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TO OPTIMIZING ENERGY UTILITY USING CELL-LEACHPROTOCOL IN WIRELESS SENSOR NETWORK

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ABSTRACT

In this paper, we analyses the effectiveness of Cell-LEACH protocol in optimizing energy-constrained wireless sensor networks. Wireless sensor network consisting of independent sensor, communicating with each other in distributed fashion in order to monitor the environment. Sensors are attached to microcontroller and are powered by battery. The aim of Wireless sensor network is to have high reliability and long life time with maximum coverage. Routing techniques, which are the most important issue for networks where resources are limited. LEACH is one of the first hierarchical routing approaches for wireless sensor networks. Wireless Sensor Network (WSN) originates an important role in the Cell-Leach based approach where WSN is known for Wireless Sensor Network. In a WSN, which has a large number of nodes and many number of sensors connected to each node. In a WSN, which integrates various circuits, several computing embedded systems, many sensors, distributes large wireless communication, certain modern networks, gives out technological acquisition and allocates more information processors. Wireless sensor networks have powered battery sensor nodes and they are used for transmitting information over the environment monitors. At this point energy efficiency is an important problem in numerous WSN. Consequently, in various routing techniques have progressed such as to improve lifespan of the network, to achieve greatest scalability and also to increase the highest reliability. On other side, WSN uses a common hierarchical clustering protocol called LEACH and it initiates a standard algorithm. The proposed algorithm used is Cell- LEACH and which is elaborated as Cell Low Energy Adaptive Clustering Hierarchy. Numerous sensors are built-in with each of the cell-heads. In this formation no recalling and re-clustering is done. Here, the cell head sends all data at a specific time by TDM. In this, Cell head performs aggregation of data and sends the processed data to cluster heads while it executes similar function and transfers data to base stations while it executes similar function and transfers data to base station.

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INTRODUCTION

A Wireless Sensor Network (WSN) consists of tiny sensor nodes that monitor environmental or physical conditions such as pressure, sound, temperature, and humidity. These networks must possess self-configuration capabilities since the positions of individual sensor nodes are not predetermined. Routing strategies and security issues are significant research challenges in WSNs. This paper focuses on routing protocols, which play a crucial role in ensuring efficient data transmission in resource-constrained environments. Among the various routing protocols proposed for WSNs, hierarchical protocols like LEACH (Low-Energy Adaptive Clustering Hierarchy) are the most popular. These protocols are designed to reduce energy consumption by aggregating data and minimizing transmissions to the Base Station. LEACH is widely recognized as a highly effective routing protocol due to its cluster-based approach, which significantly reduces energy consumption. In this paper, we first analyze the LEACH protocol and then discuss the phases of the CELL-LEACH protocol. A WSN typically comprises numerous sensor nodes deployed in specific areas. These nodes gather environmental data, which is then transmitted to a base station. The base station processes the data and sends it to designated nodes, which further transmit the relevant information to end-users. To facilitate this process, WSNs require network protocols that ensure efficient data transmission. Routing protocols, which are sets of rules governing the path data takes through the network, are essential in this context. WSNs employ various routing protocols, including LEACH, GSTEB (General Self-Organization Tree-Based Energy-Balance), TBS (Tree-Based Clustering), and PEGASIS (Power-Efficient Gathering in Sensor Information Systems). WSNs face significant challenges due to their medium storage volume, average battery lifespan, limited bandwidth range, and constrained resources. These limitations make storage capacity and battery utilization critical concerns in the design and operation of WSNs. Therefore, the development of efficient routing protocols, such as LEACH and CELL-LEACH, is essential to optimize energy usage and extend the network's operational life.

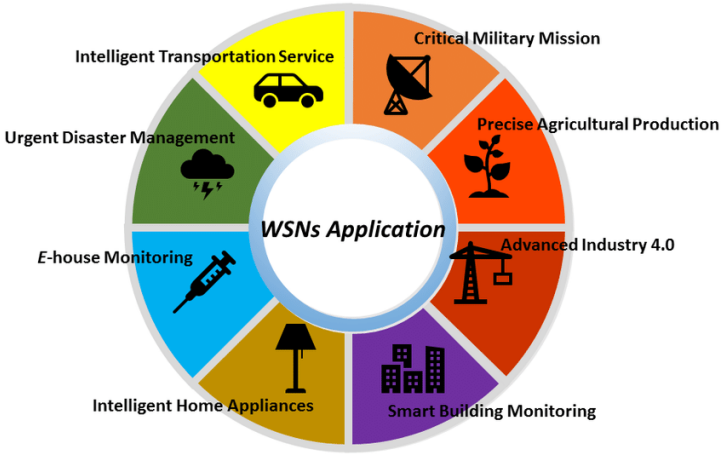

Figure 1 Wireless sensor network

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Introduction to Wireless Sensor Networks (WSNs)

