Performance Analysis of Routing in Wireless Sensor Network Using Optimization Techniques

S. Selvaraj
Department of Computer Science
Periyar University
Salem, India
Selvarajphd2016@gmail.com

R. Rathipriya
Department of Computer Science
Periyar University
Salem, India
rathi_priyar@periyaruniversity.ac.in

***Abstract*- This paper describes the concept of optimization techniques in Wireless Sensor Networks. Wireless Sensor Network consist of many sensor nodes in which each sensor node collects the data from sensing environment and transmit to the base station. Optimization techniques used in wireless sensor networks for minimizing energy consumption generally and for solve routing problems. For improving network lifetime and energy consumption various optimization techniques have been proposed. The paper gives overview of most successful classes of swarm intelligence (SI) based algorithm for solving energy based lifetime optimization problem.**

Keywords- Optimization, Wireless sensor network, Energy efficiency

1. INTRODUCTION

A Wireless Sensor Network (WSN) can be defined as a network of small embedded devices called sensors which transmit wirelessly following an ad hoc configuration. They are placed strategically inside a physical medium and are able to interact with it in order to measure physical parameters from the environment and provide the sensed information. Recent advances in sensing, computing and communication technologies coupled with the need to continuously monitor physical phenomena have led to the development of Wireless Sensor Networks (WSNs). WSN consist of four main components: A radio, a processor, sensors and battery. A WSN is formed by densely deployed sensor nodes in an application area. In most deployments, the sensor nodes have self-organizing capabilities, to form an appropriate structure in order to collaboratively perform a particular task. In Wireless Sensor Networks each node do not save a fixed a huge energy which leads to the permanent failure and reduce the lifetime of the network. So energy efficiency and distance should be considered as major criteria for optimized path selection. This paper is organized as follows: II describes the literature review needed for the research work. Section III discusses them methods and materials required for the study. Section IV concludes the proposed work with possible future enhancement.

2. RELATED WORK

Table 1. Related Work

Author name	Contribution
Mohammad, imad(2010)	The main goal of that study was to maintain network lifetime at a maximum while discovering the shortest paths from the source nodes to the sink node using improved swarm intelligence based optimization.
H.kulkarni,Rahul.A(2010)	In order to conquer the inadequacy of the standard particle swarm optimization, improved means for clustering and routing are adopted, in this work used in this paper.
Ravindranath(2011)	Conventional methods is to prolong the network lifetime as well as minimize the computational time for both sensing coverage and connectivity of the network.
Ruchiaggarwal, Ramandeepkaur(2011)	Optimization techniques used in wireless sensor networks for minimizing energy consumption and for solving routing problems.
Basmafathi, Alaasheta(2012)	The genetic algorithm was able to provide a significant improvement of a node lifetime in many cases. Finally, plan to modify algorithm such that it a mobile environment.
Anandnayyar, Rajeshwarsingh(2012)	The routing protocol for wireless sensor networks is to give a better

	platform for research work on the various shortcomings of protocols developed to date to develop efficient routing protocol.
Sheelasobana rani(2013)	Objectives considered in maximizing network coverage connectivity and network lifetime. A fuzzy rule to construct with the input parameters such as node degree, link residual energy.
Mohammad,mostafa(2013)	The simulation results show that the proposed algorithm reveals the significant effect of both topology construction and maintenance.
Chandramouli, Desai(2014)	The robust and complex real-time applications and dramatically increased sensor capabilities.
Raghavendra,kulkarini(2014)	Wireless sensor networks that arise from communication link features, memory and computational constraints and limited energy.

3. METHODS AND MATERIALS

Swarm intelligence (SI) techniques are heuristic stochastic search processes. SI approaches can be generalized as follows: all approaches are initiated with a set of solutions called population, and then in successive steps, each candidate of the set learns collectively from other candidates and adapts itself in accordance to the solution space. Strategy incorporated and learning mechanism of these techniques mostly mimic the natural facts and phenomena. Such nature inspired mathematical models can be plugged into one framework.

