**SYNOPSIS FOR ENERGY OPTIMIZATION IN ROUTING ALGORITHM OF WIRELESS SENSOR NETWORKS**

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**Abstract**

Wireless Sensor Networks (WSNs) have emerged as a critical component in various applications, such as environmental monitoring, surveillance, and industrial automation. These networks are typically comprised of a large number of energy-constrained sensor nodes that communicate with each other to collect and transmit data. Prolonging the network's lifespan and ensuring efficient energy utilization are paramount challenges in the design and operation of WSNs. This project focuses on addressing these challenges through the development and optimization of routing algorithms for WSNs.

The primary objective of this project is to enhance energy efficiency and extend the operational lifetime of wireless sensor networks by improving the routing protocols used to relay data between nodes.

**Introduction**

In today's interconnected world, Wireless Sensor Networks (WSNs) have emerged as a transformative technology with vast applications across various domains, including environmental monitoring, healthcare, agriculture, and industrial automation. These networks consist of numerous small, energy-constrained sensor nodes that collaborate to collect and transmit data. However, the limited energy resources of these nodes pose a significant challenge to the longevity and efficiency of WSNs.

The heart of any WSN lies in its routing algorithm, as it dictates how data is transmitted from the source to the sink node. Maximizing the network's operational lifetime while ensuring reliable and efficient data delivery is a fundamental concern. Energy consumption is a critical factor as the sensor nodes typically rely on batteries or energy harvesting mechanisms with finite capacities.

This project, "Energy Optimization in Routing Algorithms for Wireless Sensor Networks," addresses this challenge by focusing on the development and enhancement of routing protocols designed to significantly extend the lifetime of WSNs through improved energy management. By optimizing energy utilization, we aim to enhance the sustainability and reliability of WSNs, enabling them to operate for extended durations with minimal human intervention.

Key objectives of this project include:

1. **Algorithm Development:** The design and implementation of routing algorithms that prioritize energy-efficient data transmission while maintaining data reliability and network connectivity.
2. **Energy-Aware Metrics:** The development of comprehensive energy-aware metrics to evaluate the performance of routing algorithms, taking into account parameters such as node energy levels, traffic patterns, and network topology.
3. **Dynamic Adaptation:** Implementation of mechanisms for dynamic adaptation, allowing routing protocols to adjust their behavior in response to changes in network conditions and energy availability.
4. **Simulation and Evaluation:** Rigorous simulation and evaluation of the proposed routing algorithms, comparing their performance against existing protocols in terms of energy efficiency, network lifetime, data latency, and scalability.
5. **Real-World Application:** Exploration of real-world applications and case studies, demonstrating the practicality and effectiveness of the developed energy-optimized routing algorithms in various scenarios.

**Objective**

The objective of our minor project is to investigate energy optimization within routing algorithms. We aim to achieve this objective through the following steps:

* **Study Existing Algorithms:** First, we will comprehensively study and analyze the current routing algorithms in the context of energy consumption. This includes understanding the algorithms' structures, parameters, and their impact on energy efficiency.

* **Comparative Analysis:** Next, we will conduct a comparative analysis of these existing routing algorithms. We will evaluate their performance in terms of energy optimization, identifying strengths and weaknesses.
* **Proposal of New Mechanism:** Leveraging the insights gained from our study and comparative analysis, we will propose a novel routing mechanism that focuses on energy optimization. This mechanism will incorporate principles of soft computing or machine learning (ML) to enhance the routing process's adaptability and energy-efficiency. We will design, develop, and implement this new mechanism, taking into consideration the specific requirements and constraints of the problem.

Our minor project's goal is to contribute to the field of energy-efficient routing by developing an innovative mechanism that outperforms existing solutions while utilizing soft computing or ML techniques.

**Literature Review**

A comprehensive literature review is conducted of research papers from recent years in order to gain a deeper understanding of the project's fundamental concepts. It provides information on the most recent methods and theories related to the project. In addition, it provides ideas for research initiatives based on the existing systems.

| Reference No. | Description |
| --- | --- |
| [1] | This paper describes the concept of optimization techniques in Wireless Sensor Networks. Optimization techniques used in wireless sensor networks for minimize energy consumption and for solve routing problems. Energy efficiency, task allocation, node deployment and network lifetime are main constraints in Wireless Sensor Networks. For improving network life time and energy consumption various optimization techniques have been proposed. In this paper describe the various optimization techniques as Fire Fly Optimization (FFO), Genetic Algorithm (GA), and Ant Colony Optimization (ACO). In this paper also compare these optimization techniques. |
| [2] | Wireless sensor network (WSN) coverage problem is to think about how to maximize the network coverage to obtain reliable monitoring and tracking services with guaranteed quality of service. In this paper, a simplified slime mould algorithm (SSMA) for solving the WSN coverage problem is proposed. In SSMA, we mainly conducted 13 groups of WSNs coverage optimization experiments and compared them with six well-known meta-heuristic optimization algorithms. The experimental results and Wilcoxon rank-sum test show that the proposed SSMA is generally competitive, outstanding performance and effectiveness. We proposed SSMA algorithm could be helpful to effectively control the network nodes energy, improve the perceived quality of services and extend the network survival time. |
| [3] | Wireless Sensor Networks consisting of nodes with limited power are deployed to gather useful information from the field. In WSNs it is critical to collect the information in an energy efficient manner. Ant Colony Optimization, a swarm intelligence based optimization technique, is widely used in network routing. A novel routing approach using an Ant Colony Optimization algorithm is proposed for Wireless Sensor Networks consisting of stable nodes. Illustrative examples, detailed descriptions and comparative performance test results of the proposed approach are included. The approach is also implemented to a small sized hardware component as a router chip. Simulation results show that proposed algorithm provides promising solutions allowing node designers to efficiently operate routing tasks. |
| [4] | In order to overcome drawbacks of unreasonable cluster-head selection and excessive energy consumption in wireless sensor networks (WSNs), a modified cluster-head selection algorithm based on LEACH (LEACH-M) was proposed. Based on distributed address assignment mechanism (DAAM) of ZigBee, both residual energy and network address of nodes were taken into account to optimize cluster-head threshold equation. Furthermore, by leveraging a cluster-head competitive mechanism, LEACH-M successfully balanced the network energy burden and dramatically improved energy efficiency. The simulation results in NS-2.35 show that the proposed algorithm can prolong the network lifetime, minimize the energy consumption, and increase the amount of data received at base station whether region is in a 100 × 100m2 or in a 300 × 300m2. |
| [5] | Wireless Sensor Networks (WSNs) consist of a large number of spatially distributed sensor nodes connected through the wireless medium to monitor and record the physical information from the environment. The nodes of WSN are battery powered, so after a certain period it loose entire energy. This energy constraint affects the lifetime of the network. The objective of this study is to minimize the overall energy consumption and to maximize the network lifetime. |

