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Performance of Particle Swarm Optimization for Sensor Networks: A Survey

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***Abstract*—** The Quality of Service provided by any network is affected by some specific factors. An efficient network achieves its goal by solving all the challenges and satisfies the factors. Many researchers develop several approaches, protocols, techniques, algorithms and methods to improve the performance of network. In this paper, we have conducted a survey to understand the problems of sensor network. The Swarm Optimization Algorithm is reviewed to solve these problems. We analyze that the particle swarm optimization is a capable algorithm to optimize each and every NP hard problems and develops an efficient network.

***Keywords*—** Performance, Quality of Service, Swarm Optimization Algorithm, Wireless Sensor Network

I. INTRODUCTION

The advanced technology gives us the cheap and effectively service providing systems. In the current time, the small-sized wireless sensor networks those consume less power are available to provide better quality of service. The basic work of sensor network is to sense, process and collect data from any specific environment. The main part of the whole network is the nodes those are used to send the data to sink node for future purposes. The Wireless Communication technology has very vast level useful applications such as for military purposes, industrial areas, health, home purposes and transportation. The nodes are working on the power of battery that is supplied to it. In various situations it is difficult or not possible to change the batteries after the batteries become dead [7]. To make a sensor network an efficient one, many developed methods, protocols, techniques and algorithms are required [4]. Many experiments have been done on WSNs by using developed techniques, and algorithms to justify the optimal solutions of the problems of sensor networks. The issues regarding the WSN are such as Power/Energy Consumption, Coverage Rate, Routing and Network Lifetime. All of the above mentioned problems affect the quality of service of wireless network. The main objective of this paper is to study and understand problems of wireless sensor network and realize the importance of Swarm Optimization algorithm in the wireless sensor network [6].

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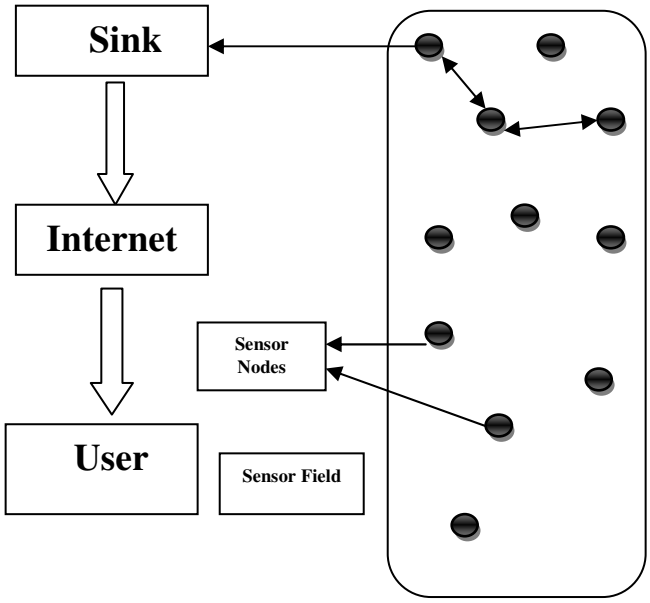

Fig. 1 Sensor Network [16]

II. SWARM OPTIMIZATION ALGORITHM: AN OVERVIEW

The solution of any problem depends upon the decisions making that provides the optimal results. The optimization algorithms are used to achieve the best solutions. An optimization algorithm was invented in 1940s, when the British military faced the allocation problem of limited items to the several activities [4]. The optimization techniques are also known as nontraditional optimization

techniques. These methods are genetic algorithms (GA), particle swarm optimization (PSO) algorithm, ant colony optimization, fuzzy optimization, and neural networks [2] [5]. In 1995, Dr. Kennedy and Dr. Eberhart introduced the PSO algorithm (Particle Swarm Optimization algorithm). The simplicity and mathematical operators makes this a popular algorithm. Swarm Optimization is able to solve the discrete, non-linear, integer variable type, and continuous problems.

A. *PSO Algorithm Parameters*

Some of the parameters affect the performance of the swarm optimization algorithm, and sometimes these factors have little effect on quality of service [3]. The effect of parameters depends upon the type of problems for which the PSO is being used. The basic parameters are as follow:

1) *Swarm size:* The main part is the particles; a swarm is the collection particles. The number of particles represents the size of swarm. The large swarm size provides a large search space. The large search space helps to achieve good results but it takes much computational time which increases the execution time. From empirical studies, most of the time an interval of $[20,60]$ is used as size of swarm.

