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AN EFFECTIVE ENERGY EFFICIENT LEACH PROTOCOL IN WSN

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Abstract

The paper you mentioned proposes a Multi-Hop LEACH energy efficient routing protocol for Wireless Sensor Networks (WSNs) that aims to address the challenge of limited battery life in WSNs. The protocol utilizes a combination of particle swarm optimization technique and E-LEACH protocol, along with a multi-hop network design. The networking concept is divided into multiple layers to facilitate network engineering.

The proposed protocol utilizes the Low Energy Adaptive Clustering Hierarchy (LEACH) algorithm to ensure a balance between energy consumption and delay in WSNs. LEACH is a popular algorithm for energy-efficient clustering in WSNs. The protocol selects nodes with the maximum residual energy to forward the data to the base station, which helps to achieve a better packet delivery ratio with lesser energy utilization.

To further improve the energy efficiency of the WSN, the paper proposes a novel modified routing algorithm that considers both the residual energy of the nodes and the average energy of the networks. This algorithm ensures that the nodes with the highest residual energy are selected for data forwarding to the base station, thus extending the lifetime of the WSN.

Overall, the paper presents a useful approach for addressing the energy efficiency challenge in WSNs. By utilizing a combination of optimization techniques and clustering algorithms, the proposed protocol can help extend the lifetime of WSNs, making them more practical for a wide range of applications.

Keywords: *LEACH, Wireless Sensor Network, WSN, Cluster Head*

I. Introduction

Wireless Sensor Networks (WSNs) have indeed gained significant attention in recent years due to the advancements in MEMS technology and wireless communications. A WSN typically consists of a large number of wireless sensor nodes that communicate with each other to form a sensor field, and a sink that collects the data from these nodes. The low power rating of the sensor nodes and their limitation to short-range communication are some of the major challenges in WSNs.

Despite these challenges, WSNs have several applications such as monitoring natural events and environmental changes, tracking traffic movements, ensuring security, and supporting military operations. However, to make these applications more reliable, ongoing research has focused on the use of heterogeneous WSNs. Heterogeneous WSNs involve the use of sensor nodes with different capabilities, such as varying

power levels, sensing ranges, and communication protocols. The idea is to improve the reliability of the network by incorporating redundancy, fault tolerance, and efficient energy management techniques. Additionally, heterogeneous WSNs can also be designed to adapt to changing environmental conditions, making them suitable for a wider range of applications.

In summary, WSNs have emerged as an exciting area of research, with a wide range of potential applications in various fields. Ongoing research is focused on addressing the challenges associated with WSNs, such as low power consumption and short-range communication, by utilizing heterogeneous networks and advanced energy management techniques.

It seems like you have provided some information about WSNs and LEACH, which is a clustering algorithm used to reduce energy consumption in WSNs. You have also mentioned some advantages and drawbacks of LEACH, such as the fact that it can evenly divide the charge imposed at CHs, but it impairs single-hop communication with the sink. Additionally, you have highlighted the importance of energy efficiency and network longevity in WSNs and how LEACH can help achieve these goals through distributed cluster construction, local processing, and randomized cluster-head rotation.

You have also discussed the challenges faced in far-flung frameworks, such as radio connections that rely on transmission control, concealing, and impedance, which can sabotage data transport execution. To address this challenge, you suggest using a method of active bundle length management to accelerate execution in these changing settings. However, there is a tradeoff between reducing header overhead and reducing package bungle rates (PER) inside the packages.

Overall, it seems like you are interested in improving energy efficiency and network longevity in WSNs and exploring different approaches to address the challenges faced in far-flung frameworks. Wireless Sensor Networks (WSNs) have gained a lot of popularity in recent years due to their diverse applications such as environmental monitoring, industrial automation, health monitoring, and many more. In WSNs, sensor nodes are the most important components as they are responsible for sensing and collecting data from the environment.

However, sensor nodes are often energy-constrained, meaning that they have limited battery life, and once the battery is exhausted, the node becomes inactive, which leads to network failure. Therefore, minimizing energy dissipation and optimizing network longevity are critical considerations in the design of WSN applications and protocols.

