IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12483

DESIGN AND IMPLEMENTATION ENERGY EFFICIENT LEACH PROTOCOL IN WIRELESS SENSOR NETWORK

Nikita Walthare[1], Tanushree Mumandwar[2], Shrikant Doppala[3], Sneha Awathare[4]

Dr. J. S. Gawai[5]

Department of Electronics Engineering, K.D.K College of Engineering[1-5]

Abstract: The paper presents a novel algorithm called Modified End-to-End Secure Low Energy Adaptive Clustering Hierarchy (ME-LEACH) for extending the lifetime of Wireless Sensor Networks (WSNs). Energy constraints are a significant challenge in WSNs, and thus, efficient energy usage is essential for all activities within a WSN. Existing protocols have been introduced to address energy dissipation issues, such as the End-to-End Secure Low Energy Adaptive Clustering Hierarchy (E-LEACH) protocol, which is a hierarchical routing algorithm. However, E-LEACH suffers from high energy consumption as each Cluster Head (CH) directly sends data to the base station. In the proposed ME-LEACH method, a CH identifies the nearest CH and uses it as the next hop, forming a chain of CHs that serve as a path to the base station or sink. This approach aims to improve energy efficiency in WSNs and reduce energy dissipation during data transmission. The widespread applications of WSNs in various fields of science and technology highlight the significance of this research.

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

I. INTRODUCTION

An internetwork, also known as the internet, is a network of networks that spans across the globe, connecting wide area networks (WANs) and even local area networks (LANs) and home networks. The internet uses the TCP/IP protocol suite and IP as its addressing protocol. Currently, IPv4 is predominantly used, but due to the shortage of address spaces, there is a gradual shift towards IPv6.

Wireless sensor networks (WSNs) are communication platforms that have the potential to impact various information and communication applications in the future. WSNs rely on small, disposable devices called sensor nodes to form a network. These nodes can detect environmental parameters, process the data, and transmit it wirelessly to a central unit for further processing. The demand for WSNs is increasing in areas such as military, civilian, ground, and space applications. WSNs have emerged as an interesting field of research due to advancements in micro-electromechanical systems (MEMS) technology and wireless communications.

WSNs typically consist of multiple sensor nodes that work together to achieve tasks such as data sensing, tracking, and transmission, making them suitable for monitoring natural events, environmental changes, traffic patterns, security, and military applications. However, WSNs face challenges such as a large number of nodes, limited power resources, and short-distance communication limitations. To improve the reliability of sensor networks, recent research has focused on heterogeneous WSNs.

One common approach in WSNs is clustering, where sensor nodes are grouped into clusters to achieve network scalability. Each cluster is typically headed by a Cluster Head (CH), which is chosen by the members of the cluster or pre-assigned by the network designer. Nodes with higher resources can also act as CHs. Clustering has several benefits, including optimized communication, increased battery life of sensor nodes, and improved network operation. WSNs are usually deployed randomly in a specific area to collect various environmental data and transmit it to a base station (BS) for monitoring and detection purposes.

To address the limitations of conventional methods and extend the lifespan of wireless sensor networks (WSNs), we propose a novel and improved energy-efficient routing protocol called IEE-LEACH. In our proposed protocol, the threshold setting takes into account four parameters: the initial energy of nodes, residual energy of nodes, total energy of the network, and average energy of the network. By considering these parameters, IEE-LEACH aims to achieve better energy balancing and reduced energy consumption.

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023
DOI: 10.17148/IJARCCE.2023.12483

One key feature of our proposed IEE-LEACH protocol is that the node closest to the base station (BS) compared to the Cluster Head (CH) does not participate in the cluster formation process. This approach helps in distributing the energy load more evenly across the network and minimizing energy consumption. Additionally, IEE-LEACH compares the energy consumption of single-hop and multi-hop communication modes during the data transmission phase, and selects the mode with the lowest energy consumption. This further reduces the overall communication cost and significantly improves the network's lifespan.

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

The authors of this paper present a novel energy-efficient scheme for wireless sensor networks (WSNs) used in manufacturing processes. WSNs have transformed the way information is collected and processed in smart city applications. However, the rapid depletion of sensor batteries due to extensive computational tasks and communication operations is a major concern, especially in urban areas where battery replacement can be costly and challenging. To address this issue, the authors propose a variant of the LEACH protocol called LEACH enhanced with probabilistic cluster head selection (LEACH-PRO).

