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Dynamic Shortest Path Routing In Mobile Adhoc Networks Using Modified Artificial Bee Colony Optimization Algorithm

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Abstract— **The Mobile Adhoc Networks (MANETs) is always self-organization, decentralization and infrastructure-less network of mobile devices connected without wires. The most necessary characteristic in mobile adhoc networks is topology transformation. Finding the shortest path for the routing problem in Mobile Adhoc Networks (MANETs) will become a dynamic optimization problem. The Modified Artificial Bee Colony Optimization (MABCO) algorithmic techniques are used to find the global optimum value in a given space. The Modified Artificial Bee Colony Optimization (MABCO) algorithm has shown to be a good technique for identifying multiple stable paths between source and destination nodes.**

Keywords— **Mobile Adhoc Networks, Bacterial Foraging Optimization, Evolutionary algorithm.**

I. INTRODUCTION

A mobile adhoc network is a decentralized group of mobile nodes which exchange data temporarily by means of wireless data transmission [1]. Routing in MANET is a dynamic optimization problem as the search space changes over time due to the time varying nature of the topology of the networks. Traditional routing techniques such as distance-vector and link-state algorithms that are used in fixed networks cannot be directly applied to mobile ad-hoc networks. Centralized algorithms have scalability problems, static algorithms have trouble Keeping up-to date with network changes, and others distributed and dynamic algorithms have oscillations and stability problems [4]. MANET supports robust and efficient operations by incorporating the routing functionality into MHs. In MANETs, the unicast routing establishes a multihop forwarding path for two nodes beyond the direct wireless communication range. Routing protocols also maintain connectivity when links on these paths break due to effects such as node movement, battery drainage, radio propagation, and wireless interference [2-3]. In multihop networks, routing is one of the most important issues that have a significant impact on the performance of networks. In this paper, we investigate the shortest path routing problem, which belongs to the topological routing. The DSPRP in MANETs is a real world dynamic optimization problem (DOP).

II. BACKGROUND AND PAST WORK

To solve a problem, a GA maintains individual population (also called strings or chromosomes) and modifies the population probabilistically by some genetic operators such as selection, crossover and mutation, for obtaining a near optimal solution to the problem. The several components that involve in designing GA: genetic representation of nodes, initialization of the population, calculating the fitness function, selection mechanism, crossover, and mutation scheme.

III. PROPOSED METHOD

In the proposed method, the dynamic shortest path can be found using the algorithm Modified Artificial Bee Colony Optimization (MABCO). The MABCO algorithms find the shortest path to a global optimum solution. The main goal is to prove that these algorithms provide computational efficiency and the quality of the solution is better than the genetic algorithm.

A. *MANET Routing*

Normally the Network layer is used to Route the data in MANETs. The main aim of routing in MANETs is to identify the path between the source node and destination node over which data packets can be forwarded. A MANET routing algorithm is not only to identify the shortest path between the source and destination, but it has also been adapted. The majority of MANETs is connectionless in nature. The connections are less effective in delivering the QoS that is required in the rapidly changing MANET environment. The MANETs is also multi-hop in nature. The packet needs to be relayed through other nodes to get to the destination. This MANETs requires that traditional algorithms to be redefined to accommodate these additional requirements. Every MANET routing algorithm has three essential components such that route discovery mechanism, route error correction mechanism and route maintenance mechanism [5-9].

B. ***Inspiration from Nature***

The central idea of this paper surrounds the application of Artificial Bee Colony Optimization to the problem of

MANETs. Artificial Bee Colony Optimization falls into a class of biologically inspired algorithms that have recently been developed. To name a few, the techniques of Particle Swarm optimization and Bacterial Foraging have been inspired by natural phenomenon. The Artificial Bee Colony Optimization mimics the behaviour of Bees in nature while they are searching for honey. Particle swarm optimization is inspired by the behaviour of flocks of birds as they fly in search of food. Bacterial foraging is yet another recent algorithm that simulates the behaviour of bacteria searching for food. All these techniques are combined in nature and when viewed in the perspective of optimization involve searching for the optimum solution in a given search space. It has been observed that when these patterns, that are observed in nature, are applied to complex engineering problems, they provide better solutions[10-14].

C. *Dynamic SP Routing problem*

First, construct the network model and then formulate the DSPRP (Dynamic Shortest Path Routing Problem). Consider a MANET operating within a fixed geographical region. The model contains an undirected and connected topology graph G0 (V0, E0), where V0 represents the set of wireless nodes (i.e., routers) and E0 represents the set of communication links (edges) that connect two neighbouring routers which falls into the transmission range. A communication link (i, j) cannot be used for packet transmission unless both node i and node j have a radio interface each with a common channel. In addition, delay and cost will occur due to message transmission on a wireless communication link. Table 1. represents the notations used for the MANET topology graph.

