Optimization of Wireless Sensor Network Using PSO Algorithm

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Abstract:
A network is designed to have maximum area coverage with less energy consumption. Energy and coverage both are the current issue of wireless sensor network. The performance of wireless sensor network is affected by these two issues. Several methods are developed to make a network efficient. In this paper PSO Algorithm has been reviewed to resolve the challenges and issues of wireless sensor network. This paper concludes that the PSO algorithm is able to make a network more efficient.

Keywords: *Coverage, Energy Cost, Network Lifetime, Particle Swarm Optimization Algorithm, Wireless Sensor Network.*

INTRODUCTION

With the development of wireless communications, it is possible to construct cheap, small-sized and low-power sensor nodes that can perform functions of sensing, computation and data communication of any condition. WSN (Wireless sensor networks) is made up of these sensor nodes that can send the processed data to a center node called sink for other purposes. This technology can be used in several areas such as military, industrial production, transportation, and health etc. The sensor node is a device that works on battery power. In certain situations it is not possible to replace the batteries [1]. To operate the Wireless sensor networks more efficiently energy efficient deployment, architecture, protocols and algorithms are needed [2].

Many techniques, algorithms and methods were developed and applied to the WSNs. Coverage, Energy Consumption, Lifetime and efficient Routing are the major issues that causes problem for efficient performance of network. The objective of this paper is to take the survey of PSO (Particle Swarm Optimization) algorithm to operate wireless sensor network more efficiently by optimal deployment of nodes, energy efficient data transmission, etc [3].

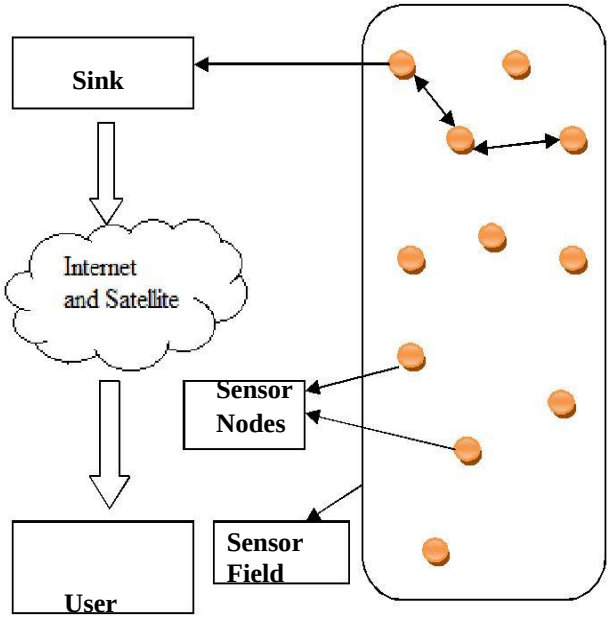

Figure 1: Sensor Network

PARTICLE SWARM OPTIMIZATION ALGORITHM (PSO)

With time passage, the world becomes more complex that's why the decisions must be optimal one. It is optimization method to obtain best result. Optimization was originated in the 1940s, when the British military faced the problem of allocating limited resources to several activities [4]. There are several optimization methods for solving different optimization problems. The optimization methods are also

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known as nontraditional optimization methods. These methods are particle swarm optimization (PSO) algorithm, genetic algorithms (GA), neural networks, ant colony optimization, and fuzzy optimization [4] [5].

The PSO algorithm (Particle Swarm Optimization algorithm) was first introduced in 1995, by Dr. Kennedy and Dr. Eberhart. This algorithm is basically learned from animal's behavior to solve optimization problems. In this algorithm, the population is called a swarm and each
member of the population is called a particle. Initially start with a randomly initialized population and moving in randomly selected directions. Each particle goes through the searching space and remembers the best previous positions of its neighbors and itself. Particles of a swarm dynamically adjust their own position and velocity. They communicate the good positions and velocity is derived from the best position of all particles. When all particles have been moved the next step begins. At last, all particles moving towards better positions. This continues until the swarm move to close to optimum positions. This method is becoming very popular because of its simplicity of implementation and uses only primitive mathematical operators. It is faster, cheaper and more efficient. PSO is used to solve the non-linear, discrete, continuous, integer variable type problems.

