A Survey of Various Algorithms to Detect Black Hole Attack in Wireless Sensor Network

Soni Rani[1], Charanjit Singh[2]
[*1]Electronics and Communication Engineering,Punjabi University,Patiala,Punjab India[1]
[*2] Professor, Electronics and Communication Engineering, Punjabi University, Patiala, Punjab, India[2]

Abstract **- In today's world, wireless sensor network has numerous applications in military, health and environmental areas due to ease of use and having ability to withstand harsh environmental conditions. These networls are self-administered network in which nodes are self-organized to have reliable communication between them. To have secure communication among various self-organized nodes, security issues are of main concern. There are various types of attacks that vulnerable to wireless sensor network. Black hole attack is very common because it stop communication from source to destination. There are various measures to detect black hole attack in network. This paper focus on various algorithms to detect black hole attack. Algorithms are categorized as soft computing algorithms and AODV routing algorithm.**

Keywords **- Wireless Sensor Network, Black Hole Attack, Genetic Algorithm, ACO, PSO, GSA, AFSA.**

I INTRODUCTION

Wireless Sensor Network is network having self-directed sensor nodes connected through wireless connection. In a WSN, sensor nodes intellect the situation and use their communication modules in order to transmit the sensed data over wireless channels to other nodes and to a selected sink point, denoted to as the Base Station (BS). BS gathers the data transmitted to it in order to act either as a administrative control processor or as an access point for a human interface or even as a gateway to further networks [1,2].

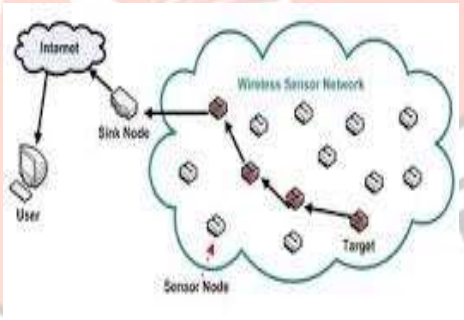

Figure1: Wireless Sensor Network

Wireless Sensor Network is used in various applications like to monitor physical environmental conditions, battlefield applications. So we require security over these network. There are some threats to these network in the forms of various attacks like black hole attack, Sink hole attack, worm hole attack etc. But black hole attack is very common and critical attack because it stops communication from source end to destination end.

Black hole attack is attack in which malicious node sends fake message to source node claiming that it has the optimized fresh and shortest path to send all packets to the required destination node or base station. User sends all its data through this path that is get by falsely information and lost all information.

Security against this attack is challenging problem which can be detect and prevents by various techniques. Several researchers have proposed different detection and prevention techniques. In this paper, we review some natural optimization techniques for detection and prevention of black hole attack. Also explains about AODV routing protocol to secure over this security threat.

In this paper we compare some detection and prevention techniques of black hole attack in wireless sensor network. Section II defines the black hole attack detection using soft computing algorithms. Section III Black hole detection using other algorithms. Section IV defines some parameter analysis of network for black hole detection. Section V gives comparison among algorithms. Section VI gives conclusion.

II BLACK HOLE DETECTION USING SOFT COMPUTING ALGORITHMS

We can detect black hole attack in wireless sensor network using various soft computing algorithms like genetic algorithms, ant colony optimization algorithm, Particle swarm Optimization, BAT algorithm, cuckoo search, gravitational search algorithm, Artificial fish swarm algorithm etc. Soft Computing is very close to nature so its results can be better.

GENETIC ALGORITHM:- Genetic Algorithm is a type of soft computing which works on the two laws i.e. law of selection and evolution. We take problem as model of structure like chromosomes to implement this algorithm. The optimal solution of problem can be find by using this to secure our computer network

The basic functionality of genetic algorithm as follows:-

(i) Identify the population i.e. data set.
(ii) Form chromosomes by individual coding using bits, characters and integers.
(iii) Find the genuine chromosomes by using evaluation function that is on chromosomes.
(iv) To imitate the breeding and evaluation, perform two different operations i.e. crossover and mutation.
(v) The best chromosome is selected towards the fittest function. Fit chromosomes is optimal solution of our problem.

GENETIC ALGORITHM working to detect black hole as shown in figure.

