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Deployment Strategy of Homogeneous and Heterogeneous Wireless Sensor Network

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Abstract: **Wireless sensor networks have developed as most innovative research topic due to the development of sensor devices, as well as wireless communication technologies. Wireless networks of sensor nodes are envisioned to be deployed in the physical environment to monitor a wide variety of real-world phenomena. Wireless sensor networks (WSN's) are becoming popular in military and civilian applications such as surveillance, monitoring, disaster recovery, home automation and many others. A sensor networks is defined as being composed of a large number of nodes which are deployed densely in close proximity to the phenomenon to be monitored. It usually randomly deployed in wide application areas such as disaster areas, polluted environments, and military operations where battery replacement or recharge is difficult. For this reason, network lifetime is to crucial aspect in WSN. In this paper we present the deployment strategies of WSN's to gain better sensing, transmitting and computational power according to the application scenario**.

Keywords: **Wireless Sensor Network, Homogenous, Heterogeneous, Sensor Deployment.**

I. Introduction

Wireless sensor network are consist of large numbers of minimal capacity sensing range, computing power, and communicating devices and various types of actuators. WSN operate in complex and noisy real world, real-time environments.

Due to a wide diversity of WSN application requirements, however, a general-purpose WSN design cannot fulfil the needs of all applications. Many network parameters such as sensing range, transmission range, and node density have to be carefully considered at the network design stage, according to specific applications. To achieve this, it is critical to capture the impacts of network parameters on network performance with respect to application specifications. Node localization is the problem of determining the geographical location of each node in the system. Localization is one of the most fundamental and difficult problems that must be solved for WSN

Wireless Sensor Networks (WSN) has off late, found applications in wide-ranging areas. In this section we list some of the prominent areas of applications of WSN. The list would be very lengthy if we exhaust all the areas of WSN applications. [7]

- **The military applications** of sensor nodes include battlefield surveillance and monitoring, guiding systems of intelligent missiles and detection of attack by Weapons of mass destruction

- **The Medical Application**: Sensors can be extremely useful in patient diagnosis and monitoring. Patients can wear small sensor devices that monitor their physiological data such as heart rate or blood pressure.

- **Environmental monitoring**: It includes traffic, habitat, Wild fire etc.

- **Industrial Applications**: It includes industrial sensing and diagnostics where it is used to sense appliances, factory, supply chains etc.

- **Infrastructure Protection Appl.:** It includes power grids monitoring and water distribution monitoring etc.

Wireless sensor networks which consist of number of sensor nodes also known as motes are deployed in homogenous and heterogeneous that monitoring different environments according to the application areas.

Figure 1: Sensor Node

Wireless sensor nodes are small, embedded computing devices that interface with sensors/ actuators and communicate using short-range wireless transmitters. Such nodes act autonomously, but cooperatively to form a logical network, in which data packets are routed hop-by-hop towards management nodes, typically called sinks or base stations.

Sensor nodes cooperate to each other [1] and combine their local data to transfer their Base station. In WSN's there are two main components, first is central server known as "Base station" & second is cluster-heads called as "Aggregation points".

In homogenous WSN, all the nodes in the network have the same storage, computation, communication, sensing and energy capabilities. The communication link between the sensors is symmetric. On the other hand in heterogeneous sensor networks, two or more different types of nodes with different battery energy and functionality are used. [2][3]

There are three types of heterogeneity in sensor nodes. The first, computational heterogeneity, means that at least one node contains a more powerful microprocessor and large memory that a normal node. The second type is known as Link heterogeneity and means that at least one heterogeneity node has higher bandwidth and a longer-distance network receiver than a normal node. The third type, energy heterogeneity, means that at least one heterogeneous node is line-powered or that its battery is replaceable.[12] The main applications of sensor network is to periodically gather data from a remote terrain where each node continually senses the environment and sends back the data to the Base Station (BS) for further analysis, which is usually located considerably far from the target area. The most restrictive factor in the lifetime of wireless sensor network is limited energy resource of the deployed sensor nodes. Because the sensor nodes carry limited and generally irreplaceable power source, the protocols designed for the wireless sensor networks must take the issue of energy efficiency into consideration.

The rest of the article is organized as follows. First section is about introduction of sensor nodes and network models. Then we elaborate related work done in WSN's. After that we introduce deployment strategy and then compare it with our proposed deployment strategy for both homogeneous and heterogeneous WSN's models.

II. Related Work Done

The research of heterogeneous wireless sensor network is not new. Several node placements have been proposed in literature concerning WSNs.

Younis et al [13] present a survey for strategies and techniques for node placements in WSNs and provide a categorization of the placement strategies into static and dynamic, depending on whether the optimization is performed at the time of deployment or while the network is operational.

Toumpis et al [14] provide an optimal deployment of large wireless sensor networks so as to minimize the number of nodes that is needed in order to transmit data from multiple sources to multiple sinks.

In [5], present an algorithm to decide how many and where heterogeneous nodes should be deployed in the wireless sensor network. The core algorithm, based on the locations of all sensor nodes, can optimize placement of heterogeneous nodes in an arbitrary Sensor network.

III. Deployment strategy

A sensor node is composed of a sensing unit, a processing unit, a transceiver unit, and a power unit. Each unit consumes a different energy level. Usually, the main consumers of energy are the transceiver unit and the processing unit. The sensing unit consumes energy for a variety of sensors and for ADC converters. The processing unit requires energy to aggregate data, compute routing, and maintain security, etc. Since the purpose of the transceiver unit is to both transmit and receive data, it is no doubt that it consumes quite a lot of energy.

If a WSN allows direct communication from a node to a sink, then this will be very expensive. For this reason, we consider multi-hop communication in WSNs and thus energy consumption by transmitting and receiving a message has to be analyzed based on a hop-by-hop communication scheme.

