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Optimal Tiring with Base Station Position for Wireless Sensor Network

[1]Prince Rajpoot, [2]Pragya Dwivedi

[1]Assistant Professor in Information Technology REC Ambedkar Nagar, Akbarpur, India
[2]Computer Science and Engineering Department MNNIT Allahabad, Prayagraj, India
princeraj2904@gmail.com, pragyadwi86@mnnit.ac.in

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Abstract

WSN is used for sensing data from surrounding and delivers it to the user for processing. It is spreading in various fields for various applications. There are many issues while deploying a WSN, we need to reduce the effect of such issues to enhance the lifetime of network. One important way to reduce the effect is clustering approach. Tiring also plays important role in energy consumption in clustering. Sink position is also a part of efficient communication. So here, we have introduced two types of tiring model for efficient transmission process. In first model, the sink is in center and the tiring is done in circular form from center to outer part with four partitions. In second model, we have placed the sink at top and the nodes are distributed in hierarchy in tiers. Results show that the first model provides optimal tiring with optimal sink position.

Keywords; *Wireless Sensor Network (WSN); Tiring; Sink Position; Lifetime of Network; Clustering*

I. INTRODUCTION

This is the digital world, everything is moving towards automation. Sensor is playing important role in this digitalization and automation due to small in size with low cost. As the utilization is increasing, scope is also increasing and moving towards the remote areas where human non-reachability exists. Due to this, the sensor becomes non-rechargeable or non-replaceable. So this creates the need of efficient communication and data passing. There are many approaches that try to provide efficient communication [1] - [6] [15] [21] - [23]. Clustering, routing, tiring, node placement are some of those approaches.

In clustering [6] - [14], the whole area is partitioned into optimal number of clusters. There is one Cluster Head (CH) in each cluster that works for information gathering and passing after aggregation. CH should be chosen in such a way that the total communication be in efficient manner. Routing provides best path for transmission of collected data. It may be shortest route or may be other root that could provide the less delay or consume less energy.

Tiring provides hierarchical data transfer each hierarchy named as tier. The nodes are arranged in such a way so that they can form tiers. Node placement tries to minimize the total number of nodes with high coverage of sensing. Nodes should be placed in such a way that they can communicate with minimum amount of energy.

Sink position is also played an important role for efficiency in terms of lifetime. According to application and the area of deployment, the sink is placed in such a way so that communication could take place in efficient manner.

So, we can say that there is a need of efficient model that could provide effectiveness to the data collection with the use of optimal tiring with effective position of sink. Here, we have proposed

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two models for tiring with different sink positions. We are doing clustering in each tiers and provides multi- hop data transfer with efficient consumption of power. The models are defined in detail in our proposed algorithm section.

E_Total={ █(p*E_electric+ p*ϵ_fsp D_length^2 ,if D_length<d_0@p*E_electric+ p*ϵ_amp D_length^4 ,if D_length≥d_0)┤

E_{Total} - total energy required to transfer the data.

$E_{electric}$-initialization power. 'd_0'- threshold

ϵ_{amp}- amplification

ϵ_{fsp}- free space

power to receive k packets:

$$E_{k_R}(k) = E_{(R-electric)} * k = k * E_{electric}$$

The next organization is like: first in next section, we have covered some literature of WSN. After this, we have given details of our approach following the results generated due to the effectiveness and last but not the least, conclusion provided the major outcomes of our proposed over old LEACH approach.

II. RELATED WORK

Today, it is very tough to discover a resolution based on energy efficient for WSN. Data broadcast and data gathering is the crucial feature for any optimization process because the lifespan of WSN based on it. Data broadcast may be direct or indirect. In direct data broadcast, broadcast has done by sensor node (SN) to Base station (BS) and data gathering required extra energy that affect the life of WSN. The problem of direct data broadcast is resolved by using clustering technique. Many authors introduced clustering technique based algorithm in ad-hoc as well as in WSN field [28] -[41]. There are many operations in WSN where clustering method used such as communication and transformation the energy, coverage, layered based communication, and selection of CH etc. Many algorithms have used direct transfer from CH to BS [28] [33] [35] [39]. Some another approaches are used in clustering are heuristic and Meta- heuristic. One of the Heuristic clus- tering processes is LEACH [28]. LEACH work on random number and probabilistic approach for the selection of BS. The LEACH has two phases: the set up phase and the steady State. In set up phase, CH selection and steady state, data transmitted between the nodes. The selection of CH done by, which nodes have higher strength, make as CH. The distance range of communication in LEACH protocol is 10s of km and it is solitary hop self-organized algorithm. After the CH formation, all nodes send the data to CH and CH collect all these data and send it to BS through TDMA and CDMA. The main disadvantage of LEACH protocol is energy unbalanced problem. There are many improvement of LEACH comes [42][50], LEACH-C is one of them.