A. PSO Algorithm Parameters

There are some parameters those may affect the performance of PSO. For any problem, some of the parameters have large impact on the efficiency of the PSO algorithm, and other parameters have small or no effect [6]. The basic PSO parameters are as follow:

B. Swarm size

Swarm size is the number of particles *n*. The large swarm size generates larger search space per iteration, but sometimes large number of particles may require less number of iteration to obtain a good solution. On the other hand a large amount of particles increase the computational complexity, and takes more time to obtain good solutions. From empirical studies, it has been shown tha t most of the implementations use an interval of

n [ ] for the swarm size.

∈ 20,60

C.Iteration numbers

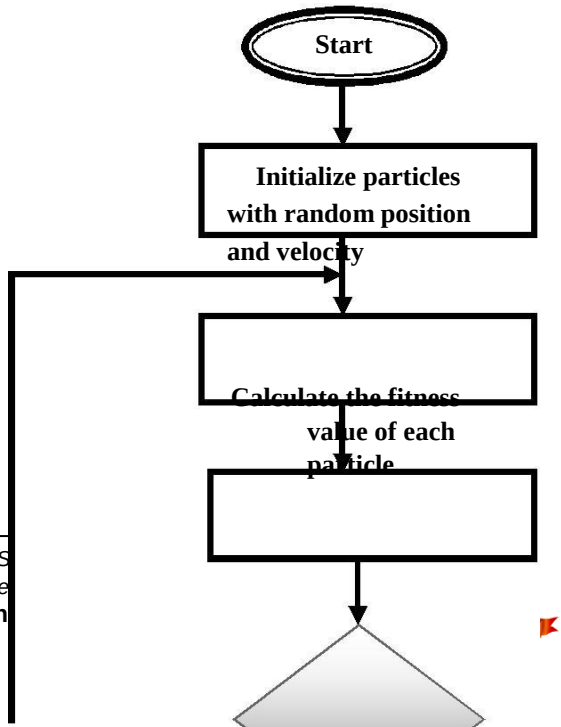
The number of iterations depends on the problem. Low number of iterations may stop the search process prematurely, and on the other hand large iterations added computational complexity and more time consumption [7].

D. Velocity Components

The velocity components are important to update the particle velocity. There are three terms of the particle's velocity

a) The term inertia component that provides a memory of the previous flight direction that means movement in the immediate past.
b) The term is called cognitive component which measures the performance of the particles relative to past performances.
c) The term for *gbest* PSO or for *lbest* PSO is called social component which measures the performance of the particles relative to a group of particles or neighbors.

E. Basic Flow of PS



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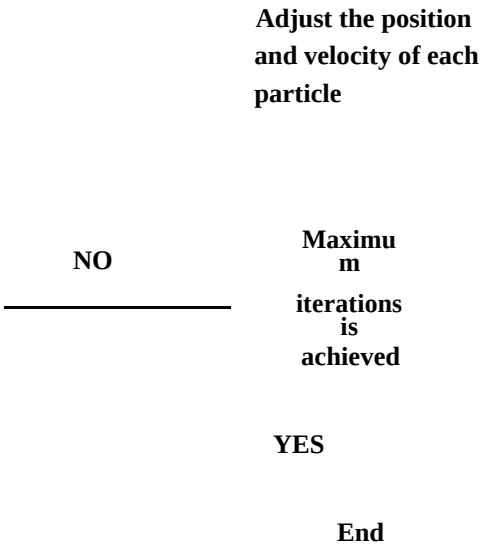

