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Optimization of Energy of Sensor Network through Ant Colony Algorithm: A Review

[1] Nishant Dev Rathi,[2] Dr. Rishu Bhatia,[3]Dr Rakesh Joon,

[1] Research Scholar, Department of Electronics and Communication Engineering, Ganga Institute of Technology and Management, Haryana, India

[2] Associate Professor, Department of Electronics and Communication Engineering, Ganga Institute of Technology and Management, Haryana, India

[3] HOD, Department of Electronics and Communication Engineering, Ganga Institute of Technology and Management, Haryana, India

ABSTRACT: This research gives a high-level taxonomy of strategies for managing energy consumption in WSNs. Multiple energy provision methods are evaluated, including ones that rely on batteries or energy harvesting. There is also an emphasis on the recent advancement of wireless energy transfer to a sensor node as an alternative to traditional batteries. We suggest that while creating energy-efficient solutions for a sensor network, designers consider both time-tested energy-saving practises and cutting-edge advances in energy generation. In the end, the purpose of energy management is to prevent any node in the network from failing due to a shortage of power. Sensor nodes have a limited energy supply, thus it's important to balance the demands of various applications. Energy is a scarce commodity for sensor nodes deployed in remote locations, and it may be very difficult, if not impossible, to restore power after it has been depleted. Therefore, it is essential to regulate both supply and demand in order to avoid energy shortages in a network. This survey is useful for the research community since it provides a snapshot of the present state of energy management practises. In order to clarify the subject at hand, we have split energy management in WSNs into two distinct classes. We'll start by discussing some of the challenges that might occur when powering a sensor node in a variety of ways, and then go on to discussing some of the solutions that can be implemented and the sets of protocols that can be built based on energy needs. Most sensor nodes in use today run-on batteries that can be removed, charged, and replaced. To get beyond the constraints of a lack of batteries, several researchers have begun to use ambient energy. If a sensor network can gather enough energy from its surroundings, it can keep working eternally. Energy harvesting-based solutions can only go so far, however, since there are scenarios in which a node has less harvesting capacity than its power requires. When the energy levels of individual nodes diminish, the whole network's performance suffers. The optimization of routing in wireless sensor networks is the primary research topic of this thesis. Due to the sensors' limited energy supplies, it is essential for a WSN routing strategy to prioritise lifespan. In this paper, we provide Ant Colony Optimization as a heuristic method for reducing the power consumption of WSN routing procedures.

KEYWORDS: Wireless Sensor Networks (WSNs), Ant Colony Optimization, WSN routing

I. INTRODUCTION

The wonder of technological advancements is that they allow us to drastically alter our daily routines and the ways in which we engage with the world around us. The explosive growth of WSNs is one example of a technology that is undergoing rapid development (WSNs). Randomly placed, independently operating nodes called Sensor Nodes (SNs) are deployed in WSNs to gather information about a given event. WSNs have the same capabilities as wireless ad hoc networks, including the ability to adopt dynamic networks and topologies and the capacity for self-organization without any manual intervention, but have much less or no fixed infrastructure. These benefits recommend WSNs for use in situations where there is either no existing network in place or where establishing a permanent infrastructure network would be impractical. Because of their adaptability, WSNs can be used for a wide range of purposes, including but not limited to: habitat monitoring; adversary surveillance; item tracking; structural health monitoring; and smart farming. Although WSNs hold great promise for the future, there are also significant obstacles that must be addressed.