LEACH-PRO incorporates several measures to extend the lifetime of WSN nodes. One such measure is the use of a probabilistic function for cluster head node selection based on maximum residual energy and minimum distance to the sink. Simulation results demonstrate that LEACH-PRO outperforms LEACH and direct transmission protocols in terms of network lifetime and generated traffic overhead. The proposed scheme has the potential to significantly extend the lifetime of sensors, making WSN deployments more viable in smart city scenarios..

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

The authors of this paper present a novel energy-efficient clustering algorithm for wireless sensor networks (WSNs) used in smart cities applications. WSNs have revolutionized the way information is collected, processed, and used for event detection and monitoring in smart cities. However, the rapid depletion of sensor batteries due to extensive computational tasks and communication operations is a major concern. The cost of replacing batteries can be prohibitively expensive, particularly in areas with difficult access, such as urbanized cities.

To address this issue, the authors propose a new variant of the LEACH protocol called LEACH enhanced with probabilistic cluster head selection (LEACH-PRO). LEACH-PRO introduces several measures to extend the lifetime of WSN nodes, such as cluster head node selection using a probabilistic function based on maximum residual energy and minimum distance to the sink. Simulation results demonstrate the superiority of LEACH-PRO over LEACH and direct transmission protocols in terms of achieved network lifetime and generated traffic overhead. Importantly, LEACH-PRO has the potential to significantly extend the lifetime of sensors, making this type of deployment more viable in smart city scenarios.

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

This paper first constructs a mathematical model for both problems. For relay node placement problem, it is assumed that HWSN contains unreachable area, where sensor nodes could not be placed. For energy efficient routing, it is transformed to path length of wireless communication. As the problem is non-deterministic polynomial (NP) hard, a heuristic method called whale optimizer is used. The paper studies the effect of whale optimizer method with three adaptive schemes. Numerical simulations are done to test the proposed method for HWSN. The analysis and discussion show that the proposed method is useful to address NP hard relay node placement and energy saving problems for HWSN.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12483

4. LEACH Protocol Enhancements for Increasing WSN Lifetime

Year 2019 IEEE Volume: 5 Issue 2
Authors: Seham Nasr; Muhannad Quwaider

Wireless Sensor Network (WSN) has become one of the most common techniques in different applications such as agriculture, factory monitoring, health care and fire track. WSN has many advantages such as low cost, small size, multifunctional, self-organized and able to be routed by WSN protocols. On the other hand, WSN has some backward which obstructs some applications such as low battery, short lifetime, area of sensor deployed and sensor energy consumption.

In this paper, we propose a new approach to achieve better enhancement of WSN in terms of network lifetime and data transmission time represented by reducing the packet delay time. Then, we compare the simulated result of the proposed algorithm with the basic LEACH protocol with fixing parameters. The proposed algorithm achieved 128.80% improvement compared with the basic LEACH in the concept of network lifetime

III. METHODOLOGY

In proposed work, presents the existing works relating to our scheme. Many kinds of cluster based routing protocols have been proposed for wireless sensor networks. These can be categorized into two types of nodes called Static and Mobile Nodes. LEACH is well known clustering protocol for wireless sensor networks. In LEACH, the nodes are organized themselves into local clusters. Each node has the same initial energy because of homogeneous networks. The operation is divided into rounds. In the set-up phase, the CH is selected from the organized clusters if a random number between 0 and 1 chosen by CH is less than threshold value.

In the steady-state phase each node the CH aggregates the data and sends it to the BS. But the cluster formation is initiated in each round is not energy efficient and also it does not support mobility. The LEACH-Mobile protocol is supports sensor nodes mobility in WSN by adding membership declaration to the existing LEACH protocol.

The LEACH Mobile outperforms LEACH in terms of packet loss in mobility environment. But it needs membership declaration. Cluster head election in LEACH-Mobile has been improved by LEACH-Mobile Enhanced (LEACH-ME) as proposed whereby the sensor node with minimum mobility factor is elected as cluster head.CBR-Mobile supports the sensor nodes mobility by adaptively reassigning the timeslots according to sensor nodes mobility and traffic.

Two owners are created for each time that is original owner and alternative owner, such that CBR-Mobile can work adaptively to sensor nodes mobility and traffic. It is significantly increases the packet delivery ratio in comparison with the LEACH Mobile protocol. It does not require any extra timeslot for calculating the mobility of sensor node. So that it provide faster data delivery to BS.Cluster-based Energy-efficient Scheme (CES) for Mobile Wireless Sensor Networks (MWSNs) which relies on weighing k density, residual energy and mobility parameters for cluster-head election. The CES scheme carries out a periodical cluster head election process after each round. Moreover, CES enables the creation of balanced 2-hopclusters whose size ranges between two thresholds called upper and lower thresholds.