(i) Deploy sensor nodes in the network.
(ii) Define coverage area.
(iii) If packets are not sent by particular node then there is black hole in the network.
(iv) Genetic algorithm is performed as explained above.
(v) Evaluates all the parameters to check the performance of the network.[4]

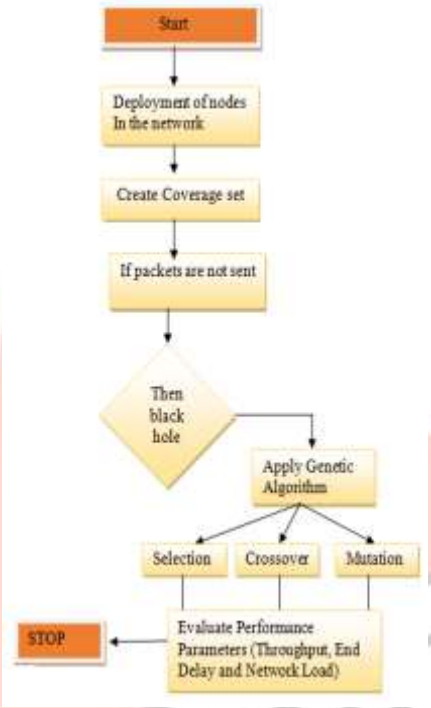

Figure2. Genetic algorithm to detect black hole attack.

CROSSOVER of two parent sequence with Pcr probability and is transported by turn over one segment with corresponding segment at random position. Multiple sites use this to increase its efficiency. As shown in figure below

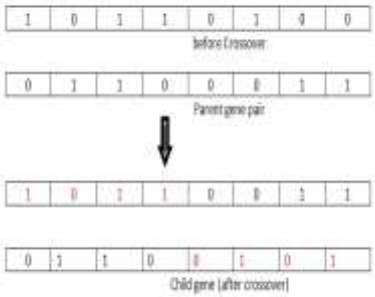

Figure3: Crossover at random crossover location

MUTATION Operation is obtained by swapping the randomly selected bit and p_m is mutation probability is very small. as shown in Figure

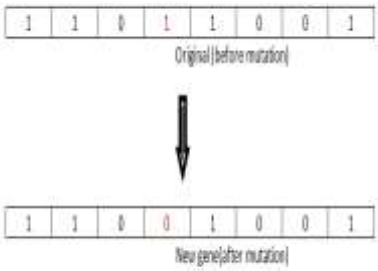

Figure4:. Representation of mutation at a single site by throwing a random selected bit.

ANT COLONY OPTIMIZATION:- The ant colony optimization (ACO) is swarm intelligence based algorithm. It was inspired from the behavior of a real ant colony, which is able to find the shortest path between its nest and a food source [5].
The working of ACO is as follows:
Group of ants construct probabilistic optimized solution to given problem at each iteration under certain conditions to give suitable model. Then local search algorithm is applied to build solutions, which is optional step. Some of these solutions are used for next iteration that are used for any updation in the network.

PARTICLE SWARM OPTIMIZATION: - This nature inspired technique based on social behavior of birds flying in the sky in search of goal (food etc) or fish behavior to get protection from giant fishes [4,5]. While searching food birds adjust their path as per flying behavior of itself and their flock members. Optimization position finds by each member of flock.
Best value achieved by each particle is called fbest and by its neighbor is called gbest. Birds (particles) find their optimum location PSO gives very effective results by varying its few parameters. Birds (particles) find their optimized position by following considerations:-

- The current positions,
- The current directions,
- The distance between the current position and fbest,
- The distance between the current position and the gbest[6]

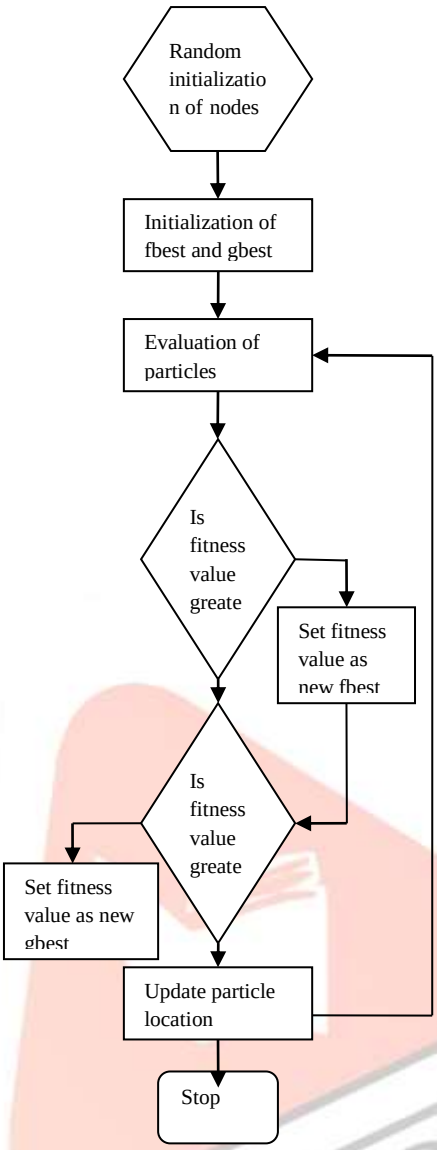

Figure5 : - Flow Chart of PSO algorithm.