A Swarm can be defined as a set of mobile agents which are likely directly or indirectly communicate with each other and collaboratively solve a distributed problem. Swarm intelligence is the area which deals with nature and system collected individuals that synchronize using self-organization decentralization. There are five fundamental principles to describe swarm intelligence:

- A Principle of proximity: to carry out simple space and time computation.
- A Principle of quality: responding to quality factors in the environment.
- A Principle of diverse response: should not commit activity along excessively narrow channels.
- A Principle of stability: with environment changes should not change its mode of behavior.
- A Principle of adaptability: change behavior mode when the worth of computational price.

The classification of swarm intelligence algorithm is on the basis of the social behavior of animals, human immune system, among which algorithm based on the behavior of animals can be explored as:

3.1. Particle swarm optimization

The Particle Swarm Optimization algorithm, originally introduced in terms of social and cognitive behavior by Kennedy and Eberhart (1995) solve problems in many fields, especially engineering and computer science. The individuals, called particles hence forth, are flown through the multidimensional search space with each particle representing a possible solution to the multidimensional optimization problem. Each solution's fitness is based on a performance function related to the optimization problem being solved. The movement of the particle is influenced by two factors using information from iteration-to-iteration as well as particle-to-particle. As a result of iteration-to-iteration information, the particle stores in its memory the solution visited so far, called p best, and experiences an attraction towards this solution as it traverses through the solution search space. As a result of the particle-to-particle interaction, the particle stores in its memory the best visited by any particle and experiences an attraction towards this solution, called gbest as well the first and second factors are called cognitive and social components, respectively. PSO based algorithm is used to locate the optimal sink position in the nodes to make the network is more energy efficient. Some of the techniques are used to improve the network lifetime of Wireless Sensor Network. PSO is more robust and easy to achieve the solution for the real world (A.Mishra, 2012)

3.2. Genetic Algorithms (GA)

Genetic algorithm (GA) based on biological evolution and genetics is a kind of random searching method, developing by natural selection and evolutionary mechanism. It mainly includes three operators of choice, crossover, and mutation. Because of its simplicity, currency and strong robustness, a genetic algorithm is used widely in optimal scheduling, data mining, combination optimization and other fields . The steps of the algorithm are as the following:

- Choosing encoding methods and expressing the feasible solution as genotype string structure in the genetic space.
- Defining the fitness function f(x).
- Confirming genetic strategy, choosing the number of initial population, selection operators, cross-operator and mutation operator, cross probability, and mutation probability, the evolution terminate way.
- Initializing the population, calculating the fitness.
- Evolving into the next generation group by the genetic strategy.

3.2.1. Ant colony optimization

Ant colony Optimization was discovered by M. Dorigo and colleagues for finding the solution to varied hard co problems in the early 1990s. The basic foundation of ACO algorithms is real ant colonies. Ant roams randomly in the environment to determine food source and find the shortest path between source and nest. In order to exchange information regarding which path to follow, ants communicate via the use of chemical substances called pheromone. An ant moves from the same trial, laying the trail of pheromone. The trail becomes more attractive when followed by the huge majority of ants. Using this mechanism, ants are able to transport the food from source to nest in an efficient way ((Heo, 2012).

3.3. Firefly optimization

Firefly Optimization algorithm is the Meta heuristic algorithms proposed by Dr. Xin She yang at Cambridge University in 2007. It finds the Particle Position and mainly depends upon these methods (Billing & Zhu, 1994).

- All fireflies are unisex. These attract to each other on the basis of flashlight.
- The attractiveness of fireflies on basis of light directly proportional to its brightness.
- If the distance between fireflies increases means light intensity decreases.
- Objective function related to the brightness of Firefly. According to inverse square law intensity of light(I) decreases as distance r between fireflies increases. Intensity (I) inversely proportional to the radius as: I α $\frac{1}{r^2}$
- Firefly algorithm mainly depends on light intensity and attractiveness. According to the inverse square law I(r)=I_s/r^2 where I_s Intensity of source and r radius (distance between fireflies). Light intensity changes with changes in distance as r changes. The Firefly algorithm improves network lifetime and the throughput of the network with a selection of CH basis of residual energy and nodes in cluster coverage selected on basis of distance.

