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# FPOA Implementation for WSN Energy Efficient Routing

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***Abstract*—**In this paper, a soft computing technique Flower Pollination optimization Algorithm(FPOA) for WSN is proposed. The Sensor Network is heterogeneous in nature. Proposed algorithm is designed and implemented in MATLAB. In this technique some nodes send data directly to base station as local pollination and some by Multihop routing as global pollination. A routing scheme is process which helps in minimizing the energy consumption. The performance of FPOA is compared with techniques that are already developed.(Low Energy adaptive clustering hierarchy (LEACH), Stable Election Protocol (SEP) and Zonal-Stable Election Protocol (Z-SEP) Simulation results show that FPOA enhance first node dead time, throughput and overall energy efficiency than existing protocols like LEACH, SEP and Z-SEP.

**Keywords**- *Flower Pollination optimization Algorithm (FPOA); Wireless sensor network(WSN); energy efficiency; Multihop routing; sensor nodes.*

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## I. INTRODUCTION

Now a days wireless sensor network garning a great demand because low value of sensor element nodes, self organization and sensing capability of atmosphere conditions. Routing is the necessary technique in wireless sensor network. Energy efficiency is the most vital performance factor in wireless sensor network. Wireless sensor network made up of thousand sensor nodes .In such cases maximum amount energy of node is restricted, networks lifetime is taken into account to be a vital issue. As there is scarcity of energy sources conjointly, the batteries are low powered; an energy efficient routing is supposed to be vital challenge in WSN.

In WSN most of the energy is consumed throughout transmission and receiving/ communication between data packets. As a result the energy-aware routing technique should be design in such a way that controls and manages energy with efficiency.

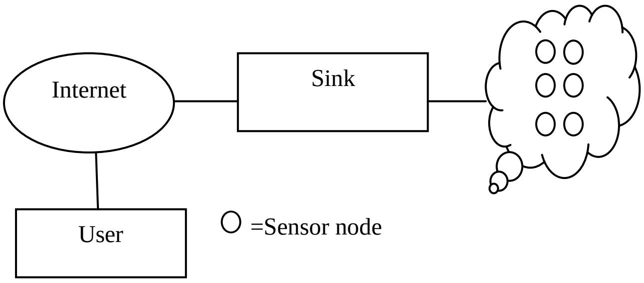


Figure 1. Wireless Sensor network Architecture [14]

The main components of communication are:

- Sensor nodes have the ability to collect and send data to the sink wirelessly and communicate with the sink nodes can be single-stage or multi-stage.
- The base station (sink) that communicates with the user via the Internet or satellite.
- Something that user wants to receive information about it.
- The user that data collected to measure /monitor the behavior of the phenomenon.

A WSN typically consists of a large number (tens to thousands) of low-cost, low-power, and multifunctional sensor nodes that are deployed in a region of interest. These sensor nodes are small in size, but are equipped with embedded microprocessors, radio receivers, and power components to enable sensing, computing, communication, and actuation. These components are integrated on a single or multiple boards, and packaged in a few cubic inches. A WSN communicates over a short distance through wireless channels for information sharing and cooperative processing to accomplish a common task. WSNs can be deployed on a global scale for environmental monitoring and habitat study, over a battlefield for military surveillance and reconnaissance, in emergent environments for search and rescue, in factories for condition based maintenance and process control, in buildings for infrastructure health monitoring, in homes to realize smart homes, or even in bodies for patient monitoring [1].

## II. RELATED WORK

Energy Efficient Routing is very important factor in the design of WSNs. The work done by several researchers till date is described in this section.

Hady et al. [2] presented in a Low energy Adaptive Clustering Hierarchy Centralized Sleeping Protocol (LEACH-CS) for wireless sensor networks has been proposed. LEACH-CS extends the lifetime of wireless sensor networks by proposing a mechanism that performs an intelligent choice of functioning nodes depending on the data sensed at the time being. If the data received from certain clusters appears insignificant in a period of time, these clusters are set to sleeping mode till the next data round.

Alnuaimi et al.[3] described depending on the application, mobile ferries can be used for collecting data in a WSN especially those at a large-scale with delay tolerant applications. A ferry based approach eliminates or minimizes the need for multi-hop forwarding of data, and as a result energy consumption at the nodes will be significantly reduced especially nodes that are near the base station as they are used by other nodes to forward data to the base station.

