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NATURE INSPIRED FLOWER POLLEN ALGORITHM FOR WSN LOCALIZATION PROBLEM

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ABSTRACT

Location of sensor node is required for improving efficiency and performance of node management. An accurate localization algorithm with better efficiency and lesser computing time is required. Moreover the complexity of the algorithm and the memory required should be less. The algorithm should be faster for the usage in sensor node self localization. In this paper a novel nature inspired based algorithm called flower pollen localization algorithm is introduced for sensor node localization problem. Flower pollination is a process of reproduction of plant species and survival of the fittest.

Keywords: lower pollen localization algorithm, sensor node localization, pollination, anchornode, target node.

1. INTRODUCTION

The growth of very large scale integration, memory devices, wireless communication technology, better programming environment has led to resource constraint multifunction sensor nodes [1]. The self-organizing sensor nodes form a wireless sensor network and can take different infrastructure topology depending on the application. These sensors are randomly deployed. The location information of the sensor nodes is important for data sensed by sensor nodes to be meaningful information. The location determination by an individual node is assisted by anchor nodes or beacons. This anchor node knows the location priori by using global positioning system. But installing a GPS for every node would not be feasible, majorly because of energy constraint and cost of wireless sensor networks. So the sensor node has to self predicted the location by using the information of anchor nodes.

Information got from different geographical region is collected, processed and send to the next level network. Wireless sensor networks are used for habitat monitoring, environment monitoring, forest fire detection, medical applications, and agriculture. A smart dust sensor network can be used to know the temperature, pressure and humidity of the atmosphere at different points [2]. Localization algorithm should be scalable. That is even if more sensor nodes are added to the existing infrastructure to accommodate the increased demand, the algorithm should be in such a way that it does not expect the increase in hardware, computation and energy requirement [2]. Most of the above application requires the location information of the nodes. Network topology control, routing based on geographic information, location information of sensor nodes is necessary. Localization information forms the core support for several applications which involves monitoring [3].

Localization of wireless sensor networks is needed for optimal deployment of sensor nodes; correct functioning of the sensor network and for network management and topology control [4]. Localization increases the lifetime of the network by reducing the unwanted communication between the sensor nodes and base station for information sharing regarding localization. Localization makes the sensed information and event occurrence data in the network a meaningful one.

Localization can be classified as range based and range free localization, anchor based and anchor free localization, distributed and centralized localization algorithm. Several methods like time of arrival, time difference of arrival are considered in different literatures [5]. Range based technique with trilateration method using RSSI is considered in this paper. Location has to be determined by less communication with anchor and other nodes. Node localization becomes tedious process because sensor nodes are resource constraint with less battery resource, limited memory, limited processing capability and high energy requirement for communication [6]. A three dimensional range based localization that uses radio signal strength and uses only 3 anchors is discussed in paper [7]. A range based distributed flower pollen localization algorithm is proposed, analyzed and implemented in this paper.

2. NODE LOCALIZATION SCENARIO

Localization scenarios of 40 sensor nodes are considered. In this 8 anchor nodes with known location information and 32sensor nodes within known location is considered. The aim is to find the location of these 32 unknown sensor nodes with the location knowledge of anchor nodes. Range based method is used which implies trilateration method. Three known anchor nodes which are nearer to the selected unknown node are chosen. With the help of these anchor nodes, its location information, the distance of these anchor nodes with the chosen unknown node, the location of unknown node is found.

The location information estimation involves distance calculation and minimization of the localization

error estimated by the localization objective function. The distance between the 3 anchor nodes and unknown nodes are calculated by using the equation (1).

$$d_{est} = \sqrt{((x_{est} - x_{anchor})^2 + (y_{est} - y_{anchor})^2)} \quad (1)$$

The localization objective function is given by the equation (2)

$$f(X_{est}, Y_{est}) = \left[\sqrt{(X_{est} - X_{anc})^2 + (Y_{est} - Y_{anc})^2} - d_{est}\right]^2 \quad (2)$$

3. FLOWER POLLEN ALGORITHM DESIGN

Flower pollen localization algorithm is a nature inspired algorithm which gets the idea from the characteristics of flowering plants. This localization algorithm is referred from the Flower algorithm developed by Xin-She Yang in 2012. In earth 80 % of plants are flowering plants [8]. Flower is used for reproduction of its own species through pollination.