GRAVITATIONALSEARCH ALGORITHM: - Gravitational search algorithm is method of soft computing. Through this algorithm, the search negotiations are the entities that can be taken as planets in solar system. These entities are moving using Newton's law of gravitation and results the progress in the swap of information with each other.

Just about every mass (agent) has four specifications: position, inertial mass, active gravitational mass, and passive gravitational mass in GSA. The algorithm improves gravitational and inertia masses with the aid of heavy masses and finds the optimum. This artificial world of masses obeys Newton's law of gravity and motion.
This algorithm can be applied to detect black hole attack in the network by changing its fitness function taking into account of packet loss. Because whenever there is more packet loss in the network then there is the black hole present in that network.
GSA Procedure:-
a) Search space identification.
b) Randomized initialization.
c) Fitness evaluation of agents.

d)Update G(t), best(t), worst(t) and $M_i(t)$ fo i=1,2,.N.
best(t)=min fit(t)
worst(t)=max fit(t)
$m_i(t) = (fit_i(t)-worst(t))/(best(t)-worst(t))$
$M_i(t)= m_i(t)/\sum m_k(t)$ where k= 1 to n
e) Calculation of the total force in different directions.
f) Calculation of acceleration and velocity.
g) Updating agents' position.
h) Repeat steps c to h until the stop criteria is reached.[7]

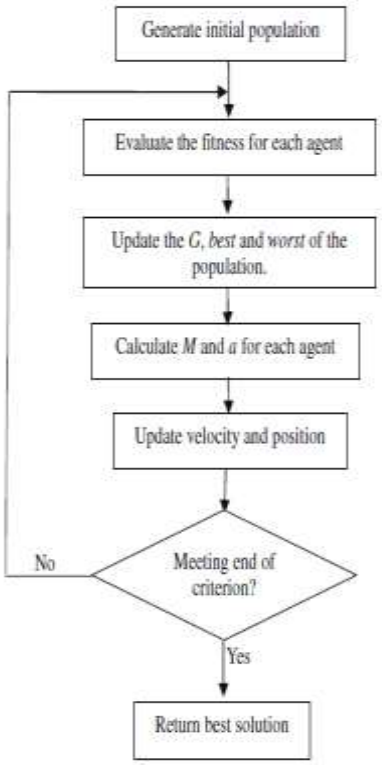

Figure6:- Working of GSA algorithm.

ARTIFICIAL FISH SWARM ALGORITHM: AFSA (artificial fish-swarm algorithm) is one of the finest methods of optimization among the swarm intelligence algorithms. This algorithm is moved by the collective movement of the fish and their various social behaviors. Primarily based on a number of instinctive manners, the fish always try to their colonies and accordingly express brilliant behaviors. Searching for food, immigration and dealing with dangers all happen in a social form and interactions between all fish in a group will bring about in an intelligent sociable behavior.

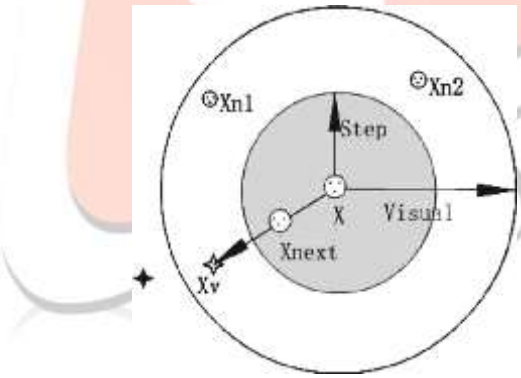

Figure7. Artificial fishes and their environment

The AF realizes external understanding by its vision showed in Figure. X is the current state of a AF, Visual is the visual distance, and *Xv* is the visual position at some moment. In case the state at the visual position is better than the current state, it goes ahead a step in this direction, and arrives the *Xnext* state; otherwise, proceeds an inspecting tour in the vision.

The more number of inspecting tour the AF does, the more understanding about overall states of the vision the AF obtains. Certainly, it will not need to going through complex or infinite positions,[8] which is helpful to find the global optimum by allowing certain local optimum which includes uncertainty.

