applying the fitness function technique to optimize the energy consumption in Ad Hoc on Demand Multipath Distance Vector (AOMDV) routing protocol. The protocol used is AOMDV with fitness function (FF-AOMDV). The problem identified is usage of intermediate nodes for forwarding packets is more. It reduces the energy of the nodes. In this paper, the usage of intermediate nodes is reduced based on maximum transmission range by using Enhanced Fitness Function. It conserves the energy of the remaining nodes in the network and increases the lifetime of the network.
Key words: MANET, AOMDV, RREQ, RERR

I. Introduction

MANET stands for Mobile Ad hoc Network also called as wireless ad hoc network or ad hoc wireless network. They consist of set of mobile nodes connected wireless to form a network. It is a self-configured, self-healing network without having a fixed infrastructure. The topology of the network changes as the MANET nodes are free to move. Each node behaves as a router as they forward traffic to other specified node in the network.

MANET may operate as standalone manner or they can be the part of larger internet. The main challenge for the MANET is limited energy source as they rely on batteries. Network topology, which is typically multi-hop, may change randomly and rapidly with time, it can form unidirectional or bi-directional links. Wireless links usually have low reliability, efficiency, stability and capacity when compared with wired network. Each node can act as a host and router. As the nodes, rely on batteries or other exhaustible means for their energy. Mobile nodes have less memory, power and lightweight features. They require minimum human intervention to configure the network, since they are dynamically autonomous in nature.

In MANET, the limited energy source of each node affects the network where the links are actively involved in routing. When the energy of the node is exhausted, the links are broken. Packets are lost [5]. By forwarding the packets through the nodes having high energy levels, the network lifetime is increased.

II. Background and Related Work

A. Routing Protocols

The Routing protocols is divided into three categories: Proactive routing protocol, Reactive routing protocol and Hybrid routing protocol. The proactive routing protocol maintains the route information in a routing table for each node in a network. Periodically sends the message to ensure the packet transmission. DSDV, OLSR are some proactive routing protocols. The Reactive routing protocols discovers the route only on-demand. The hybrid routing protocols is the combination of both reactive and the hybrid routing protocols.

B. AODV

The route discovery and the route maintenance are the two phases in this routing protocol. If a source node needs to send the packet to the destination, the process initiated by broadcasting the route request (RREQ) to all nodes. The route request again broadcasted by the received node until it reaches the destination node. The destination node sends the route reply response (RREQ) to the source node through the same route packets received. If the link breaks in active routing, the route error (RERR) message will be sent to the source node.

C. FF-AOMDV

In AOMDV at first, a source node once broadcasts RREQ, the multiple routes to the destination are found and the shortest path is selected to forward the packets without knowing the quality of the route. Now, once a RREQ is broadcasted and received, node selects the shortest and optimized route with reduced energy consumption using fitness function [1].

D. Fitness Function

The fitness function calculates the shortest path from source node to destination node to reduce the energy consumption in multipath routing. The fitness function is an optimization technique that comes as a part of many optimization algorithms such as genetic algorithm, bee colony algorithm, fire fly algorithm and particle swarm optimization algorithm. The fitness function finds the most important factor in the optimization process [1].

Aqeel Taha [1] proposed an algorithm called fitness function that deals with multipath routing protocol to conserve the energy of the nodes in a network and provides better packet delivery ratio, throughput and the end-to-end delay.

K.Sumathia [2] proposed an Adaptive HELLO messaging scheme to determine the link connectivity information for monitoring the link status between nodes along with the incorporation of Dynamic on Demand Routing Protocol to reduce the energy consumption of mobile nodes.

Santhosh Kumar Das [3] proposed a method called Vague Set Measurement technique, which selects an energy efficient route uses interval, based membership function that is driven by an expert system.

Nadeem Iqbal [4] proposed a Hop count and Node energy based routing protocol, which uses multi-function routing protocol that combines energy and hop count on routing path decision.

Wen-Kaung Kau [5] proposed a Branch and Bound algorithm to efficiently solve the energy insufficient problem by considering the upper and lower bounds.

C.E. Perkins [6] proposed a secured route discovery protocol to maintain energy and to maximize the network lifetime. The node updates its energy to the nearby nodes in a network.

Shanthi Jaisal [7] proposed Improved Network Lifetime Multipath Routing using dragon fly topology reduces the energy conservation in a network.

Sheng Hao [8] proposed a Learning Automata that evaluates node stability measurement and a ratio for energy efficiency to provide stable and energy efficient routing.

Arvind Kumar [9] proposed a Random waypoint mobility model which selects the next hop to forward packets with minimum usage of energy.

Mahendra Maiti [10] proposed a learning based optimization technique that calculates the fitness value for cluster heads, which increases the network lifetime.

