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APPLICATION OF PSO ON WIRELESS SENSOR NETWORKS

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ABSTRACT:
In Wireless Sensor Networks (WSN), sensors are randomly deployed in the sensor field which brings the coverage problem. It is a unique problem and in maximizing coverage, the sensors need to be placed in a position such that the sensing capability of the network is fully utilized to ensure high quality of service. Particle Swarm Optimization (PSO) is intelligent approach that can be applied for finding fast and efficient solutions of such problems. In this paper, particle swarm algorithm was used to find the optimal positions of the sensors to determine the best coverage. This algorithm is an optimization technique which belongs to the fertile paradigm of swarm intelligence. It is a derivative free and is a very efficient global search algorithm with few algorithm parameters.

1. INTRODUCTION

A wireless sensor network (WSN) is a group of low cost, low power, multifunctional and small size distributed networked sensors. These sensors work together to sense the environment with a little or no human intervention. PSO has been successfully used in numerous engineering applications like in training of neural networks to identify Parkinson's disease, extraction of rules from fuzzy networks, image identification, optimization of electric power distribution networks, structural optimization, inhabitant monitoring, environmental monitoring, monitoring deep oceans currents, smart home building and military applications among many others. One of the fundamental issues that arise in WSN is coverage area in addition to location identification, tracking, and deployment.

A wireless sensor network in its simplest form can be defined as a network of devices (possibly low-size and less complex) which are denoted as nodes that can sense the environment and communicate the information gathered from the monitored field through link or wireless channel. The data is forwarded, possibly via multiple hops relaying, to a sink that can use it locally, or connected to other networks. The idea of development of wireless sensor networks was initially motivated by military applications. Wireless sensor network (WSN) provides a reliable, low maintenance, low power method for making measurements in applications for WSN where cabled sensors are impractical or otherwise undesirable. So a WSN is a large network of resource constrained nodes with multiple preset functions, such as sensing and processing, to fulfill different application objectives. The wireless sensor networks are interesting network to study due to the fact that large number of applications wireless network are being developed using these networks.

1.1. Sensor Coverage

A sensor placed on a location point (x1, y1) can cover a location point (x2, y2), if the Euclidean distance between these two points is

$$(x_1 - x_2)^2 - (y_1 - y_2)^2 \le r^2 \quad (1)$$

Where, r is the sensing range of the sensor. The mean value of the location points (xi, yi) for i =1, 2, · ··M, is represented by (mx, my). Sensor node is the centroid of location points it has to cover. The distance between the sensor node and the farthest location point denote the sensing range r. Area A is divided into R regions and each region is placed with a sensor node by minimizing the Euclidean distances between location points and their closest centroid. Area A is covered with R sensor nodes. The coverage problem can be formulated as an optimization problem and defined as: P is the set of points and R is the fixed no. of sensors, the optimum location for deploying all R sensors such that every location point is covered is

$$F = \forall_R \forall_j (\max(\text{ distance } (S_R, P_j))) \quad (2)$$

2. LITERATURE REVIEW

Wei Qu [1], study in this paper, energy-efficient routing control strategy based on genetic optimization technique in wireless sensor networks (WSN) is proposed for solving the problem of selecting optimal routing set of nodes for wireless sensor networks with high density. Our strategy adopted the elitist operate to recover the speed of optimization process; It introduced the idea of taboo and designed the system of using chromosome template as taboo object and establish searching neighborhood base on the template to achieve the effective local search process, in which can improve the ability of global optimization scheme. Simulation and analysis showed that premature convergence of GA can be inhibited effectively and global optimization can be accessed in a greater degree, energy consumption of nodes was reduced and the lifetime of network was prolonged effectively. Consider the energy consuming of each node and the total energy consuming of network as the optimization targets to study the issue of energy-efficient routing control in wireless sensor networks with density nodes, and proposed the energy-efficient routing control strategy based on genetic algorithm and hybrid optimization. Simulation and theoretical investigation showed that the cracking introducing and elite operation optimized algorithm the quality of population and improved the speed of optimization.

Sunil R. Gupta [3], in a WSN, many researchers proved that the clustering scheme improves the longevity of the network holes. The load of handling traffic increasing on the nodes which are closer to the sink or the base station (BS), as it has to carry others traffic along with its own towards the base station and depletes more energy which causes network holes technique. The power transmitted by the nodes could be controllable and each sensor

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can transmit directly to the BS but the farthest nodes consume more power and die earlier. The develop an efficient clustering method in which cluster heads are formed and are supposed to send the data to the base station (BS) and the role of cluster heads (CH) is changed in each turning round. The finalization of the cluster heads is based on the energy distribution and its selection procedure is optimized using GA. The results show that with this approach the stable operative period increases and is compared through probabilistic and EC algorithm. The result shows that our approach achieves a greater value for network lifetime, and network throughput and also analyzed that the delay in packet delivery is minimized. They have gone through multiple strategies that can reduce the hot spot problem. The proposed algorithm can be tested for the wireless sensor network (WSN) consisting of static BS and other mobile nodes.

3. PARTICLE SWARM OPTIMIZATION

The PSO algorithm is an evolutionary computing technique, modeled after the social behavior of a flock of birds. In the context of PSO, a swarm refers to a number of potential solutions to the optimization problem, where each potential solution is referred to as a particle. The aim of the Particle Swarm Optimization is to find the particle position that results in the best evaluation of a given fitness function. In the initialization process of Particle Swarm Optimization, each particle is given initial parameters randomly and is „flown" through the multi-dimensional search space.