LEACH-C is pivot on the average power of the entire network. The selection of CH based on higher energy, if any node having highest energy more than average of entire network. Heuristic clustering method such as HEED is single hop clustering protocol. It is form on amount of neighbours node and residual energy [29] and independent of total size of energy as well as density.

In the selection of CH, the foremost elements are residual energy and message rate. The prime constraint is residual energy and subordinate constraint is Average Minimum Reach- ability Power (AMRP). There is overlapped and unbalanced CHS size problem in HEED that is resolve by Distributed Weight-based Energy efficient Hierarchical Clustering protocol (DWEHC). DWEHC used residual energy as primary key and based on density as well as size of WSN [35]. In the iterative procedure, HEED and DWEHC having countless messages group that gives huge quantity of overhead. Another similar clusters sized based clustering method is fast local (FLOC) clustering that having non-overlapping property [33]. There is a condition for connection to CH, if any node is far from m hop then it cannot connect to CH but if distance is less than m hop

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(single hop) then node connected to CH. Energy Efficient Clustering Scheme (EECS) is the another heuristic clustering constructed algorithm [37]. This algorithm resolved energy unstable problem in network by using three main utility and weighted dynamics. These gatherings are used to finding the CH in network. However, there are some restriction of EECS that are remove by Energy Efficient Unequal Clustering (EEUC) [39].

However, there are lots of energy wastage because of CHs consume lots of energy for transmission and nodes takes more energy for managing the information of CH [37]. An algorithm is based heterogeneous clustered structure [51] and all nodes having some remain energy after maintain the information of CH. Some energy balanced clustered algorithm for individual node that constructed on power constraint for WSN [52]. The reaming energy consumed because of four key factors, which used by this algorithm. There is another heterogeneous clustering based Enhanced Developed Distributed Energy- Efficient Clustering [53] where CH selection done by prob- ability mechanism and having three classification such as regular, advance and excellent node. Some algorithms based on position conscious and position unconscious properties. There is an algorithm that based on these two properties is Power-Efficient and Adaptive Clustering Hierarchy protocol

[41] and it also having multilevel clustering feature. It is main concern to main balanced and lowest energy consumption during the clustering, GA algorithm [54] based on it. Selection of CH process by local minima whereas data gathering and transformation had done by using some algorithm-based ap- proaches [55] [57]. There are numerous methodologies, which established on MADM. Some MADM methodologies that used clustering designed for ranking are TOPSIS and AHP. These approaches used for selection of CHs in WSN. There is countless solicitation of AHP in engineering field because it used motion, energy as well as space for selection of CHs in WSN [58] - [63]. Whereas, TOPSIS also used for selection of CHs but it uses foremost three factor such as detachment toward the BS, amount of neighbours and residual energy [64] [66]. Since topology management is an NP-hard problem, so its impossible to find the perfect solution for a problem. For this optimization is needed, in the series of WSN optimization we have given here an approach that provides two types of optimized tiring and compared with LEACH algorithm and also compared with each other.

III. PROPOSED APPROACH

We have proposed two models: model1 and model2 includ- ing two types of tiring with different Base Station (BS) or sink position. We can describe the models as follows:

Tiring Model1 with BS in Center of Deployment Area

In this model, we have placed the sink at the center of deployment area and circles are drawn to divide the area into tiers in such a way that the distance between two circles is always be d0/2. This d0/2 distance verifies that the distance need to transfer the data from one tier to another is likely to be less than to d0. This creates the benefit in energy consumption as the energy model shows that the energy consumption is directly proportional to the square of the distance if the distance is less than d0. So, we have utilized this concept and prepare the tiers to optimize the distance that directly provides the signal transmission without amplify the signal. The total communication is of multi-hop based in which the data travels from one tier to another till BS. Every tier is divided into four parts. Each part contains CHs equal in number to the tier number. These CHs collect the packets from other nodes and forward it to the next tier.

