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A Bio Inspired Energy And Delay Aware Multipath Routing Algorithm For Manet

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ABSTRACT

The high mobility of nodes in MANET causes frequent topological changes in the network which may make routes invalid thus in turn leads to the frequent route discovery process and high overhead. Multipath routing appears to be a promising technique for ad hoc routing protocols. The decisive issue in MANET is constrained energy which raises the need of energy efficient routing protocol for MANET. Here, a Novel Bat inspired Energy and Delay aware Multipath Routing Algorithm (B-EDMR) is proposed. This algorithm modifies and extends AODV to establish multiple energy and delay aware node-disjoint routing paths with the usage of BAT optimization technique that provides better packet delivery ratio, minimum end-to-end delay and reduced energy consumption and guarantees load pondering and enhanced network throughput.

1. INTRODUCTION

Most of the on-demand routing protocols of MANET uses the shortest path method during the path establishment process for data transmission and fix to the path till it break [1,3,4]. The persistent usage of a single path will lessen the battery power. The power failure of a mobile node not only affects the node itself but also the overall network lifetime.The mobile nodes in the MANET are typically powered by limited energy reservoir. Reducing the number of hops will not be the aim of a routing algorithm, instead the optimization of multiple parameters such as energy consumption, delay, packet delivery ratio, bandwidth, routing overhead, multipath

establishment etc. Among these issues, decisive issue is constrained energy which raises the need of energy efficient routing protocol for MANET [6,7].

The delay is the total latency experienced by a packet to traverse the network from the source to the destination. The end-to-end delay of a path is the summation of the node delay at each node, plus the link delay at each link on the path.

The multipath routing reduces the frequency of route discovery effectively and therefore the latency for discovering another route is reduced when currently used route is broken. Multiple paths can be useful in improving the effective bandwidth of communication, responding to congestion and heavy traffic, and in increasing delivery ratio [8, 9]. The establishment of multiple paths between source and destination in a single route discovery will drastically reduce the frequency of route establishment process which in turn increases the overall network performance [12, 13,14].

The above said issues lead to the development of energy and delay aware routing protocols.

In addition, metaheuristic algorithms start to emerge as major thespians for multi objective global optimization; they often mimic the best characteristics in nature, especially biological systems. Many new algorithms are emerging with many important applications [5, 7, 10]. Recently, a new meta heuristic search algorithm, called BAT algorithm (BA), has been developed by Xin-She Yang [15, 16]. Initial studies reveal that the Bat algorithm is very potential and could outperform existing algorithms. This optimization algorithm is applied with the traditional AODV routing protocol [11] for finding effective energy and delay aware routing in MANET.

In this paper, a Novel Bat inspired Energy and Delay aware Multipath Routing Algorithm (B-EDMR) is proposed. This algorithm modifies and extends AODV to establish multiple energy and delay aware routing paths with the usage of BAT optimization technique that provides better packet delivery ratio, minimum end-to-end delay and reduced energy consumption and guarantees load pondering and enhanced network throughput.

The remainder of this paper is organized as follows: Section 2 portrays the overview of the Bat optimization algorithm. In Section 3, the mechanism of the proposed Novel Bat inspired Energy and Delay aware Multipath Routing Algorithm (B-EDMR) is conferred in detail. In Section 4, the performance of the algorithm B-EDMR is analysed and compared with the existing unipath routing protocol AODV. The summarised results are depicted in Section 5.

2. BAT ALGORITHM – AN OVERVIEW

BAT algorithm is a recently developed meta heuristic algorithm by Xin-She Yang that adopts the behaviour of the natural bats for solving optimization problems [15, 16].

Bats are fascinating animals. They are the only mammals with wings and they also have advanced capability of echolocation. Most bats uses echolocation to a certain degree; among all the species, microbats are a famous example as microbats use echolocation extensively while mega bats do not. Most micro bats are insectivores. Microbats use a type of sonar, called, echolocation, to detect prey, avoid obstacles,

and locate their roosting crevices in the dark. These bats emit a very loud sound pulse and listen for the echo that bounces back from the surrounding objects. Their pulses vary in properties and can be correlated with their hunting strategies, depending on the species.

Studies show that microbats use the time delay from the emission and detection of the echo, the time difference between their two ears, and the loudness variations of the echoes to build up three dimensional scenario of the surrounding. They can detect the distance and orientation of the target, the type of prey, and even the moving speed of the prey such as small insects. Indeed, studies suggested that bats seem to be able to discriminate targets by the variations of the Doppler Effect induced by the wing-flutter rates of the target insects [2].

Obviously, some bats have good eyesight, and most bats also have very sensitive smell sense. In reality, they will use all the senses as a combination to maximize the efficient detection of prey and smooth navigation. Here, the echolocation and the associated behavior are considered.

3. BAT INSPIRED ENERGY AND DELAY AWARE MULTIPATH ROUTING ALGORITHM (B-EDMR)

The new proposed algorithm B-EDMR is an Energy and Delay Aware Multipath Routing scheme that uses the behavior of the real Bats to find multiple optimal paths between source and destination nodes.

