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Node Deployment For Improving Coverage Area In Wireless Sensor Network

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Abstract- *Wireless sensor network (WSN) [1] is a self-organized network composed of hundreds or thousands of nodes has been observed tremendous growth in the use of Wireless sensor networks (WSN) in the last decade. WSNs behave like an interface between the virtual and physical worlds. The Sensor nodes sense the changes in external environment and send the collected data to the sink nodes in the network called Base Station (BS). Node deployment is one main design issue in wireless sensor network. Node placement in WSNs is of two types manual or randomized. In manual placement, the sensors are manually allocated and data is routed across predetermined paths. Though, in random node placement, the sensor nodes are dispersed randomly, crafting an ad hoc routing infrastructure. The node deployment in wsn should be in such a way that the communication between nodes never failed. So to maintain the proper communication between these nodes an excellent routing protocol is required. This paper represents a survey on the recent routing protocols in wireless sensor network (WSN) for node deployment.*

***Keywords*— Wireless Sensors Network, node deployment algorithms, Energy Efficiency**

1. Introduction

WSN (Wireless Sensor Networks) are specially distributed autonomous sensors to monitors physical or environmental conditions such as temperature, pressure, sound etc. and to cooperatively send the data through the network to a main location. The more current networks are bi-directional, also allowing control of sensor activity. The improvement of wireless sensor networks was encouraged by military applications such as battleground surveillance; today such networks are used in numerous industrial and consumer applications, such as industrial process checking and control, machine health observing, and so on. The WSN is built of from a few to several hundreds or even thousands, where each node is connected to one or several sensors. Each such sensor network node has generally several parts: a radio transceiver with an interior antenna or gathering to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, regularly a battery or an embedded form of energy harvesting . Sensor nodes work together to complete the task in time and to provide information correctly. Sensor nodes sense the external environment or application area and send the data to base station located inside or outside the network via single hop or multi-hop. Sensor nodes work with some restricted assets like battery power, memory and bandwidth etc. Wireless sensor networks lifetime depends upon battery power of nodes as every node operation consumes energy; hence node goes out of energy. And it is not possible to recharge or replace the battery of nodes. Therefore, efficient energy consumption by the nodes is the prime design issue for wireless sensor network from the circuitry of sensor nodes to application level to network protocols. [2]

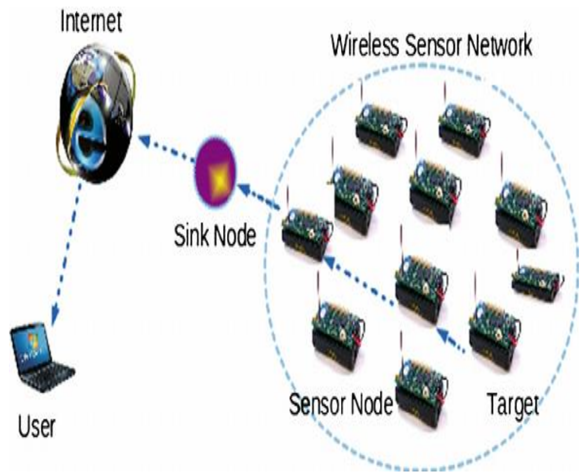

Fig.1: Wireless Sensor Network Architecture [4]

Clustering algorithms are considered energy efficient approaches for wireless sensor networks. Clustering divides the nodes into independent clusters and each cluster elect their own cluster heads. Nodes send the collected data to respective cluster head; cluster head (CH) applies data fusion/aggregation to reduce the collected data to some useful information and sends aggregated data to base station (BS). Communication between two nodes is the main energy consuming process that depends upon the distance between the two nodes. Clustering avoids long distance communication between two nodes and only cluster heads are communicating to base station (BS). To load balance the network, the cluster head is rotated among all nodes. Leach is the one protocol that using clustering technique. This clustering technique gives improvement in lifetime if wireless sensor networks. That's why leach is most commonly used for lifetime improvement if WSN. [3]

1.1 WSN Chalenges

There are various challenges which are occurred in WSN are:

1.1.1 Node deployment:

Node placement in WSNs is application-dependent and can be whichever manual or randomized. In manual placement, the sensors are manually allocated and data is routed across predetermined paths. Though, in random node placement, the sensor nodes are dispersed randomly, crafting an ad hoc routing infrastructure. If the resultant allocation of nodes is not uniform, optimal clustering becomes vital to permit connectivity and enable energy-efficient web procedure.