In contemporary applications, Wireless Sensor Networks (WSNs) are utilized in various real-time scenarios such as intrusion detection, military tracking, environmental monitoring, seismic activity observation, health monitoring, and traffic analysis. A typical WSN comprises three main types of sensor nodes:

1. **Sensor Subsystem:** This includes numerous sensors responsible for monitoring environmental parameters such as humidity, temperature, and sound.
2. **Processing Subsystem:** This consists of microcontrollers that handle the computation of locally sensed data, manage action control, and store data in internal memory.
3. **Communication Subsystem:** This subsystem is responsible for transmitting data from sensor nodes to sink nodes.

LEACH Protocol

The Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is a Time Division Multiple Access (TDMA)-based Medium Access Control (MAC) protocol designed to enhance the lifespan of WSNs by minimizing energy consumption during the creation and maintenance of Cluster Heads. The LEACH protocol operates in multiple rounds, each consisting of two phases:

1. **Set-Up Phase:** The goal during this phase is to form clusters and select a Cluster Head for each cluster by choosing the sensor node with the highest energy.
2. **Steady Phase:** This phase, which is longer in duration than the Set-Up Phase, focuses on aggregating data at the Cluster Heads and transmitting the aggregated data to the Base Station.

Hierarchical routing in WSNs aims to conserve energy and manage multi-hop cluster communications effectively. The protocol enhances communication efficiency and scalability by organizing nodes into clusters and optimizing energy usage. The hierarchical routing structure is divided into two types of energy nodes:

1. **Higher Energy Nodes:** These nodes are responsible for processing operations and sending information.
2. **Low Energy Nodes:** These nodes focus on sensing the accessibility of targets.

The hierarchical routing system facilitates energy efficiency, scalability, and extended network lifespan by forming clusters, assigning unique cluster-head tasks, and minimizing message transmission to the Base Station. The hierarchical approach is structured into two layers:

1. **First Layer:** This layer is responsible for selecting the Cluster Head.

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2. **Second Layer:** This layer handles the routing tasks.

Overall, hierarchical routing in WSNs supports energy-efficient operation, effective data aggregation, and improved scalability.

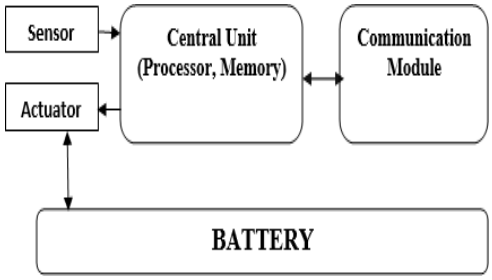

Figure 2 Working of leach Protocol

LEACH Protocol Overview

The Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol focuses on improving the lifespan of Wireless Sensor Networks (WSNs) by efficiently managing cluster head (CH) duties and communication with the base station (BS). LEACH operates through a two-phase process:

1. **Setup Phase:** This phase involves the formation of clusters and the selection of cluster heads (CHs) based on the highest energy levels. The CHs then handle the scheduling of data transmission within their cluster.
2. **Steady State Phase:** During this phase, data aggregation occurs at the CHs, which compresses the collected data before transmitting it to the BS.

The LEACH protocol divides the network into multiple clusters. This division relies on local data coordinates rather than minimizing transmission to the sink. It helps in constructing scalable and robust data routing distributions. LEACH's key features include:

- **High Energy CHs:** It places CHs in positions that are dynamically adjusted to optimize energy usage.
- **Cluster Head Advertisement:** LEACH uses advertisements and scheduling to manage cluster head roles effectively.
- **Single-Hop Routing:** LEACH employs single-hop routing for communication between CHs and the BS, reducing the energy expenditure of multi-hop routes.