3.4. Cuckoo Search algorithm

This algorithm highlights the brood parasitism behavior of cuckoo bird with the cuckoo search algorithm. The sounds produced by cuckoos are always a wonder to listen. It is an inspiration to Indian light music. One astonishing nature of these birds is the brood parasitism behavior, a peculiar behavior of the birds belonging to family cuculiadae. The brood parasites character includes a cuckoo bird laying eggs in the nest to increase the hatching chances. Even they lay eggs in other bird's nest, which belongs to some other species. Some species of cuckoo can even mimic the color and pattern of the host bird's egg so that the probability of the egg being detected is reduced. They choose a nest with eggs just laid for increasing the chances of hatching of their eggs. The fight behaviors of these birds show a levy flight distribution (8 (Yunxia, 2014) The algorithm is based on the following bird's behavior aspects:

- Each cuckoo lays one egg at a time and dumps its egg in randomly chosen nest.
- The best nests with high quality of eggs will carry over to the next generations.
- (Yunxia, 2014)The numbers of available host nests is fixed and the egg laid by a cuckoo is discovered by the host bird with a probability ofp_a ∊ $[0,1]$, the host bird can either throw the egg away or abandon the nest and build completely a new nest.

3.5. Artificial Bee Colony

The ABC algorithm, a new swarm intelligence method inspired by the intelligent foraging behavior of honey bees, is used for the dynamic deployment problem. The aim of the optimization technique is to maximize the coverage rate of the network. The coverage ratio of the WSN is calculated by E

q(1): $= \frac{U_{ci}}{A}, i \in s$, in the network's scenario, it is assumed that:

- The detection radii of the sensors are all the same (r).
- All of the sensors have the ability to communicate with the other sensors.
- All sensors are mobile.

In the ABC algorithm, 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. Therefore, the deployment of the sensors in the sensed area (each solution of the deployment problem) refers to a food source in the algorithm. The coverage rate of the network is the total coverage area corresponds to the fitness value of the solution. In the ABC model, artificial bee colonies, in which the goal of the bees is to find the best solution, comprise 3 groups of bees: employed bees, onlookers, and scouts. A bee waiting in the dance area to determine the choice of a food source is an onlooker and when a bee goes to a previously visited food source, it is an employed bee, a bee that carries out random searches is called scout (geeta, 2014).

3.6. Bat Algorithm

A bat algorithm, which uses social behaviors of the bats to form solution for the optimization problem is getting popular in now days. Bat is the only mammals which have wings and uses echolocation to find the prey. But having the capability to sense echolocation and differentiate between the food and other objects. Bats emit loud sound and sense reflection of that sound to recognize objects. Bats fly randomly, with random velocity and frequency and varying wavelength and adjusting their wavelength according to the position of the prey. Bats poses advanced capability some bats can have advanced vision. Bats can hunt without seeing the object.

Bats are enthralling mammals with hand wings and they also have the echolocation capability. There are approximate 1000 bat species can be found worldwide. The smallest bat measures only 2.5 inches known as the canyon bat while the largest bat is up to 7.5 inches, world's 70% Bats are feed on insects and remainder Bat feed on fruits, fishes, frogs, lizards, birds etc.., The world's 0.01 % bats are feed on blood, found in south America. The Bats are not blind, they can see almost as well as humans. They use a type of sonar rays which called Echolocation to find prey, avoid obstacles, shelter etc.., when the bats are hunting for prey, the pulse emission rate can be seep up to about 200 pulses per second when they fly near their prey. The Bats are used the time delay between the emission and detection of the echo behavior (Yunxia, 2014).

3.7. Differential Evaluation

DE is successfully applied to a remarkable number of NP-hard problems because of search through vast spaces of possible solutions. Clustering a network to minimize the total energy dissipation is an NP-hard problem. For the total number of sensor nodes in WSN is N, a sensor node is either elected as CH in each solution, that there are $2^N - 1$ different combination of solutions for the WSN. Storm and Price (1995) firstly proposed the differential evolution (DE) which has become one of the most frequently used evolutionary algorithms for solving the global optimization problems compared with most evolutionary algorithms, DE is based on a mutation operator, which adds an amount obtained by the different of two randomly chosen individuals of the current population (j.pan, 2012).

3.7.1 Mutation

The most popular mutation strategy is generated according to the following equation: $y_i(t) = x_i(t) + f_m[x_{i_2}(t) - x_{i_3}(t)] i = 1,2 \dots . N$ is the individual's index of population; $x_{i_1}, x_{i_2}, x_{i_3}$ are randomly chosen vector from the sets $\{x_{i_1}, \ldots, x_{N_p}\}$; N_P is the population size; the mutation factor f_m is a parameter in [0,1], which controls the amplification of the difference from two individuals so as to avoid search stagnation.