1.1.2 Energy consumption without losing accuracy:

Sensor nodes can use up their manipulated supply of power giving computations and sending data in a wireless environment. As such, energy-conserving forms of contact and computation are essential. Sensor node lifetime displays a forceful dependence on battery lifetime. In a multihop WSN, every single node plays a dual act as data sender and data router. The functioning of a little sensor nodes due to manipulation wreck can cause the momentous topological adjustments, and could need rerouting of packets and reorganization of the web.

1.1.3 Data reporting method:

Data describing in WSNs is application-dependent and additionally depends on the period criticality of the data. Data describing can be categorized as whichever query-driven, time-driven, event driven, , or a hybrid of all these methods. The time-driven transport method is suitable for requests that need periodic data monitoring. Sensor nodes sense the nature and send the data of attention at steady periodic period intervals.

1.1.4 Fault tolerance:

Some sensor nodes could be blocked due to lack of domination, environmental interference, or physical damage. The wreck of sensor nodes ought to not alter the finished task of the sensor network. If countless nodes flounder, medium admission manipulation (MAC) and routing protocols have to accommodate formation of new links and paths to the data collection BSs.

1.1.5 Connectivity:

High node density in sensor webs precludes them from being completely remote from every single other. Therefore, sensor nodes are anticipated to be exceedingly connected. This, though, could not stop the web topology from being variable and the web size from shrinking due to sensor node wreck.

1.1.6 Coverage:

In WSNs, every single sensor node obtains a precise think of the environment. A given sensor's think of the nature is manipulated in both possibility and exactness; it can merely cover a manipulated physical span of the environment. Hence, span coverage is additionally an vital design parameter in WSNs.

1.2 Application

WSN is very useful in many applications some important applications of WSN are explain as:-

1.2.1 Military Applications:

Since wireless sensor networks are based on the dense deployment of expandable and low-cost sensor nodes, destruction of some nodes by warlike actions does not affect a military operation as much as destruction of a traditional sensors, which makes sensor networks concept a better. Some of the military applications of wireless sensor networks are approach for battlefields examples:- Monitoring forces, equipment and inspect the area, Battlefield surveillance, Biological, Nuclear and chemical attack detection and reconnaissance.

1.2.2 Health Applications:

Some of the health applications of sensor networks are providing edge for the restricted; integrated patient monitoring; drug administration in hospitals; diagnostic; monitoring the internal processes and movements of insects or other small animals; monitoring the human physiological data; and tracking the location of doctors and patients inside a hospital.

1.2.3 Home Appliances:

As technology advances, smart sensor nodes can be engaged in appliances, such as, refrigerators, vacuum cleaners, micro-wave ovens, and VCRs. These sensor nodes inside the indoor devices can interact with each other and with the external networks via the Internet or Satellite. These sensors allow end users to manage home devices locally and remotely more easily.

1.2.4 Environmental Applications:

Some of the environmental applications of these sensor networks include tracking the movements of birds, insects and small animals; monitoring the environmental conditions that affect crops; chemical/ biological detection; disease detection; precision agriculture; biological, pollution, and environmental monitoring in sea, soil, and atmospheric contexts; forest fire detection; pressure monitoring; meteorological research such as; flood detection; bio-complexity mapping of the environment; and pollution study.

1.2.5 Civil

a. Pothole Detection.

A arrangement is industrialized to notice potholes on metropolis streets. Used on taxi cabs, the sensor nodes encompass an accelerometer, and can converse employing whichever opportunistic Wi-Fi or cellular webs.

b. Wireless E-911.

In North America, the Enhanced 911 emergency telecommunications ability, or E911, was instituted to link callers alongside emergency services in a manner that should associate a physical locale alongside the phone number of the caller. Wireless E-911 is the subsequent period of the E911 ability mandated by the FCC, that needs wireless cellular mechanisms to automatically furnish user locale after the ability is implored.

1.2.6 Commercial

a. Service Industry.

One such span is the ability industry. Firms such as Skill gent are growing multimedia protocols for ability robots that present tasks such as frank patient care in nursing residences, maintenance and protection in workplace constructions, and food and concierge ability in diners and resorts.

b. Housekeeping.

The iRobot Roomba is an automated vacuum cleaning robot for internal use. The Roomba creates a chart of the room as it moves by employing feedback from a collection of bumper and optical sensors.