IV. BLOCK DIAGRAM

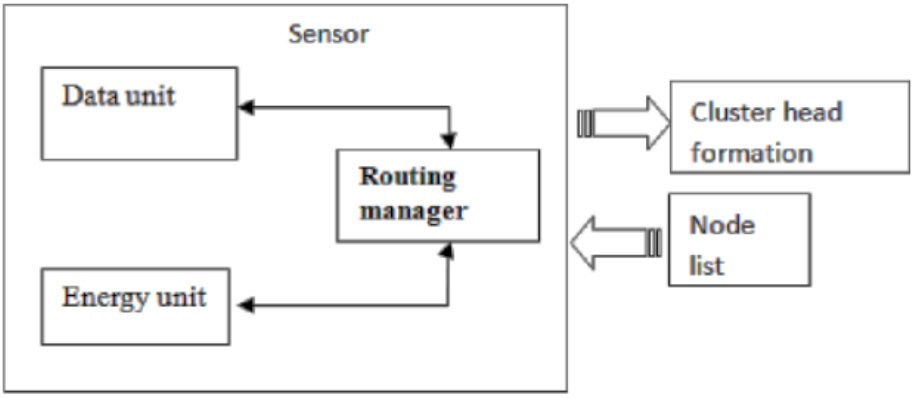

Figure 1. Block diagram FOR Clustering system

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12483

In wireless sensor networks (WSNs), recharging the batteries of sensor nodes is impractical, making network lifetime a primary concern. Routing protocols are used to prolong the network lifetime and can be classified into two types based on the network topology: flat routing protocols and hierarchical routing protocols. Flat routing protocols are not suitable for large-scale WSNs as they require maintaining routing table data and cannot aggregate sensed data.

Hierarchical routing protocols, on the other hand, offer a solution to this issue. Direct Transmission (DT) is a basic hierarchical routing protocol that directly transfers data from source to destination without any intermediate node. However, DT consumes more power when transmitting data towards the base station (BS), especially when the BS is located far from the sensing field. This rapid depletion of nodes' batteries due to DT can significantly reduce the overall lifetime of the network.

V. OBJECTIVES

LEACH (Low Energy Adaptive Clustering Hierarchical) is a routing protocol designed for energy-efficient hierarchical routing in wireless sensor networks. It utilizes a clustering approach to minimize energy consumption. The network is divided into clusters, each of which is governed by a randomly selected cluster head based on energy level. Other low-energy nodes sense data from their surroundings and transmit it to the cluster head, which aggregates and communicates it to the Base Station. This method reduces energy consumption as only the cluster head is responsible for data transmission, unlike all sensor nodes.

In an unstructured Wireless Sensor Network (WSN), which consists of a dense collection of sensor nodes, network maintenance such as managing connectivity and detecting failures can be challenging due to the large number of nodes. On the other hand, in a structured Wireless Sensor Network (WSN), sensor nodes are deployed in a preplanned manner, resulting in fewer nodes, lower network maintenance costs, and improved coverage in specific areas.

LEACH is a cluster-based protocol that employs a centralized clustering algorithm where clusters are formed by the Base Station (BS). Each node sends information about its location and energy level to the BS, which computes the average node energy. Nodes with energy below this average cannot be cluster heads for the current round. The BS then identifies possible cluster heads among the remaining nodes using the simulated annealing algorithm to solve the NP-hard problem of finding optimal clusters. This algorithm minimizes the energy required for non-cluster head nodes to communicate their data to the cluster head by minimizing the total sum of square distances between non-cluster head nodes and the closest cluster head. Finally, the BS broadcasts a message containing the cluster head ID for each node. The steady-state phase of LEACH-C is similar to that of LEACH.

Simulation results using matlab

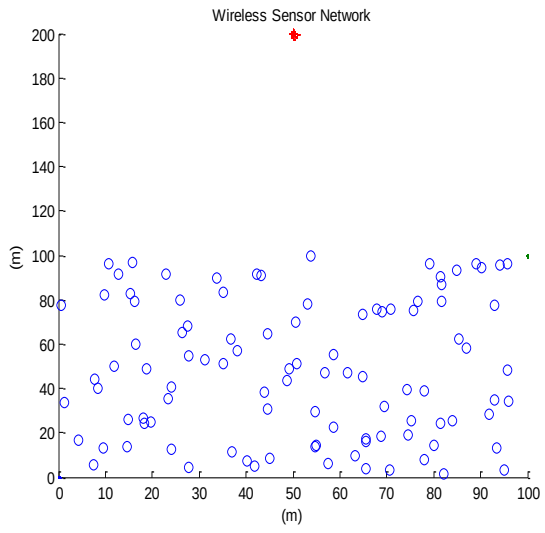

Figure 2.