LEACH (Low-Energy Adaptive Clustering Hierarchy) is an energy-efficient clustering algorithm that is widely used in WSNs. It uses a distributed cluster construction approach and local processing to decrease global communication, and randomized cluster-head rotation to balance energy consumption among nodes.

WSNs are often deployed in harsh and inaccessible environments, making it challenging to replace or recharge the batteries of the sensor nodes. Therefore, the efficient use of battery energy in sensor nodes should be a primary objective when designing protocols and hardware structures for WSNs.

Several routing protocols have been proposed to address the energy efficiency issue in WSNs, such as Energy-Efficient Routing (EER), Directed Diffusion, and Geographic Routing. These protocols aim to reduce energy consumption by minimizing unnecessary communication and data transmission, as well as balancing the energy consumption among nodes.

Overall, the energy efficiency and longevity of WSNs are crucial factors that need to be considered in the design of WSN protocols and hardware, especially in applications where sensor nodes are deployed in harsh and inaccessible environments.

II.Literature Review

1. A Novel energy Efficient Scheme for Wireless Sensor Networks Manufacturing Process

IEEE Xplore: 30 June 2020

Authors: Rama Shankar Yadav; Anju Mishra

is designed to address the energy depletion issue in WSNs used in manufacturing processes in smart city applications. The proposed scheme employs a probabilistic function for cluster head node selection based on residual energy and distance to the sink. By selecting nodes with high residual energy and proximity to the sink, the scheme reduces the energy consumption of nodes during communication and computational tasks, thereby extending their lifetime.

The authors compare the performance of LEACH-PRO with LEACH and direct transmission protocols through simulations. The results show that LEACH-PRO outperforms the other protocols in terms of network lifetime and generated traffic overhead. The proposed scheme has the potential to significantly enhance the lifetime of sensors, making WSN deployments more viable in smart city applications.

Overall, the paper presents an innovative approach to address the energy depletion issue in WSNs by proposing a new variant of the LEACH protocol. The proposed scheme has the potential to improve the efficiency and reliability of WSN deployments in smart city applications.

2. A Novel Energy-Efficient Clustering Algorithm for More Sustainable Wireless Sensor Networks Enabled Smart Cities Applications.

IEEE Xplore: 24 August 2022

Authors: G. Vishnupriya; R. Ramachandran

G. Vishnupriya and R. Ramachandran discusses a WSN consisting of countless sensor nodes deployed in certain areas. The nodes have a limited power supply and generate instructions that need to be transmitted to a sink when certain events occur. Nodes near the sink use their energy more quickly, resulting in a shorter network lifetime. To improve the network lifetime, researchers have developed energy-efficient algorithms and optimized node schemes. However, network lifetime also depends on other factors.

The article presents a case study of sensor network survival and proposes a tree-based solution. The paper also discusses network connectivity rejuvenation in extreme environments, such as field surveillance of wired sensor networks that experience large-scale infections causing nodes to fail and the network to split into

disconnected segments. In such cases, updating network connectivity is critical to prevent adverse effects on operations.

The article reviews recent research findings and guidelines related to wireless sensor network connectivity rejuvenation and identifies the limitations of the existing approaches.

3. A Novel relay Node and Placement and Energy efficient Routing Method for Heterogeneous Wireless sensor network

IEEE Xplore: 18 July 2022

Authors: Jiazu Xie; Baoju Zhang

The paper proposes a mathematical model to solve two major issues in heterogeneous wireless sensor networks (HWSNs): relay node placement and energy-efficient routing. The authors assume that there are unreachable areas in the network where sensor nodes cannot be placed. To address the non-deterministic polynomial (NP) hard nature of the problem, a heuristic method called the whale optimizer is used, along with three adaptive schemes.

The proposed method is evaluated through numerical simulations, and the results demonstrate its effectiveness in addressing the relay node placement and energy-saving problems for HWSNs. The authors' analysis and discussion provide insight into the benefits of using the whale optimizer for HWSNs and the impact of the adaptive schemes on the overall performance of the proposed method. Overall, the paper presents a valuable contribution to the field of HWSNs by proposing a mathematical model and a heuristic method to address two critical issues. The proposed method has the potential to improve the efficiency and reliability of HWSNs, making them more suitable for various applications, including environmental monitoring, healthcare, and smart cities.

