# Shifting of Sink Position in Wireless Sensor Network

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***Abstract*— Wireless sensor Network (WSN) has attracted much attention in recent years due to their potential use in much application such as border protection, combat field surveillance, disaster management and security surveillance. Given the critically of such application, a fundamental objective is a maintaining a dependable operation of the network. However, the resource-constrained nature of sensor nodes and the ad-hoc formation of the network, often coupled with an unattended deployment, pose non-conventional challenges and motivate the need for special techniques for dependable design and management of WSN. In wireless sensor networks, the major source of a sensor node failure is battery exhaustion and replacing this energy source in the field is usually not practical. Therefore, the use of energy efficient infrastructure, such as repositioning the sink in a clustered wireless sensor network, is able to prolong the lifetime of the network and improve the overall network data. In this project, an energy-efficient protocol for the repositioning of mobile sink using genetic algorithm in wireless sensor networks can improve the network lifetime, data delivery and energy consumption compared to existing energy-efficient protocols developed for this network.**

***Index Terms*—Wireless sensor networks, Sink, Genetic Algorithm.**

## I. INTRODUCTION

Wireless sensor networks are a family of networks in wireless communication system and have the potential to become significant subsystems of engineering applications. Sensor network is composed of a large number of low cost and low power sensor nodes that can be spread on a densely populated area and a sink in order to monitor and control various physical parameters [1]. These sensors are endowed with a small amount of computing and communication capability and can be deployed in situation that wired sensor systems couldn't be deployed.

Wireless sensor network should operate with minimum possible energy to increase the life of sensor nodes. Protocols and algorithms in sensor network must possess self-organizing capabilities in order to achieve this target. The challenges in the designing and managing of sensor network rely on combination of the constraint in energy supply and bandwidth, and deployment of large number of sensor nodes [2]. The design of sensor network seldom includes its sensor nodes and sink. The sink usually collects data and exploits data in which way it prefers. Positioning the sink of the network is one of the interesting issues to investigate. The focus of this research is to design wireless sensor network with carefully positioning its' sink in order to improve the network lifetime in critical environment.

In this paper we'll find optimized position of Sink toward the cluster head node in network, we will try the node can gather data and send it to sink with the least possible energy usage. Finding sink optimized position; we've considered distance and parameters. Sink optimized positioning is a NP-hard problem. Therefore we'll use GA to solve positioning problem.

The rest of this paper is organized as follows: In the next section we will point out related work; Section III describes the network model and assumptions, in section IV we will discuss GA algorithm and how to use this algorithm to find sink optimize position. Section V presents simulation results and performance evaluation the conclusion and future work's presented in sections VI.

## II. RELATED WORK

There are two types of sink positioning in wireless sensor networks, static positioning and dynamic positioning. In static sink positioning, the sink is not moving and the optimal location of sink is calculated before deploying the sink to the network area. In dynamic sink positioning, the sink is moving and the optimal location of sink is calculated after deploying the sink to the network area.

In static base repositioning the authors in [3] proposed that to minimize total communication power, the BS is to be located Such that maximum distance to a sensor node is minimized. A computational geometry based algorithm, whose complexity is linear in the number of nodes n, is proposed. This algorithm tries to determine the circle with the least diameter that encloses the nodes. Such a circle can be formed, with at most three points, selected among the locations of the sensors. The BS then is positioned at the center of the circle.

In dynamic base station repositioning the authors in [4] proposed a limited motion to the stationary Base Station towards the sources of largest traffic. Such approach has multiple advantages. First, the Base station will be near to nodes collecting maximum data, thus reducing communication related energy consumption. It is thus expected that the average energy per packet to be reduced. In addition, the overall latency time for data collection will be lower.

The authors in [5] proposed issues related to when should the BS be relocated, where it would be moved to and how to handle its motion without negative effect on data traffic. Further they presented two approaches that factor in the traffic pattern for determining a new location of the BS for optimized communication energy and timeliness, respectively.

Amir Mollanejad at al. [7] they have proposed the primal population consists of n chromosomes which show the position of BS. Each chromosome includes two parts; X (length of network environment) & Y (width of network environment). They have encoded by binary encoding scheme. Each chromosome is evaluated by fitness function. They have applied modified 2-point crossover and random point flip for mutation operation. In additional, for new population replacement, they will replace selected population with next population. The condition of genetic algorithm expiry is based on the number of generations they have supposed.