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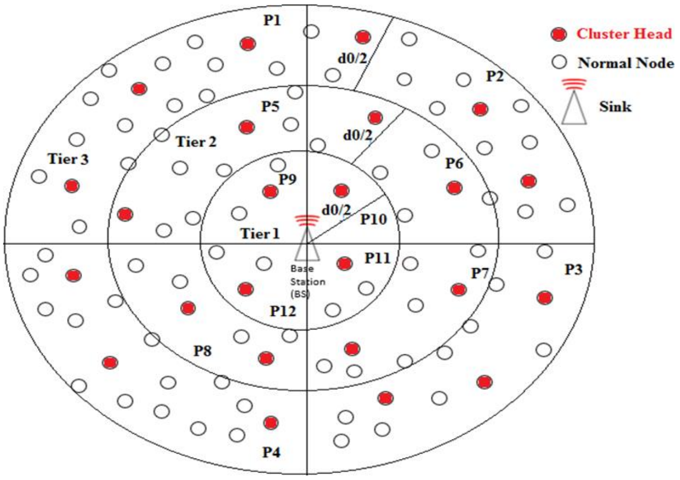

Fig. 1. Tiring model 1 with BS in center of deployment area

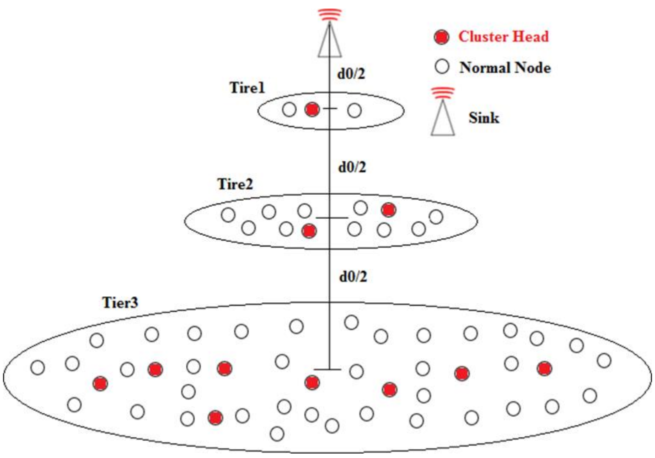

Fig. 2. Hierarchical tiring model 2 with BS in outer region

The 1 represents this architecture in which there are three tiers with sink in center. The distance between two tiers is d0/2. The area is divided into four parts from center means every tier is having four parts as shown in figure. Every part of tier1 contains one CH. In continuity, every parts of tier2 and tier3 contain two and three CHs respectively. We have chosen the CHs based on three factors: residual energy of nodes, distance to CHs from nodes, and distance to CH in lower tier using the concept of previously proposed clustering approach [67]. The clustering process starts with the lower tier and continued to the last upper tier.

Hierarchical Tiring Model2 with BS in Outer Region

In this model, we have provided a model suggested by [68] with a modification of d0 distance between two consecutive tiers. BS is placed at the top of the model and outside the network. First tier consists minimum amount of nodes that increases as the tier number increases. d0 distance manages the minimum energy consumption between two consecutive tiers. Data is forwarded among the tiers to the BS. Communication is of multi-hop type in this model also. The 2 represents this architecture in which there are three tiers with sink in top and out from the tiers. The distance between two tiers is d0/2. Here, the area is not divided into parts as shown in figure. Every tier contains optimal number of CHs required for data collection and process with transfer. The optimal number of CHs can be enumerated as:

$$CH_{optimal} = \frac{\sqrt{N}}{\sqrt{2\pi}} \sqrt{\frac{\epsilon_{fsp}}{\epsilon_{amp}}} \frac{S}{Dist_{tosink}^{2}}$$

where S*S - Size of area, N - Sensor Count, and 〖Dist〗_tosink

is length distance to Sink.

We have chosen the CHs based on three factors: residual energy of nodes, distance to CHs from nodes, and distance to CH in lower tier using the concept of previously proposed clustering approach [67]. In this tiring also, the clustering process starts with the lower tier and continued to the last upper tier.

IV. RESULTS AND ANALYSIS

Application of MATLAB tool provides more realistic implementation of WSN with a clear view of dead nodes and the energy consumption during the packet transmission. The node is known as dead when the energy drained out or less than threshold. The network is known as dead when total 75% nodes get dead. We have compared our both architectures base proposed algorithm with base

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algorithm and LEACH algorithm using number of dead sensors and total energy of network remained after number of rounds of data collection. The figures shows that both the algorithms are providing better results than the base algorithm.

When we talk about first and second architecture, then we found that first architecture is much better than the second one because it has more nodes near to BS also in every direction that reduces the black hole problem effectively. But it can be possible only when the BS can be placed in the inside the sensing region. Whereas if we are deploying the sensors in remote area then only choice is the second architecture because we can place the nodes in remote area randomly but the BS must be placed as some place where we can access the BS easily. We have used A1 for first model, A2 for second model, and A3 for LEACH protocol.