4. LEACH Protocol Enhancements for Increasing WSN Lifetime

Year 2019 IEEE Volume: 5 Issue 2

Authors: Seham Nasr; Muhannad Quwaider

The authors propose a new approach to improve the lifetime and data transmission time of Wireless Sensor Networks (WSNs) by reducing the packet delay time. WSNs have become popular in various applications due to their low cost, small size, and self-organizing ability. However, their limited battery life and energy consumption hinder their efficiency. The proposed algorithm is compared with the basic LEACH protocol with fixed parameters, and simulation results show a 128.80% improvement in network lifetime. This research

contributes to the development of efficient WSN protocols that can improve the overall performance of WSN-based applications.

V. Methodology

LEACH (Low-Energy Adaptive Clustering Hierarchy) is a popular clustering protocol for wireless sensor networks that organizes nodes into local clusters to reduce energy consumption and extend network lifetime. In LEACH, nodes take turns serving as cluster heads (CH) for each round and the CH selection process is based on a randomized threshold value. This protocol assumes homogeneous networks where all nodes have the same initial energy level.

CBR-Mobile is another clustering protocol that supports mobility in WSNs by adaptively reassigning the timeslots based on the sensor node's mobility and traffic. It does not require any extra timeslot for calculating the mobility of sensor node, which results in faster data delivery to the base station. CBR-Mobile significantly improves the packet delivery ratio compared to LEACH-Mobile protocol.

Cluster-based Energy-efficient Scheme (CES) for Mobile Wireless Sensor Networks (MWSNs) is a protocol that aims to improve energy efficiency and prolong the network lifetime of MWSNs. CES takes into consideration the residual energy, density, and mobility parameters of each sensor node for cluster-head election. The CES protocol periodically performs a cluster-head election process after each round and creates balanced 2-hop clusters whose size ranges between two thresholds, the upper and lower thresholds. By creating these balanced clusters, the protocol aims to distribute the energy consumption among the sensor nodes more efficiently and avoid early depletion of energy from some nodes. Overall, CES can help improve the network lifetime of MWSNs and reduce energy consumption.

VII .Block diagram

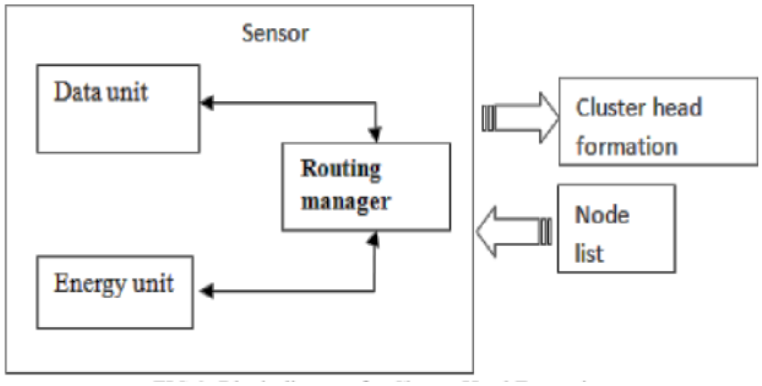

Figure 1. Block diagram FOR Clustering system

The block diagram shows a clustering system for Wireless Sensor Networks using the LEACH protocol. The LEACH (Low-Energy Adaptive Clustering Hierarchy) protocol is a popular hierarchical routing protocol used in wireless sensor networks to save energy consumption.

The diagram shows three main phases in the LEACH protocol, namely Setup phase, Steady-state phase, and Data transmission phase.

In the Setup phase, the network is initialized, and cluster heads are selected randomly. Each sensor node decides whether to become a cluster head or a member of a cluster based on a probability value calculated using the remaining energy level of the node. The selected cluster heads send a message to their members, inviting them to join their clusters.

