A Review on Novel Energy Efficient Routing Technique Using Flower Pollination Optimization Algorithm for Wireless Sensor Network

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Abstract-*As wireless sensor networks still struggling to extend its lifetime, nodes clustering and nomination, or selection of cluster head node are proposed as solution. LEACH protocol is one of the oldest remarkable clustering approaches that aim to cluster the network`s nodes and randomly elects a cluster head for each cluster. It selects cluster heads but it is not responsible for proper clustering formation. In this paper study the Flower Pollination Optimization Algorithm (FPOA) to propose a WSN energy aware clustering formation model based on the intra-cluster distances. The objective is to achieve the local optimization for WSN lifetime. Flower Pollination Algorithm is the most recently developed nature inspired algorithm based on pollination process of plants. Flower Pollination Algorithm is principally used to solve constrained and unconstrained optimization problems.*

Keywords-Wireless Sensor Network; Energy-aware algorithm; Flower Pollination Optimization Algorithm; nature inspired algorithm.

I. INTRODUCTION

A few sensor devices (also called nodes) can be deployed together to create a wireless sensor network (WSN). A WSN can contain few to thousands of these devices at a time. The networks may be dense or sparse with different network topologies. The sensor devices collect data through sensing and monitoring from their respective environment and send to a sink for further processing. As the cost and size of sensor devices decreasing fast, the application areas of such wireless sensor networks have also expanded rapidly. The major application domains are home and o□ce, control and automation, logistics and transportation, environmental monitoring, healthcare, agriculture, security and surveillance, tourism and leisure, military-related activities, education and training, and entertainment. Sensors are now present everywhere including digitally equipped smart homes and buildings, vehicle tracking and detection, monitor of manufacturing process in factories, inventory control, natural habitats, and patients in hospitals, and so on .The requirements in the above applications are as diverse as the application areas themselves. Figure 1.1 shows typical application areas.

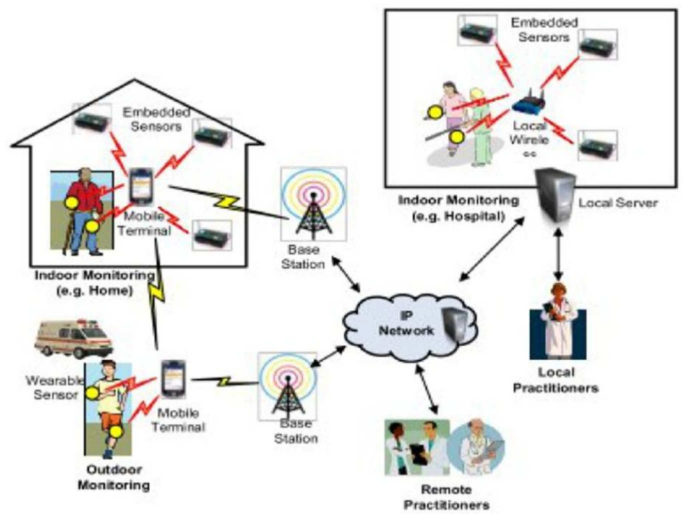

Figure 1.1 (WSN APPLICATIONS)

As discussed earlier, a sensor network comprises of sensor nodes1. The size of a sensor node generally varies between the sizes of a typical match box to that of a dime. A sensor node is equipped with a MEMS2 sensor. The sensors can be of various types. Some of the more well known types of MEMS sensors are seismic, light, temperature, acoustic, stress etc. A temperature sensor, for instance, measures the ambient temperature in terms of an electric signal. A sensor node further has a small power aware CPU. The CPU has low computation power. The computation power of a particular CPU is of a few MHz. And it is a 8-bit processor. Similarly a sensor node has 128 kilobytes of on-board flash memory to hold the program and 512 kilo bytes of flash memory to hold data. A sensor node has a small embedded operating system which is used to operate a sensor node. Tiny OS is one example of operating systems in vogue for sensor nodes. Tiny OS is built normally on a UNIX like platform using Java. A sensor node also has a low power communication transceiver which can transmit approximately 40,000 bits per second. It has a range of a few hundred feet. In order to operate the whole sensor node, it is also equipped with a small battery

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power source. The limited battery power is a constraint which determines the effective life time of a sensor node. In order to increase the life of a sensor node it is required to have a robust and power efficient routing algorithm at the network layer. So by using a power efficient routing algorithm the life of a sensor node can be extended to almost 10 years.