Case 1: Sink=0,0. Sensors=500. Round=100

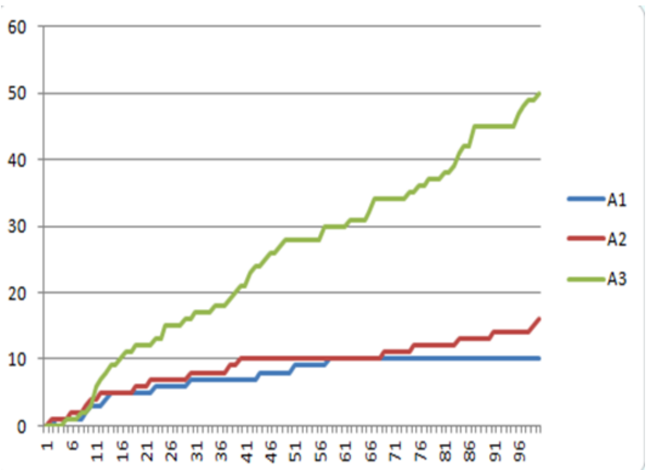

Fig. 3. Dead nodes comparison among algorithms

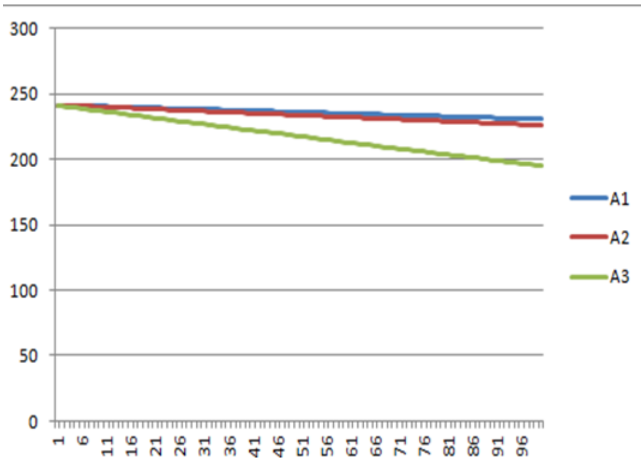

Fig. 4. Residual energy comparison among algorithms

Case 2: Sink=150,50. Sensors=500. Round=100

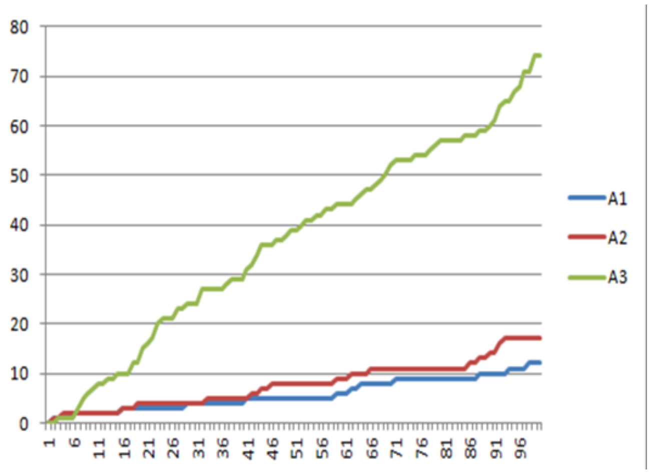

Fig. 5. Dead nodes comparison among algorithms

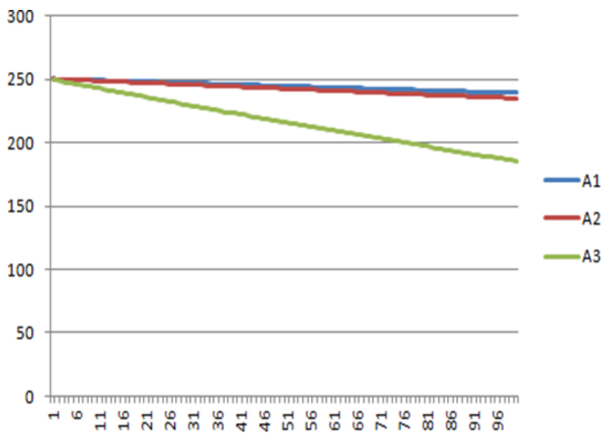

Fig. 6. Residual energy comparison among algorithms

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V. CONCLUSION

The given approaches provide better tiring approach for both the conditions, either the BS is in center or out of network. The minimum energy is consumed during the information gathering process. First approach is more efficient than the second one, so it may be seen as optimal node placement to gather the data from surroundings. Distance between the tiers

i.e. d0/2 confirms the data transmission without the need of

amplification. So our proposed approach provides better results in terms of lifetime of network and energy consumption.

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