Particle Swarm Optimization (PSO) is a population based stochastic search technique introduced by Kennedy and Eberhart in 1995 [Eberhart R. and Kennedy J. (1995)], [Jin-zhu Hu et al. (2009)], inspired by social behavior of bird flocking or fish schooling. It works in the same way as genetic algorithms and other evolutionary algorithms. Similar to evolution algorithm, PSO algorithm adopts a strategy based on particle swarm and parallel global random search. This algorithm determines search path according to the velocity and current position of particle without more complex evolution operation. PSO algorithm has better performance than early intelligent algorithms on calculation speed and memory occupation, and has less parameter and is easier to realize [Lin Lu et al. (2008)]. All these algorithms update a set of solutions (called swarm in the context of PSO) applying some operators and using the fitness information to guide the set of solutions for better regions of the search space.PSO is a novel stochastic optimization algorithm based on the study of migration behaviors of bird flock in the process of searching food. In this process of searching food, each bird can find food through social collaboration of neighboring birds and the birds who have found food can guide other birds around them to fly to the food location.

4. PROBLEM FORMULATION

The main objective of the present work paper is to minimize the distance between the neighboring nodes, maximizing coverage in the network, while simultaneously satisfying all constraints.

- All sensor nodes are homogenous and have mobility.

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 We assume the deployed sensor nodes can fully cover the sensing field. Sensing coverage and communication coverage of each node is assumed to have a circular shape without any irregularity.

 The design variables are two-dimensional coordinates of the sensor nodes.

 All the nodes cover equal sensing field areas [Singh M.P. and Gore M. M. (2005)].

The above are common assumptions for many sensor network applications.

4.1 Flow Chart

The flowchart contains a recursive iteration loop (generations) and can be described by the following pseudo code. Fitness F given in "Eq. (2)" depends on the Euclidian distance between the sensor node and the nearest centroid. Calculate fitness for each particle. Among the swarm, the particle with the least fitness is considered as the global best particle as it is closest to the optimum solution. The swarm is said to have accomplished the task if all the particles in it have acquired fitness less than or equal to the range of sensors incorporated in the network. In the particle swarm optimization algorithm, we perform the following actions:

1. Network information and algorithm parameters- inertia weight, learning factor, velocity boundary value, and the largest iterative number are initialized. Array of particles are initialized with random position and velocity vectors.

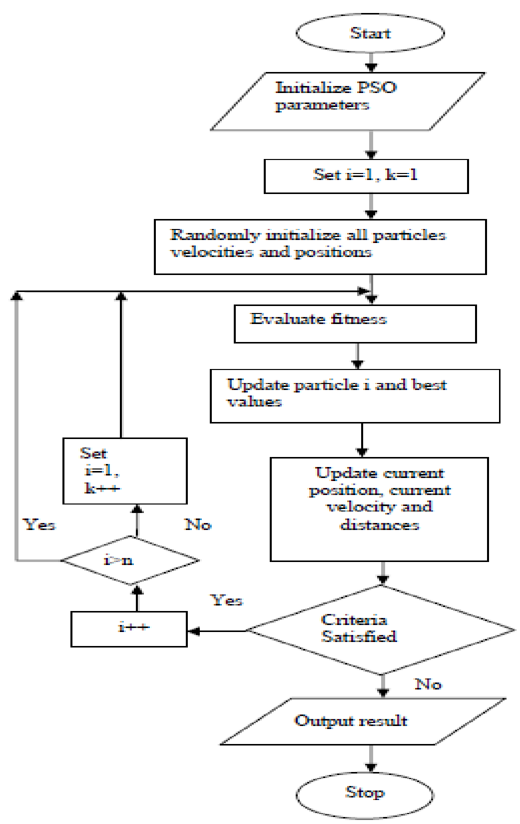
2. Find the distance of the interest point to its nearest sensor. Fitness is evaluated for every particle at its

current position using Euclidian distance as in "Eq. (1)".

3. Minimize the fitness value; ideally the fitness value should be equal to zero, where the distance between the interests points with their nearest sensors are within the sensors' sensing range. If the fitness of the particle is lesser than that of the best particle, then the particle would be the best particle for the next move, and the fitness of this particle is taken as best fitness.

4. Each particle is made to modify its current position, current velocity, the distance between current position and pibest, the distance between current position and pgbest.

$$p_{gbest} = (p_{g1}, p_{g2}, \ldots\ldots p_{gd})$$
$$v_i(t+1) = w * v_i(t) + c_1 * rand() * (p_{ibest} - x_i) + c_2 * rand() * (p_{gbest} - x_i)$$
$$x_i(t+1) = x_i(t) + v_i(t+1)$$



5. If the next position of the particle is best, then the particle chooses a new position, otherwise, the same algorithm is continued.

6. This process is repeated in iterations, until all the particles communicate with each other and generate maximum coverage.

CONCLUSION

The proposed work has the ability to achieve optimal solution of coverage problem with minimum number of sensors in wireless sensor networks. This approach cultivates an innovative is idea in employing the PSO algorithm with enhanced fidelity. In this paper the optimization of hop distance and update time has performed using particle swarm optimization algorithm.

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