3.1 Route Discovery Phase

The steps involved in the new B-EDMR algorithm to establish paths on-request using a reliable reverse path establishment method are as follows:

1. Whenever the source node S wants to send data to the destination node D, it floods the RREQ bats in the network. The bats which are small control packets carrying the D-id, travel in all available paths to D, and use their behaviours echolocation and loudness to collect details about the path they travel to reach the D.

a) Echolocation behaviour calculates the time delay taken by the bats to reach the destination.

b) Loudness behaviour measures the total energy level of all the nodes in the path it travelled to reach D.

2. Upon receiving the RREQ Bats, the destination D inturn rebroadcasts the Reverse RREQ Bats in all available paths to source S.
3. The Reverse RREQ (R-RREQ) Bats while travelling from D to S, collect the time delay taken by each node to reach the source and the total average residual energy of all nodes in the path they travelled.
4. In the B-EDMR, the intermediate node stores the incoming R-RREQ bats for a particular time interval along with their energy and delay taken to reach this node from the destination node. Among the several arrived R-RREQ bats, the R-RREQ bat which has the maximum energy level and minimum time delay is selected and forwarded to the neighbours.

5. In order to reduce the number of R-RREQ bats flooding and to select the best next hop node among the existing next hop nodes, the bat uses its loudness and echo property. A hello packet which carries the D-id will be sent to all the next neighbouring nodes for checking the availability of paths to the destination D through them. The R-RREQ bats will be forwarded to the neighbouring nodes that have paths to D and responded for the hello messages within the stipulated time period.
6. Upon receiving multiple Reverse RREQ Bats from D, the source filters only the node disjoint paths represented by the bats and discards the other paths.
7. The selected paths(N) are ranked based on the higher residual energy and minimum delay values.
8. The $\in$ number of required paths which also satisfy the QoS requirements of the application are selected as the best paths in the list and data transmission is distributed among them.

3.2 Route Maintenance

In B-EDMR algorithm, the routes are maintained as follows: If a node along a path moves or a route fails due to irregular circumstances, a link failure message will be sent to the source through the intermediate nodes to inform the erasure of the route. Upon receiving the link failure message, the source node removes the broken route from the existing path list and redirects the data packets in the remaining available paths in the path list. Thus the overhead is drastically reduced due to the avoidance of frequent route discoveries and uninterrupted data transmission.

4. PERFORMANCE EVALUATION

4.1 Analysis of Performance between AODV and B-EDMR

The Network simulator (NS-2) is used to evaluate the performance of the proposed algorithm [63]. In the simulation, the Distributed Coordination Function (DCF) of IEEE 802.11 for wireless LANs is used as the MAC layer protocol. It has the functionality to notify the network layer about link breakage.

Table 1.1 Simulation Scenarios

Simulation Terrain Dimension	1000 X 1000 meters
Transmission Range	250 m
Mobility model	Random way point
Number of Nodes	50
Node Speed	0-30 m/s
Routing protocols	AODV, B-EDMR
Traffic Source Model	Constant Bit Rate
Channel Data Rate	2 Mbps
Initial energy	20 Joules

4.1.1 Packet Delivery Ratio

Figure 4.1 portrays the performance of the proposed protocol B-EDMR in terms of Packet Delivery Ratio over Velocity. The Packet Delivery Ratio of B-EDMR is higher with a hike of 10% to 23% when compared to the traditional AODV.

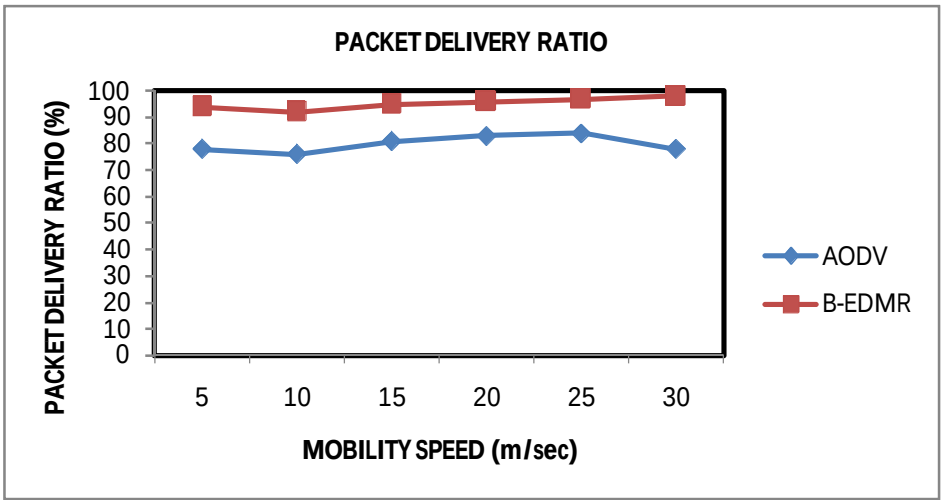

Figure 4.1 Effect of Velocity on Packet Delivery Ratio

4.1.2 End-To-End Delay

Figure 4.2 divulges the effect of Varying Number of Nodes over End-to-End Delay of two protocols. The proposed algorithm B-EDMR shows very minimum delay (up to 60%) when compared to that of AODV.