Muruganathan et al. [4] presented wireless sensor networks consist of small battery powered devices with limited energy resources. Once deployed, the small sensor nodes are usually inaccessible to the user, and thus replacement of the energy source is not feasible. Hence, energy efficiency is a key design issue that needs to be enhanced in order to improve the life span of the network.

Shang and Lei [5] described a network of energy constrained sensors deployed over a region. Each sensor node in such a network is systematically gathering and transmitting sensed data to a base station (via cluster-heads). Firstly, we pro-posed an Energy-balanced Clustering Routing Algorithm called LEACH-L, which is suitable for a large scope wireless sensor network. Secondly, optimum hop-counts are deduced. Lastly, optimum position of transmitting node is estimated. Simulation results show that our modified scheme can extend the network lifetime by up to 80% before first node dies in the network.

Yue et al. [6] defined data aggregation is an effectual approach for wireless sensor networks (WSNs) to save energy and prolong network lifetime. Cluster-based data aggregation algorithms are most popular because they have the advantages of high flexibility and reliability. But the problem of unbalanced energy dissipation is the inherent disadvantage in cluster based WSNs.

Amine et al.[7] discussed main concern of clustering approaches for mobile wireless sensor networks (WSNs) is to prolong the battery life of the individual sensors and the network lifetime. For a successful clustering approach the need of a powerful mechanism to safely elect a cluster-head remains a challenging task in many research works that take into account the mobility of the network.

Kannan and Raja[11] defined wireless sensor network (WSN) provides a significant contribution in the emerging fields such as ambient intelligence and ubiquitous computing. In WSN, optimization and load balancing of network resources are critical concern to provide the intelligence for long duration. Since clustering the sensor nodes can significantly enhance overall system scalability and energy efficiency this paper presents a distributed cluster head scheduling (DCHS) algorithm to achieve the network longevity in WSN.

Eshaftri et al.[12] presented in wireless sensor Networks (WSNs), clustering techniques are usually used as a key effective solution to prolong the network lifetime by reducing energy consumption among the sensor nodes. Despite many works on clustering in WSNs this issue is still outstanding. However, the most existing solutions suffer from long and iterative clustering cycles.

Amiri et al.[13] focused wireless sensor network (WSN) is a collection of sensor nodes that dynamically self-organize themselves into a wireless network without the utilization of any preexisting infrastructure. In this paper, we propose an optimal routing protocol for WSN inspired by the foraging behavior of ants. The ants try to find existing paths between the source and base station.

## III. FLOWER POLLINATION ALGORITHM

FPA was developed by Xin-She Yang in 2012 [8], inspired by the flow pollination process of flowering plants. For simplicity, the following four rules are used:

1. Biotic and cross-pollination can be considered processe of global pollination, and pollen-carrying pollinators move in a way that obeys Lévy flights (Rule 1).
2. For local pollination, abiotic pollination and self-pollination are used (Rule 2).
3. Pollinators such as insects can develop flower constancy, which is equivalent to a reproduction probability that is proportional to the similarity of two flowers involved (Rule3).
4. The interaction or switching of local pollination and global pollination can be controlled by a switch probability $p \in [0,1]$, slightly biased toward local pollination (Rule 4).

For global pollination, pollinators such as insects are intend to travel long distances to achieve the global optimization of reproduction based on flower consistency, this can mathematically achieve by:

$$x_i^{t+1} = x_i^t + L(x_i^t - g_*) \qquad (1)$$

Where

$x_i^t$: is the pollen i or solution vector at $x_i$ iteration t.

$g_*$: is the current best solution found all solutions at the current generation/iteration.

L : is the strength of the pollination, which essentially is a step size. In using Levy`s flight model to mimic the characteristic of the flying insects efficiently. That is, L > from a Levy`s distribution.

$$L \sim \frac{\lambda\Gamma(\lambda)\sin(\Pi\lambda/2)}{\Pi}\frac{1}{S^{1+\lambda}} \quad (s>>s_0>0) \qquad (2)$$

Where

$\Gamma(\lambda)$: is the standard gamma function.This distribution is valid for large steps s > 0.

For the local pollination, that achieved by abiotic and self-pollination based on flower constancy, the mathematical representation is as follows:

$$x_i^{t+1} = x_i^t + \epsilon(x_j^t - x_k^t) \qquad (3)$$

Where

$x_j^t$ and $x_k^t$ are the pollens from the different f lowers of the same plant species.

ϵ: is local random walk drawn from the uniform [0,1].