## III. SYSTEM MODEL

### A. Network Model Assumption:

The sensor network model that is used in this paper is a sensor network incorporates the following specific features:

- Each sensor node generates equal amount of data per time unit and each data unit is of same length.
- All sensor nodes are stationary and homogeneous with limited energy.
- All sensor nodes are aware of their location information.
- Base station is able to move in entire Network.
- For simplicity, the time taken for base station movement is negligible.

### B. Energy Model:

Our energy model for the sensors is based on the first order radio model as used in [12]. In this model, the transmitter dissipates energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio electronics. The radios can perform power control and hence use the minimum energy required to reach the intended recipients. Due to attenuation with distance, an energy loss model with $d^2_{ij}$ is used for relatively short distances and $d^4_{ij}$ is used for longer distances, where $d_{ij}$ is the distance between sensor nodes i and j. Thus, in order to achieve an acceptable Signal-to-Noise-Ratio (SNR) in transmitting an $l$-bit message over a distance d, the energy expended by the radio is given by:

$$E_{TX}(l,d) = l.E_{elec} + l.\varepsilon_{FS}d^2, if\ d < d_0 \quad (1)$$
$$= l.E_{elec} + l.\varepsilon_{TR}d^4, if\ d \geq d_0 \quad (2)$$

Where $E_{elec}$ is the energy dissipated per bit to run the transmitter or the receiver circuit, $\varepsilon_{FS}$ and $\varepsilon_{TR}$ depends on the transmitter amplifier model we use, and $d_0$ is the threshold transmission distance. To receive an $l$-bit message, the radio expends:

$$E_{RX}(l) = l.E_{elec} \quad (3)$$

For the simulations described in this paper, the communication energy parameters are set as: $E_{elec}$=50nJ/bit, $\varepsilon_{FS}$ =10pJ/bit/m$^2$ and $\varepsilon_{TR}$ = 0.0013pJ/bit/m$^4$.

The data fusion model used in our simulations assumes that the overall information collected by a cluster of n nodes, where each node collects k bits of data, can be compressed to k bits regardless of the number of nodes in that cluster. In our simulations, the energy cost for data aggregation is set as $E_{DA}$= 5nJ/bit.

## IV. GENETIC ALGORITHM

In genetic algorithm the primal population consists of n chromosomes which show the position of sink. Each chromosome includes two parts; *X* (length of network environment) & *Y* (width of network environment) which are encoded by binary encoding scheme. Each chromosome is evaluated by fitness function. Here modified 2-point crossover and random point flip for mutation operation is applied. In additional, for new population replacement, the selected population is replaced with next population. The condition of genetic algorithm expiry is based on the number of generations they have supposed.

#### 1) Population

Binary encoding in the proposed algorithm is applied that is each chromosome is related to sink position. The length and width are supposed for the environment which sensors are distributed. It has supposed that all of the sensors are placed in a point with a specific width and length. Chromosomes are consisted of two parts: First binary part is related to *X* (length of sensor point) and the second binary part is related to *Y* (width of sensor point). The number of *X* & *Y* bits depends on the length and the width of network environment.

#### 2) Fitness

Fitness function is calculated based on distance and residual energy parameters in sensors. Each chromosome which enjoys random *X* & *Y* that it shows the position of sink. Summation of distance between this random point and all of the sensors is achieved by multiply ratio for each sensor (this ratio introduces inverse of residual energy in sensor) that shown in equation 4.Residual energy is supposed as a number between 1 and 10.

$$abf = \sum_{i=1}^{n} \frac{1}{w_i}\sqrt{(x-x_i)^2-(y-y_i)^2} \quad (4)$$

Where n = number of sensor nodes.

The fitness function is given as follows:

$$\textbf{\textit{Fitness}} = \textbf{\textit{m}} - \textbf{\textit{abf}} \qquad (5)$$

Table 1 The parameters used in equation 5 and fitness function

| Parameter | Description |
|---|---|
| $i$ | Index of nodes |
| $x_i$ | position length of node of i |
| $y_i$ | position width of node of i |
| $w_i$ | Residual energy node of i |
| $m$ | A very large number |

**3) Selection**

The selection process selects chromosomes from the mating pool according to the survival of the fittest concept of natural genetic system. In each successive generation, a proportion of the existing population is selected to breed a new generation. This approach uses 80% as crossover probability, which means that 80% of the population will take part in crossover. The probabilities for each chromosome are calculated according to their fitness values, and selection is in proportion to these probabilities here the chromosome with lower probability has more chance of being selected. The proportions are calculated as given below.

$$prob(ch_i) = \frac{fitness(ch_i)}{\sum_{i=1}^{n} fitness(ch_i)} \qquad (6)$$

Once the probabilities are calculated, Roulette Wheel selection is used to select parents for crossover may be viewed as a roulette wheel where each member of the population is represented by a slice that is directly proportional to the member's fitness. A selection step is then a spin of the wheel, which in the long run tends to eliminate the least fit population members.