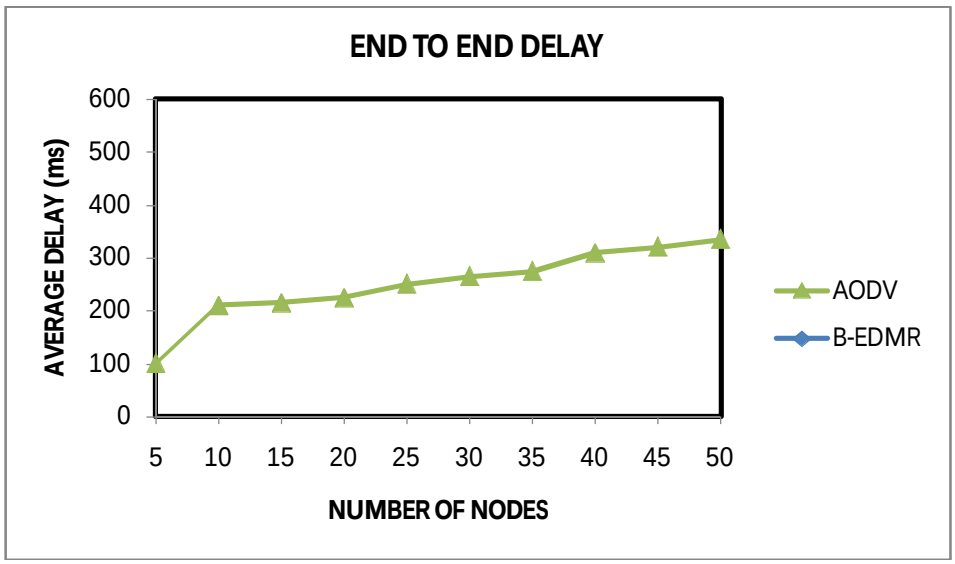

Figure 4.2 Effect of Number of Nodes over End-to-End Delay

4.1.3 Average Remaining Energy

Figure 4.3 expounds the effect of number of nodes on average remaining energy of nodes under two protocols. The remaining energy of the nodes at the end of simulation is much higher for B-EDMR than AODV. In B-EDMR, the reduction in energy consumption is about 44% to 66% than the traditional AODV. This is because the nodes which have higher energy are taken for data transmission.

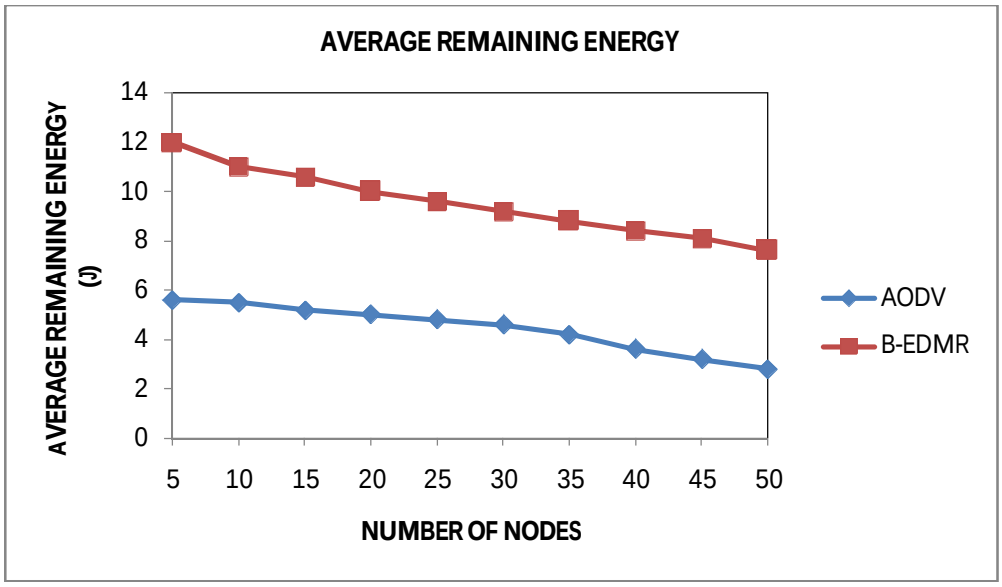

Figure 4.3 Effect of Number of Nodes on Average Remaining Energy

5. SUMMARY

The proposed Bat inspired Energy and Delay aware multipath on-demand routing algorithm (B-EDMR) improves the QoS parameters delay and energy. The proposed algorithm selects the paths with the minimum delay and the maximum residual energy at nodes. The B-EDMR produces better results than the existing AODV in terms of packet delivery ratio, end-to-end delay, and residual energy at nodes.

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