2) *Iteration numbers:* The number of iterations decides the optimality of results. Low numbers of iterations stop the process prematurely. The large number of iterations increases complexity [1]. The iterations should be average.

3) *Velocity Component:* The velocity is the main component. The particles moves and change their positions according to the velocity. The following are the sub-parameters of velocity component.

Table1: Velocity Parameters

Parameters	Description
Weight Inertia	It remembers the previous movements.
Cognitive Component	Measures the performance of particles.
Local Best	Measure the performance relative to neighbors.
Global Best	Measure the performance relative to a group of particles.

III. WORKING OF ALGORITHM

A. *Flow of Algorithm*

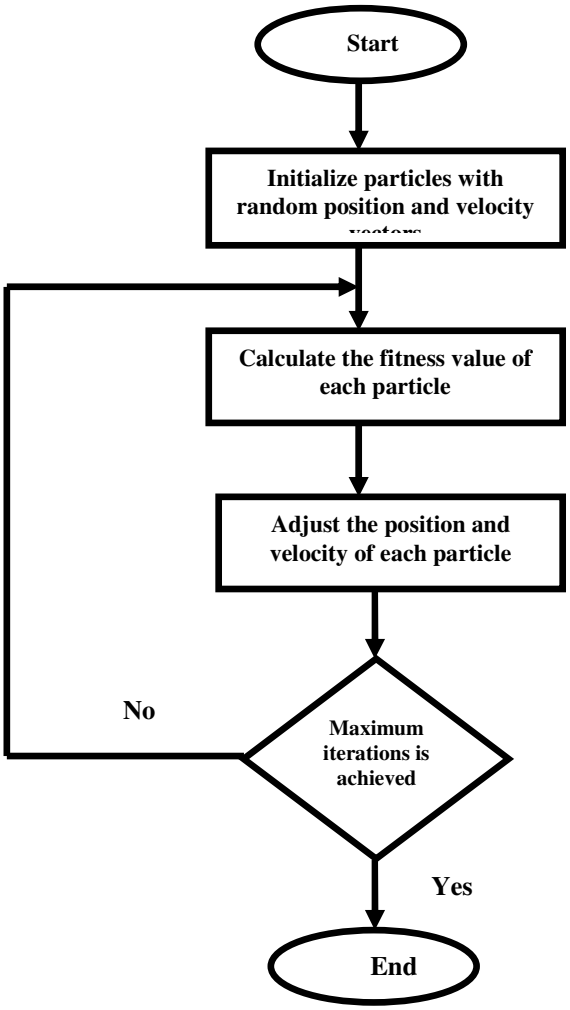

Fig. 2 Flow of Particle Swarm Optimization

B. *Steps of Optimization*

It is basically learned from the behavior of animals. In this optimization algorithm, the population is known as swarm and each member of the population is known as particle.

1. Initial population is randomly generated and movement is also in directions those are randomly selected.
2. Each particle moves to the directions by passing the search space. While moving, each particle remembers the best positions of its own and its neighbors.
3. The positions and velocity of swarms are adjusted dynamically. The new positions and velocities are derived from the best positions of all swarm particles.
4. The iterations are performed.
5. In the last step, all particles moved towards the better positions.

6. Till the swarm is not moved close to the optimum positions the iterations are performed.

IV. LITERATURE REVIEW

Bagherinia et al. in **[8]** develops new hybrid method based on PSO and DE Algorithms to solve the coverage rate problem of Wireless sensor networks. The results of hybrid technique are analyzed and compared with the results of Simple Swarm Algorithm under similar conditions. The results represents that the proposed hybrid algorithm gives long lifetime of the network than PSO. The consumption of energy reduces and the coverage increases. The performance of the hybrid algorithm is better than the PSO algorithm.

Jie et al. in **[9]** develop a new algorithm named as Virtual Force CPSO. It is based on CPSO algorithms and on the Virtual Force algorithm. More number of swarms is used to optimize the solutions. The current velocity of particles is calculated from the previous velocities and also from the virtual forces of nodes. The result of this paper shows that Virtual PSO is effective than other algorithms. Virtual Force CPSO gives good coverage rate and less execution time. The performance of Virtual Force CPSO algorithm is stable. The placement of hybrid technique of WSNs is rapid, effective and robust.

Pradhan et al. in **[10]** presents a new method for energy efficiency. The nodes send their data through a high energy node to sink node which is known as relay node. Multi objective algorithm is developed for and energy efficient layout of network. Sensors movement is performed to make a uniform network. The two objectives such as Coverage, Lifetime of network is considered to optimize. It shows that the results are improved with the increase of generations of the algorithm.

