Improved Quality of Services in Mobile Ad Hoc Networks (MANETs) using Evolutionary Algorithms

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Abstract--- Path selection process is one of the critical tasks in MANETs. After finding the best path QOS is basic requirement of any network. In this paper for improving QOS we use different Optimization Algorithm like GA, PSO, ACO, and ABC. These all Optimization Algorithms are based on Evolutionary Algorithm and principle of Swarm Intelligence. Some known examples of swarms are bird flocks, fish schools and the colony of social insects such as terminates ants and bees. Use of these insect's intelligent – Evolutionary Algorithms (GA, PSO, ACO, ABC, etc) are developed to solve a computational and complex problem in different area. Entomologists studied SI behavior of insects to model biological swarms, and engineers applied these models as a framework for solving complex real-world problems.

Keywords: Mobile Ad Hoc Networks (MANETs), Quality of Services (QOS), Genetic Algorithm (GA), Partial Swarm Optimization (PSO), Ant Colony Optimization (ACO), Artificial Bee Colony (ABC).

I. INTRODUCTION

A. ROUTING

Routing is the path selection process from source to destination node. For routing between source and destination point will be possible using of different types of routing algorithms. An ideal routing algorithm is one which is able to send the packet data to its destination with minimum amount of delay. It must be adaptive and intelligent enough to make the decisions. The routing tables are every time updated by exchanging routing information between the routers.

B. MOBILE AD HOC NETWORKS

A mobile Ad Hoc Network is a set of mobile nodes which communicate each other via radio waves. MANETs do not need any infrastructure so it's call an infrastructure less network. So these types of networks are very flexible and suitable for several applications. All nodes are changes in arbitrarily; so no any central authority for control them. Then the network is decentralized. Every node in MANETs is free to move independently in any direction. Each node can directly communicate with those nodes whose are in its communication range.

In recent years, a large number of MANET routing algorithms have been proposed. These algorithms all deal with dynamic aspects of MANETs in their own way, using reactive or proactive behavior or a combination of both. The demand for real time and quality of services (QoS) in the network has been increased as the internet expands. However, the service level is sensitive to the characteristics of network transmission, such as delay, bandwidth, packet loss rate and cost.

The role of a QoS routing strategy is to compute paths that are suitable for different type of traffic generated by various applications while maximizing the utilizations of network resources. But the problem of finding multi constrained paths has high computational complexity, and thus there is a need to use algorithms that address this difficulty.

The main advantages of an Ad Hoc network are:-

- Independence from central network administration
- Self-configuring, nodes are also routers
- Self-healing through continuous re-configuration
- Scalable-accommodates the addition of more nodes
- Flexible-similar to being able to access the Internet from much different location [2].

II. TYPES OF MANETS [3]

(1) Vehicular Ad-Hoc Networks (VANET's) VANET is a type of Mobile Ad-Hoc network where vehicles are equipped with wireless and form a network without help of any infrastructure. The equipment is placed inside vehicles as well as on the road for providing access to other vehicles in order to form a network and communicate.

(2) Intelligent Vehicular Ad-Hoc Networks (InVANET's) The main aim of designing InVANET's is to avoid vehicle collision so as to keep passengers as safe as possible. This also help drivers to keep secure distance between the vehicles as well as assist them at how much speed other vehicles are approaching. InVANET's applications are also employed for military purposes to communicate with each other.

(3) Internet Based Mobile Ad-Hoc Networks (iMANET's) these are used for linking up the mobile nodes and fixed internet gateways. In these networks the normal routing algorithms does not apply.

III. EVOLUTIONARY ALGORITHMS

Evolutionary algorithms that try to find a best fit solution given a population based. It is a stochastic search method that mimic of the biological evolution and behaviors of social animals like birds, ants, bees.

Evolutionary Algorithm has been applied on virtually every imaginable area of optimization. Even an incomplete reference Listing here would be ineffective at establishing the basic of prior art. however, the reader who is new to in this field should be aware that successful application of Evolutionary Algorithm have been implemented in industrial scheduling, production mix optimization, financial

forecasting, military planning, anomaly screening, pharmaceutical design, diagnostic device optimization, image and other signal analysis, data mining, video game character development, credit scoring, modeling social conflicts and a long list of other cases.

A. GENETIC ALGORITHM (GA)

The Genetic algorithm is an adaptive heuristic search method based on population genetics. Genetic algorithm introduced by John Holland in the early 1970s. GA try to work on principle of natural selection, as in natural selection over the time individuals with "good" genes survive whereas "bad" ones are rejected .GA collects the possible alternative solutions of a problem as a genetic string [4].