3.7.2 Crossover

Crossover operations are applied to increase the potential diversity to the population which uses binomial crossover scheme. The binomial crossover constructs the trial vector by taking, in a random manner, element either from the mutant vector $x_i(t)$ or from the current element $y_i(t)$ described as in equation (1).

$$\widehat{y_i^j}(t) = \begin{cases} y_i^j(t) & if \;\; rand(0,1) <= CR \; or \; j = I_i \\ x_i^j(t) \; otherwise \end{cases} \tag{1}$$

I_i is a randomly selected index from {1,2,….n}which ensures that at least one component is take the mutant vector $y_i\,(t)$. The parameter CR is a user specified constant within the range[0,1] which controls the number of components inherited from the mutant vector and influences the convergence speed.

3.7.3 Selection

When all N trial points $\widehat{y_i}\,(t)$ have been generated selection operator is applied. We must decide which individuals between $x_i(t)$ and $\widehat{y_i}\,(t)$ should survive in the next generation$x_i(t+1)$. In addition the DE dynamically tracks current searches with, its unique memory capability to adjust its search strategy. DE has comparatively strong global convergence capability and robustness and no need with the help from information about the characteristics of the problem.

3.8. Glowworm Swarm Optimization

In GSO, a swarm of glowworms is randomly distributed in the search space of object functions. The agents in the glowworm algorithm carry a luminescence quantity called luciferin along with them. Each glowworm is attracted by the brighter glow of other neighboring glowworms. A glowworm identifies another glowworm as a neighbor, when it is located within its current local-decision domain. The glowworm's luciferin intensity is related to the fitness of their current locations. The higher the intensity of luciferin, the better is the location of glowworm in the search space. In each iteration, all the glowworms position will change, and then the luciferin value also follows updates. Each iteration consists of a luciferin updates phase followed by a movement phase based on a transition rule (Liu.y & Liang.W, 2014)

- Luciferin update phase: At time t, the location of the glowworm$i$ is $x_i(t)$, and its corresponding value of the objective function at glowworm is located at time t is $J(x_i(t))$. The luciferin level associated with glowworm i at time is given by equation(2) ,Where p is the function luciferin decay constant (0<p<1), γ is the luciferin enhancement constant.

$$l_i(t) = (l - p)l_i(t-1) + \gamma J(x_i(t)) \tag{2}$$

- Movement phase: Find the neighbors j for each glowworms i: $\mathrm{N_i(t)}$ using equation (3)

$$j \in N_i \; if \; f \; Distance_{ij} < rd_i(t) \; and \; l_j(t) > l_i(t) \tag{3}$$

Each Glowworm i moves towards a neighbor j with a certain probability computed by equation (4)

$$p_{ij}(t) = \frac{l_j(t) - l_i(t)}{\sum_{k \in N_i(t)} l_k(t) - l_i(t)} \tag{4}$$

The glowworm i position is updated using equation (5)

$$x_i(t+1) = x_i(t) + st * \left(x_j(t) - x_i(t)\Big| \Big|x_j(t) - x_i(t)\Big|\Big|\right) \tag{5}$$

Where st is the step size.

- Local decision range update rule: The neighborhood range is updated using equation (6)

$$rd_i(t) = \min\{rs, \max[0, rd_i(t-1) + \beta(nt - |N_i(t-1)|)]\} \tag{6}$$

Where β is a constant parameter and nt is a parameter used to control the number of neighbor.

3.9. Evoluationary Algorithms

3.9.1 Genetic Algorithms (GA)

Genetic algorithm (GA) based on biological evolution and genetics is a kind of random searching method, developing by natural selection and evolutionary mechanism. It mainly includes three operators of choice, crossover, and mutation. Because of its simplicity, currency and strong robustness, a genetic algorithm is used widely in optimal scheduling, data mining, combination optimization and other fields . The steps of the algorithm are as the following:

- Choosing encoding methods and expressing the feasible solution as genotype string structure in the genetic space.
- Defining the fitness function f(x).
- Confirming genetic strategy, choosing the number of initial population, selection operators, cross-operator and mutation operator, cross probability, and mutation probability, the evolution terminate way.
- Initializing the population, calculating the fitness.
- Evolving into the next generation group by the genetic strategy.