III BLACK HOLE DETECTION USING OTHER ALGORITHMS (AODV ROUTING PROTOCOL)

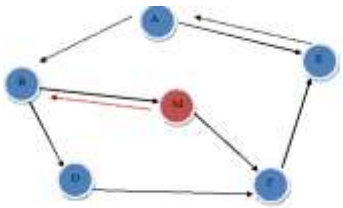

Fig 8 Routing Discovery Process in AODV protocol

AODV can be described as a reactive routing protocol which is a significant on-demand routing protocol, whenever the source node needs a route to a specific destination then only it starts route establishment by initializing a route discovery process. In this process a RREQ packed is forwarded to all the neighbors of the source node by source node itself and this forwarding of packets to the neighbors & their neighbors goes on until the destination node is reached or an intermediate node is reached which is having a fresh enough route to the desired destination. When an intermediate node has an adequate fresh route to the destination then only it sends a reply by unicasting a RREP packet to the node from which it received the RREQ packet. The route maintenance procedure works after selecting & establishing the route is completed needed.
This route maintenance goes on till the destination is available with its every possible passage from the source node or the established route is no more When the route link is lost or faded then a RERR message is used as a notification to make other nodes aware of the loss of the route link.

IV.ACCOMPLISHMENT METRICS

- **Packet Drop** = Number of packets send -Number of packets received.

It is defined as the difference between number of packets sent to the number of packets received. There will be more packet drop in case of black hole present in the network.

- **Packet Delivery Ratio** = Σ Number of packets received / Σ Number of packets sent.

It is defined as the ratio of total number of packets received at particular node to the total number of packets sent from the source node. For better performance of any routing algorithm, packet delivery ratio should be more.

- **End To End Delay**=Σ{arrival time– send time}/ Number of Connections

It is defined as the average time taken by the packets to send from source to destination. There should be less end to end delay to have better performance results.

- **Throughput:-** Within the given time period, the number of packets received by the destination.

V. COMPARISON AMONG ALGORITHMS

S.NO.	TECHNIQUES	DESCRIPTION	PROBLEMS
1.	Genetic Algorithm(GA)	It is soft computing based algorithm works on the best value of chromosomes taken. It has the capacity to manage complex issues. It can deal with different types of optimizations, whether the fitness function is changeable or not changable, constant or broken.	Definition of fitness function, utilization of populous size, the decision of essential parameters such as crossover and mutation.
2	AntColony Optimization(ACO)	ACO is a probabilistic technique useful in problems that deal with finding better paths based on behavior of ants through graphs seeking a path between their colony and source of food. ACO has some advantages as Inherent parallelism, Positive Feedback accounts for rapid discovery of good solutions[7]	Hypothetical examination is difficult, Arrangements of arbitrary choices (not autonomous), research is exploratory instead of hypothetical
3	Particle Swarm Optimization(PSO)	It was produced by Kennedy and Eberhart in 1995 taking into account swarm conduct in nature, for example, fish and winged creature tutoring.PSO has been connected to verging on each range in enhancement computational knowledge, and outline applications. Rather than use mutation/crossover or pheromone, it uses real-number randomness and global communication among the swarm particles The PSO calculation seeks the space of a target capacity by modifying the directions of individual specialists, called particles, as the piecewise ways framed by positional vectors in a semi stochastic way. .	The true best solution calculated by this algorithm is different from true globally found solution of the problem.
4	Gravitational search algorithm(GSA)	Gravitational search algorithm is method of soft computing. Through this algorithm, the search negotiations are the entities that can be taken as planets in solar system. These entities are moving using Newton's law of gravitation and results the progress in the swap of information with each other. It is memory less system and works efficiently with systems having memory.	There are still more enhancements could be done to the structure of GSA and there are a lot of possible hybrid techniques could be explored

5	Artificial Fish Swarm Algorithm(AFSA)	AFSA (artificial fish-swarm algorithm) is one of the best methods of optimization among the swarm intelligence algorithms. This algorithm is inspired by the collective movement of the fish and their various social behaviors. Based on a series of instinctive behaviors, the fish always try to maintain their colonies and accordingly demonstrate intelligent behaviors	High intricacy, be deficient to have equilibrium between global and local search, be deficient to have profiting from experiences of collective members for the next movements.
6	AODV (Ad hoc On Demand Vector) Protocol	Set up connection on demand, Utilizes Destination Sequence Numbers to discover most recent course to destination Requires less time in setting up connection	Different RREPs in light of a solitary RREQ can prompt overwhelming control overhead, Intermediate nodes have stale entries

VI. CONCLUSION

In summary, we briefly examined the different Nature-inspired meta-heuristic algorithms like Genetic Algorithm, Ant colony algorithm, Particle swarm optimization, Gravitational search algorithm and Artificial fish swarm algorithm and one routing algorithms i.e AODV to detect black hole attack in wireless sensor network Here we have also enlightened advantages and disadvantages. of each algorithm .There is undoubtedly that all algorithms reviewed will be applied to detect black holes but they can work more efficiently when we combined them.

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