Deployment of sensor nodes may deploy in Random manner and Uniform manner or manually. In [8], considers the both type of WSN models: homogenous WSN's also known as single sensor model consist of same type of sensor motes with same computation receiving and transmission range and heterogeneous WSN model also known as multiple sensing model, which consist of two different type of sensor motes, one with same computation receiving and transmission range and second is of with large computation, sensing and transmission range.

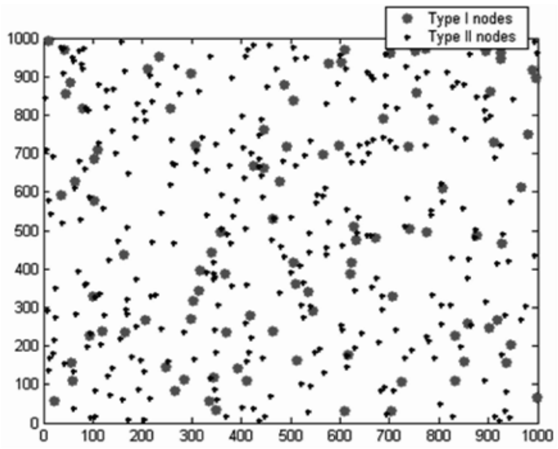

Figure 2: Poisson Deployment

The simulation is performed on MATLAB and use uniformly and independently deployed in a square area of 1000 X 1000. Such a random deployment results in a 2D Poisson point distribution of sensors as. Total no. of sensor deployed with the area is of 500.

In homogeneous deployment al the 500 sensors are same. Here with in the simulation result of deployment, they are using two types of sensor nodes.

- Type I sensor that has a larger sensing range, as well as a longer transmission range.
- Type II sensor that has a smaller sensing range, as well as a shorter transmission range.

While within the heterogeneous *figure 2* deployment of sensor, these total 500 sensors are divided as:

- Type I sensor is 200
- Type II sensor is 300

IV. Proposed Deployment strategy

Our simulation is also implemented on MATLAB, which generates the better deployment results than Poisson deployment.

We are deploying the sensors in 2D Grid random uniformly distribution by using the same parameters as above discussed:

Description	**Quantity and range**
Area	1000 X 1000 sqm
Sensors	500
Sensor range	10 to 100
Grid square transaction (diagonally per cluster)	200

In homogenous WSN, all the nodes in the network have the same storage, computation, communication, sensing and energy capabilities. For the homogenous sensor deployment results are as:

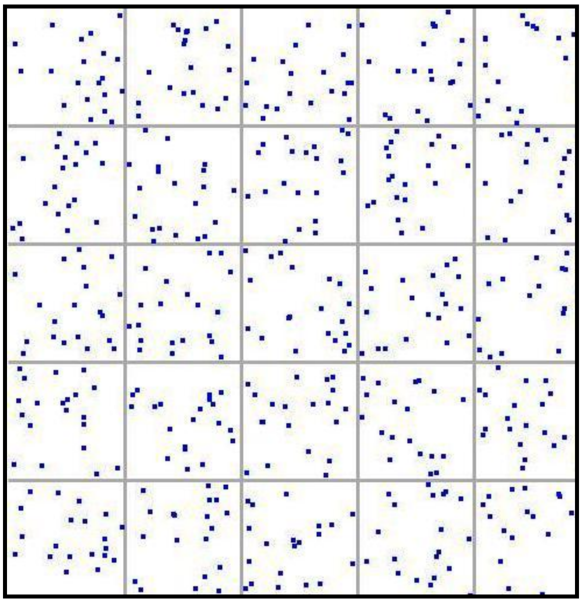

Figure 3: Homogenous Deployment

In heterogeneous deployment we are also using two types of sensor nodes.

- Type I sensor is 200 with large sensing range and transaction range
- Type II sensor is 300 with small sensing and transaction range.

Description	**Quantity and range**
Area	1000 X 1000 sqm
Sensors	Type I nodes 200 Type II nodes 300
Sensor range	Type I nodes 120 Type 2 nodes 40
Grid square transaction (diagonally per cluster)	200

The application scenario is of military based applications where is to detect intruders and there malicious activities.

The heterogeneous sensor deployment results are as:
Type I nodes are in RED colour and Type
II nodes are in BLUE colour combination

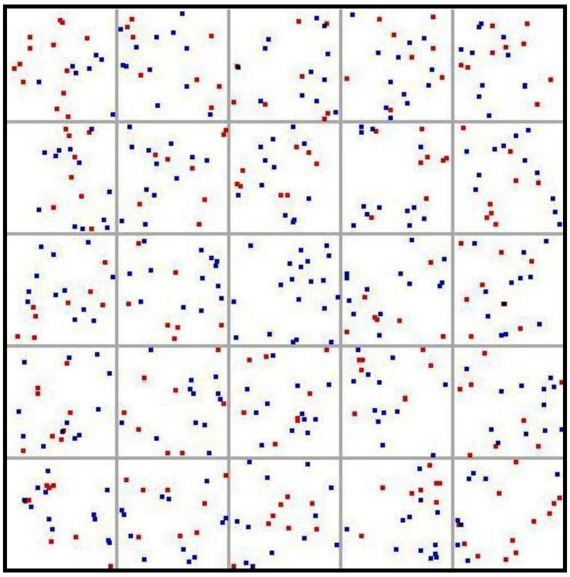

Figure 4: Heterogeneous Deployment

V. Conclusion

Having obtained results our simulation results with 2D Grid random uniformly deployment provides the better deployment of sensor as in Poisson deployment. Every cluster with the transaction distance (diagonally per cluster) 200 in the 2D Grid has the equal no. of sensors in both WSN models either in Homogeneous deployment and Heterogeneous deployment.

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