**Project Features**

**1. Sensor Placement Using SSMA**

The Simplified Slime Mould Algorithm (SSMA) is a bio-inspired optimization algorithm that draws inspiration from the behavior of real slime molds (Physarum polycephalum) as they forage for food sources. This algorithm mimics the decentralized and self-organizing properties of slime molds, making it suitable for solving various optimization problems, especially those related to network design, such as road network optimization and sensor placement.

**2. Route Optimization Using ACO:**

The Ant Colony Optimization (ACO) algorithm is a popular nature-inspired optimization algorithm that is based on the foraging behavior of ants. It was developed in the early 1990s by Marco Dorigo. ACO is often used to find solutions to optimization and search problems. The algorithm is particularly known for its ability to find near-optimal solutions to complex combinatorial problems.

**3.Real-Time Data:**

WSNs are often used to monitor and collect real-time data, which can be essential in applications like environmental monitoring or disaster response.

**4.Scalability:**

WSNs can scale from a small number of nodes to thousands or even more. They are adaptable to various deployment scenarios.

**5.Ad Hoc Networking:**

Sensor nodes can form ad hoc networks, meaning they can communicate directly with one another without relying on a fixed infrastructure. This feature is essential for flexibility and scalability.

**Research Methodology**

**Analysis**

**Literature Review:** Conduct an extensive literature review to gain a comprehensive understanding of the existing routing algorithms and their energy optimization aspects. Identify key research papers, articles, and books related to routing algorithms, energy efficiency, and soft computing or ML in networking.

**Data Collection:** Collect relevant data and datasets that will be used for evaluating the existing algorithms and for training and testing our proposed mechanism.

**Design**

**Algorithm Selection:** Choose a set of existing routing algorithms known for their energy efficiency attributes. Define the criteria for selecting these algorithms based on their relevance to the research objectives.

**Experimental Design:** Design experiments for evaluating the selected routing algorithms' performance. Determine the parameters to be measured, such as energy consumption, latency, and throughput.

**Model Selection:** Decide on the soft computing or machine learning models to be used in the development of the proposed mechanism. Select appropriate libraries or frameworks for implementation.

**Development**

**Implementation:** Implement the selected routing algorithms for the purpose of comparison. Develop the proposed energy-optimized routing mechanism using soft computing or ML techniques.

**Dataset Preparation:** Preprocess the collected datasets for training and testing the proposed mechanism. Ensure data quality, consistency, and relevance to the research objectives.

**Evaluation**

**Performance Metrics:** Define a set of performance metrics, including energy consumption reduction, routing efficiency, and scalability, to assess the algorithms and the proposed mechanism.  
**Comparative Analysis:** Evaluate the selected routing algorithms based on the defined metrics and gather data on their energy optimization performance. Assess the efficiency and effectiveness of the proposed mechanism using the same metrics.

**Statistical Analysis:** Perform statistical analysis to determine the significance of differences between the existing algorithms and the proposed mechanism. Use appropriate statistical tests to draw valid conclusions.

**Project Time-line**

|  | August | September | | | |
| --- | --- | --- | --- | --- | --- |
| Plan | Week 4 | Week 1 | Week 2 | Week 3 | Week 4 |
| Identify Research Area |  |  |  |  |  |
| Topic Evaluation Presentation |  |  |  |  |  |
| Data Procurement and Synthesis |  |  |  |  |  |
| Writing Research Synopsis |  |  |  |  |  |

|  | October | | | | November | | | | December | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Plan | Week 1 | Week 2 | Week 3 | Week 4 | Week 1 | Week 2 | Week 3 | Week 4 | Week 1 | Week 2 |
| Study about WSN |  |  |  |  |  |  |  |  |  |  |
| 2nd Presentation |  |  |  |  |  |  |  |  |  |  |
| Comparing Existing Algorithm and their features |  |  |  |  |  |  |  |  |  |  |
| 3rd Presentation |  |  |  |  |  |  |  |  |  |  |
| Proposing our algorithm using soft computing/ML |  |  |  |  |  |  |  |  |  |  |
| Final Paper Submission |  |  |  |  |  |  |  |  |  |  |
| Final Progress Presentation |  |  |  |  |  |  |  |  |  |  |
| Final Report Submission |  |  |  |  |  |  |  |  |  |  |

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