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A Node Distribution Strategy for Complete Area Coverage in WSN

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ABSTRACT: Wireless sensor nodes are characterized by their compact size, light weight, straightforward construction, and low energy requirements. Following deployment, the nodes' locations are unknown because they are randomly placed when being deployed in the monitoring region. It is simple to have an uneven node dispersion, leading to dense and sparse nodes in different regions. The surveillance area is frequently covered in node-dense areas because of the too close spacing between nodes. Owing to the excessively large distance between nodes in a sparsely noded area, it becomes difficult to cover blind zones. The complicated layout of wireless sensor networks (WSNs) is the focus of a suggested coverage algorithm that adjusts the nodes' spacing. Moreover, we have divided the WSN's area into equal sized circular zones like a circular plate in hard disk. The distribution of nodes is uneven in the WSN, as to avoid energy dearth near the sink node/ base station (BS). The recommended method produces an added lifespan to the WSN. Moreover, it transmitted more number of packets towards BS for a long time.

KEYWORDS: Non-Random Node Deployment, Co-centric Zones, Power Constraint
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I. INTRODUCTION

A wireless sensor network (WSN) is also called a sensor network or an actor network [1]. It is a distinctive category of ad-hoc networks, as it has a high density of sensor motes as compared to other types of ad-hoc networks. A WSN can have different types of topology, like star, multi-hop wireless mesh network, tree, peer to peer and hybrid topology [2]. Nodes in the sensor network can change topology by using different power level for broadcasting. In a dense deployment, if a node broadcasts with less power, the battery of the sensors is saved without affecting the working of a network.

A sensor mote is competent of sensing an event, carrying out some processing tasks and can connect to other nodes in the network via a wireless link. It is capable of converting a physical event like sound, heat or motion into an electrical signal. It is a tiny, low-powered, work in large densities, lightweight, autonomous and power constrained device [3]. A sensor network has a number of technological weaknesses, including connectivity range, surveillance range, low battery life, and network deployment environment issues, such the challenge of constructing a sensor network in eruptions, terrain, or seas. The installation with its two distinct forms is regarded as a particularly efficient solution to the problem of optimizing energy use, connection, routing, and other factors in WSNs.

Only extremely small areas where man may step in to debug, configure, change power sources, and substitute or move nodes are suitable for stochastic deployment. In unconstrained regions where human intervention is either impractical or challenging, random dispersal is beneficial. The development of MEMS devices has made it possible to produce extremely tiny sensor nodes that are both affordable and capable in regards to handling and storing data. One of the considerations sought after by academics employing installation in their work is to increase the lifespan of networks while maintaining full coverage of the Zone of interest (ZOI). The dispersed nature of the sensor nodes and the challenge of implementing the technique of enabling sensor nodes in the network are two drawbacks of this solution for the stochastic type. Understanding placements (optimal distribution) and using remote control is essential in places where it can be challenging for humans to intervene, such as particular danger zones.

In this study, we propose the semi-random implementation, a novel kind of deployment. Deterministic benefits, such as understanding the spatial distribution of orientations are utilised in this deployment. Additionally, it uses random deploying techniques to distribute nodes. The anticipating configuration stage and the scheduling process step make up the semi-random distribution methodology. The anticipatory configuration stage is configuring a few crucial parameters and only ever keeping them in memory to be used for the nodes scheduling procedure. Our experiments demonstrate that the semi-random deployment is effective when compared to other distribution strategies.

II. RELATED WORK

The WSNs' constrained capabilities make working out how to precisely cover a monitoring area one of their initial challenges. The WSN's two most important issues are coverage and connectivity [4]. The addition of more sensors has long been thought of as one way to improve the coverage of the global network. The implementation, coverage, connectivity, and longevity of this system are ineffective, nevertheless. In actuality, a number of the key characteristics that significantly affect the WSN's effectiveness directly include the placement and cooperation of sensors. The two primary categories of WSN deployment strategies are predictable and non-deterministic [5]. Coverage, connection, and network longevity are the three primary performance indicators that are taken into consideration during the installation of a WSN. We concentrate on coverage and connectivity among these metrics.

