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# State of Art Techniques for Wireless Sensor Network Lifetime Maximization

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**ABSTRACT: The rapid advancement of digital electronics and wireless communications has resulted in more rapid development of Wireless Sensor Networks (WSN) technology. In the recent years, WSNs have seen great development in design and applications. WSNs involve deployment of huge number of wireless sensor nodes essentially for monitoring certain area and collecting data and sent collecting data to the base station and further processed as per requirements. One of the important challenges faced by WSNs is to maximize the network lifetime. State of art techniques for maximizing lifetime of network is being presented in this paper.**

**Keywords: Wireless sensor networks, network lifetime, energy efficiency.**

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## INTRODUCTION:

WSNs consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations[1]. Sensor nodes in large number are densely deployed either inside the actual phenomenon or very closed to it to monitor the environment [3]. This fast growth of WSNs has resulted in focus being given into solving the challenges that has to face. One such challenge is to maximise the network lifetime while the nodes remain monitored constantly. The main tasks of a sensor node are to collect data (monitoring), perform data aggregation, and then transmit data. Among these tasks more energy is required in transmitting data than processing data. The most recent efforts on optimizing the wireless sensor network lifetime have been focused on routing protocol (i.e., transmitting data to the base and data request from the base to the sensor node). The dense and random deployment of sensor nodes also makes it almost impractical to recharge such a large amount of devices . Each low-cost sensor node has only limited resources such as power, computational ability, bandwidth and memory. Once a sensor node consumes all its battery energy, it will "die" - disappear in the network. The network may stop to work when the remaining sensor nodes are not sufficient to complete the assigned tasks. Energy efficiency is a central issue in satisfying sensor network functionalities and extending system lifetime.

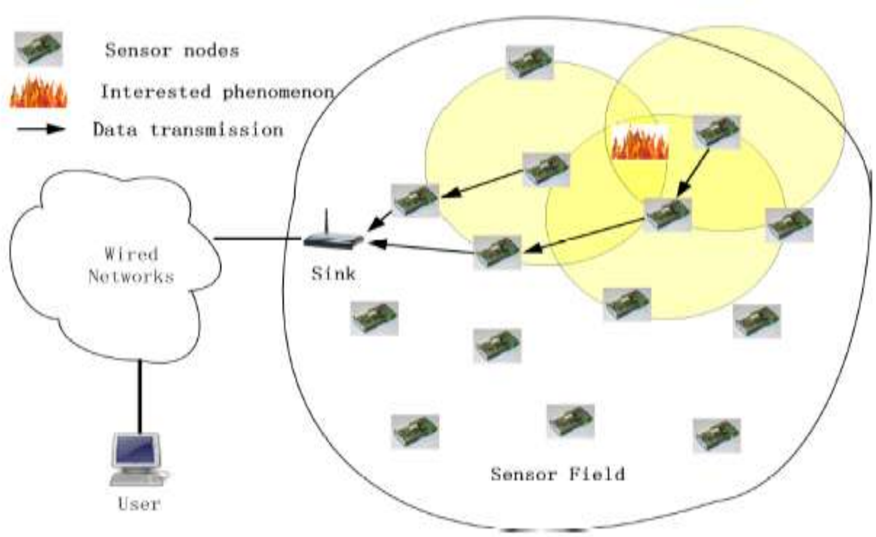


**Figure 1.1: A typical sensor network architecture [3]**

A sensor network architecture shown in Figure 1.1 depicts a scenario where fire is sensed by sensors around it. The sensor nodes report the sensed data and communicate to the sink node via single or multi-hop communications. One or more central controllers called sink nodes collect and further process the data generated by the sensors. The sink node may communicate with the users via traditional wired or wireless network infrastructures. As the sink node may not be unattended, it is usually regarded as a node in the network with infinite (i.e. sufficiently large) resources such as battery energy and processing capability.

**Literature Survey**

Wireless sensor networks are usually self-organized ad hoc networks consisting of a large number of wireless sensor nodes with small size, low battery capacity, small processing power, limited buffer capacity and a low-power radio. Several techniques have been presented by researchers to enhance the functionality of WSNs. An approximation algorithm for Target Coverage problem in WSN has been presented in [1]. This paper analyzed energy model of target coverage problem, obtain three rules to reduce network scale. In their work they try to extend network lifetime based on minimizing energy consumption of key target and maximizing energy efficiency of sensor node. The algorithm is highly effective and good scalable, which has a lower computational complexity. An approximation algorithm discussed the types of coverage problem according to different standards presented in [2]. This paper analyzed the types of the coverage problem according to the use of the networks, the characters of monitored areas or targets, the sensing models of sensor nodes and so on. Using the mobility of nodes, the algorithm can move redundant nodes to uncovered area. Although there are some limits of energy and node hardware, the algorithm is still effective in practice.