Tripti Nema [11] proposed a sleep mode when the energy of the node is minimum. In the sleep mode, the node is idle and do not participate in any transmission.

III. PROPOSED SYSTEM

Though the fitness function used to find the optimal path from source to destination, the number of intermediate nodes used for forwarding packets is more. In this paper, the proposed protocol Enhanced fitness function, which is the combination of fitness function and the maximum transmission range.

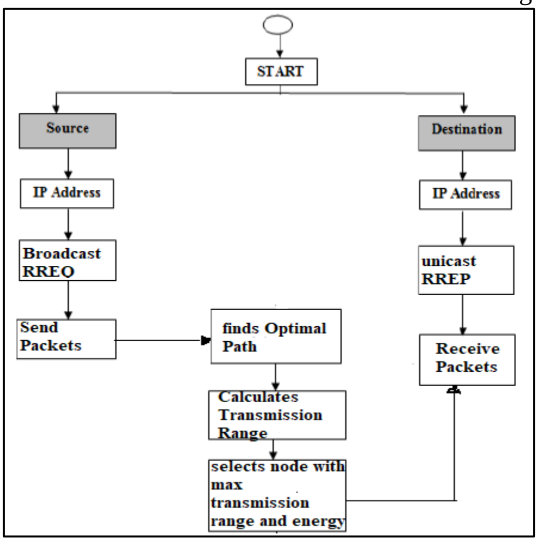

Fig. 1: Flow Diagram

The fitness function calculates the information about each node's energy level, distance between the nodes and the energy consumed in route discovery. If a node transmits and receives a packet at a distant, intermediate nodes are used to forward data packets to reduce packet loss. If the n number of intermediate nodes used for forwarding packets, then it minimizes the energy of the node and lifetime of the network. Each node has its own transmission range. A node can send packets to any node without using intermediate nodes in its range. By apply this technique in fitness function maximizes the lifetime of the network. The flow of the process is shown in Fig 1.

A. *MANET Environment*

In the Simulation model NS-3 (3.26), 50 nodes with mobility are created in a 600m area network. The network topology is initially set, then the topology undergoes some random changes since the nodes have random movement. The transmission range of the nodes was set to 50m, while, for each node, the initial energy level was set to 100 joules.

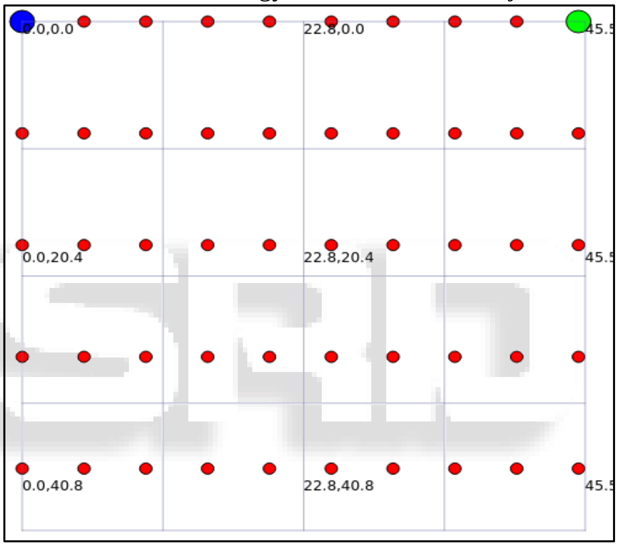

Fig. 2: Representation of nodes in a network

B. *Fitness Function*

The fitness function calculates the optimum routes from the source to destination,

$$\text{opt} = \frac{\Sigma\, e(n) \in r(e(n))}{\sum e \in E}$$

In the above equation, opt is the optimum path, e represents the link (edges) in the optimum route r and E represents the all the links in the network [1].

C. *Transmission Range*

Source node sends the data packets to the destination node, if both are in direct transmission range. If not, the process is carried via intermediate nodes for routing process as they forward the data packet and does not generate or modify packets. The node follows rectangle mobility model. Each and every node has its own transmission range. If the source node sends the packets to the destination node through intermediate nodes, then the source node selects the next node for forwarding packets from its transmission range. This way of transmitting packets restricts flooding and conserves the remaining energy.

$$T_R = \left(2E_{el} + E_{am}\left[\frac{2n}{2n+1}r_{max}\right]^2\right)\frac{bd}{r_{max}}\left(1+\frac{1}{2}n\right)\ldots(1)$$

where Eel(nJ/bit) represents the energy dissipated per bit by transmitter or receiver electronics and Eam (pJ/(bit m−2)) is the energy spend per bit to run the transmitting amplifier depending on the distance r. T_R represents the transmission range of the network.