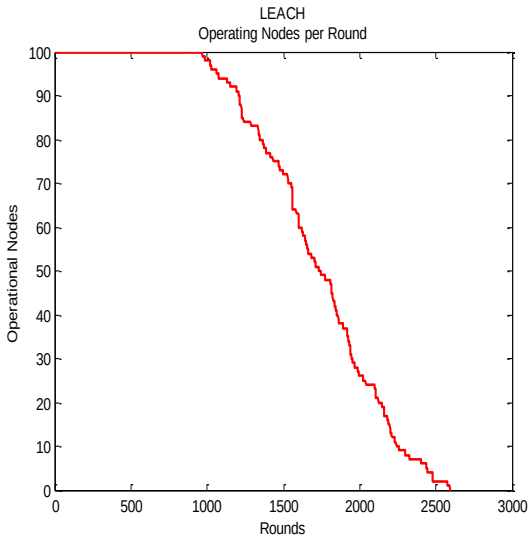

Figure 3.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12483

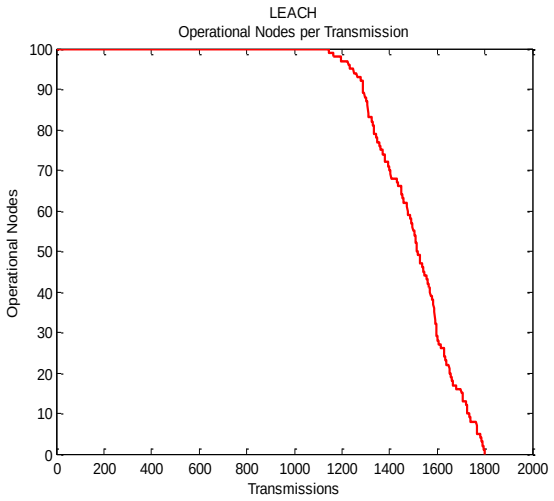

Figure 4.

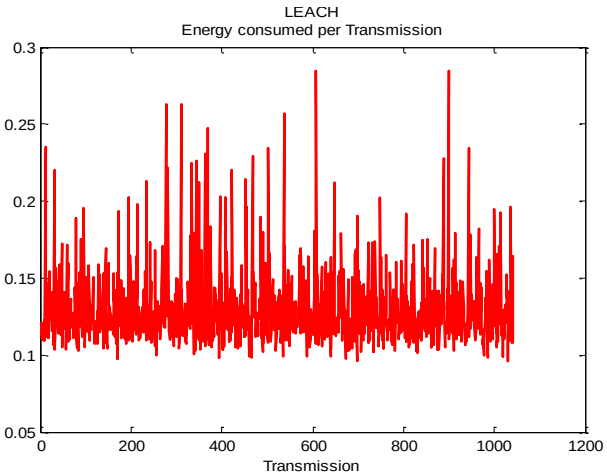

Figure 5.

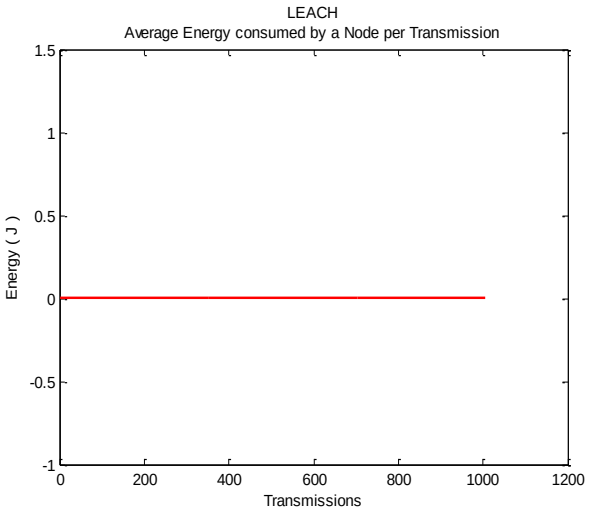

Figure 6.