Figure 2: Basic Flow of PSO

RELATED WORK

***Samaneh et al. in* [8]** presents a multi-objective optimization method for wireless sensor network design. A PSO algorithm is used for optimization of most important parameters of WSNs. Optimal operational modes of the nodes have been studied in order to minimize the cost of energy satisfy the application-specific requirements. Clustering and sensing range is also optimized. The energy consumption depends on the number of active nodes, and on distances between sensors which are studied in this paper. Fitness function is the summation of different parameters in which the energy parameter values are tried to minimize and the density parameters are maximized. The parameters such as Mean Relative Deviation (MRD), Spatial Density Error (SDE), Sensors-per-Clusterhead Error (SCE), Sensors-Out-of-Range Error (SORE), Operational Energy (OE), and Communication Energy (CE) are used to calculate the fitness. This method is presented for homogeneous network. Sensors may be either active or inactive. An active sensor may operate as a CH, HSR or LSR. The primary goal of the algorithm is to find the best
operational mode for each sensor. Optimal sensor network constructed by the algorithm satisfied the most important parameters of the network.

K. Sheela et al. in [9] proposed a multi-objective PSO (Particle Swarm Optimization) and fuzzy based optimization model for deployment of sensor nodes. The objectives of this paper are to maximizing coverage, network lifetime and connectivity. The input parameters of fuzzy model are such as node degree, residual energy, and link quality. According to the fuzzy logic output, the nodes are such as good, normal and bad. The initial deployment of good nodes, multi-objective PSO technique is applied for the deployment of left nodes. The good nodes are taken as reference nodes. PSO iteration is performed to connect to one good node. The reference point's positions are determined such that the distance between the normal or bad node to the RN is small and the distance between the Base station and the RN is large. The fitness function is derived using the longer and shorter distances. The results proved that the fuzzy logic provides better packet delivery ratio with reduce delay, energy consumption and also provides efficient and accurate node deployments.

Nor Azlina et al. in [10] proposes a new method to optimize sensor coverage using Voronoi diagram and PSO. PSO is used to find the optimal positions of the sensors in order to maximize coverage and Voronoi diagram is used to evaluate the value of fitness of the solution. The results of proposed method provide good coverage within efficient time. The execution time is affected by the number of sensors in the network. The results suggested that this approach is to be used for a large network in a large ROI, while the grid method is used when the network is small and the execution time does not matter.

Xue Wang et al. in [11] proposes a dynamic deployment algorithm named as VFCPSO. It is the combination of CPSO (co-evolutionary particle swarm optimization) algorithm with the VF algorithm. Multiple swarms are used to optimize different components of the solution for dynamic deployment. The velocity component is updated according to the historical solutions and also according to the virtual forces of sensor nodes. The results conclude that Virtual PSO is

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more efficient than other algorithm. VFCPSO gives effective coverage area and time of computation. The performance of the VFCPSO becomes stable. The deployment of hybrid WSNs is effective, rapid and robust.

Isa Maleki et al. in [12] proposed new approach which is the hybrid PSO and Differential Evolution (DE) Algorithms. The authors studied the area coverage problem of Wireless sensor networks. PSO algorithm is implemented and the results of hybrid approach are compared with the results of PSO in the same conditions. The results showed that the hybrid algorithm make more increase in lifetime of the network and reduction in use of energy and increase the coverage. The efficiency of the hybrid algorithm is better as compared to PSO algorithm.

Nor Azlina Ab Aziz in **[13]** presented three algorithms to optimize mobile coverage of sensor network. Energy consumption is also considered in this paper. Mobile sensor network improves its coverage by moving the sensors, the movement also consumes energy. The algorithms are based on particle swarm optimization (PSO). PSO is chosen due to its good performance record. The three PSO based algorithms are presented WSNPSOvor, WSNPSOper and WSNPSOcon. The aim of 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. Results showed that the algorithms are able to achieve their objective/goal.

Valeria Loscri et al. in **[14]** consider sensors that move according to Particle Swarm Optimization (PSO) scheme in order to improve network coverage. Two different versions of the algorithm have been studied: a global version that allows nodes to use information of the whole sensor area and a local version based only on neighborhood information. The author implemented some PSO techniques by considering the sensors as agents, distributed in a virtual searching field. Sensors are able to collect information about events that occur in their sensing field and they move according to a specific update formula, which is based on neighborhood. The behavior of the algorithm is tested by Coverage and energy consumption for movement and has shown that the proposed techniques obtain remarkable results for both parameters considered. Simulation results showed that nodes moving with this scheme covered the target areas. The concept of pioneer's sensors is used. The result of usage of these specific sensors is that we are able to obtain a remarkable coverage of the interesting zones and drastically reduce the energy consumption.