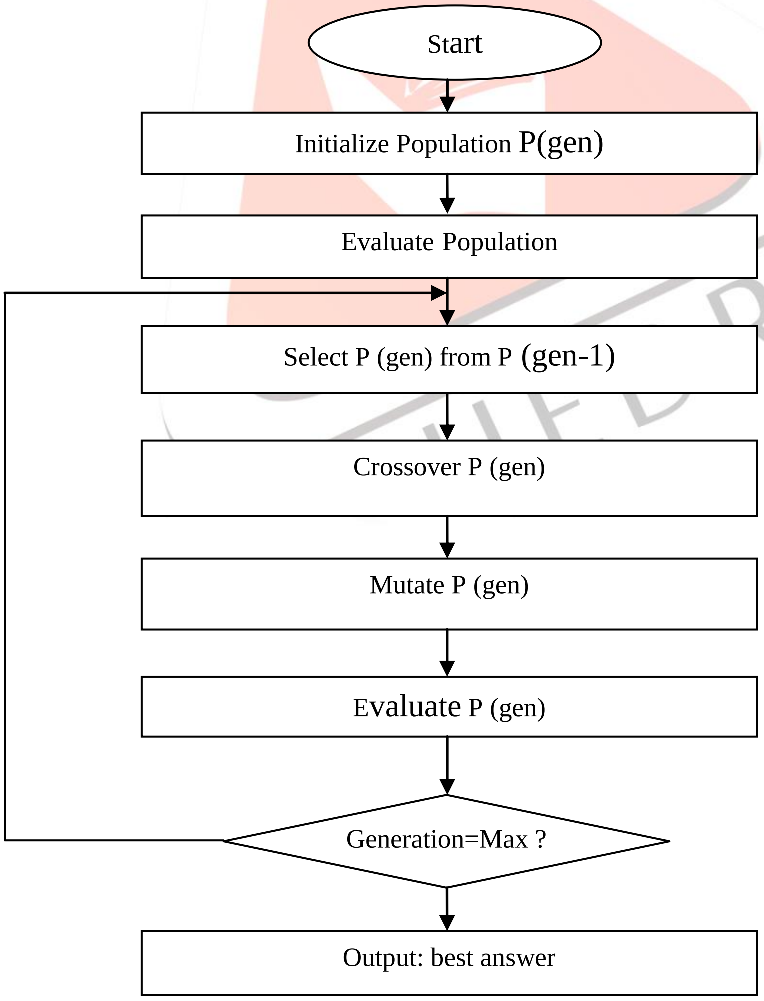


Figure 1Genetic algorithm flow chart

**4) Crossover and Mutation**

Here modified two point's crossover for crossover operation that selects two cut points for each of two chromosomes. One cut point for Y part and a cut point for X part are supposed. These points are selected randomly.

For mutation one need to select one or two random points on chromosome. One part X and the other part for Y and flip the randomly selected bits.

## V. SIMULATION AND RESULTS

For implementation of wireless sensor network consisting of 100 nodes that are placed randomly within an area of 100x100, 200x200 and 500m x 500m is modeled in the simulation. Each sensor node is supplied with 0.4 Joules of initial energy. The sink has unlimited amount of energy. Table 2 shows the Network Parameters and its Values.

Table 2 Network Model Assumption

| **Description** | **Value** |
|---|---|
| Number of nodes | 100 |
| Initial energy | 0.4 J |
| Iterations | 100 Rounds |
| Electronics energy | 50 nJ/bit |
| Free space energy | 10 pJ/bit/m$^2$ |
| Multipath co-efficient | 0.0013 pJ/bit/m$^4$ |
| Data aggregation | 5 nJ/bit |

Figure 2 shows the comparison between LEACH and Leach with Genetic Algorithm with 100x100 area of network. From this figure it is been observed that the residual energy of the sensor nodes is almost same after 10 rounds but it has been improved after 100 rounds of iterations