Pollination means transfer of pollens from one flower to another flower in the same plant or another plant. This transfer of pollens can happen through pollinators such as birds, insects, bats and other animals [9].

Pollination by birds, animals, bats and insects are termed as biotic pollination. Pollination by wind and diffusion is called as a biotic pollination. Further pollination can be classified as cross pollination and self pollination. If pollination or fertilization happens between flowers from different flower plants then it is called as cross pollination. If pollination happens between flowers in the same flowering plant then it is called as self pollination. Pollination of flowers is a process of reproduction and survival of the fittest of a particular plant species [10]. This fitness characteristic is used to define the optimization of the localization problem in wireless sensor networks.

Some insects and bees can have levy weight behavior, means the jumps or fly distance steps obey Levy distribution. Some pollinators have developed flower constancy, means some flowers are related to some birds and insects. They are interdependent. That birds and insects jump or fly to only certain species flower plants. And the flower also provides food required by the certain birds and insects [11]. This flower constancy increases the pollination process in certain specific flower species and so maximizing the reproduction.

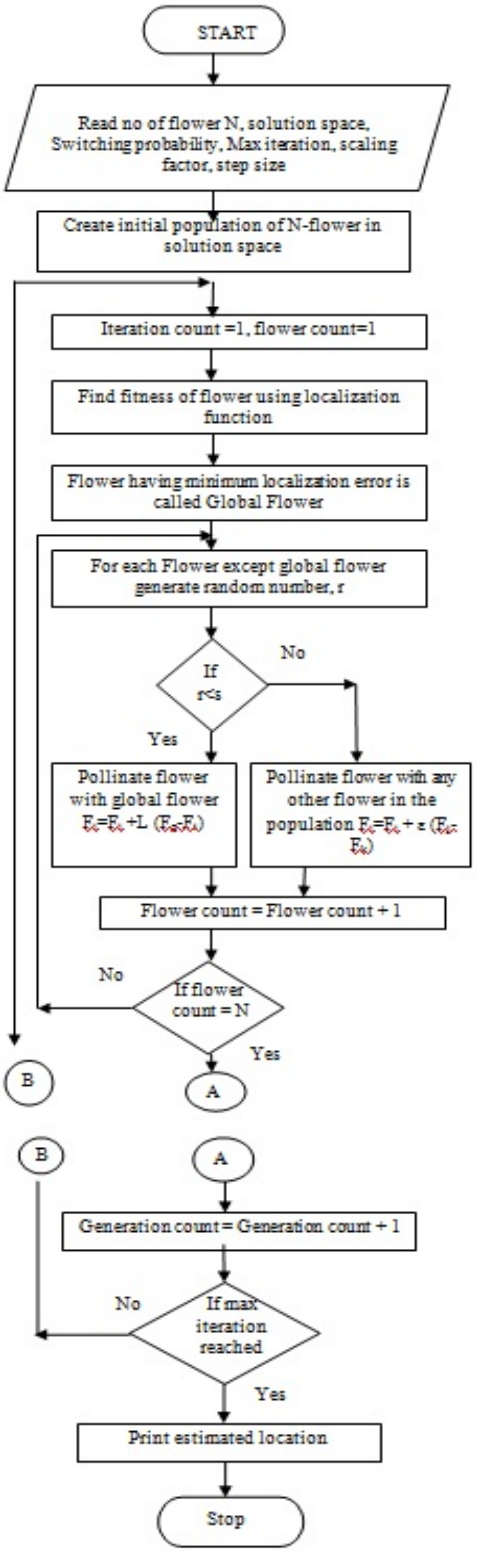

Figure-1. Flowchart of flower pollen localization algorithm.

Flower pollen localization algorithm uses the following rules referred from [12].

1. Biotic and cross pollination is taken as global pollination and they obey levy flight behavior.
2. A biotic and self pollination is taken as local pollination
3. Flower constancy is equivalent to reproduction probability.
4. Interaction of local and global is set by switching probability p € (1, 0).

The minimization of localization error of sensor nodes is optimized by flower pollen localization algorithm. For the implementation of the algorithm, the parameters of a space size of 100 units, population of 20 flowers, 100 pollination iterations, step size γ = 0.01, constant λ=1.5, scaling factor ε=0.3, switching probability p=0.7 is considered. The flowchart of the flower pollen localization algorithm is shown in the figure.1.The flower pollen localization algorithm has the following steps.