For the fourth rule, the switch probability $p \in [0,1]$ is used to control the exchange of the pollination process from local to global and vice versa.

## IV. PROPOSED MODEL AND METHODOLGY

*A . Network Architecture*

Network model to be considered in proposed work is based on the model developed by S. Faisal et al. in [9].Network field is divided in three partitions. Partition 0, Partition 1 and Partition 2, on the basis of energy levels and Y co-ordinate of network field. Here it is assumed that a fraction of the total nodes are equipped with more energy. Let m be fraction of the total nodes n, which are equipped with α time more energy than the other nodes. These nodes refer as advance nodes, (1-m) ×n are normal nodes.

- ○ = Partition 0 normal nodes
- ○ = Partition 1 advance nodes
- ○ = Partition 2 advance nodes
- X = Base station

Partition 0: Blue Normal nodes are deployed randomly, lying between 20<Y<=80.

Partition 1: Half of green advance nodes are deployed randomly in this zone, lying between 0<Y<=20.

Partition 2: Half of red advance nodes are deployed randomly in Partition 2, lying between 80<Y<=100.

X is in the middle is a base station.

The reason behind this type of deployment is that advance nodes have high energy than normal nodes. As corners are most distant places in the field, so if a node is at corner then it requires more energy to communicate with base station so high energy nodes (advance nodes) deployed in Partition 1 and Partition 2.

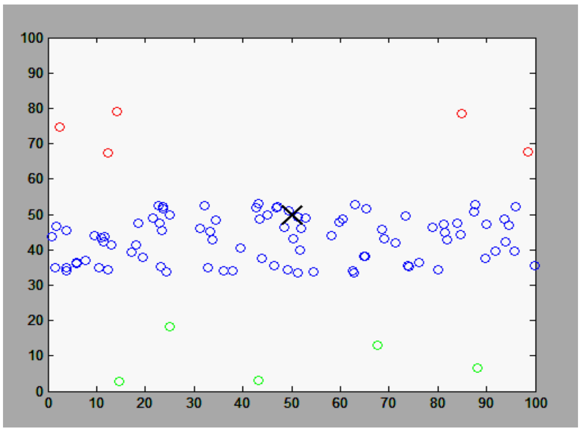


Figure 2. Network Architecture

*B. Implementation flower Pollination in the model and data transmission*

There are 100 nodes out of which 90 normal nodes and 10 advance nodes.

5 nodes in Partition 1 and 5 nodes in Partition 2.

90 nodes are in Partition 0.

Apply Flower Pollination in the Middle of Network that is in Partition 0.There occur two scenarios.

Partition 0 occurs in two parts on both sides of base station.

a) The nodes which are nearer to the base station used local pollination as they directly send data to base station. (Self-pollination).
b) The nodes which are far away from base station using multihop routing which find best shortest path or nearest neigbor to send data to base station as global pollination (Cross-pollination).
c) If probability function $p \in [0, 1]$ is greater than minimum energy of nodes then global pollination is used otherwise local pollination occurs.

*C. Energy Model*

In [10] the proposed technique Energy Aware Sleep Scheduling Clustering based Routing scheme (EASSCR) for Wireless Sensor Network is used. First order radio model is adopted here for measuring energy consumption by sensor nodes while communicating. Equation 4 represents the amount of energy consumed for transmitting l bit of data to d distance. Equation 5 represents the amount of energy consumed for receiving l bit of data subject to circuit loss.

$$E_{TX}(l, d) = l \times E_{elec} + l \times \epsilon_{fs} \times d^2, \text{ if } d \le d_0$$
$$= l \times E_{elec} + l \times \epsilon_{mp} \times d^4, \text{ if } d \ge d_0 \quad (4)$$
$$E_{RX}(l, d) = l \times E_{elec} \quad (5)$$

Where d refers the transmission distance i.e. distance between a member-node and its cluster-head or between cluster-head and base station (BS); $d_0$ is threshold distance ; Eelec the energy consumption per bit in the transmitter and receiver circuitry by a node when $d < d_0$ and $d \ge d_0$, where $d_0 = \sqrt{\frac{\epsilon fs}{\epsilon mp}}$.$\epsilon_{fs}$ and $\epsilon_{mp}$ are the energy consumption coefficient of the amplifier.