Genetic algorithm is a probabilistic search algorithm based on the mechanics of natural selection and natural genetics. Genetic algorithm is started with a set of solutions called population. A solution is represented by a chromosome. The population size is preserved throughout each generation. At each generation, fitness of each chromosome is evaluated, and then chromosomes for the next generation are probabilistically selected according to their fitness values. Chromosomes of the new generation may have higher average fitness value than those of the old generation. The process of evolution is repeated until the end condition is satisfied. The solutions in genetic algorithms are called chromosomes or strings [5].

Genetic algorithms fall under the heading of evolutionary algorithm. Evolutionary algorithms are used to solve problems that do not already have a well defined efficient solution. Genetic algorithm have been used to solve optimization problems (scheduling, shortest path, etc), and in modeling systems where randomness is involved (e.g., the stock market) [5]. GA is a method for moving from one population of "chromosomes" (e.g., strings of ones and zeros, or "bits") to a new population by using a kind of "natural selection. The selection operator chooses those chromosomes in the population that will be allowed to reproduce, and on average the fitter chromosomes produce more offspring than the less fit ones [6].

The evolution from one generation to the next one involves mainly three steps: fitness evaluation, selection and reproduction [7];

First, the current population is evaluated using the fitness evolution function and then ranked based on their fitness. A new generation is created with the goal of improving the fitness. Simple GA uses three operators with probabilistic rules: reproduction, crossover and mutation. First selective reproduction is applied to the current population so that the string makes a number of copies proportional to their own fitness. This results in an intermediate population.

Second, GA select "parents" from the current population with a bias that better chromosome are likely to be selected. This is accomplished by the fitness value or ranking of a chromosome.

Third, GA reproduces "children" (new strings) from selected parents using crossover and/or mutation operators.

B. PARTICLE SWARM OPTIMIZATION (PSO)

Particle Swarm Optimization (PSO) is a biologically inspired computational search and optimization method developed in 1995 by Eberhart and Kennedy based on the social behaviors of birds flocking or fish schooling. A number of basic variations have been developed due to improve speed of convergence and quality of solution found by the PSO [8].

Particle Swarm Optimization (PSO) is a well-known pervasive optimization technique in artificial intelligence that is based on behavior of social animals such as bees and birds. In the PSO technique each individual member of social colony, like a bird, is called a particle. For example, we observe PSO in a swarm of birds in a field. Their goal is to find the location with the highest density of food. Without any prior knowledge of the field, the birds begin their search in random locations with random velocities [9].

The various steps involved in Particle Swarm Optimization Algorithm are as follows: [10]

Step 1: The velocity and position of all particles are randomly set to within pre-defined ranges.

Step 2: Velocity updating – At each iteration, the velocities of all particles are updated according to,

$$Vi = Vi + c1R1(Pi,best-Pi)+c2R2(gi,best-Pi) \quad (1)$$

In Equation (1), pi and vi are the position and velocity of particle i, respectively; pi,best and gi,best is the position with the 'best' objective value found so far by particle i and the entire population respectively; w is a parameter controlling the dynamics of flying; R1 and R2 are random variables in the range [0,1]; c1 and c2 are factors controlling the related weighting of corresponding terms. The random variables help the PSO with the ability of stochastic searching.

Step 3: Position updating – The positions of all particles are updated according to,

$$Pi=Pi+Vi \quad (2)$$

After updating, pi should be checked and limited to the allowed range.

Step 4: Memory updating – Update pi, best and gi, best when condition is met

$$Pi,best=Pi \text{ if } f(Pi)>f(Pi,best)$$
$$Gi,best=gi \text{ if } f(gi)> f(gi,best) \quad (3)$$

In equation (3), f(x) is the objective function to be optimized.

Step 5: Stopping Condition – The algorithm repeats steps 2 to 4 until certain stopping conditions are met, such as a pre-defined number of iterations. Once stopped, the algorithm reports the values of gbest and f(gbest) as its solution.

C. ANT COLONY OPTIMIZATION (ACO)

ACO, a famous swarm intelligence approach, has taken the inspiration from the social behaviors of real world ants. When multiple paths are available from nest to food, ants do random walk initially. During their trip to food as well as their return trip to nest, they lay a chemical substance called pheromone, which serves as a route mark that the ants have taken [1]. In this algorithm best path for the routing is found out from the pheromone deposited by the ants. Upon finding food, they return back to their nests and simultaneously deposit pheromone along the paths. Therefore, they likely move through these paths and strengthen (update) the existent pheromone. Over time, the pheromone starts to evaporate and strength is reduced. At regular intervals several ants are launched toward the destination node to discover the feasible low cost path to that node from the

source. Each ant in ACO considers two parameters to select its next hop. The first one is the amount of pheromone deposited on the path to the next node, and the other is the queue length associated with the link [2].