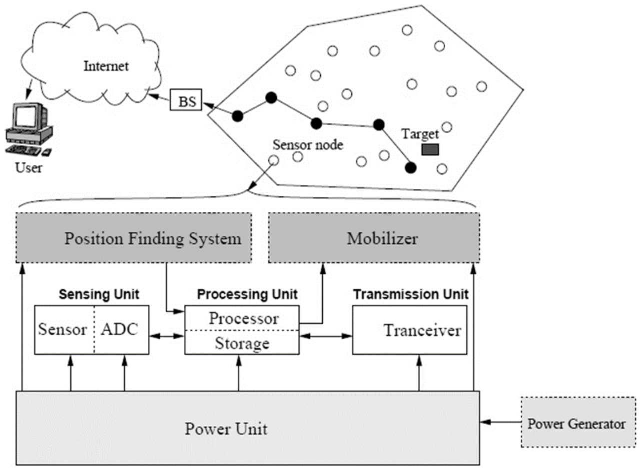

Figure 1.2 SENSOR NODE

II. APPLICATIONS OF SENSOR NETWORKS

- Military: Military situation aware ness. Sensing intruders on basis. Detection of enemy unit movements on land and sea. Battle field surveillances.
- Emergency situations: Disaster management. Fire/water detectors. Hazardous chemical level and fires.
- Physical world: Environmental monitoring of water and soil. Habitual monitoring. Observation of biological and artificial systems.
- Medical and health: Sensors for blood flow, respiratory rate, ECG (electrocardiogram), pulse oximeter, blood pressure and oxygen measurement. Monitoring people's location and health condition.
- Industrial: Factory process control and industrial automation. Monitoring and control of industrial equipment.
- Home networks: Home appliances, location awareness (blue tooth). Person locator.
- Automotive: Tire pressure monitoring. Active mobility. Coordinated vehicle tracking.

III. LEACH PROTOCOL

Low Energy Adaptive Clustering Hierarchy (LEACH) is one of the mostly used hierarchical cluster-based routing protocols for wireless sensor network. LEACH is a data aggregation algorithm that is based on cluster based routing. In such a situation, the data from the each node must be sent to a central base station, often located far from the sensor network, through which the end-user can access the data. LEACH is a self-organizing, adaptive clustering protocol that uses randomization to allocate the energy load equally among the sensors in the network. The LEACH protocol is works in rounds such that each round has two phase's i.e setup and steady state phase. In the setup phase, Cluster Head (CH) selection is based on two factors. First, the percentage P of nodes in network and secondly history of nodes that has served as CH. A threshold value T (n) is set and decision is made by each node n based on the random number i.e. lies between 0 and 1. If the random number is less than threshold value, (T (n)), then, the node become a cluster head for the current round. The threshold value calculated based on the equation i.e. given below:

$$T(n) = \left\{ \frac{p}{1-p\,(r \bmod 1/p)} \;,\; if\ n \in G \right\}$$

Here P is the desired percentage of cluster heads and r is the current round, G is the group of nodes that has not been the CHs in the last rounds. The sensor node i.e. selected as a CH is not selected in the next rounds until all other nodes in the network becomes cluster heads. In the steady state phase, nodes send their collected data by using their allocated TDMA slot to CH. The CH aggregates the data when received and send it to the Base Station (BS). Figure 1.11 shows the LEACH protocol as given below.

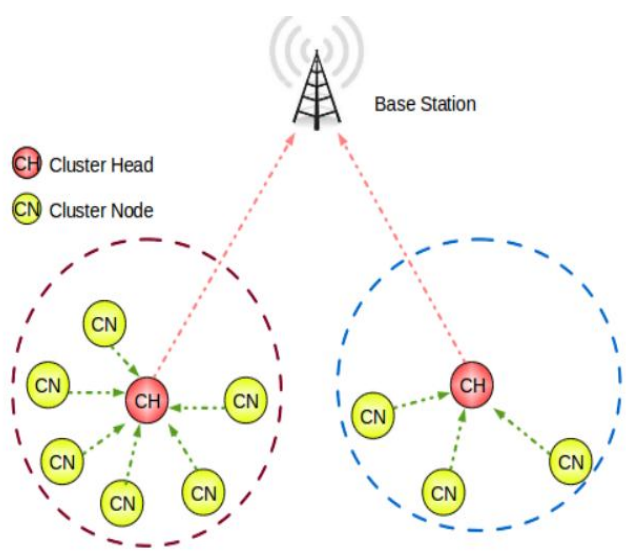

Figure 1.3 LEACH aggregation algorithm

LEACH operation is broken into rounds, with each round having a set-up phase and a steady state phase.

The Set-up Phase: First, the LEACH protocol randomly selects cluster heads (CHs) by randomly generating a number (n) between 0 and 1, for each node. If this randomly generated number is less than the threshold value given by threshold function T (n), the node would be selected as cluster head node. Where P is the cluster-head probability and G is the set of nodes that never be chosen as cluster-head nodes before 1/p round. After the selection of cluster head nodes, each cluster-head node will send information via CDMA code to other nodes and normal nodes will join the corresponding cluster-head nodes. Then the cluster head nodes use TDMA to provide data transmission time for every node connected to them.

The Steady-state: This stage is for data transmission where normal nodes sense data and send this sensed data to their respective cluster-head nodes. The processing of received data (data aggregation and data fusion) is done by cluster head nodes and processed data will be sent to the base station.