Vahe et al. in **[11]** discussed a multi-objective optimization technique for designing of wireless sensor network. Clustering methods and range of sensing is optimized to reduce the energy consumption which depends upon the number of working nodes and distances between nodes. Fitness function is the sum of values of all the considered parameters. In the fitness function the value of energy parameter is trying to minimize and maximize the density. The algorithm is used for homogeneous network. The goal of study is to obtain the best mode of operation for each node. The sensor network designed by this algorithm satisfied all the required parameters of the network.

Devarajan et al. in **[12]** develops a multi-objective algorithm based on Swarm Optimization. The fuzzy based optimization model is also studied. The objectives of this paper are to maximized coverage, Network lifetime and Connectivity. Three nodes are such as good, normal and bad are used. Initially, good nodes are placed. The proposed technique is applied for the remaining nodes. The fitness function is affected by the longer and shorter distances. The results give better packet delivery ratio, less delay, and less energy consumption, Efficient and accurate node deployments.

Ammar et al. in **[13]** proposes a new method based on Voronoi diagram. Swarm Optimization is used to get the best positions. Voronoi diagram is used to evaluate the fitness function. The results give good coverage in efficient time. The computation is affected by the number of nodes in the network. This technique is used for a large network or Region of Interest. The grid method is used for the small network. The execution time in this technique does not matter.

Natalizio et al. in **[14]** studied two different versions of the newly proposed algorithm. One is the global version that allows nodes to use information of the whole sensor area and the other is a local version based only on neighborhood information. Sensors collect data from events in the field and the movement is based on neighborhood nodes. The behavior of the algorithm is tested by energy consumption. The results show that the sensors are capable to get a remarkable coverage of the interesting zones. There is a drastically reduction in the energy consumption.

Aziz in **[15]** compares three algorithms to optimize coverage of mobile network. PSO is chosen because of its good performance. The three PSO based algorithms WSNPSOvor algorithm is to maximize the coverage, WSNPSOper algorithm maximizes coverage with minimum energy cost and WSNPSOcon algorithm maximizes the coverage of limited mobility network are used. Mobile sensor network improves its coverage by moving the sensors. Results showed that the algorithms are able to achieve their objective/goal.

Table2: Highlights of Literature Survey

Ref. No.	Algorithms	Conclusions
[8.]	Hybrid PSO and Differential Evolution Algorithms is used.	Proposed hybrid algorithm gives better results than the Simple swarm algorithm.
[9.]	CPSO (co-evolutionary particle swarm optimization) algorithm with the Virtual Force.	The proposed technique is rapid, effective and robust.
[10.]	The behavior of Multi objective PSO algorithm is tested by nodes to communicate to send	As the number of generations increases the performance also increases.

	their data to a high energy node.	
[11.]	Multi-objective PSO Algorithm	The energy depends on the number of active nodes, and on distances between sensors.
[12.]	Multi-objective PSO technique	The fuzzy logic provides efficient packet delivery ratio with less delay, Reduction in energy consumption and Efficient and accurate node deployments.
[13.]	PSO and Voronoi diagram	The proposed technique is used for a large network or Region of Interest. The grid method is used for small network.
[14.]	Particle Swarm Optimization (PSO) versions such as a global version and a local version is used	The sensors are able to obtain a remarkable coverage of the interesting zones. The drastically reduction the energy consumption.
[15.]	PSO based algorithms for Mobile sensor network.	The proposed algorithm maximizes the area coverage with less energy consumption.

V. ANALYSIS OF STUDY

From all the above study, we collect information regarding the implementation of Swarm Algorithm. We study the major key points of PSO algorithm such as the parameters of algorithm as well as affect of parameters on the performance of algorithm. We analyze that the parameter values depends upon the type of the problem for which the algorithm is used. Mostly the combination of PSO algorithm with other algorithms is used to solve the problems. The hybrid technique gives fast convergence and better solutions.

VI. CONCLUSION & FUTURE SCOPE

There are various versions and combinations of PSO algorithm to optimize the problems of wireless sensor network. In this paper, a review has been conducted on PSO optimization technique. This paper helps to understand the problems and optimize those problems based on PSO to achieve the best solutions. We conclude that the swarm optimization is one of the capable techniques to make a network an efficient network. In future, we will implement the PSO for solving the issues of WSN and develop a new hybrid technique to analysis the performance of PSO in both the cases for better solutions.

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