Review of Various Optimization techniques in MANET Routing Protocols

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Abstract - **Mobile Ad hoc Network (MANET) is an autonomous, self-configuring and infrastructure-less system in which various mobile nodes are connected by wireless links. In Mobile Ad Hoc Network (MANET), various routing protocols are there like AODV, DSDV, TORA, DSR etc. Due to the nature of changing topology and infrastructure less in MANETs there are various issues and constraints which affect the performance of the network like mobility, overhead, battery drainage, delay and interference. Various optimization techniques can be used to find out the best and optimal solution. Nature inspired algorithms are meta heuristics that mimics the nature for solving optimization problems opening a new era in computation.**

***Keywords*: Routing, MANET, Optimization Algorithms, Bio Inspired Algorithms**

I. INTRODUCTION

A Mobile Ad Hoc Network (MANET) consists of self configurable autonomous nodes, and these nodes work together in a distributed manner and for its operation it does not rely on any fixed infrastructure. In MANET, individual devices can move freely in any direction [1]. There are various characteristics with which we can differentiate mobile ad hoc network from other wireless network like configuration of dynamic topology, node mobility, infrastructure less and multi-hop forwarding.

To establish communication path between nodes, efficient routing protocols are needed. In MANETs there are various routing protocols and are categorized into three major categories: Reactive, Proactive, and Hybrid routing protocols.

Reactive Routing Protocols discover routes only on demand basis and do not take initiative for finding a route. They do not update route tables constantly. E.g. AODV, DYMO, TORA, ARA. Proactive Routing Protocols maintain table of each node which contain the latest information of routes to nodes, to know its local neighbourhood. In this control messages are periodically exchanged. E.g. DSDV, OLSR, WRP. While the combination of Reactive and Proactive Routing Protocols fall into the category of Hybrid Routing Protocols. E.g. ZRP, FSR, HOPNET, DDR.

By Optimization, we can find the desirable solution from all outcomes [2]. Various Optimization approaches can be used to find the optimal and best solution. For optimization biologically inspired algorithms is the category of algorithms that resemble with the performance of nature. By these algorithms various problems can be solved due to their advantages: First, to reach a solution, we don't have to follow any mathematical approaches. Second, results come very fast and are accurate [3]. Optimization approaches which fall into the category of these algorithms are:

- Genetic algorithms
- Particle Swarm Intelligence
- Ant Colony Optimization
- Artificial Bee Colony Optimization
- Artificial Neural Networks
- Bacterial Foraging Algorithm

II. RELATED WORK

Al-Ghazal, M. et al. in [4], this paper works on algorithm which is based on genetic algorithm (GA) and cluster head gateway switching protocol (CGSR) by which we can improve routing in clustering algorithm. Genetic algorithm (GA) keeps up to date state information about the neighbouring network and GA mechanisms make systems to be self configured. Genetic algorithms find the best path from source to destination in network but it is not necessary that it should be shortest one and also allows allow a node to change routing information quickly and efficiently to adjust an ever changing local topology, initiating fewer

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link breakages and increasing lower MAC layer overhead.

Karthikeyan, D. and Dharmalingam, M. in [5], this paper works on ant colony optimization (ACO) algorithm which is inspired by the nature. In MANETs, the routing algorithms are developed easily by this technique. In this technique, the autonomous agents interact with each other and their collective behaviour is studied to reach a given solution by finding the best global solution. Algorithm based on energy efficient routing is proposed for MANETs to extend the lifetime of overall system by minimizing energy consumption of nodes. Swarm intelligence is a computational intelligence technique that involves collective behaviour of autonomous agents that locally interact with each other in a distributed environment to solve a given problem in the hope of finding a global solution to the problem.

Alireza, S. et al. in [6], this paper proposes an algorithm based on particle swarm optimization (PSO) in the mobile ad hoc network for multicast routing. The PSO algorithm has better performance and speed than GA based multicast routing. The main focus is on energy consumption efficiency and delay in multicast routing. It generally means selecting the node with the minimum energy consumption in the route selection and building a multicast tree with minimum delay. Here, the problem was formulated as a PSO problem. A novel multicast routing algorithm based on the PSO algorithms was proposed.

Nancharaiah, B. and Mohan, B.C in [7], this paper works on ant colony optimization (ACO) and particle swarm optimization (PSO). In ACO, ant's acts as mobile agents to give the best optimal path and provide input to particle swarm optimization. In PSO the position and velocity of particle is selected best over previous one by considering the minimum cost and delay. The combination of these two performs better than ACO. PSO finds the best solution over the particle's position and velocity with the objective of cost and minimum End-to-end delay. This hybrid algorithm exhibits better performances when compared to ACO approach.

Anuj, K. and Harsh, S in [8], this paper focus mainly on the routing which is the most challenging task. So ant colony Optimization (ACO) which is based on the swarm intelligence is good approach by which routing algorithms are developed easily. The ants find the best path, by releasing chemical substance called pheromone. The ants and mobile ad hoc networks (MANETs) have lot of similarities like their physical structure, configuration and origin of route. This mechanism from collective intelligence is applied to the ad hoc network by researchers.

Zulfiqar Ali and Waseem, S. in [9], this paper works on two approaches which are based on swarm intelligence; ant colony optimization (ACO) and particle swarm optimization (PSO). These both approaches provide multipath and loop free routing in the ad hoc networks. Various routing algorithms are designed based on swarm intelligence in MANETs: Node Neighbor Number Algorithm (NNNA), GPS/Ant Line Routing Algorithm (GPSAL), and Accelerated Ants Routing (AAR). All these approaches provide optimized routing and are Meta heuristic in nature. SI based routing algorithms are more promising for specific nature of Ad hoc & Sensor Networks due to the freely mobility and frequent topology changes. The computational intelligence approaches are very effectively applied to NP-hard problems and results more promising.