IV. FLOWER POLLINATION

Pollination:

The reproduction in plants happens by union of the gametes. The pollen grains produced by male gametes and ovules borne by female gametes are produced by different parts and it is essential that the pollen has to be transferred to the stigma for the union. This process of transfer and deposition of pollen grains from anther to the stigma of flower is pollination. The process of pollination is mostly facilitated by an agent. The pollination is a result of fertilization and it is must in agriculture to produce fruits and seeds.

There are two types of pollination:

1. Self-Pollination.
2. Cross Pollination.

Self- Pollination:

When the pollen from a flower pollinates the same flower or flowers of the same plant, the process is called self-pollination. It occurs when a flower contains both the male and the female gametes.

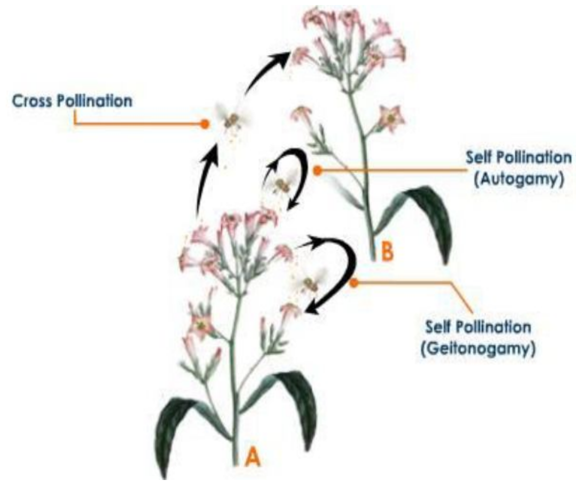

Figure 1.4 Pollination

Cross Pollination:

Cross Pollination occurs when pollen grains are moved to a flower from another plant. The process of cross pollination happens with the help of abiotic or biotic agents such as insects, birds, snails, bats and other animals as pollinators. Abiotic pollination is a process where the pollination happens without involvement of external agents. Only about 10% of plants fall in this category. The process of pollination which requires external pollinators is known as Biotic Pollination to move the pollen from the anther to the stigma. Insects play most important role as the pollinators. Insect Pollination occurs in plants with coloured petals and strong odour which attract Honey bees, moths, beetles, wasps, ants and butterflies. The insects are attracted to flowers due to availability of nectar, edible pollen and when insect sits on the flower, the pollen grains stick to the body. When the insect visits another flower, the pollen is transferred to stigma facilitating pollination. The pollination is also facilitated by vertebrates like birds and bats. Flowers pollinated by bats mostly have white coloured petals and strong odour. The birds usually pollinate flowers with red petals and without odour.

FLOWER POLLINATION ALGORITHM:

Flowering plants flow pollination process inspired Xin-She Yang to develop Flower Pollination Algorithm (FPA) in 2012. For ease, the four rules given below are used.

1. Biotic and cross-pollination can be considered processes of global pollination, and pollinators carrying pollen move in a way that confirms to Lévy flights.

2. For local pollination, abiotic pollination and self-pollination are used.

3. Pollinators, like insects develop flower loyalty, which is comparable to the reproduction possibility proportional to the matching of two flowers involved.

4. Switching or the interaction of global pollination and local pollination can be controlled by a switch probability p □ [0, 1], slightly biased towards local pollination.

To formulate the updating formulas, these rules have to be changed into correct updating equations. The main steps of FPA, or simply the flower algorithm are illustrated below:

min or max objective f(x), x = (x1, x2 , . . . , xd)
Initialize n flowers or pollen gametes population with random solutions
Identify the best solution (g*) in the initial population
Express a switch probability p □ [0, 1]
While (t < Max Generation)
for i = 1 : n (all n flowers in the population)
if rand < p,
Draw a (d-dimensional) step vector L from a Levy distribution
Global pollination via $x_i^{t+1} = x_i^t + \gamma L(g_* - x_i^t)$
else
Draw from a uniform distribution in [0,1]
Do local pollination via $x_i^{t+1} = x_i^t + (x_j^t - x_k^t)$
end if
Evaluate new solutions
If new solutions are better, update them in population end for
Find current best solution
end while
Output the best solution obtained

V. CONCLUSION

This paper introduces the evolutionary characteristics of flower pollination to solve unconstrained local optimization problem. In this paper, need for optimization techniques, limitations of traditional optimization techniques and the benefits of nature inspired algorithms are discussed. Study indicates that Flower Pollination algorithm is simple, flexible and exponentially better to solve optimization problems. FPA can be used for solving both single objective and multi objective optimization problems. We propose a flower pollination based optimization clustering algorithm for WSN. It is exposed for homogenous wireless sensor environment. It further enhances the wireless sensor network lifetime by associating the cluster nodes according to the distance to the proper cluster head and also study indicated that FPA reduces time, improves the results and the performance is better compared to other optimization techniques. FPA looks very promising and is still in nascent stage and can be applied for medical image Analysis.

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