*D. Steps of methodology Flowchart*

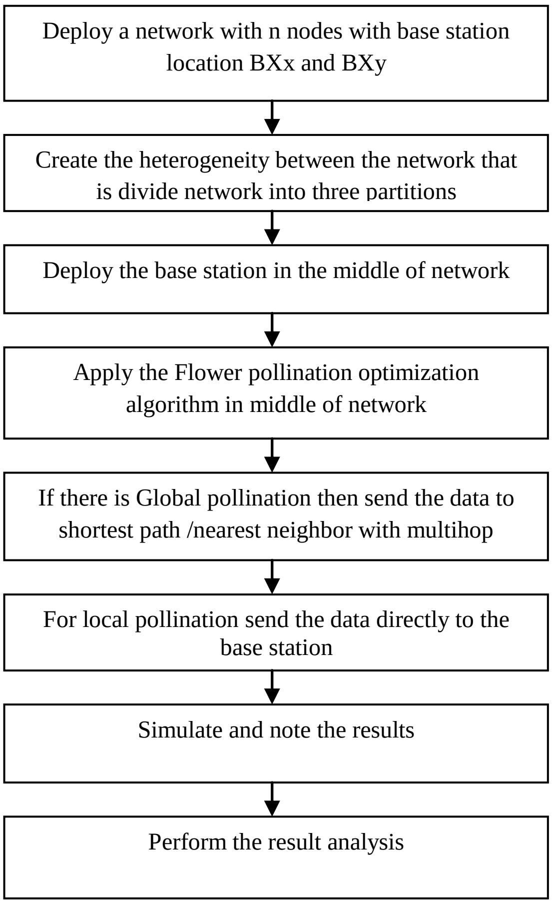


Figure 3. Steps of methodology

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## V. SIMULATION

The proposed model has been simulated and studied using MATLAB environment.The dimensions are 100m×100m and 100 nodes deployed in specific partitions with respect to their energy. Base station is placed in the middle of the network field.

Table1. Simulation Parameters

| Parameter | Value |
|---|---|
| Network Size | 100x100m$^2$ |
| Number of nodes | 100 |
| Packet data size | 4000 bits |
| Initial energy $E_0$ | 0.5 J/node |
| Minimum energy | 0.0001J |
| Transmitter electronics($E_{elec}$) | 50nJ/bit |
| Receiver electronics($E_{elec}$) | 50nJ/bit |
| Data aggregation energy$E_{DA}$ | 5nJ/bit/signal |
| Amplification energy for short distance ($\epsilon_{fs}$)if $d \leq d_0$ | 10pJ/bit/m$^2$ |
| Amplification energy for long distance ($\epsilon_{mp}$)if $d \geq d_0$ | 0.0013pJ/bit/m$^4$ |
| Probability $p_{opt}$ | 0.1 |
| Number of rounds | 3000 |

## VI. PERFORMANCE ANALYSIS OF RESULTS

Comparison results of proposed technique with SEP, LEACH and Z-SEP. Goals in conducting simulation are:

- To examine the First dead node time in terms of rounds of LEACH, SEP, Z-SEP and FPOA
- To examine the throughput of LEACH, SEP, Z-SEP and FPOA.

Fig.4, Fig.5 and Fig.6 shows result for the case when *m*=0.1and α=2.This means that there are 100 nodes out of which 90 normal nodes and 10 advance nodes.

According to proposed work 5 nodes will be placed in Partition 1 and 5 nodes will be in Partition 2.

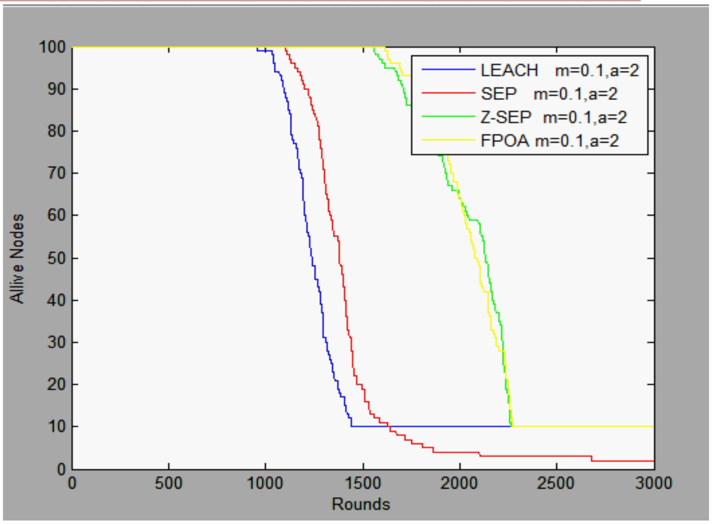


Figure 4. Alive nodes in LEACH, SEP, Z-SEP and FPOA

Fig.4 shows the number of alive nodes against rounds. It clearly shows that proposed technique performs better than SEP, Z-SEP and LEACH.