In the Steady-state phase, the sensor nodes communicate with their cluster heads, and the cluster heads aggregate the data and transmit it to the base station. The cluster heads also perform data fusion, reducing the number of transmissions and saving energy.

In the Data transmission phase, the base station receives the aggregated data from the cluster heads, and the data is processed and analyzed. The base station may also send commands to the cluster heads for data acquisition or to adjust the network parameters.

Overall, the LEACH protocol helps to prolong the network lifetime by evenly distributing energy consumption and reducing the amount of data transmitted in the network.

Objectives

The objectives of the proposed work are as follows:

To study the E-LEACH protocol, which is an energy-efficient hierarchical routing protocol for wireless sensor networks.

To implement the E-LEACH protocol and evaluate its performance in terms of energy consumption and network lifetime.

To design a clustering method where the network is divided into several groups known as clusters, and each cluster is governed by a randomly selected cluster head based on energy level.

To evaluate the performance of the E-LEACH protocol in terms of data transmission, where the low-energy nodes sense the data from surrounding and transmit it to the cluster head, which aggregates and communicates it to the base station.

To identify methods to reduce energy consumption by having the cluster head transmit data rather than all sensor nodes, which can prolong the network lifetime.

To study the advantages of a structured wireless sensor network, where fewer nodes can be implemented with lower network maintenance and management costs.

To identify specific node deployments to provide coverage and avoid uncovered regions.

To analyze the simulated hardening algorithm for finding k optimal clusters using residual nodes as possible cluster heads.

To implement an algorithm that minimizes energy consumption for non-cluster head nodes to communicate their data to the cluster head, by minimizing the total sum of square distances between all non-cluster head nodes and the closest cluster head.

To deploy the E-LEACH protocol in practical applications and broadcast a message that covers the cluster head ID for each node to have a practical effect.

Results:

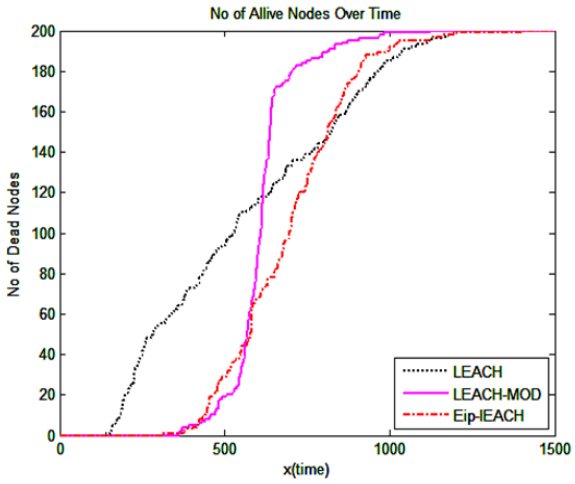

Figure 2. No. of Alive Nodes over time with respect to the dead Node

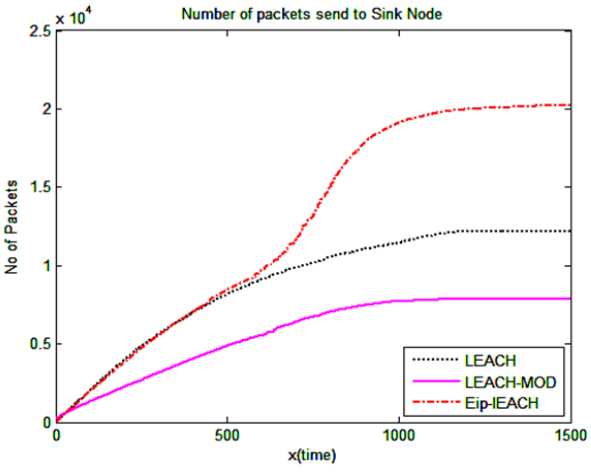

Figure 3. total number of Packets send to the sink Node during the interval of time t