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023
DOI: 10.17148/IJARCCE.2023.12483

VI. CONCLUSIONS

The main objective of this study is to create a set of guidelines that can provide superior and reliable remote sensor organisation services using a stable system with hubs.

an extended lifetime. In the past, method. The cluster heads determine which nodes in the cluster have lower energies in each round, and those nodes must be put into sleep mode once they have been identified. Therefore, they won't use up a lot of energy and can work for a long time. Every time the round changes in this situation, the same procedure is repeated, causing a large number of messages to be sent and increasing energy usage. This work may be expanded in the future utilizing a round-robin schedule, where the cluster heads for each round are chosen initially, or during the first phase. The protocol's primary goal should be to reduce energy consumption within the WSN and lengthen the life of the network. Additionally, it is anticipated that the WSN's throughput will rise as a result of a decline in network energy usage. As a result, the network is more stable and has a longer lifespan.

REFERENCES

[1] Z. Aliouat an M. Aliouat. “Improving wireless sensor networks robustness through multi-level fault tolerant routing protocol”, In the proceeding of the fourth International Conference on Modeling Approaches and Algorithms for Advanced Computer Applications (CIIA’2013), pp.115-124, Saida, Algeria, 2013.

[2] El korbi et al. “Coverage-Connectivity based faulttolerance procedure in wireless sensor networks”. In the Proceeding of the9th International Conference on Wireless Communications and Mobile Computing Conference (IWCMC’2013), pp.1540- 1545, Sardinia, Italy, 2013.

[3] M. Lehsaini and H. Guyyenet. “Improvement of LEACH for fault-tolerance in sensor networks. In the proceeding of the fourth International Conference on Modeling Approaches and Algorithms for Advanced Computer Applications (CIIA’2013), pp.175-183, Saida, Algeria, 2013.

[4] V.Katiyar et al.. “Improvement in LEACH protocol for large-scale wireless sensor networks”, International Conference on Emerging Trends in Electrical and Computer Technology (ICETECT),pp.1070-1075, Tamil Nadu, 2011.

[5] W. Heinzelman, A. Chandrakasan and H. Balakrishnan.”Energy-efficient communication protocols for wireless microsensor networks”, Proceedings of the 33rd Hawaii International Conference onSystems Sciences, pp.1-10, Hawaii, 2000.

[6] Razieh Sheikhpour, Sam Jabbehdari and Ahmad Khadem-Zadeh“Comparison of Energy Efficient Clustering Protocols inHeterogeneous Wireless Sensor Network,zs,” International Journal of AdvancedScience and Technology Vol. 36, November, 2011.

[7] Rabia Noor Enam , Mumtazul Imam and Rehan Inam Qureshi “Energy Consumption in Random Cluster Head selection Phase of WSN,” 2012 IACSIT Hong Kong Conferences IPCSIT vol. 30 (2012) © (2012)IACSIT Press, Singapore.

[8] Wendi,B.Heinzelman, Anantha P.Chandrakasan andHari Balakrishnan“An Application specific protocol architecture for wireless Micro-sensornetworks,”IEEE Transactions on wireless communications vol.1 NO.4 2002.

[9] Do-Seong Kim and Yeong-ee Chung, “Self - Organization RoutingProtocol Supporting Mobile Nodes for Wireless Sensor Network Proceedings of the First International Multi Symposiums on Computerand Computational Sciences (IMSCCS'06), 2006.

[10] G. S. Kumar, M. V. Vinu Paul, G.Athithan and K. P. Jacod, “Routing Protocol enhancement for handling node mobility in wireless sensor network”, TENCON 2008 – 2008 IEEE Region 10 Conf, 2008,pp. 1-6.

[11] S. A. B. Awwad, C.K. Ng, N. K. Noordin and M. F. A. Raisd, “Cluster Based routing protocol for mobile node in wireless sensor network,”in collaborative technologies and system, 2009. CTS ’09. International Symposium on, 2009, pp. 233-241.

[12] Lutful Karim and Nidal Nasser “Energy efficient and Fault TolerantRoutingprotocol for mobile Sensor Network,”IEEEICC2011processdings.

[13] Lehsaini M., Guyennet H. and Feham, M. “Wireless Sensor and ActorNetworks II,” 2008, in IFIP International Federation for InformationProcessing, Volume 264; (Boston: Springer),

[14] Hla Yin Min, and Win Zaw “Energy Efficient, Fault Tolerant Routing LEACH (EF-LEACH) Protocol for Wireless Sensor Networks” International Conference on Advances in Engineering and Technology (ICAET'2014) March 29-30, 2014 Singapore.