**Particle Swarm Optimization in Wireless Sensor Networks Localization: A Survey**

Yesha A. Patel

*Department of Computer Engineering*

*SVM Institute of technology*

*Bharuch 392-001, Gujarat, India*

yesha.patel30@yahoo.com

Nital H. Mistry

*Department of Computer Engineering*

*SVM Institute of technology*

*Bharuch 392-001, Gujarat, India*

misnit\_22@yahoo.com

***Abstract*— In Wireless Sensor Network (WSN), there are two main aspects, one is wireless sensing and other is data networking. To solve the issues of WSN like route recovery, task allocation, target tracking, localization of WSN nodes are very important. So to be a viable framework, it is appreciated that every node of WSN must know its location perfectly. Particle Swarm Optimization (PSO) is a computational system that advances an issue by iteratively attempting to enhance a hopeful arrangement as to a given measure of value by social behavior of bird hocking or fish schooling. The PSO system initialized with a population of random solution and search for optima by updating generations. In general, in PSO the potential solutions called particles are impacted by its neighborhood best referred position which is upgraded when better positions are found by different particles. PSO is an optimization algorithm which can be used to solve the issues of wireless sensor networks hence it is well suited for the highly resource constrained WSN environment. In this paper, we aim to study and analyze the way PSO is used to improve localization techniques in WSN.**

***Keywords— Particle Swarm Optimization (PSO); Wireless Sensor Networks (WSN); Localization***

# Introduction

Wireless Sensor Networks (WSNs) are a developing innovation that has potential applications in observation, environment and natural surroundings checking, auxiliary checking, human services, and disaster administration [1]. In many applications, the position of sensor node is critical, for example, environment detecting, inquiry and salvage, and land steering and following, the position of every node ought to be known [2]. WSN issues, such as node deployment, localization, energy-aware clustering and data-aggregation are regularly planned as enhancement issues. Conventional expository streamlining systems require huge computational endeavors, which develop exponentially as the issue size increments [1]. An optimization method that obliges moderate memory and computational assets but then delivers great results is attractive, particularly for usage on an individual sensor node [1]. Bio-motivated streamlining techniques are computationally effective distinct options for scientific systems. Particle Swarm Optimization (PSO) is a prominent multidimensional advancement procedure. Simplicity of implementation, high nature of arrangements, computational effectiveness and pace of meeting are qualities of PSO [1].

The rest of Paper is organized as follow: In section II basic concept of PSO is discussed. In section III related works on various methods based on localization using PSO is mentioned and in final section paper is concluded.

# PSO in Localization

The exploration on limitation issues is imperative to the down to earth utilization of remote sensor systems (WSN) innovation. Localization is a process to find out the locations of sensor nodes which are deployed randomly in the sensing area [3]. Particle Swarm Optimization algorithm is used to solve the issues related to Localization. It is used to choose the best optimal solution among the set of solutions. These potential solutions are called as particles.

The PSO calculation, as other improvement calculations, should be introduced with beginning stage where it ought to start the pursuit [4]. Particles have versatile speeds that focus their development in the pursuit space and memory which empower them for recollecting the best position in the hunt space ever gone to [5]. PSO algorithm initializes a certain amount of random particles, and then to find out the best solution by iterative calculations to the fitness function [6]. In any case, it generally happens that the consequences of evaluated nodes' limitations meet the space separation imperative without meeting the geometric topology requirement due to extending blunders in some useful applications [4].

# Related Work

Zhang *et al.* [2] proposed the algorithm for path planning using grid scan for expanding Localization effect. WSNs are deployed with a limited number of beacon nodes so the iterative algorithm is used to improve localization accuracy. The authors have used a node localization algorithm; which includes node broadcast algorithm and the unknown sensor node localization algorithm. The broadcast algorithm broadcasts a Wake Up Signal (WUS) to wake up the unknown sensor nodes along with an Initial Start Signal. Other Localization algorithm has the function of calculating the node co-ordinates using the signal strength attenuation received from at least three signals. These co-ordinate values are calculated using PSO. In the proposed approach, one mobile beacon node moves through the sensing field and transmits the mobile messages. And then, the unknown nodes apply the statistical median to compute their coordinates based on the advertised positions of the mobile beacon nodes. The authors have compared their work i.e., localization based algorithm based PSO with multilateration with the same condition. It has been found that restriction impact of proposed plan is fundamentally superior to the multilateration plan for the mobile-assisted localization model for unknown environment.