Shah, S.K. and Vishwakarma, D.D. in [10], this paper proposes an artificial neural network optimization technique which is used in reactive AODV routing protocol. In this the frequency of the Hello interval between two events is determined to check the network performance. Unnecessary traffic may occur due to updating information at some time interval. So to improve the performance of the network, we have to make the time interval of these messages to be adaptive. Information update at some fixed time interval can cause unnecessary traffic in the wireless network so to make adaptive the time interval of these messages is a technique to improve the performance of the network.

Harpreet K., Jasmeet S. in [11], works on bio inspired optimization algorithm known as bacterial foraging optimization algorithm (BFOA). The behaviour of bacteria is simulated and accordingly applied in various fields. A new protocol BFAODV is proposed, which result from AODV protocol when BFOA technique is applied on it. By this protocol, various metrics related to performance of network are improved and it also reduces the energy consumption and overhead of neighbor discovery processes.

E. Hemalatha, J. and Dr. Kannammal in [12], this paper works on new framework by technique, Artificial Bee colony optimization in MANET for the best route discovery. This technique finds the global optimum value and works on the principle of artificial honey bee's collective intelligence. The Artificial Bee Colony Optimization (ABCO) algorithm has shown to be a good technique for identifying multiple stable paths between source and destination nodes.

III. DIFFERENT OPTIMIZATION APPROACHES FOR MANETs

A. Genetic algorithms (GA)

This technique was proposed by Holland in 1975. Genetic algorithm is branch of computational models, which are based on the principles of natural selection. This optimization technique is the most powerful among others. These algorithms are inspired by human

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evolution. Genetic algorithms perform best in the optimization and referred to as function optimizer. In this population of solution called chromosome is initialized for the algorithm [4]. Fitness is evaluated for each chromosome using appropriate fitness function. From this, the best chromosomes are selected and undergo crossover and mutation for better offspring. GA is useful and efficient when:

- The search space is large complex or poorly known.
- No mathematical analysis is available.
- Domain knowledge is scarce to encode to narrow the search space
- For complex or loosely defined problems since it works by its own internal rules.
- Traditional search method fails.

B. Particle Swarm Optimization (PSO)

PSO is a population based stochastic optimization technique and was proposed by Kennedy and Eberhart in 1995.This technique is inspired by group behavior of bird flocking and fish swimming. In PSO, each member is represented by particle having velocity and position of each of them. The particle's best position is evaluated by the highest fitness value [6].
Various steps involved in PSO algorithm are as:

- Initialize the particle in a given search space.
- Evaluate the performance of each particle.
- Compare the particle's fitness value with pbest. If the value of particle is better than pbest then set this value as pbest
- Update the position and velocity of particles.

C. Ant Colony Optimization (ACO)

ACO is the Meta heuristic technique which is inspired by foraging behavior of ants [8]. This optimization technique was proposed by Dorgio and Dicario in 1999. In this three main functions are structured:

- Ant Solution Construct: In this artificial ants move through adjacent states of problem.
- Pheromone Update: Once the solution is built completely, pheromone trails are updated.
- Daemon actions: In this additional pheromone is applied to the best solution.

D. Artificial Bee Colony Optimization (ABC)

Based on the behaviour of the bees in nature, various swarm intelligence algorithms are available. This algorithm is based on the foraging behaviour of honeybee swarm and was proposed by Basturk and Karaboga. These algorithms are classified into two; foraging behaviour and mating behaviour [12].
In ABC algorithm there are mainly three groups of bees:

- Onlookers
- Employed
- Scouts

For a food source, bee waiting for making a decision is referred as onlookers.
As it goes to the food source, which it visited before is named as employed bee.
The bee carries out random search referred to as scouts.

E. Bacterial Foraging Optimization Algorithm (BFOA)

This algorithm is global optimization algorithm inspired by foraging behavior of bacteria named ac Escherichia Coli. BFOA is inspired by chemotaxis behavior of bacteria. These bacteria get the direction to food based on gradients of chemicals [11]. The information processing strategy is achieved through series of processes.

- Chemotaxis: Cells move along the surface one at a time.
- Reproduction: Best set of bacteria of is selected, so that it contributes to the next generation.
- Elimination and Dispersal: Cells are discarded and new samples are inserted.

IV. COMPARATIVE ANALYSIS

Table 1 Survey of Optimization approaches

Applied Approach	**Operators**	**Areas of Application**
Genetic Algorithm	Crossover Mutation Selection Inversion	Web page classification system, Power System Optimization problems,
Particle Swarm Intelligence	Initialize Updater Evaluator.	Edge detection in noisy images ,balancing problem in production and operations management,
Ant Colony Optimization	Pheromone Update and Measure, Trail evaporation	Job-Shop Scheduling problem. dynamic problem of data network routing, a shortest path problem
Artificial Bee Colony	Reproduction Replacement of bee, Selection	Scheduling problems, image segmentation, capacitated vehicle routing problem.
Bacterial Foraging Optimization	Reproduction, Chemotaxis, Dispersion , Elimination	machine learning, an application of job shop scheduling benchmark problems,

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V. CONCLUSION

Optimization is the basic criteria for finding optimal and best solution from the possible outcomes. There are various optimization techniques available and could be applied accordingly to give the better results. Main focus is on optimization approach which makes the network more reliable, efficient and without any loss of original link during data transmission. These optimization schemes should be used according to the scenario.

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