Table 1.
The notations used for the graph

Notation	Indicates
G0(V0,E0)	initial MANET topology graph
Gi(Vi,Ei)	MANET topology graph after the i^{th} change
S	source node
R	destination node
Pi(s, r)	path from s to r on the graph Gi
d_l	transmission delay on the communication link l
c_l	cost on the communication link l
Δ(Pi)	total transmission delay on the path Pi
C(Pi)	Total cost of the path Pi

The DSPRP can be informally described as follows. Initially, a network of wireless routers, a delay upper bound, a source and a destination node, aiming to find a delay bounded least cost path without loop on the topology graph. Then, periodically or stochastically, some nodes are informed to sleep or some sleeping nodes are informed to wake up due to energy conservation. Therefore, the network topology will change from time to time [15-18].

The objective of the DSPRP is to quickly find out the new optimal delay-constrained least cost acyclic path after each change in topology. More formally, consider MANET G (V, E) and a unicast communication request from the source to the destination node (i.e.,node s to r) with the delay upper bound Δ. The dynamic delay-constrained SP problem is to find a series of paths {Pi |i ∈ {0, 1,…}} over a series of graphs {Gi |i ∈ {0, 1, . . .}}, which satisfy the delay constraint, as shown in (1), and have the least path cost,

$$\Delta(P_i) = \sum_{l \in P_i(s,r)} d_l \leq \Delta \qquad (1)$$

$$C(P_i) = \min_{P \in G_i} \left\{ \sum_{l \in P(s,r)} c_l \right\}. \qquad (2)$$

D. *Artificial Bee Colony optimization*

Based on the behavior of the bees in nature, various swarm intelligence algorithms are available. These algorithms are classified into two; foraging behavior and mating behavior. Artificial Bee Colony is a predominant algorithm simulating the intelligent foraging behavior of a honeybee swarm, proposed by Karaboga and Basturk. In ABC algorithm, the colony of artificial bees contains three groups of bees: employed bees, onlookers and scouts[21].

A bee waiting for the dance area for making a decision to choose a food source is called onlooker and one going to the food source visited by it before is named employed bee. The other kind of bee is scout bee that carries out random search for discovering new sources. The position of a food source represents a possible solution to the optimization problem and the nectar amount of a food source corresponds to the quality (fitness) of the associated solution. A swarm of virtual bees is generated and started to move randomly in two-dimensional search space. Bees interact when they find some target nectar value [19-20].

E. *Modified Artificial Bee Colony optimization (MABCO) Algorithm for Shortest Path Routing Problem (SPRP)*

The following steps are repeated until a termination criterion is met.

a. Calculate the nectar amounts by sending the employed bees on to the food sources.
b. After sharing the information from employed bees select the food sources by the onlookers and determine the nectar amount of food sources.
c. Determine the scout bees and send them to find out new food sources.

Pseudo code for MABCO algorithm

a. Initialize population with random solutions.
b. **repeat**
c. place the bees on their food sources
d. place the bees on their food sources depending on their nectar amount.
e. Send the scouts to the search area for discovering new food sources.
f. Memorize the best food source found so far
g. **Until** requirement are met.

The Modified Bee Colony Optimization algorithm is a hybrid routing algorithm which is based on the Artificial

Bee colony algorithm and contains both reactive and proactive elements . The algorithm in reactive in that it keeps routing information of only those nodes involved in communication. It is proactive because nodes exchange routing information while the communication is going on.

F. Route Discovery

In the MABCO forwarding algorithm, when an onlooker Bee reaches an intermediate node, then the node finds out it's routing table to see whether it has a route to the destination over any of its neighbours. In MABCO, a route is specified by a positive nectar value in the node's routing table over any of its neighbours to the employed bees destination. If such a neighbour is found, the employed bee is forwarded to only that neighbour, otherwise, it is flooded to all its neighbours as in the flood scheme. The scout bee finds out the iteration of the flooding scheme

G. Route Maintenance

MABCO uses a proactive updates to improve route quality. Nodes periodically broadcast information about the best nectar values to each destination at that node. The neighbouring nodes on receiving the information, then adjust the value of their existing nectar values of the routing table entries to every destination over the broadcasting node. This diffusion process is much slow and could result in new paths being revealed to the destination. However, these paths are not reliable and are thus not used directly in packet forwarding, and are marked as virtual pheromones to be explored later during another route discovery phase. Neighbourhood discovery is done through the periodic broadcast of HELLO messages.

H. Route Error Correction

A link error may be identified when a Hello message is not established from a neighbour for a timeout period of the network, or if a packet fails to transmit though a link. The algorithm corrects the routing table to reflect the link failure. In the case of packet sending failure, MABCO checks for alternative routes. If it is not found to begin a route repair process. They broadcasts a link failure notification to inform its neighbours about the change in routing information.

I. Simulation Parameters

The simulations are conducted in an area of 2000m x 2000m. Node mobility is restricted to a maximum speed of 10 m/s and according to the random waypoint mobility model. Simulation time for each instance of an experiment is 500s. For each experiment the sample size is 7. 20 Constant bit rate connections are configured between the nodes. The random seed for the simulation is initially set to 250. Through each experiment various performance metrics of the algorithm are measured in terms of Packet Delivery Ratio , End-to-End delay, Jitter, and Throughput at receiver node.