A distributed algorithmic framework to enable sensors to determine their leep-sense cycles based on specific coverage goals discussed in[3]. The framework prioritizing each sensor into local cover sets and then negotiating with its neighbors for satisfying mutual constraints. A neighbour based topology control protocol has been proposed in[4].This paper mapped an irregular cellular learning automation to network. This approach finally forms a proper topology which causes to lower network's energy consumption. A distributed algorithm approach for Sensing Coverage Problem in WSNs discussed in [5]. This paper defined the maximum sensing coverage region problem for randomly distributed WSNs and proposed the distributed algorithm to solve this problem. The main design features is selecting a small number of delegated sensor nodes by identifying and removing redundant nodes in high-density networks. They does not apply this algorithm to a multi-hop routing protocol for large scale wireless sensor networks. A force based,grid based approach discussed in [6]. This paper approved Coverage Strategies for WSNs aimed to review the common strategies used in solving coverage problem in WSN. They reviewed the researches done in maximizing coverage of WSN by sensors positioning. The strategies reviewed are categorized into three groups based on the approaches used namely; force based, grid based or computational geometry based approach. Theory and concepts along with the examples of the algorithms proposed using these approaches was presented. The reviewed strategies each have their own benefits or costs.

A greedy based approach discussed in [7]. This paper presented the survey of coverage problem in sensor network. This paper described the two main challenges, namely maximizing network lifetime and network connectivity. Various problems that are relating to coverage in WSN are also outlined. Brief summary and comparison of existing coverage schemes is also provided. A heuristic based approach has been discussed in[8]. This paper considers huge number of static sensor nodes that are used for monitoring a number of target points in the region. It has a long runtime and therefore not feasible for large scenarios. An approximation algorithm for Target Coverage problem inks discussed in [9].This paper studied the network lifetime issue of the target coverage problem and consider Constant-Approximation for Target Coverage Problem in Wireless Sensor Networks. This paper define the problem in term of reduce minimum weight sensor coverage problem, which is to find the minimum total weight of sensors to cover a given area or a given set of targets with a given set of weighted sensors with the help of polynomial time approximation algorithm. A distributed based approach for solving the coverage problem in sensor networks is discussed in[10] .This problem in a 2D space is solved with an efficient polynomial-time algorithm. This paper shows that tackling this problem in a 3D space is still feasible with in polynomial time.

A SNR based dynamic clustering discussed in[11].This paper presented an Efficient and Secure Routing Protocol for WSNs through SNR Based Dynamic Clustering Mechanisms and use clustering technique for calculating the lifetime of the WSN. This paper is not discussed the amount of overhead involved in their proposed scheme

A dynamic programming based approach has been discussed in [12].This paper defines the maximum sensing coverage region problem for randomly distributed WSNs and proposed the distributed algorithm to solve this problem. This paper reduced total energy consumption in the whole system and increased significantly network lifetime.

Comparative analysis of different algorithms along with their limitations and strengths is presented in Table 1.

**Table 1: Comparative Analysis**

| Paper | Approach Used | Strengths | Limitations |
|---|---|---|---|
| A Heuristic Greedy Optimum Algorithm for Target Coverage in WSNs[1] | Heuristic Greedy Optimum Algorithm | Extend network lifetime | Adaptability and Stability is not so high |
| A Study on the Coverage Problem in WSNs[2] | A coverage algorithm with node mobility | Move redundant nodes to uncovered or weak-covered areas | some limits of energy and node hardware |
| A Distributed Algorithmic Framework for Coverage Problems in WSNs[3] | A distributed algorithmic approach | The several variations of the Dependency Graph and the weight functions are currently being explored. | |
| A Self-Organized Energy Efficient Topology Control Protocol based on Cellular Learning Automata in WSNs(SEETCLA)[4] | Self-Organized Protocols | high number of transmission ranges | More energy consumption. |
| An Algorithm for Sensing Coverage Problem in WSNs[5] | distributed algorithm approach | reduced total energy consumption in the whole system and increased Significantly network lifetime. | Does not apply to multi-hop routing protocol for large scale wireless sensor networks. |
| Coverage Strategies for WSNs[6] | force based, grid based or computational geometry based approach | maximizing coverage of WSN by sensors positioning | costly |
| Coverage Problem in WSNs: A Survey[7] | greedy method | Defined relationship between coverage points and sensors | For heterogeneous network require different set arrangement |
| AN Energy Efficient Algorithm For Connected Target Coverage Problem IN WSNs[8] | Heuristic approach | Provide quality of service,no restriction on the network configuration, has polynomial time | Long runtime therefore not feasible for large scenarios. |

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|---|---|---|---|
| | | complexity in worst case | |
| Constant-Approximation for Target Coverage Problem in WSNs[9] | dynamic programming | Give a polynomial time approximation algorithm for target coverage problem | Take exponational time complexity |
| The Coverage Problem in Three Dimensional WSNs[10] | distributed algorithm approach | Work for both centralized As well as fully distributed manner independently by each sensor | does not give any information about how each point (or subspace) covered by sensors |
| Efficient and Secure Routing Protocol for WSNs through SNR Based Dynamic Clustering Mechanisms[11] | SNR-based dynamic clustering | Security, improves the energy efficiency | More delay in data delivery |
| Energy Balance on Adaptive Routing Protocol Considering the Sensing Coverage Problem for WSNs[12] | distributed and light overhead traffic approach | reduced total energy consumption, increased significantly network lifetime | costly |

## Conclusion

Advances in WSNs technology have enabled small and low-cost sensors with the capability of sensing various types of physical and environmental conditions, data processing, and wireless communication. Exhaustive literature survey of various techniques to maximize network lifetime of WSN has been presented in this paper. The strengths and limitations of different algorithms have also been presented. We are working towards designing a distributed approach for maximizing the lifetime in a sensor network with adjustable sensing ranges.

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