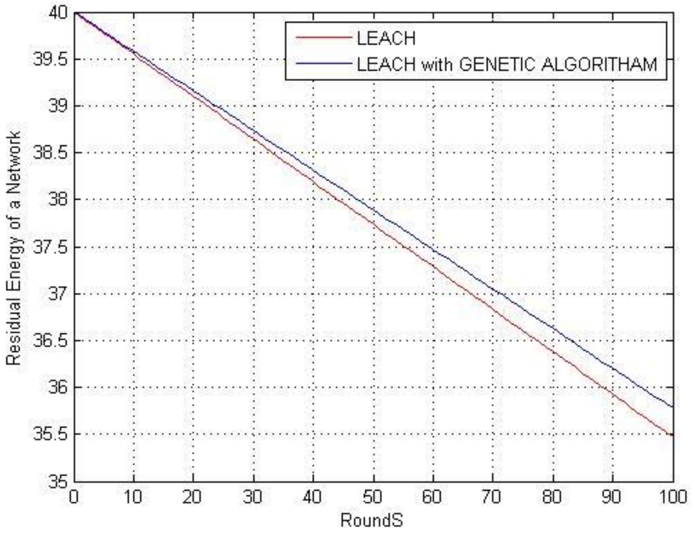


Figure 2 Comparison of Residual energy of LEACH and LEACH with Genetic Algorithm Sink location at (100x100)

Figure 3 shows the comparison between LEACH and Leach with Genetic Algorithm with 200x200 area of network. From the figure it is been observed that the residual energy of the sensor nodes has been improved much better after 100 rounds of iterations.

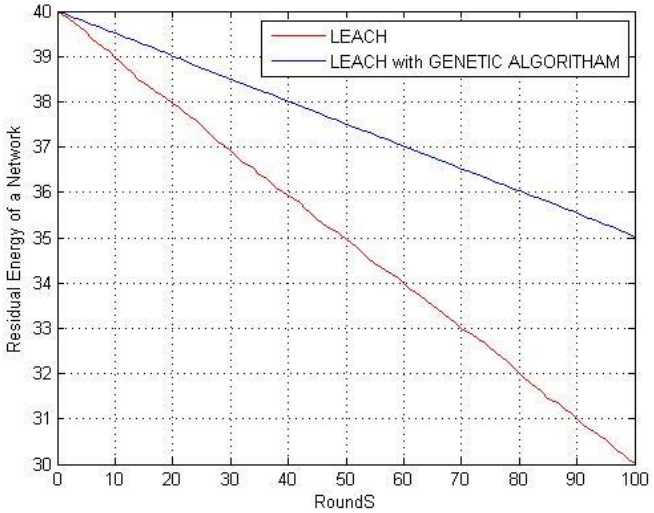


Figure 3 Comparison of Residual energy of LEACH and LEACH with Genetic Algorithm Sink location at (200x200)

Figure 4 shows the comparison between LEACH and Leach with Genetic Algorithm with 500x500 area of network. From the figure it is been observed that the residual energy of the sensor nodes has been improved much better after 100 rounds of iterations.

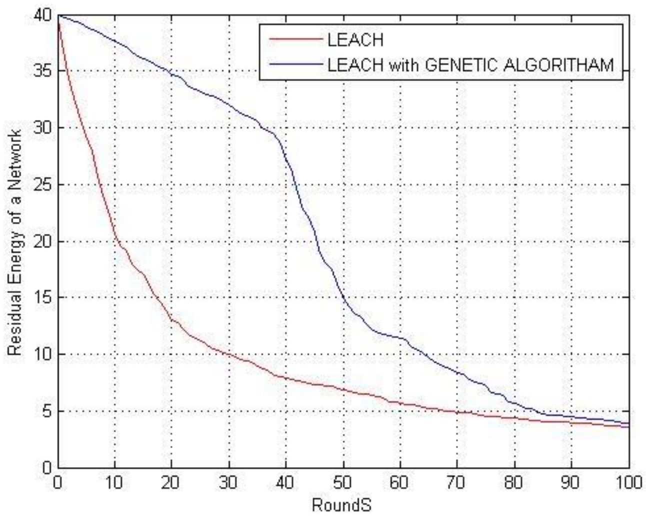


Figure 4 Comparison of Residual energy of LEACH and LEACH with Genetic Algorithm Sink location at (500x500)

## VI. Conclusion

In this paper described a new technique for mobile sink problem in wireless sensor networks. A mechanism to reposition the sink in a wireless sensor network is introduced. This mechanism is based on Genetic algorithm that selects the optimal position based on distance and residual energy function of cluster heads. This algorithm is applicable where the objective is to improve the energy efficiency of a network and consequently, increase the data delivery in a network and to improve network life time as well.

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