Zain *et al.* [3] proposed algorithm for node localization in wireless sensor networks called Binary Particle Swarm Optimization (BPSO) in which every unknown node creates a path with its three or more neighboring node and this localized node is used as reference for other nodes. The goal of this approach is to estimate the location of sensor nodes using anchor nodes in which anchor nodes are assumed to know their own location. It is a centralized approach in which base station communicates with anchor nodes for distance measurements. The distance is calculated using the received signal strength indication (RSSI). Simulation result taken in MATLAB shows that the proposed algorithm reduced the calculation time needed for the localization by 58.90% while expanding the localization error by 11.27%. The modified BPSO could lessen more that 38.98% while keeping up the same normal localization error. BPSO algorithm gives better result in case of computation time and localization error so the life time and energy of the network can be saved.

Singh *et al.* [5] proposed two approaches called Particle Swarm Optimization (PSO) and Biogeography Based Optimization (BBO) to solve this target localization issue. It is compulsory to have the accurate location of the target node in wireless sensor network (WSN). It affects the overall performance of the network. PSO algorithm has fist convergence result but it is less mature. Distributed localization has one important advantage of reducing the number of transmissions to the base station. It is helpful to converge the energy of the nodes so that it can perform for a longer time.

Hu *et al.* [6] proposed improved PSO algorithm with hybrid and mutation operators to decrease the possibility of falling into local minima and to gain high level of particle population diversity. Those improved PSO algorithms are HPSO, MPSO and HMPSO. HPSO has the hybrid operators by which two child particles are produced and it’s both parents particles falls into different local optimal solutions. So the child particle can inherit the both parents particle’s advantages. To solve the problem of particle falling into same local optima MPSO put the particle in center and generates the two new particles through expansion and contraction. The best two fitness values are used in next iteration. HMPSO puts the both hybrid operator and mutation operators at the same time in the algorithm and get the better result. Authors compare the results of these three approaches with the PSO. The simulation result shows that HMPSO gives the best solution to the accuracy problem of range-based localization algorithms. The HMPSO is the best algorithm because it takes effective care of the issue of accuracy and fitness value convergence. HPSO has better union convergence, and MPSO has a super convergence speed. PSO gives worst result compared to others.

Nguyen *et al.* [7] proposed the new PSO with long-barrier algorithm which requires only the received signal strength indicator (RSSI) measurements. The localization algorithm is used only in the case of four neighbor anchor nodes. Number of nodes can be extended easily but if it has more than four nodes then initially original localization algorithm is applied to every possible combination. To choose the best solution, a selection scheme is used in which the best solution is chosen by comparing all the possible solutions. If the number of nodes is less than four, the algorithm can still be applied but the accuracy will be affected. RSS-based localization approach is investigated with the path loss parameters estimated in real time. The problem under investigation is formulated in as a nonlinear constrained problem to determine optimally the path loss parameters and the unknown locations that best match the RSS measurements. A real-time particle swarm optimization (PSO) is used to solve this optimization problem. Experimental results show that the accuracy is improved by estimating the path loss parameters. The nonlinear constrained problem is solved by first converting the unconstrained problem using log-barrier method. It requires a less memory and improves the computational speed.

Zhong *et al.* [9] proposed a node self-localization algorithm to solve node self-localization problem. A modified particle swarm optimization (PSO) is used to find out the location of unknown nodes. After comparing both algorithms, the simulation result shows that the proposed algorithm can search global optimal solution faster than traditional PSO. Particle swarm optimization is used to locate the node position. The modified PSO reduces the negative influence of the ranging error and has good robustness. More anchor nodes will increase the cost and energy consumption of system, while less anchor nodes will reduce the localization precision.

Cao *et al.* [11] describes the comparison and evaluation of the Localization accuracy based on six PSO variants includes PSO algorithm with inertia weight, PSO algorithm with compression factor, PSO algorithm with changed constant, Gaussian dynamic PSO algorithm, Logistic dynamic PSO algorithm and four population topologies includes Gbest, ring, wheel and square. There are two new PSO variants described, one is GDPSO (Gaussian dynamic PSO algorithm) and other is LDPSO (Logistic dynamic PSO algorithm). In Gbest topology all particles have access to the information of all other nodes. It has fast convergence speed so it is possible to trap in a local minimum. To solve this drawback ring topology with PSO is proposed which improve the performance and stability of the algorithm by only passing the information to only their neighborhood. In wheel topology one particle attaches the other particles and they are not interring connected with each other. Square topology performs better than all other topologies in which one particle is connected to its two neighborhood particles and those two particles are connected to other one at different side. After analyzing the population result at different topologies it is conclude that ring and square topology gives the best result for node Localization using PSO.