In the experiential findings the maximum hops for the MABCO is set to 12. Other parameters include a nectar decrease constant of 0.3, a nectar increase constant of 0.5, a decrease interval of 4s, and a route select exponent of 3. Measurements are taken with varying pause time, which is indicative of the mobility of the network. Pause times are ever 30s intervals from 0s to180s. Fig. 1, 2, 3, 4 show the performance measured in terms of Packet Delivery Ratio, Throughput, End-to-End delay and Jitter for various values of pause time respectively

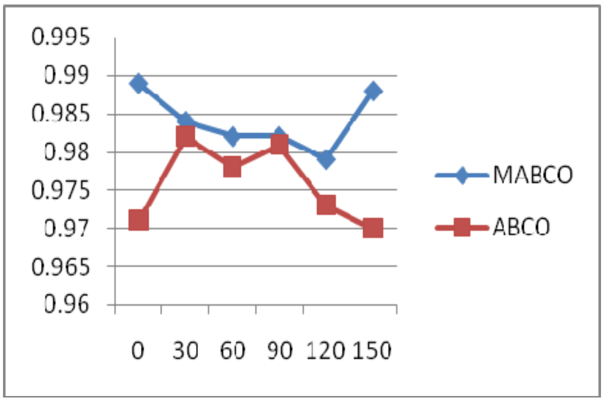

Figure 1: Delivery Ratio vs. Pause time

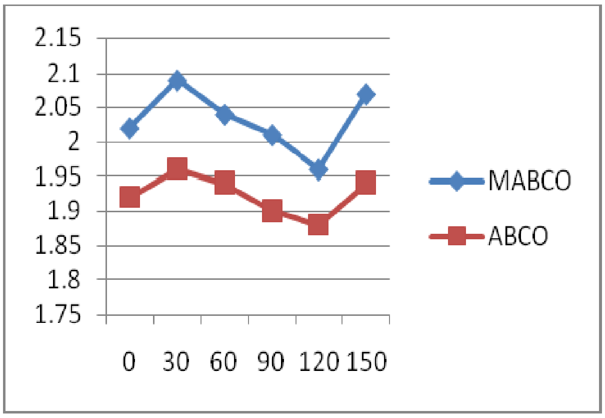

Figure2: Throughput vs. Pause time

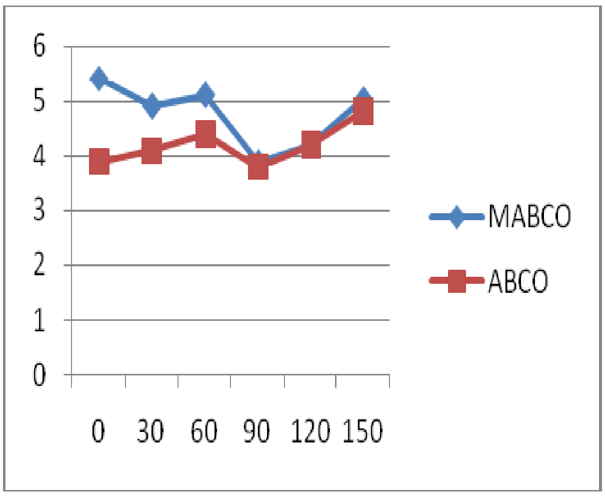

Figure 3: Delay vs. Pause time

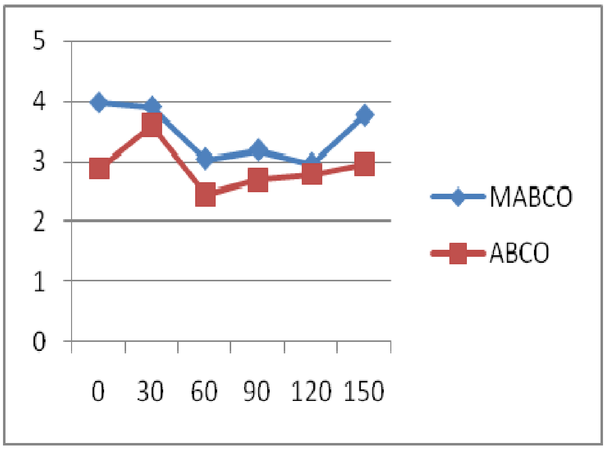

Figure 4: Jitter vs. Pause time

IV. Conclusion

In this paper a new approach is proposed for finding global optimum solution for MANET. The dynamic nature of the problem is a challenge, but it also enables the algorithms to gain additional information by storing the information obtained during the optimization at previous time steps. Many algorithmic techniques are developed for finding shortest path route in the dynamic environment. The proposed technique overcome all these problems and give optimal solution in cyclic as well as acyclic changing environment. Modified Artificial Bee Colony optimization and Artificial Bee Colony optimization can be compared based on their computational efficiency and the quality of solution. MABCO outperforms ABCO in both criteria, especially in computational efficiency for the non-linear problems with continuous variables.

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