Pyari Mohan Pradhan et al. in **[15]** propose a new method for energy efficient layout of WSN. The sensor nodes communicate with each other to transmit their data to a high energy node. Optimization of sensor is required to provide communication for a longer duration. Multi objective PSO algorithm is developed for energy efficient layout of network for good coverage. Sensors move to form a uniformly distributed network. The two objectives such as coverage and lifetime of network are considered to optimize. Basically a set of network layouts are obtained. Results showed that performance is improved with increase in number of generations in the algorithm

Ref. No.	Algorithms	Purposes	Techniques	Parameters	Conclusions
[8.]	Multi-objective PSO Algorithm	Minimize the cost of energy.	Energy parameter values are tried to minimize and the	Mean Relative Deviation, Spatial Density Error,	The energy consumption depends on the number of active nodes, and on

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			density parameters are maximized.	Sensors-per-cluster head Error, Sensors-Out-of-Range Error, Operational Energy, Communication and Energy are used to calculate the fitness.	distances between sensors which are studied in this paper. Optimal sensor network constructed by the algorithm satisfied the most important parameters of the network.
[9.]	Multi-objective PSO algorithm, fuzzy based optimization	Maximize the coverage, network lifetime and connectivity	After the initial deployment of good nodes, multi-objective PSO technique is applied for the deployment of left nodes.	node degree, residual energy, and link, bad and good nodes quality	Th result es proved that the fuzzy logicprovides efficient packet delivery ratio with reduce delay, energy consumption and also provides efficient and accurate node deployments.
[10.]	PSO and Voronoi diagram	Maximize the coverage	PSO is used to find the optimal positions of the sensors in order to maximize coverage and Voronoi diagram is used to evaluate the value of fitness of the solution.	Coverage, execution time	This approach is to be used for a large network in a large ROI, while the grid method is used when the network is small and the execution time does not matter.
[11.]	virtual force directed co-evolutionary particle swarm optimization	Efficient deployment	Combination of CPSO (co-evolutionary particle swarm optimization) algorithm with the VF	dynamic deployment, multiple swarms	The deployment of hybrid effective, WSNs is rapid and robust.

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			algorithm .		
[12.]	Hybrid PSO and Differential Evolution Algorithms	Resolve area coverage problem	Results of hybrid approach are compared with the results of PSO in the same conditions.	Energy consumption, network lifetime	The efficiency of the hybrid algorithm is better compared as to PSO algorithm.
[13.]	PSO based algorithms	Reduce energy consumption	Mobile sensor network improves its coverage by moving the sensors.	Energy and coverage	The proposed algorithm maximizes the area coverage with less energy consumption of limited mobility network.
[14.]	Particle Swarm Optimization (PSO)	Improve network coverage	Two different versions of the algorithm have been used : a global version that allows nodes to use information of the whole sensor area and a local version based only on neighborhood information.	Global version, local version	The concept of pioneer's sensors is able to obtain a remarkable coverage of the interesting zones and drastically reduce the energy consumption.
[15.]	Multi objective PSO algorithm	Energy efficient area coverage	The behavior of algorithm tested by nodes to communicate	Set of network layouts	Results showed that performance is improved with increase in number
			transmit their data to a high energy node.		algorithm.
			with each other to		generation of s in the

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CONCLUSION

Research works using PSO Algorithm are surveyed for wireless sensor networks. In the current research work we concluded that the PSO algorithm is good choice for maximizing the coverage of network, minimize energy cost, and improve lifetime to operate sensor network more efficiently. In Future we may use PSO algorithm for the efficient deployment of nodes to cover the maximum area by reducing the intersection of sensing area of sensor.

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