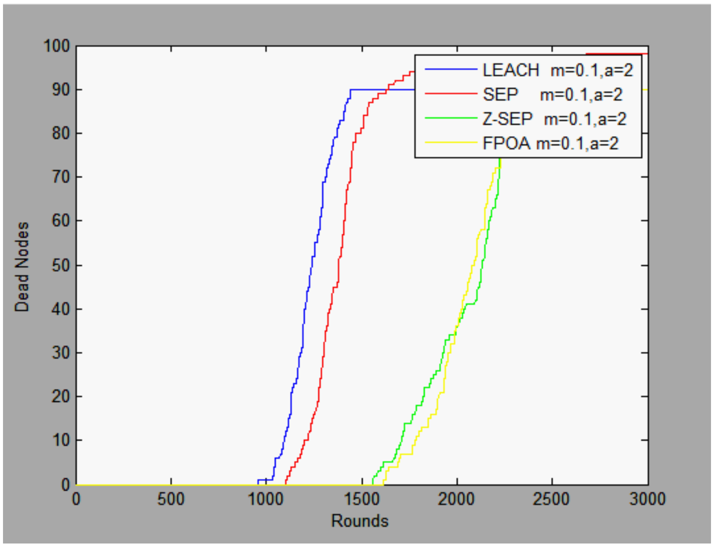


Figure 5. First dead nodes in LEACH, SEP, Z-SEP and FPOA

Fig.5 shows the number of dead nodes against rounds. It shows that when first node is dead in terms of rounds. It clearly shows that FPOA enhances number of rounds which in turns less energy consumes.

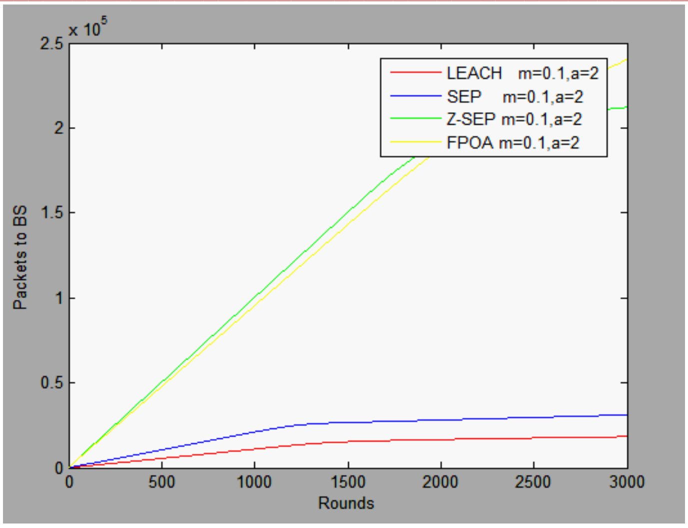


Figure 6. Throughput of LEACH, SEP, Z-SEP and FPOA

Fig.6 shows the throughput of LEACH, SEP, Z- SEP and FPOA.Throughput of FPOA is increased and better as comparative to LEACH, SEP, Z- SEP.

Table2. Comparison Table When *m*=0.1 and α =2

| Technique name | First dead node(Rounds) | Throughput (Packets) |
|---|---|---|
| LEACH | 961 | 37860145 |
| SEP | 1106 | 66265421 |
| Z-SEP | 1559 | 405395213 |
| FPOA | 1618 | 406037490 |

In Table 2, The results of proposed FPOA compared with LEACH, SEP and Z-SEP which depicts increase in first dead node round and throughput .

## VII. CONCLUSION

In this paper, FPOA is developed for a heterogeneous environment. The paper describes FPOA in which local and global pollination is done. In local pollination nodes send data directly to base station and global pollination use multipath routing. The nodes which are closest to base station directly send data to base station. Otherwise through multipath routing best path or nearest neigbor is used to send data to base station. The performance comparison shows that first dead node time in terms of rounds increases and overall energy consumes efficiently to send data packets to base station. Throughput of FPOA is also increased as compared with LEACH, SEP and Z- SEP. It shows proposed technique performes better than existing techniques LEACH, SEP and Z-SEP.

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