1.3 WSN FEATURES

A WSN typically consists of a large number of low-cost, low power, and multifunctional wireless sensor nodes, with sensing, wireless communications and computation capabilities. Some important characteristics of sensor node explain as below[5]:

- The nodes have very limited resources such as memory, computational power, communication range and most importantly battery power.
- Sensor nodes are usually randomly deployed and autonomously configure themselves into a communication network.
- The deployment of sensor nodes is totally distributive in nature. The node density is thus varying at different places. Due to this reason one can find dense as well as sparse region in the same topology.
- Sensor nodes are prone to physical damages or failures due to its deployment in harsh or hostile environment.
- In most sensor network applications, sensor nodes are densely organized in a expanse of interest and cooperate to accomplish a common sensing task. Thus, the data sensed by multiple sensor nodes typically have a certain level of correlation or redundancy.
- A sensor network is usually designed and deployed for a specific application. The proposal necessities of a sensor network change with its applications.
- The primary component of the network is the sensor, essential for monitoring real world physical conditions such as sound, temperature, humidity, intensity, vibration, pressure, motion, pollutants etc. at different locations.
- There is a Bounded Directed Stream (from /to Sink).
- The nodes are disposable and inexpensive.

2. Node deployment

The recent development of low-cost micro-sensor devices having the capability of wireless communication has caused wireless sensor network technology to attract the attention of many researchers and developers. Through such sensors it is possible to obtain information on the behaviour, condition and position of elements in a local or remote region by deploying there a network of battery-powered sensor nodes. However, the performance of wireless sensor networks in terms of coverage, connectivity, lifetime and robustness is greatly influenced by the initial physical placement of the nodes, and there have been proposals and studies for sensor node deployment. There are three major different types of sensor node deployment methods.

First, sensor nodes can be manually deployed one by one by a human or a robot. This scenario is well suited when sensor nodes are expensive, their locations are predetermined, or the monitoring region is small such as inside of buildings, bridges, or similar structures. However, such deployment requires a high initial cost and is unsuitable in the case of large-scale sensor network deployment.

Second, when all or some of the sensor nodes are mobile, they can move to appropriate locations. This scenario has the advantage that it can achieve an adaptive deployment according to the surrounding environment and varying conditions. However, its drawback is that it requires expensive mobile devices and consumes additional energy to move the sensors. Additionally, obstacles may prevent the nodes from moving to an intended location.

Thirdly, some papers consider sensor node deployment by airdropping them from an aeroplane. In most existing studies, sensor nodes are deployed stochastically, and an appropriate distribution may not be achieved. If sensor nodes are low-cost devices, they can be deployed in large quantities in order to achieve the desired coverage or connectivity, although their distributions are as clustered regions around the deployment points. However, if the number of sensor nodes is limited, a stochastic deployment method might result in coverage voids or in isolated and unconnected nodes [6].

3. Related Work

Kenan Xu *et al.* 2010[7] Deployment is a fundamental issue in WSN design. It determines the limits of many intrinsic properties of a WSN, such as coverage, connectivity, cost, and lifetime. It has been investigated in terms of sensing coverage and/or network connectivity in However, its significance on lifetime in a randomly deployed network, in which the positions of devices cannot be precisely known or controlled, has been largely unaddressed. Assuming that devices can be deliberately placed on the sensing field, some research efforts have attempted to optimize the device placement with respect to system lifetime However, the methodologies and solutions therein are not applicable in situations where deliberate placement is not feasible. The infeasibility usually occurs in two types of situation, one where the number of devices is very large, and the other where the application environment is not completely accessible. In these situations, a well-designed deployment density function becomes a viable approach to efficient network provisioning.

Celal Ozturk *et al.* 2011[8] Improvement of wireless sensor networks are growing, the problems related to these networks are being realized. Forceful organization is one of the main topics that directly affect the presentation of the wireless sensor network. The replicated bee colony algorithm is convincing to the forceful deployment of stationary and mobile sensor networks to achieve better presentation by trying to increase the coverage area of the network. A probabilistic recognition model is considered to obtain more convincing results while multiplying the successfully covered area. Presentation of the algorithms is matched with that of the particles swarm optimization algorithm, which is also a swarm based optimization technique and earlier used in wireless sensor network deployment. Results showed replicated bee colony algorithm can be necessary in the dynamic deployment of wireless sensor networks.

Xiangyu Yu *et al.* 2012 [9] The effectiveness of wireless sensor networks (WSN) depends on the coverage and connectivity provided by node deployment, which is one of the key topics in WSN. A modified virtual force-based node self-deployment algorithm for nodes with mobility is proposed. In the virtual force-based approach, all nodes are seen as points subject to repulsive and attractive force exerted among them, nodes can move allowing to the calculated force. In the projected approach, Delaunay triangulation is formed with these nodes, neighboring relationship is well-defined if two nodes are connected in the Delaunay diagram. Force can only be exerted from those adjacent nodes within the communication range. Simulation results presented that the proposed approach has higher coverage rate and faster convergence time than outmoded virtual force algorithm.