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Connectivity, link quality, localization, scalability, security, and energy efficiency are only some of the more well-known difficulties. Despite the finest design and deployment tactics, improving energy efficiency for WSNs continues to be a top challenge for academics around the world. This thesis proposes to address this critical issue by developing low-power routing protocols for WSNs. [1-5]

With the support of self-configured, autonomous SNs with constrained power and storage capacities, WSNs may gather, process, and communicate event data at the point of deployment. In a WSN, a collection of SNs can work together to process data and derive useful insights from previously inaccessible regions. Using an Analogue to Digital Converter (ADC), an SN collects information and sends it on to a Base Station (BS) or Sink, where it can be used in a number of ways. When data is being sent, every node in the network serves as a repeater, relaying the signals from other SNs to the base station. While all SNs share the ability to collect and relay data on the location and state of a given physical phenomena, more complicated SNs can also undertake tasks like data processing and aggregation to boost a WSN's efficiency. More powerful nodes have a longer communication range and can send data to the BS without going through any intermediate nodes. The SNs selected are dependent on the complexity of the program and the location where it will be used. Sensors, processors, and transceivers all need energy, and the SN's power source provides it; nevertheless, the network's limited battery life means that heavy use can quickly deplete its reserves (Akkaya Kemal, 2005). In addition, certain nodes may have Global Positioning System (GPS) receivers added for location awareness; however, such WSNs often consume a lot of energy, making them impractical for low-cost and low-power SNs. Figure 1.1 depicts a common architecture for WSNs, in which SNs form clusters under the leadership of a single node known as the Cluster Head (CH) [6-13].

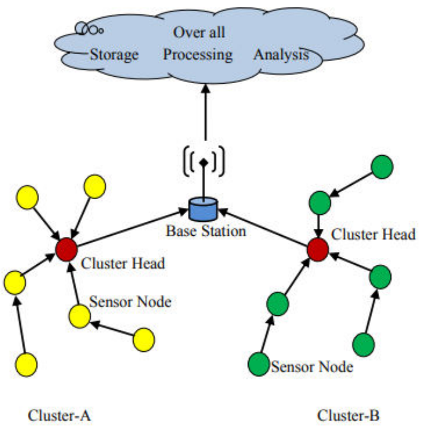

Figure 1WSN and Cluster formation

All SNs report events to their corresponding CHs, which then relay the information to the BS over a single or many wireless hops. In addition, two basic categories of wireless sensor networks (WSNs) exist: structured and unstructured (Jennifer Yick, 2008). SNs in an unstructured WSN are dispersed at random and deployed ad hoc across a given operational domain (mountains, deserts, oceans, etc.). Because of the dispersed nature of the nodes in an unstructured WSN, performing routine network maintenance is arduous. However, with a structured WSN, node administration and network maintenance are simplified because all or portion of the SNs are installed according to a predetermined plan. [13-16]

II. METHODOLOGY

In various ways, PRRP differs from LEACH and CELRP. This analysis assumes WSN nodes have GPS or low-cost location surveys and know their placements. Each sensor node may utilize various frequencies for transmission and reception due to its multichannel transceiver. Each node may deliver its data to the sink as they can communicate across bigger distances. Assuming all nodes have equal energy is normal practice. Randomly distributed sensor nodes are grid-based, with the sink in the network's geometric center. This assumption is important for disaster management and forest fire monitoring.

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Figure below shows the idea PRRP implementation network model. A WSN is evenly distributed at random when nodes are grid-dispersed throughout a sensor field. Mid-network is the static sink. On either side of the sink, sensor nodes are grouped. Depending on the network size, tiers are labeled D0, D1, etc. at increasing radii from the sink. Each tier may have more than one grid, and the number of nodes in each tier fits within a reasonable range. The sink will first broadcast an E0 signal into the network. Only nodes near the sink should get the E0 signal. After receiving the signal, these nodes will react as tier D0 nodes. The sink transmits a lower-energy signal than the source, E1. All nodes except D0 come together when this signal is received. Repeat until desired number of layers is obtained. [17-19]