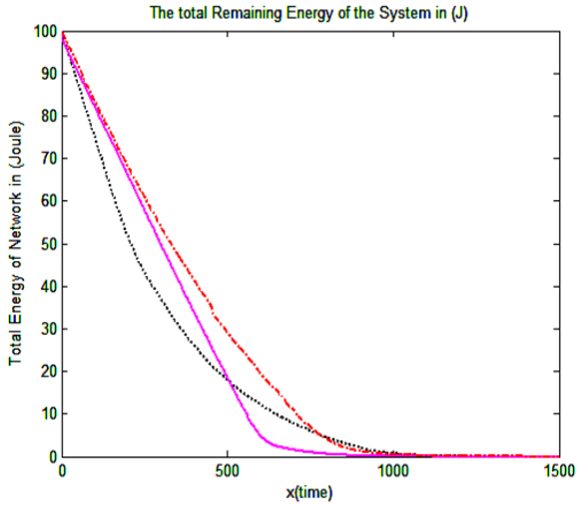

Figure 4. Indicates The Total Remaining Energy Of The System In Joules (J) with respect to the total energy of the network with respect to time

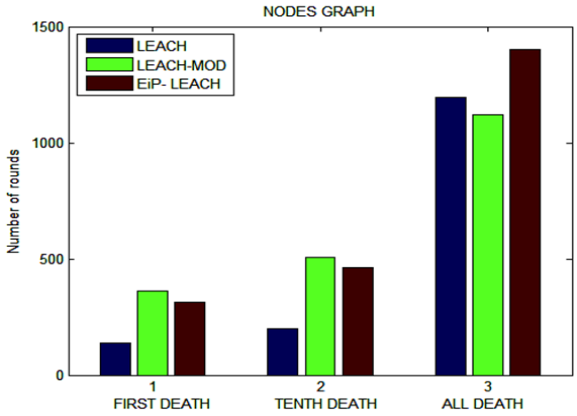

Figure 5. Indicates the overall graph with respect to Leach ,Leach Mod and Leach in terms of the number of rounds in the node

Conclusions

This paper describes a method for selecting cluster heads in a Wireless Sensor Network (WSN) based on information about the nodes' battery life and their distance from the base station. The goal is to improve the network's lifespan by conserving the energy of the nodes through clustering. The cluster head directs data between clusters and coordinates the activities of its component nodes.

To achieve this goal, the paper proposes using a multipath algorithm and a free space algorithm to select the cluster head based on battery state and separation range from the base station. The algorithms are compared with other studies, and simulations show a remarkable improvement in cluster head selection with each iteration. The results also demonstrate a significant increase in the network's lifespan in the test region.

The selection of the cluster head is a critical aspect of WSN design because it affects the energy consumption and the network's overall performance. By selecting the cluster head based on battery state and distance from the base station, the proposed method helps to extend the network's lifespan while conserving the energy of the nodes.

References

[1] Rama Shankar Yadav; Anju Mishra; Arun Pratap Srivastava IEEE Xplore (2020); A Novel Energy Efficient Scheme for Wireless Sensor Network Manufacturing Process. International Conference on Computation, Automation and Knowledge Management (ICCAKM)

[2] G. Vishnupriya; R. Ramachandran IEEE Xplore (2020). A Survey on Tree Based Energy Efficient Wireless Sensor Network. 2020 International Conference on Communication and Signal Processing (ICCSP)

[3] Jiazu Xie; Baoju Zhang; Cuiping Zhang IEEE Xplore (2020).. A Novel Relay Node Placement and Energy Efficient Routing Method for Heterogeneous Wireless Sensor Networks. IEEE Access (Volume: 8)

[4] Fatma H. El-Fouly; Rabie A. Ramadan. IEEE Xplore (2020) E3AF: Energy Efficient Environment-Aware Fusion Based Reliable Routing in Wireless Sensor Networks, IEEE Access (Volume: 8)

[5] Pengju Si; Junlei Ma; Fazhan Tao; Zhumu Fu; Lei Shu IEEE Xplore (2020). Energy-Efficient Barrier Coverage With Probabilistic Sensors in Wireless Sensor Networks, IEEE Sensors Journal (Volume: 20, Issue: 10, May15, 15 2020)

[6] Muhammad Nawaz Khan; Haseeb Ur Rahman; Mohammed Amin Almaiah; Muhammad Zahid IEEE Xplore (2020). . Improving Energy Efficiency With Content-Based Adaptive and Dynamic Scheduling in Wireless Sensor Networks, IEEE Access (Volume: 8) Page(s): 176495 - 176520.