Yang e*t al.* [12] proposed a modified version of BPSO (MBPSO) to search for the best task allocation scheme. BPSO algorithm has a discrete problem with binary solution space. It is a NP-hard problem which is multi-objective constrained optimization problem. The task workload and the connectivity are considered as constraints to ensure the accomplishment of each task and essential data exchange among selected nodes. BPSO is modified with different transfer functions and position updating procedure to achieve better optimization solution. Fitness function considers the task execution time, energy consumption and energy distribution to get the best solution. This approach is simulated in MATLAB and results shows that the proposed approach is feasible for the task allocation problem. In simulations the default tasks and sensor node are 6 and 30 respectively. After 30 independent runs the results are averaged values. MBPSO performance is analyzed on the basis of swarm size and mutation rate where swarm size is the total number of particles. There are main two advantages of MBPSO one is its convergence speed and other is the diversity of particles is improved. After analyzing performance compression of GA, BPSO and MBPSO, it is proved that MBPSO takes less time with lesser iteration.

Lv *et al.* [14] proposed the algorithm to solve the localization issue which requires less computing resources called distributed PSO. Proposed algorithm is helpful to improve the efficiency. It presents a new objective function to evaluate the fitness of particles Based on the probabilistic distribution of ranging error. It also tries to localize many unknown nodes in less number of iteration. Authors compared the distributed PSO with Bioinspired Localization method to evaluate the proposed algorithm’s performance. Simulation results are performed on OMNet++ which is component based C++ simulation library and framework. If there are 30 or more anchor nodes then proposed method can localize all the nodes. Comparison shows that the Localization error of Distributed PSO is 13-23% smaller. This method can localize more unknown nodes in higher precision and less iterations.

Haiqiang *et al.* [15] presents an approach based on negative constraints for wireless sensor networks. PSO algorithm is used to solve least square problem in localization. To perform simulations, authors take 10 anchor nodes and 35 unknown nodes. Maximum communication distance is set to 10 meters so if any node goes outside the range, the negative constraints are used for accurate Localization. Simulation results are taken in MATLAB which shows that the accuracy is improved with the increasing number of anchor nodes. Error will be reduced because unknown nodes receive high rate of information from the unknown nodes. Statistical analysis shows that the error was reduced by 20%. Proposed method can be used in inaccurate range measurement.

Stefania *et al.* [16] proposed a novel approach called Two-Stages Maximum-Likelihood (TSML). In wireless sensor network (WSN) when nodes communicate with each other through Ultra Wide Band (UWB), auto-localization problem occurs. Some location estimate techniques can not guaranteed convergence to overcome this problem TSML is used. It observes the initial system so it is possible to occur the localization problem which can be solved using particle swarm optimization (PSO). Two scenarios are considered to investigate the impact of the distance between the beacon nodes and anchor nodes. In first scenario the distance between both nodes is 4m and in other one it is 8m. The results show that the combination of PSO with TSML and MSE gives more accuracy in node position estimation.

Namin *et al.* [17] proposed a two-step distance-based algorithm in centralized architecture to solve the localization issue. The first phase of this method is DV-distance propagation method which provides distance estimate to far-off anchors. It uses multi-hop collaboration between all the nodes. Dijkstra’s or Floyd’s algorithm is applied to gathered information from all the nodes. By which propagation task and the length of the shortest path between arbitrary nodes can be calculated. In the second phase, coordinates of non-anchor nodes are accurately refined using Particle Swarm Optimization (PSO) algorithm. Node selection priority concept is proposed in this paper to avoid error propagation. At the optimization stage, optimizer chooses the node which has accurate neighborhood condition and localizes it first. The reliance coefficient (RC) is assign to the each node in the network which reflects the reliability of the current node’s location estimation. Numerical simulations were performed in MATLAB which shows that the proposed method gives better result than SAL (simulated annealing), TSA (trilateration and simulated annealing) and SDP (semi-definite programming) approaches.

# conclusion

In this paper we discuss about the localization of nodes in wireless sensor network and related issues. . In Wireless Sensor Network, the localization is a fundamental issue where the same number of uses obliges sensor nodes to know their areas. Localization can be utilized to limit the sensor node. This paper presents how the PSO technique is used to solve the localization issue in WSNs. A subjective dialog on how PSO is customized for WSN applications is introduced, and promising exploration bearings are anticipated. It is concluded that the use of particle swarm optimization for localization issues can lead to less localization errors, better accuracy of the nodes and improved convergence speed. From the present rate of development of PSO-based applications, it is imagined that PSO will proceed as a critical enhancement procedure in a few building fields including WSNs.

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