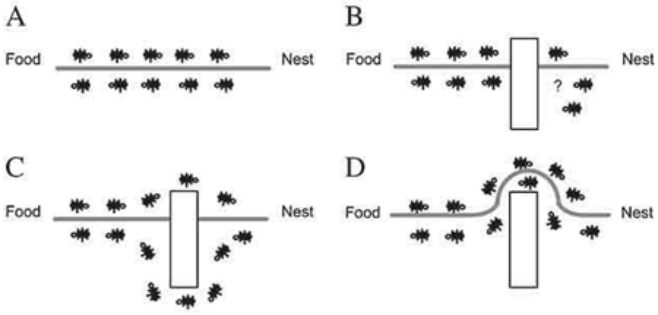

Fig. 1: Path selection by ants

There are main two types of ants. Forward Ant (FA) and Backward Ant (BA). These two ants are same in structure but different in working performance. FA is goes to source to destination like nest to food. In shown in figure (A); simple path between nest to food. So first one ant travel this path and leave one type of chemical substance call pheromone. Depending on this pheromone level other ants also travelling this path; because of this reason pheromone level increases. After sometime if no more ants travel then pheromone level automatic degrading. Now in shown figure (B&C); If an obstacle interrupts puts between the nest and food; then ants find two paths its own intelligence and to go around the obstacle. And last in figure (D); a new pheromone trail is formed along the shorter path.

D. ARTIFICIAL BEE COLONY (ABC)

Bee swarms exhibit many intelligent behaviors in their tasks such as nest site building, marriage, foraging, navigation and task selection. There is an efficient task selection mechanism in a bee swarm that can be adaptively changed by the state of the hive and the environment. Foraging is another critical task for bees. Forage selection depends on recruitment for and abandonment of food sources.

Teodorovic suggested use the bee swarm intelligence in the development of artificial system aimed at solving complex problems in traffic and transportation. For optimizing multivariable functions, Karaboga has described an Artificial Bee Colony (ABC) algorithm which is different from the virtual bee algorithm [11].

Artificial Bee Colony (ABC) algorithm, proposed by Karaboga for real parameter optimization, is recently introduced optimization algorithm and simulates the foraging behavior of bee colony for solving optimization problems.

E. STRUCTURE OF ABC

In the ABC algorithm, the colony of artificial bee contains three groups of bees.

- Employed bees
- Onlooker bees
- Scout bees

In any colony number of EB is equal to number of OB and number of EB is equal to number of food source. In ABC algorithm, each cycle of search consist of three steps.

(1) Sending a employed bee on the food source and measure the nectar amount.
(2) Selecting food source by onlookers after sharing the information of employed bee and determine nectar amount of food.
(3) Determine the scout bees and sending them possible food source.

F. Working mechanism of ABC Algorithm

1) Phase-1 Employed bee initialization phase

A set of food source position randomly select by EBs and their nectar amount are determine. After determining food source they come back on hive and share nectar information through dance. Dances are divided in main two parts.

1) Round dance: The round dance when food is very close. This dance indicates only the direction.

2) Waggle dance: It indicates distance and direction of the food source. The distance between the food source and the hive is transmitted depending on the speed of the dance. If dance is faster then, the food distance is smaller.

2) Phase-2 Employed Bee Neighbourhood selection

After sharing information, every EBs go to the food source area visited by herself in previous cycle since that food source exist in her memory and choose food source by mean value of visual information in the neighbourhood of the present one. Visual information based on comparison of food source position.

3) Phase-3 Onlookers process

An onlooker bee prefers a area for nectar is distributed area by dancing area of Employed bees. Nectar amount of food source increases, the probability with which that food source chosen by an Onlooker increases too.

After arriving a selected area Onlooker chooses a new food source in the neighbour same as a Employed bee.

4) Phase-4 Scout bee

When a nectar food source left by bees, a new food source is randomly determined by a Scout bee and replace with left one. In our model, at each cycle at most one Scout goes outside for searching a new food source and the number of EB=OB [7].

IV. QUALITIES WHOSE IMPROVE USING THESE OPTIIZATION ALGORITHMS

In any network QOS is one the basic requirement and when we talk about the MANET (mobile AD-HOC network), this is the highly constraint requirement of a user. To improve the quality of service we use different changes in MANET protocols, its parameter, routing algorithm etc [3].

The major objectives of QOS routing are

(1) To find a path from source to destination satisfying user's requirements.
(2) To optimize network resource usage.
(3) To degrade the network performance when unwanted things like congestion, path breaks appear in the network [1].

V. CONCLUSION

Wireless Mobile Ad Hoc Networks present difficult challenges like Routing; Network Congestion; collision; Call Jamming problem; Path failure; etc. For the reason of these problems degrade Quality of Services in terms of MANETs. In this paper we present different Evolutionary

Algorithm. All these Evolutionary Algorithm are Optimization Algorithm and use of these algorithm we improve Quality of Services.

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