[7] Vincent Chung; Norah Tuah; Kit Guan Lim; Min Keng Tan; Ismail Saad; Kenneth Tze Kin Teo. IEEE Xplore (2020). Metaheuristic Multi-Hop Clustering Optimization for Energy-Efficient Wireless Sensor Network. 2020 IEEE 2nd International Conference on Artificial Intelligence in Engineering and Technology (IICAIET)

[8] Gunasekar Thangarasu; P.D.D. Dominic; Kayalvizhi Subrmanian; S. Kayalvizhi; Sajitha Smiley Ma. IEEE Xplore (2020) Efficient Energy Usage Model for WSN-IoT Environments, 2020 International Conference on Computational Intelligence (ICCI)

[9] Sujata Dhumal; B.S. Shetty IEEE Xplore (2019). Energy Efficient Coverage and Sensor Localization for Scheduling, International Conference on Communication and Electronics Systems (ICCES).

[10] Zeyad Ghaleb Al-Mekhlafi; Zurina Mohd Hanapi; Ahmed Mohammed Shamsan Saleh. IEEE Xplore (2019). Firefly-Inspired Time Synchronization Mechanism for Self-Organizing Energy-Efficient Wireless Sensor Networks: A Survey IEEE Access (Volume: 7). Page(s): 115229 - 115248

[11] Anupkumar M Bongale; Anand Swarup; Shashank Shivam IEEE Xplore (2017). EiP-LEACH: Energy influenced probability based LEACH protocol for Wireless Sensor Network 2017 International Conference on Emerging Trends & Innovation in ICT (ICEI)

[12] Zhenpeng Pang; Wuxiong Zhang; Shenghu Wang; Jufeng Luo; Haiguang Chen IEEE Xplore (2018)Energy-Efficient Improvements in Mod-LEACH Protocol on Optimal Cluster Heads Selection 2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData)

[13] Seham Nasr; Muhannad Quwaider (2017). LEACH Protocol Enhancement for Increasing WSN Lifetime..

[14] Jin Wang; Kai Wang; Junming Niu; Wei Liu. IEEE Xplore (2018). A K-medoids based clustering algorithm for wireless sensor networks 2018 International Workshop on Advanced Image Technology (IWAIT).

[15] Poonam Saini; Deepak Bhatia Energy IEEE Xplore (2018) Efficient Relative Investigation of Routing Protocols in Wireless Sensor Network (WSN), 2018 International Conference on Inventive Research in Computing Applications (ICIRCA)

[16] V. Baby Shalini; V. Vasudevan IEEE Xplore (2018). Energy efficient reclustering method for wireless sensor networks 2018 2nd International Conference on Inventive Systems and Control (ICISC) L

[17] Arun L. Kakhandki; Shivaraj Hublikar; Priyatam Kumar IEEE Xplore (2017). An efficient hop selection model to enhance lifetime of wireless sensor network, 2017 Innovations in Power and Advanced Computing Technologies (i-PACT)

[18] Arun L. Kakhandki; Shivaraj Hublikar; Priyatam Kumar IEEE Xplore (2017). An analysis of hierarchical multi-hop routing protocols for large wireless sensor networks.

[19] K. Thangaramya; R. Logambigai; L. SaiRamesh; K. Kulothungan; A. Kannan; S. Ganapathy. IEEE Xplore (2017). An Energy Efficient Clustering Approach Using Spectral Graph Theory in Wireless Sensor

Networks. 2017 Second International Conference on Recent Trends and Challenges in Computational Models (ICRTCCM)

[20] Zainab Tawfeeq Alisa; Hussein A. Nassrullah IEEE Xplore (2016). Minimizing energy consumption in wireless sensor networks using modified genetic algorithm and an energy balance filter, 2016 Al-Sadeq International Conference on Multidisciplinary in IT and Communication Science and Applications (AIC-MITCSA).