LEACH operates without requiring global network knowledge, minimizing energy consumption through:

- **Reduced Energy Link Costs:** By decreasing the energy required for links between CHs and sensors.
- **Turn Off Non-Head Nodes:** Nodes that are not CHs are turned off to conserve energy.

However, LEACH does have limitations in achieving a perfectly uniform distribution of CHs and managing energy usage efficiently in all scenarios.

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Review of Literature

1. **HEED (Hybrid Energy Efficient Distributed Clustering):** Focuses on uniform distribution of CHs across the network, improving energy efficiency by considering the remaining power of nodes and cluster parameters. [4]
2. **EECS (Energy Efficient Clustering Scheme):** Emphasizes residual energy in CHs, optimizing cluster distribution through limited radio communication. [5]
3. **ECLEACH (Efficient Clustering in Low Energy Adaptive Clustering Hierarchy):** Aims to enhance the performance of LEACH by addressing acceleration problems in CHs.
4. **Alakesh Braman et al.:** Discusses WSN routing issues and challenges, comparing various energy-efficient protocols to improve LEACH. [7]
5. **J. Gnanambigai et al.:** Provides an evaluation of LEACH based on metrics such as reliability, mobility, and hop counts. [8]
6. **EELEACH (Energy Efficient in Low Energy Adaptive Clustering Hierarchy):** Focuses on the residual energy of CH nodes across different network scenarios. [9]
7. **Mian Ahmad Jan et al.:** Analyzes various LEACH hierarchical protocols, highlighting their benefits and drawbacks. [10]
8. **P. Manimala et al.:** Reviews cluster-based hierarchical routing protocols, emphasizing the differences in transmission modes and CH selection algorithms. [11]
9. **M. Usha et al.:** Examines hierarchical routing protocols derived from LEACH, addressing feature issues and disadvantages. [12]
10. **LEACH-T (Three-layer LEACH Clustering Protocol):** Introduces a three-layer approach for cluster-head selection in WSNs. [13]

Proposed Work

Energy consumption in WSNs is influenced by the communication distance and transmission protocol used. The proposed work aims to minimize additional energy consumption and optimize routing protocols to enhance energy efficiency. The focus will be on improving the LEACH protocol by reducing unnecessary energy expenditure and optimizing data transmission processes.

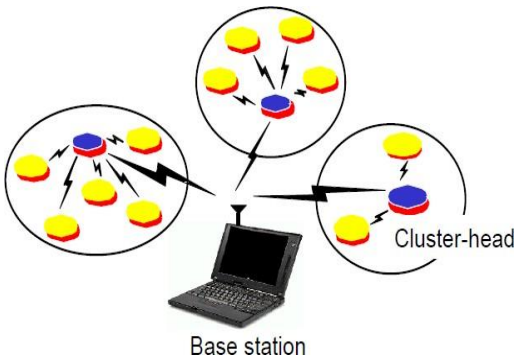

Figure 3 Working of Cell-Leach protocol

Considering the LEACH protocol, each and every node seems to be different in normal but it has the same quantity of initial energy for all networks in which the data communication slots are allocated accurately. In

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general, these nodes are chosen as CH and it consists of higher residual energy and more probability chances for selection. Additionally, Due to energy depletion the possibility of the node shrinks and terminates the operation. In the area of WSN, LEACH protocol plays a major role. The election phase of CH is based on data collection and sink nodes. Finally, the data is collected from a compression cluster of member nodes and sent to the sink node.

$$T(n) = \begin{cases} \dfrac{p}{1 - p * \left(r * mod\left(\frac{1}{p}\right)\right)} & n \epsilon G \\ 0 & Otherwise \end{cases} \quad ------(1)$$

The process of selection in CH is obtained by rand function and threshold value T(n). Here, p is thetotal number of ratios in CHs and SNs. The representation of CH is based on the probability of every node changing to 0 and the description of r gives out the present number of rounds.