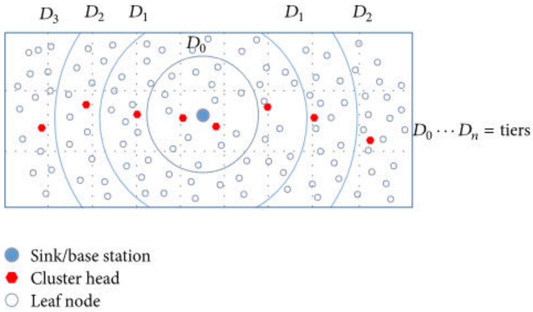

Figure 2: PRRP implementation network model

2.1 Energy Model

This study's power regulation model is predicated on the hypothesis that transmission distance is proportionate to energy consumption. The energy used by a node to transport a piece of data a few meters may be seen in Equation (1) below. The amount of power needed to receive d bits may be calculated as follows: (2) [81]

$$E_{\mathrm{Tx}} = kE_{\mathrm{elec}} + kE_{\mathrm{amp}}d^2, \quad (1)$$

$$E_{\mathrm{Rx}} = kE_{\mathrm{elec}}, \quad (2)$$

where E_{elec} is the electronics energy in transceiver and E_{amp} is the amplifier energy.

The minimum energy for a node to be able to participate in the coming round of routing (or it is the minimum energy to participate in next round) is given in (3) as $E_{\mathrm{thresholdmin}}$:

$$E_{\mathrm{thresholdmin}} = kE_{\mathrm{elec}} + kE_{\mathrm{amp}}d^2 + 8kE_{\mathrm{elec}}. \quad (3)$$

2.2 Analysis of PRRP

This section shows a brief research of cluster head node and leaf node energy consumption connected with CH node longevity. Assume a WSN has N wireless sensor nodes evenly dispersed in an m-by-m grid, and one node in each cell is the cluster leader (CH). [20]

Ein, Eth, Er, and Et signify initial, threshold, reception, and transmission energy for a single data sample. A CH with K nodes sleeps during transmission Tt, reception KTt, and sampling Ts-(K+1) Tt. When the CH's remaining energy dips below Eth, it dies. This lets us express CH lifespan in sample intervals, Ns, as

$$N_s = \frac{E_{\mathrm{in}} - E_{\mathrm{th}}}{E_t + kE_r + (T_s - (k+1)T_t)P_s}. \quad (4)$$

III. CONCLUSION AND FUTURE SCOPE

WSNs may be used for habitat monitoring, opponent surveillance, item tracking, structural health monitoring, and smart farming. WSNs show immense potential, but there are also substantial challenges. Connectivity, connection quality, localisation, scalability, security, and energy efficiency are issues. Despite the best design and deployment strategies, increasing WSN energy efficiency remains a top issue. This thesis suggests creating low-power routing methods for WSNs. Sensor nodes placed at wide distances need careful energy management due to their high energy needs. Batteries often power these nodes. Several battery-driven energies-saving measures ensure network efficiency. Since battery capacity is limited, researchers have turned to ambient energy. This research taxonomizes WSN energy management techniques. Analyses energy-providing techniques including batteries and energy collecting. Wireless

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energy transfer to a sensor node as an alternative to batteries is also mentioned. When constructing energy-efficient sensor network systems, keep both proven techniques of preserving energy and current innovations in delivering that energy in mind. "Energy management" in wireless sensor networks (WSNs) refers to how each sensor node gets and uses network power. Energy management should guarantee that no network node runs out of power. A sensor node's limited energy supply requires appropriate energy management, and applications should be regulated accordingly. In an out-of-the-way position, a sensor node's energy supply is restricted, and it's difficult, if not impossible, to refill it. Preventing network energy shortages requires careful supply and demand management. This poll informs researchers about current energy management practices. We classified energy management in WSNs into two groups to better comprehend the problem. First, we'll discuss challenges that may come from using multiple energy sources for a sensor node. Then, we'll discuss techniques and protocols that might be built based on energy needs. Most deployed sensor nodes use rechargeable batteries. Many scientists use ambient energy to overcome battery shortages. If it collects enough energy from the environment, a sensor network can run perpetually. In certain cases, a node's energy collecting capacity is less than its power demands. A node's energy levels may decline, lowering the network's efficiency. This thesis optimizes wireless sensor network routing via ant colony search. Due to sensors' limited energy, WSN routing must maximize lifetime. Ant Colony Optimization is a heuristic for reducing WSN routing energy.

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+91 99405 72462 +91 63819 07438 ijmrsetm@gmail.com