Coverage is dependent on a number of variables for the effective design and usage of sensor networks in different types of applications. The coverage measures how successfully a sensor keeps an eye on a certain location or region. A large number of sensor nodes are typically needed to provide maximum coverage. According to [6], coverage is the amount to which a sensor node covers a certain area or the distance that each point is from a sensor node. The type of coverage can vary according to the application [6], and includes barrier coverage, point coverage, and area coverage, which is further separated into two categories: full area coverage, and partially area coverage [7].

For WSNs, connection is just as important as coverage. If each deployed sensor node has at least one neighbouring node that it has connectivity with the network within the designated area is said to be connected. Two sensor nodes are linked together if and only if they can speak to one another (one-hop communication) or (multi-hop communication), according to authors in [4]. According to [8], network connection is the ability of the network's nodes to communicate with one another, whether or not data must travel via multiple hops to reach the base station. If a sensor node interacts with the BS directly throughout this transmission process, it is referred to as a single-hop transmission. Real-world scenarios often have a limited number of sensors due to cost considerations, but they must cover a big area and offer connectivity. It's also crucial to cover a space, irrespective of its geometrical arrangement or shape. There are many ways to categorise the connectivity and coverage issue. Nevertheless, in our situation, we are interested in how to cover a larger area, irrespective of its geometric design, with a certain number of the same sort of sensors while maintaining connectivity. Instead of employing circular wrapping algorithms, this research uses a genetic algorithm (GA) to cover our region of interest (regular and irregular form) [16]. Furthermore, we suggest a novel fitness function to determine the precise area that the sensors cover in order to avoid overlap caused by the sensors' random deployments.

III. PROPOSED METHODOLOGY

In order to effectively handle the issues of energy and coverage holes, the work employs a non-uniform corona centred node distribution technique that distributes sensors with varied concentrations throughout the suitable deployment/network area. There is a BS at the heart of the network region. Different concentric rings have been created by dividing the network area. Despite the nodes being concentrated close to the washbasin, all coronas have the same area. Due to the majority of the motes being located in the sink zone, this sort of dispersion completely avoids EH issues in the field. The nodes are distributed using the recommended node placement approach, which assigns the nodes differently in all the coronas with the goal of enhancing coverage, removing EH, and extending the network's lifespan.

The surveillance area has been divided into several concentric coronas in the suggested system, and the BS is located in the centre of the area. All coronas have kept their thickness constant, and it is equal to the innermost corona's radius (R). Now, with the reciprocal difference of 2πR, all circles' regions advance arithmetically starting from the BS. The earlier studies concentrated on developing constant width corona centred sensor networks without Energy Holes (EH) and cover-holes. The sensors are distributed so that this node number remains high around the sensor-net's drain node in an effort to create an energy-efficient network. The majority of the time, an unequal node distribution is employed to prevent EH in the sensor's field so that the majority of the sensors are placed in the innermost corona surrounding the node that is sinking and then decrease to the out coronas. A WSN EH problem can be avoided with the use of this distribution type.

However, in some situations, such as those involving a limited detecting range, more sensors are needed to cover each subsequent corona from the inner to the outer corona in order to prevent coverage gaps. As a result, with the even breadth corona focused network architecture, this area of all coronas increases. From now on, a sensor thickness must change from the inner to outer coronas in order to evade EH, and the sensor layer must increase in order to evade coverage-holes. In relation to node density, these constraints also have a reverse correlation with one another. As a result, we have proposed in this study a mote deployment policy that makes use of a network design that has decreased corona width. The detection coverage of the placed sensors overlays more to outer coronas when sensors are distributed unevenly in a diminishing width corona-centered network design. Let's assume that the use zone is Z X Z squares, with the washbasin located in the centre of the space, as shown in Figure 4.2. The entire area has been divided into rings of similar sizes. The network analysis was performed for all of the network's sensors, and the results are discussed as follows:

The network life is defined as the time from the network's inception until all of the sensor in any area die and a network energy hole is created. A ratio of the amount of sensors dispersed in a corona to the circle's area is used to express the node density.

IV. EXPERIMENTAL ANALYSIS

The network's overall nodes that die per cycle are displayed in Figure 1. It has been determined that the distribution of nodes boosts the area's activity. In order to extend the lifespan of all levels, the power balancing balances the power loss of all layers. If all of the nodes in a sensor network exhaust their energy at once, the network's energy is balanced. The number of active sites in a network per cycle is shown in Figure 2. The charge in the network is well described in Figures 3 and 4.