Table 2 describes the various optimization's meta-heuristic summary of first applied to mechanism of exploitation, mechanism of exploration, communication model in wireless sensor network.

Table 2. Meta-heuristic Summary

Algorithm	**Inspiration**	**First applied to**	**Mechanism Of Exploitation**	**Mechanism of Exploration**	**Communication Model**
PSO	Behavior such as flock of animals	Distributed Optimization	Avoidance of falling into local optima.	The inertia weight manipulates the trade-off between the flying points.	Broadcasting like
Genetic Algorithm	Genetic process of biological organisms	Continuous Optimization	Recovery of genetic algorithm is to generate the (N-M) number of new individuals.	The number of individuals do not meet the fitness value will be eliminated from the population.	Broadcasting like
ACO	Foraging Behavior	Continuous Optimization	Robust indicator, Memory model to record previous regions completely transfer the neighborhood structures to the next iteration.	Not robust indicator, Memory model to record previous search regions did not completely transfer the neighborhood structures to the next iteration.	Broadcasting like
FFO	Attraction on the basis of flash light	Continuous Optimization	Fire flying movement according to attractiveness	Random move to the best firefly	Broadcasting like
Cuckoo	Brood parasitism behavior.	Continuous Optimization	It lose iteration to find local optimum and perform poor convergence to the local optimum	It does not lose iteration to find the global optimum and perform good convergence to the global optimum.	Broadcasting like
BAT	Behavior of bat echolocation	Continuous Optimization	Low loudness and high pulse rate value.	High loudness and low pulse rate value.	Broadcasting like
ABC	Bee foraging	Continuous Optimization	Neighborhood search in good food sources.	Random search of scout bees.	Broadcasting like
DE	NP- D Dimensional Real – valued vector.	Continuous Optimization	Low Convergence speed but a good performance.	High convergence speed but a poor performance.	Direct
GSO	Behavior of lighting worms.	Continuous Optimization	Give a swarm position update.	Find neighbor phase discussed by sensor image.	Broadcasting like

It gives the clear picture about operator and control parameter of various optimization algorithm mentioned in this paper. Fourth row of the table 3 shows how node deployment is done in each optimization algorithm. The last two rows list the advantage and disadvantage of the optimization with respect to energy efficiency in wireless sensor network. From this study, it is known PSO and GA algorithm are used frequently and produced the better result for the energy consumption in wireless sensor network. Table 3 describes the various optimization techniques used in Wireless Sensor Network, for the optimization. Table 4 describes fitness function used in various algorithms. Table 5 describes various optimization parameter.

Table 3. Optimization Technique in wireless sensor network.