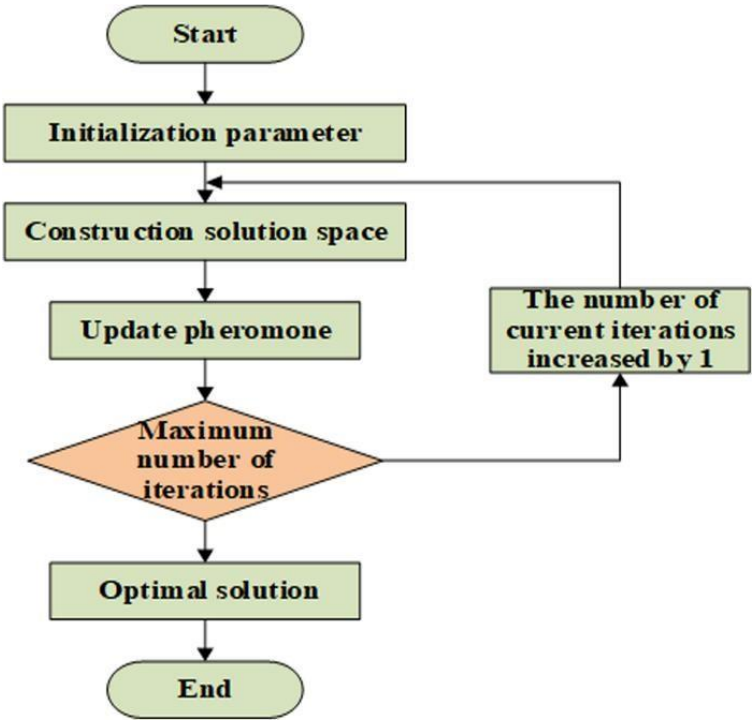

Figure 4 Flowchart of cell leach protocol

Finally, G renders the non-elected CH recent nodes set to 1/p rounds. The current network structure is explained, where the CH and members of clusters are owned by all clusters. In this way many data is collected from members of the cluster and it is forwarded to the CH. Eventually, CHs aggregate and compress information to process various data and in the end information is transmitted to sink nodes.

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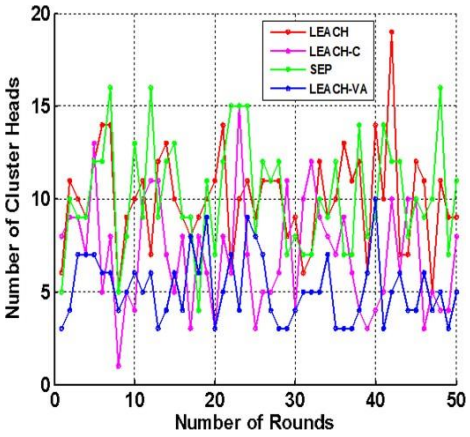

Fig 5 comparison of leach and cell-Leach

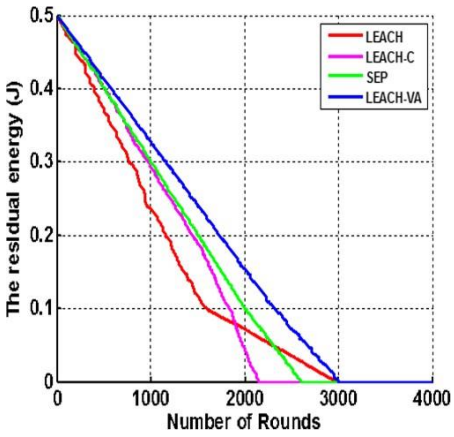

Fig 6 comparison of the residual energy

	CH election	Mobility	Scalability	Self-organization	Communication Inter cluster	Communication BS and CH
Leach	Threshold function	No	Limited	Yes	Single hop	Single hop
Leach-C	Residual energy location	No	Good	Yes	Single hop	Single hop
E-Leach	Residual energy	No	Limited	Yes	Single hop	Single hop
M-Leach	Threshold function	No	Very good	Yes	Single hop	Multi hop
V-Leach	Residual energy, Distance	No	Limited	Yes	Single hop	Single hop

Table 1 Comparision of various modified leach protocol

CONCLUSION

In this paper, in order to bring down utilization of energy and thereby enhance the lifespan of WSNs, we are using Cell-LEACH clustering protocols. In comparison with actual routing protocols, the proposed threshold Cell-LEACH protocol establishes four criteria of parameters such as (i) initial energy of nodes, (ii) residual energy of nodes, (iii) total energy of thenetwork and (iv) average energy of all nodes. Therefore, this operation process improves the energy stability and lifespan of the network.

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