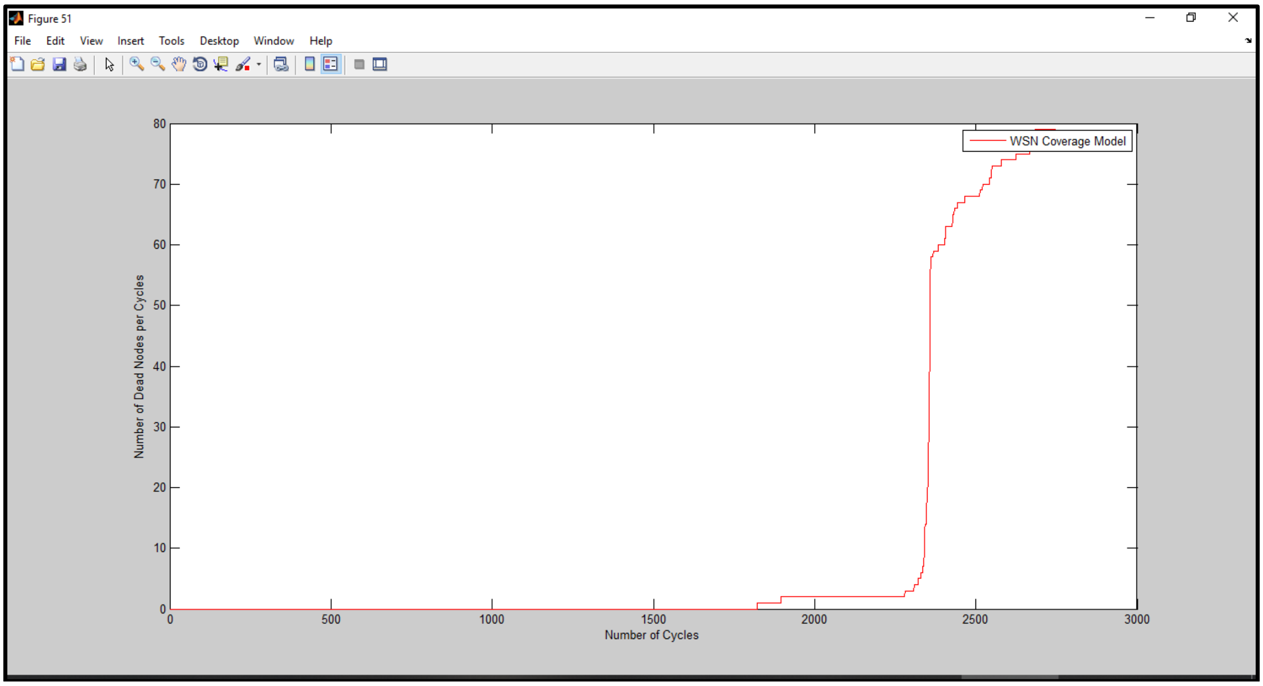

Fig. 1: Number of dead nodes per cycle in the network

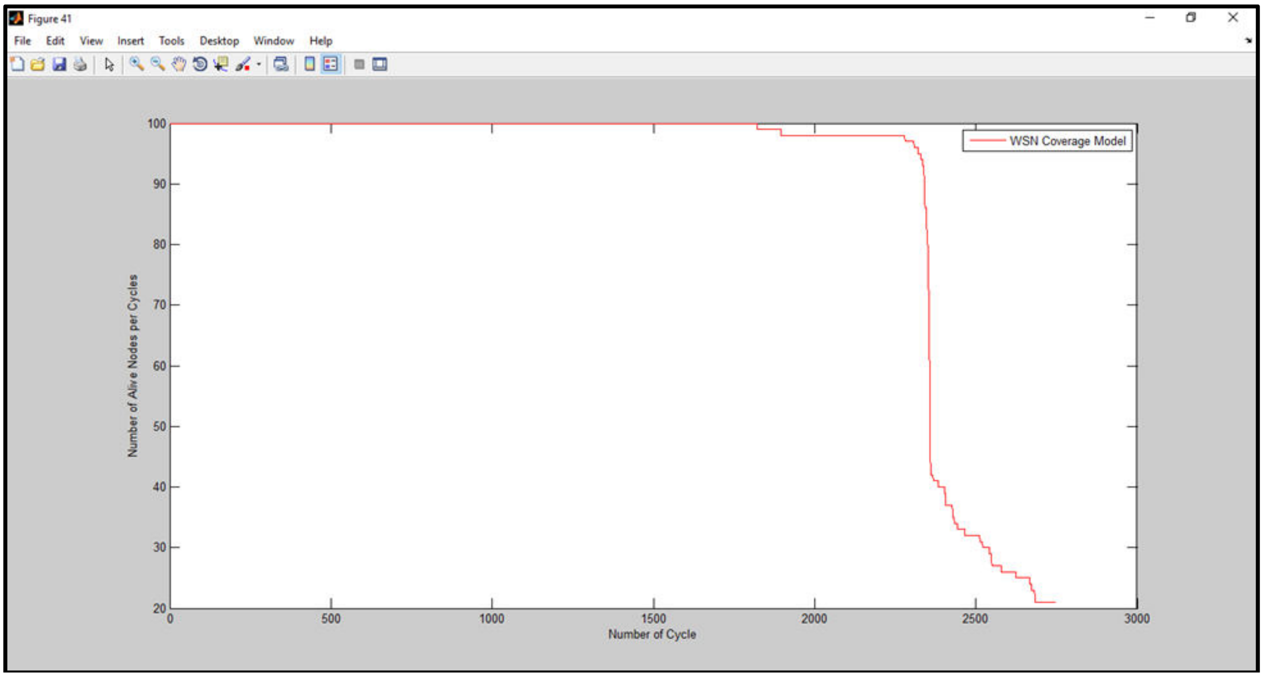

Fig. 2: Number of Alive nodes per cycle in the network

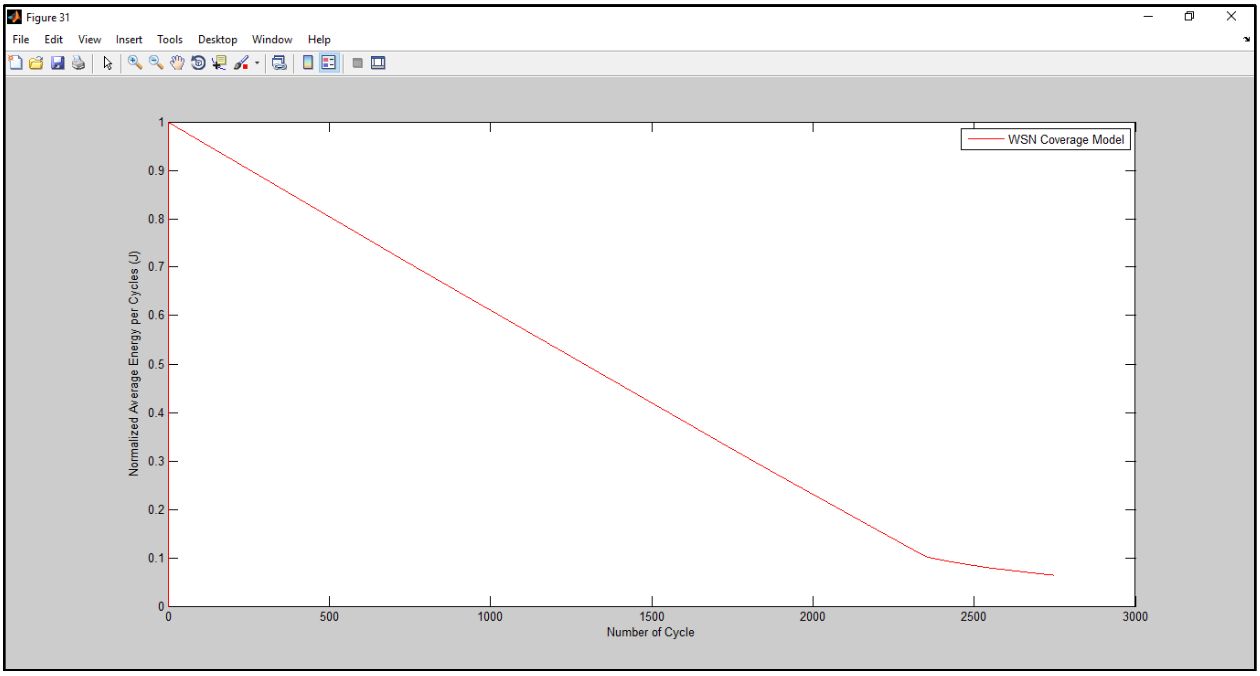

Fig. 3: Average Energy Per Round

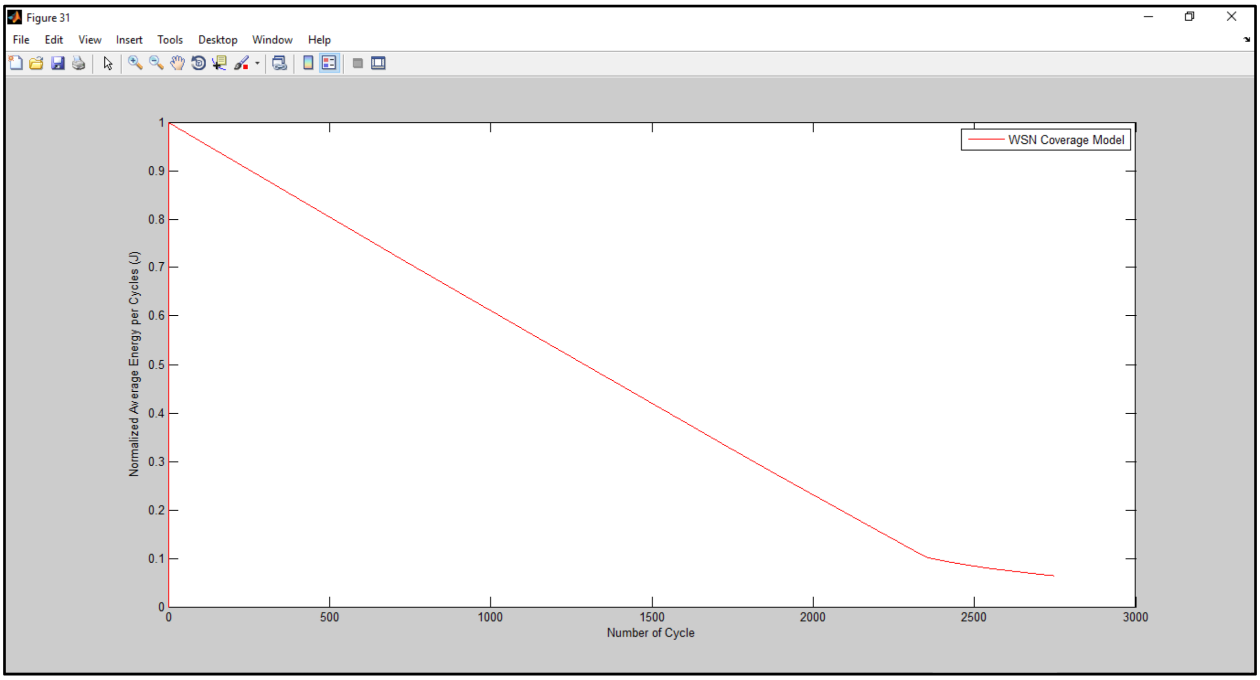

Fig. 4: Total Energy of the Network

V. CONCLUSION

This study enables sensor nodes with insufficient sensing capabilities while providing an unequal distribution of detectors in a corona-centered design. The deployment zone in the proposed work, a variable-width co-centric circle centred network architecture, has been partitioned in such a way that each coronal's section is comparable, but the distribution of node is not the same in each circle. It was proposed to use the co-centric circle centred energy stable irregular cluster distribution method for WSNs. In the proposed renovation, the estimated network area has been divided into various coronas, with the washbasin placed in the centre of the deployment zone. Every corona's region is the same size throughout the installation field. The suggested approach aims to provide power equalisation in all coronas, eliminate energy gaps, and reduce net zone coverage-hole problems.

The use of the suggested technique has been contrasted with the currently used leach technique. According to analysis, this strategy not only balances the flow of power throughout the network but also lessens and eliminates concerns with coverage and energy-holes. The suggested approach was specifically designed for applications requiring a narrow sensing window.

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