Parameters	**PSO**	**GA**	**ACO**	**FFO**	**Cuckoo**	**BAT**	**ABC**	**DE**	**GSO**
Representation	Dimensions for vector position and speed	In binary forms as 0's and 1's random variables	Undirected Graph	Attraction on basis of distance r	Brood parasitism behavior	Echolocation behavior of bats	Foraging behavior of honey bees	NP D-dimensional Real valued parameter vector	It stimulates the behavior of lighting worms.
Operators	Initial value updates and evaporation	Selection, Crossover, Mutation	Pheromone updates and trail evaporation	Light intensity attraction	Levy flight distribution	Fitness node as CH and distance by bat's loudness parameter	Initialization phase, Employed Bee Phase, Onlooker Bee Phase, Scout phase.	Initialization, Mutation, Crossover, Selection	Luciferin update phase, Movement phase, Local decision range update rule.
Control parameters	Particles position, number of particles, Range , Weight, Number of iterations	Population n size, Selection procedure, Crossover, Mutation Probability, Chromosomes	No of ants iterations, Pheromone evaporation rate	Attraction of fireflies, Light intensity	Population of n host nests, Levy fight distribution to evaluate fitness function	Population of n bats, loudness, pulse rate, frequency, velocity, Location.	Detection radius r, size of area A, no of mobile sensors m, colony size cs, maximum no of iterations Max cycle and limit for scout l.	Population n size, Initialization, Mutation, Crossover, Selection	Probability value of glowworm, Euclidean distance between glowworm, Luciferin intensity.
Node deployment	Centralized nodes deployment used to determine local best and global best position	Random as well as deterministic manner	Node deployed in distributed nature used in dynamic applications	Nodes deployed in random manner	Node deployed in optimal position with improved coverage	Node deployed in random and distributed manner	Node deployed in random manner.	Node deployed in random manner	Node deployment can maximize the coverage of sensors with limited movement after an initial random deployment.
Clustering and routing	Select higher energy nodes as CHs in every round and find optimal path	Reduce communication distance with formation of number of predefined of clusters	Find shortest path from source to destination and data transmission	Select nodes in cluster on basis of distance	Clustering mechanism is to reduce the communication overhead by balancing the energy consumption employing forms of split and conquer policy	Cluster formation depends upon the distance between the nodes and it should be less than bat's sensing range.	It optimizes the routing paths, providing an effective multi-path data transmission to obtain reliable communications in the case of node faults.	Clustering a network to minimize the total energy dissipation in an NP- hard problem	Self-organization and lifetime optimization by means of routing in WSN.
Advantages	1. It determines l-best and g-best position. 2. Inherently continuous, no overlapping and mutation calculation.	1. Handle Complex problems and parallelism. 2. Discrete	1. Can be used in dynamic applications 2. Better for travelling salesman problem	1. Effective in multi objective optimization	1. It solves problem like improving the network lifetime, steady-phase communication overhead energy is considered for calibration and comparison in WSN.	1. The loudness and pulse emission rates essentially provide a mechanism for automatic control and auto-zooming into the region	1 Ability to handle the objective cost. 2 Ability to explore local solution.	1. Handle met a heuristic problem 2. Effective for global optimization over continuous spaces. 3. Search for large spaces of candidate solutions.	1. Reduce the number of overlapped sensors, therefore minimizing the redundancy of the coverage area.
Disadvantages	1.It cannot work well for scattering and optimization 2. Not work well for non-coordinate system.	1. Dynamic data sets difficult to operate	1. Local search is not sufficient. 2. Consume large amount of energy if more number of paths.	1. It works only for randomly deployed nodes.	1. It is easy to fall into local boundary optimal value, the parasite nests are generated randomly when exceeding the b orders	1. If we allow the algorithm to switch to exploitation stage, it may lead to stagnation after some initial stage	1. The population of solutions increases the computational cost. 2. Slow down when used in sequential processing.	1. The fitness population never deteriorates. 2. DE did not guarantee an optimal solution.	1. Battery life is reduced with time due to data transmission, reception and movement of sensors.

Table 4. Fitness function used in various algorithms.