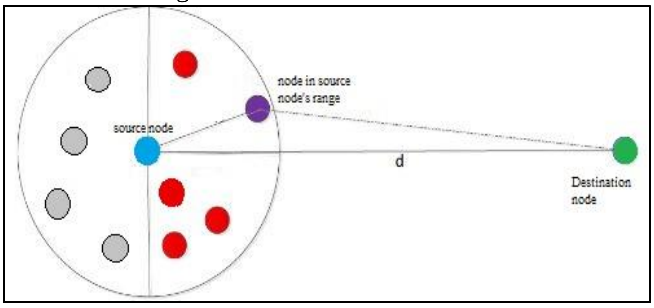

Fig. 3: Maximum Transmission Range

D. *Proposed Enhanced Fitness Function*

By combining the fitness function and the transmission range calculation, the enhanced fitness function equation is derived.

$$T_R = \left(2E_{el} + E_{am}\left[\frac{2n}{2n+1}r_{max}\right]^2\right)\frac{bd(opt)}{r_{max}}\left(1+\frac{1}{2}n\right)\ldots.(2)$$

IV. EXPERIMENTAL ANALYSIS

A. *Packet Delivery Ratio*

The packet drop ratio is evaluated from the number of data packets received and the number of packets sent. Fig 4 shows the comparison of different protocols with the proposed protocol.

Packet Delivery ratio

$$= (\text{number of packets received}) / (\text{number of packets transmitted}) \times 100$$

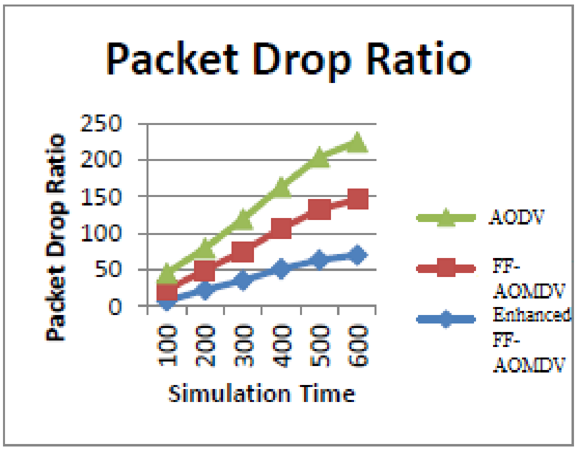

Fig. 5: Packet Drop Ratio Comparison

B. *Throughput*

The Throughput is calculated by the number of packets transmitted in a given unit of time. Fig 5 shows the increased throughput than other protocols.

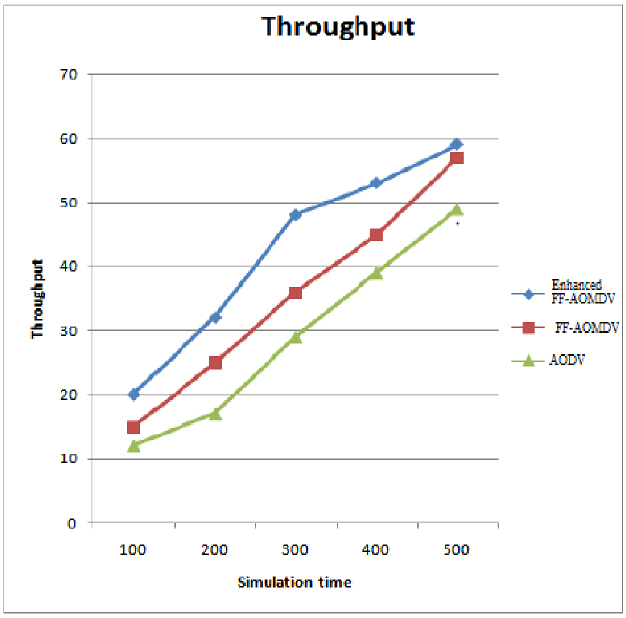

Fig. 5: Throughput Comparison

C. *Network Lifetime*

The network lifetime refers to the required time for exhausting the battery of n number of mobile nodes. Table 1 shows the comparison of network lifetime with different protocols.

	Existing Algorithms Exhausted Nodes	Simulation time (seconds)	Proposed Algorithm Exhausted Nodes
FFAOMDV	0	50	0
AOMDV	2		0
AOMR-LM	0		0
FFAOMDV	0	100	0
AOMDV	3		0
AOMR-LM	0		0
FFAOMDV	1	150	0
AOMDV	2		1
AOMR-LM	0		0
FFAOMDV	2	200	1
AOMDV	4		1
AOMR-LM	1		1
FFAOMDV	3	250	2
AOMDV	6		2
AOMR-LM	2		1

Table 1: Comparison of Network Lifework

V. CONCLUSION AND FUTURE WORK

In this paper, we proposed an Enhanced Fitness function, which improves the lifetime of the network and conserves the energy of the remaining nodes in the network. The overall performance of the network is also improved. Our future work will be implementing this algorithm in attacks, which is the another constrain of MANET.

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