Jobin George *et al.* 2013 [10] Abstract-Relay node (RN) deployment problem is undeniably a we U-considered research topic in wireless sensor network because the solutions framed for this have a strong impact on the performance and power efficiency of the system that are the basic construction block of the WSN system. Hence a good solution is indeed needed for the problem which can enhance the performance and the power consumed by the sensor nodes taking into account the factor the specific NP hard optimization problem. In this paper we proposed a modified genetic algorithm based relay node placement in wireless sensor networks. Our basic aim is to minimize the total number of relay nodes deployed and to provide maximum connectivity between sensor nodes and relay nodes such that fault tolerance is definite.

Errol L. Lloyd *et al.* 2014 [11] Wireless sensor network consists of many low-cost, low battery, sensor nodes, which can implement sensing, simple computation, and transmission of sensed information. Long distance transmission by sensor nodes is not energy efficient since energy consumption is a superliner function of the transmission distance. One Way prolonging network lifetime while preserving network connectivity is to deploy a small number of costly, but more powerful, relay nodes whose main task is communication with other sensor or relay nodes. Here supposed that sensor nodes have announcement range from r > 0, while transmit nodes have communication range R _ r, and we study two versions of relay node placement problems. In the first version, we want to organize the smallest number of transmit nodes so that, among each pair of sensor nodes, there is a connecting path consisting of relay and/or sensor nodes. In the second version, we want to deploy the minimum number of relay nodes so that, between each pair of sensor nodes, there is a connecting path consisting solely of relay nodes. We present a polynomial time 7-approximation algorithm for the first problem and a polynomial time ð5 þ _Þ-approximation algorithm for the second problem, where _ > 0 can be any given constant.

Abhishek Kumar Singh *et al.* 2015 [12] Deployment of sensors is a critical issue in the sensor network designing since it has significant impact on the performance of the network and determines the cost of deployment. Coverage and Connectivity can be considered as a performance measure of a Wireless sensor network (WSN) through which the quality of service (QOS) can be evaluated. We proposed a new strategy for sensor deployment and have calculated the deployment entropy for sensor distribution in diverse scenario. The greater the value of deployment entropy the more sensing coverage will be achieved.

Huan Zhao *et al.* 2015 [13] Sensor deployment is a fundamental problem in wireless sensor networks (WSN), the performance of WSN largely depends on a good sensor deployment scheme. Here presented a novel sensor deployment scheme based on fruit fly algorithm (FOA) to improve the coverage rate. Each fruit fly represents a solution for sensor deployment independently, and they are given the random direction and distance for finding food using osphresis. Then we find out the fruit fly with the highest smell attentiveness decision value from the fruit fly group and keep its positions and then the fruit fly group will fly towards that position by using their sensitive vision. Here proposed simulations both in the ideal and obstacle areas, FOA-based sensor deployment is compared with the classic standard PSO and the novel GSO, simulation results show the usefulness of the proposed approach.

Miloud Bagaa *et al.* 2016[14] Presented tackles the challenge of optimally placing relay nodes (RNs) in wireless sensor networks (WSN) given a limited set of positions. The proposed solution consists in i) the usage of a realistic physical layer model based on a Rayleigh block fading channel, ii) the calculation of the signal-to-interference plus-noise ratio (SINR) considering the path loss, fast fading, and interference, and iii) the usage of a weighted communication graph drawn based on outage probabilities determined from the calculated SINR for every communication link. Overall, the proposed solution aims for minimizing the outage probabilities when constructing the routing tree, by adding a minimum number of RNs that guarantee connectivity. In comparison to the state-of-the art solutions, the conducted simulations reveal that the proposed solution exhibits highly encouraging results at a reasonable cost in terms of the number of added RNs. The gain is proved high in terms of extending the network lifetime, reducing the end-to-end-delay, and increasing the good through put.

4. Conclusion

After having gone through different literatures published on the topic of energy conservation in WSN. Node deployment is one main design issue in wireless sensor network. Node placement in WSNs is of two types manual or randomized. In manual placement, the sensors are manually allocated and data is routed across predetermined paths. Though, in random node placement, the sensor nodes are dispersed randomly, crafting an ad hoc routing infrastructure. The node deployment in wsn should be in such a way that the communication between nodes never failed. So in future work we can propose a node deployment technique such as to improve wireless sensor network lifetime.

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