Step-1: Initialize N-flowers from solution space

Step-2: Find the objective function of each flower and select global flower from the population

Step-3: For each flower generate a random number

Step-4: If generated random number less than switching probability go to step 6

Step-5: Select a flower randomly from the population and use it, for local pollination, then go to step7.

Local pollination is represented by the equation (3)

$$F_i^{n+1} = F_i^n + \varepsilon (F_j^n - F_k^n) \quad (3)$$

Step-6: Pollinate a flower with global flower
Global pollination is represented by the equation (4)

$$F_i^{n+1} = F_i^n + \gamma L(F_g - F_i^n) \quad (4)$$

L is the levy weight

Step-7: Till N-number of flower, repeat step3 to step6.

Step-8: Till maximum number of generation repeat step2 to step 7

Step-9: Print best value of the flower among the generations.

The flower pollen localization algorithm output is shown in the Figure-2. It shows the position of anchor nodes, actual position and estimated position. The algorithm location estimation accuracy percentage is 65.63.

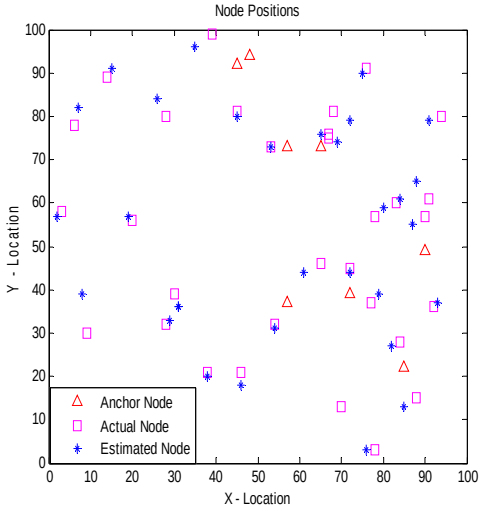

Figure-2. Flower pollen localization algorithm output.

The convergence curve of the flower pollen localization algorithm is shown in the Figure-3.

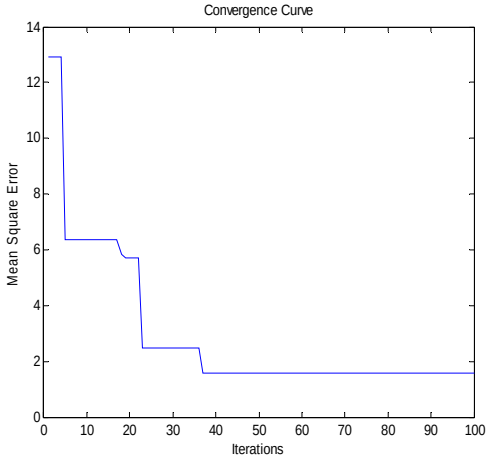

Figure-3. Flower pollen localization algorithm convergence curve.

Table-1. Parameters of flowers pollen localization algorithm.

Parameters	Value
Maximum iteration	100
Space size	100
Anchor node	8
Unknown node	32
Total nodes	40
No: of flowers	20
Switching probability, p	0.7
Constant, λ	1.5
Scaling factor, ε	0.03
Step size, γ	0.01

4. CONCLUSIONS

Wireless sensor networks are extensively used in most of the areas of modern world intelligent applications. Most of these applications demand location information of the sensor nodes. This paper provides a solution for localization of wireless sensor networks with nature inspired algorithm known as flower pollen localization algorithm. It uses a distributed localization technique, where the computation is done in collaborative manner by different sensor node. So the communication of data to the base station is reduced, due to which the energy requirement is reduced and so the life time and reliability of wireless sensor networks is improved. Flower pollen localization algorithm is used for minimization of localization error of sensor nodes in wireless sensor networks. Flower pollen localization algorithm has only one key parameter, switching along with the scaling factor. So this algorithm is easier to implement. The flower pollen localization algorithm performs well to predict the location information of wireless sensor nodes and has better accuracy and convergence. Further flower pollen algorithm design parameters can be tuned and the algorithm could be hybrid with other intelligent nature and bio inspired algorithm for better performance in terms of accuracy and convergence.

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