Author name	Description	Fitness function
Chander,diwaker(2016).	PSO algorithm modeled on swarm intelligence that locate an explanation to an optimization crisis in a search space, or model and expect public activities in the existence of objectives.	A hybrid approach of ACO and PSO is applied to deploy the gateway easily which in turn saves time and energy and by applying fitness function onto particles to enhance network lifespan.
Guangshun Yao(2016).	GA algorithm is an efficient search algorithm that simulates the adaptive evolution process of natural systems. It has been successfully applied to some issues about wireless sensor networks, such as optimization of clustering deployment of sensor nodes for coverage and selection of data fusion node.	The remainder available energy function of each node, distance function of the edge between adjacent node, energy consumption function of the edge between adjacent nodes.
Dervis Karaboga(2011)	Artificial bee colony algorithm is applied to the dynamic deployment of mobile sensor networks to gain better better performance by trying to increase the coverage area of the network. The good performance of the algorithm shows that it can be utilized in the dynamic deployment of wireless sensor networks.	Wireless sensor networks nodes operate on limited battery energy efficient utilization of the energy is very important. Network lifetime is highly related to the route selection is one of the main distinctiveness of these networks.
Selcuk Okdem(2009)	ACO algorithm to optimize routing paths, providing an effective multi-path transmission method to achieve reliable communications in the case of node faults. The aimed to maintain network life time at a maximum, while data transmission is achieved efficiently, so an adaptive approach is developed according to this goal.	The primary challenge for every routing protocol deployed in sensor nodes is energy efficiency. Sensor nodes exhaust the energy while performing varied tasks like sensing, computation and transmission. Ant Colony Optimization, a multi-path based routing protocol more efficient in packet delivery, end- to-end delivery, less routing overhead and energy efficiency will be developed.
Alaa kamal, m.n mohd(2011)	Differential Evaluation algorithm because is a simple and presented wide solvers for real-valued parameter. Moreover, concern to minimize the power consumption, and maximize the throughput and packet delivery ratio.	Fitness value we mean a lower value of the objective function in case of a minimization problem, and a higher value of the same if it is a maximization problem. To increase the potential diversity of the population, a crossover operation comes into play after generating the donor vector through mutation.
Marwa Sharawi(2012)	Bat swarm optimization algorithm is of the most recent invented and efficient meta-heuristic population based soft computing algorithms. It exposed as a meta-heuristic swarm intelligence optimization method developed for the optimal numerical optimization. Variation of the loudness parameter takes values between large loudness and minimum loudness.	The techniques shows very promising results as the after a number rounds the network reach a stability period with a fixed defined number of live nodes. The death of 50% of the nodes indicates the consumed amount of the initial energy.
Soumitra Das(2017)	Cuckoo search is a meta-heuristic optimization method for solving problems to provide optimal solution. The same can be compared with wireless sensor network, where we need to maximize the lifetime of the network and minimize the delay in data transmission.	The future we can consider more parameters and metrics components to improve network performance by considering other properties of the wireless sensor network, cuckoo search and multi-objective genetic algorithm. Also proves that the proposed method is better than leach algorithm and increases the lifetime of the network.
Asha Gowda Karegowda(2013)	The agents in the glowworm algorithm carry a luminescence quantity called luciferin along with them. Each glowworm is attracted by the brighter glow of other neighboring glowworms. A glowworm identifies another glowworm as a neighbor, when it is located within its current local-decision domain. The glowworms' luciferin intensity is related to the fitness of their current locations. The higher the intensity of luciferin, the better is the location of glowworm in the search space. In each iteration,	A sensor node is attracted towards its neighbors having lower intensity of luciferin and decides to move towards one of them. In this way, the coverage of the sensing field is maximized as the sensor nodes tend to move towards the region having lower sensor density. The approach has the advantage that it does not need centralized control and hence, it is easily scalable for large sensor networks.

Author name	Description	Fitness function
	all the glowworms position will change, and then the luciferin value also follows updates.	
A.Rekha, Yogarajan(2016)	Firefly algorithm is reducing those individual nodes/residual nodes so as to optimize the energy consumption to minimum. With the help of firefly algorithm, clustering is carried out until all the nodes become the member of any of the cluster. The performance of the Firefly algorithm in terms of Number of Individual nodes, Total Energy Consumption, Packet Delivery Ratio and Network Lifetime is compared with the PSO algorithm.	A sensor node is attracted towards its neighbors having lower intensity of luciferin and decides to move towards one of them. In this way, the coverage of the sensing field is maximized as the sensor nodes tend to move towards the region having lower sensor density. The approach has the advantage that it does not need centralized control and hence, it is easily scalable for large sensor networks.

Table 5. Algorithm Parameter

Algorithm	Parameter
PSO	Swarm Size (n), Acceleration Coefficient (c), Max velocity limit (V_{max}), Decreasing inertia (ω), Max Cycle.
GA	Population size (n), Mutation rate (CR), Max Cycle (K)
ACO	Destination Address (DA), Next Hop (NH), Pheromone value (PH)
FFO	Light intensity (I), Distance (r), Residual energy (e).
Cuckoo	Flock size (n), Nb. to be considered (k), Nb. to be shared (x), Max Cycle (k)
BAT	Micro bat length (inches), Weight (g), Echolocation (sonar rays), Frequency Range (KHZ), Pulse Emission (pulses/sec)
ABC	Colony size (n), detection radius (r), size of area of interest (A), number of mobile sensors (m), Max cycle, limit for scout (l).
DE	Swarm size (n), Amplification constant (F), Crossover Constant (CR), Max cycle (K)
GSO	Lucifer in decay constant (p), step size (st), number of neighbors (tn), constant parameter (β).

4. CONCLUSION AND FUTURE WORK

This work brief about some of the popular optimization techniques such as GA and PSO. These optimization techniques are used very frequently for optimizing the energy parameter for better or optimal energy consumption in wireless sensor network. The main purpose of this paper is to showcase how each optimization algorithm is tried for optimal energy consumption in wireless sensor network.

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