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Energy Efficient Routing Approach in Wireless Sensor Networks for Optimizing Node Energy

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ABSTRACT
Wireless Sensor Networks have originated immeasurable importance after the development of wireless technology. A Wireless Sensor Network is a blend of an enormous amount of sensing devices termed sensor nodes. Quite a lot of applications encompass landslide detection, glacial monitoring, wildlife tracking, healthcare, military applications, environmental monitoring, and a considerable quantity of applications to robotics. The sphere of influence of Wireless Sensor Network (WSNs) constitutes a very energetic research field, and Energy-Efficient Nodes have evolved core setback. This research started while working with a Network simulator for performance enhancement, taking into thought the Energy efficiency parameter and found various challenges concerning efficient node energy utilization. In this paper Network Simulator (NS2) as a simulation, modus operandi is used to study using a Low-energy adaptive clustering hierarchy (LEACH) protocol to enhance the performance of nodes as and when wherever the network nodes function on controlled energy consumption. The main objective is to utilize the lowest amount of energy while transmitting and receiving data with the smallest amount of packet loss. The planned work focuses on recuperating the source to destination communication energy efficiency utilizing the single-hop technique. A Cluster-Based Routing Protocols named LEACH (hierarchical protocol) is availed for managing the location and energy of the communication. The experimental result analysis is performed on the parameters like Node count, Throughput, Packet Delivery Ratio (PDR), and Energy. The Research key areas are underlined in the form of challenges and future research directions of the researcher endeavouring Research in WSNs and its allied domain.

Keywords: Wireless Sensor Networks, sensor nodes, Energy-Efficient, a Low-energy adaptive clustering hierarchy (LEACH) protocol, Node count, Throughput, Packet Delivery Ratio (PDR), and Energy.

INTRODUCTION

The Research in Wireless Sensor Network (WSN) is growing due to the advancement of embedded systems and wireless technology. In Wireless Sensor Networks (WSNs), due to the constraints of the nodes, power and energy effectiveness is an essential point that should be well-thought-out at the instance of a scheming of protocols. In recent times, Wireless Sensor Networks move toward distinction because they hold the impending to transform a segment of our cost-cutting workout and existence with its broad applications. Several applications comprise landslide detection, glacial monitoring, wildlife tracking, healthcare, military applications, environmental monitoring, and a considerable quantity of applications to robotics, the Internet of Things. The articulation of information is based on the Routing Protocol, which chooses the optimum route involving any nodes. Various types of Routing Protocols are useful to specific network surroundings. Routing Protocols for Wireless Sensor Networks are responsible for retaining the routes in the network and guarantee dependable multi-hop transmission beneath these situations.

WSNs include various elements of Sensor Nodes, Access Network Technologies, Topology, Data Aggregation, and Security.
The elements of WSNs exhibit characteristic that is listed as follows.
§ The Power consumption control for nodes, using batteries or energy harvesting.
§ Resilience - Ability to cope with node failures.
§ Mobility of nodes for highly mobile nodes.

§ Heterogeneity of Nodes.
§ A Scalability to large scale deployment.
§ An Ability to withstand harsh environmental conditions.
§ Cross-layer design.
§ Ease of use.

APPLICATIONS AREAS OF WSN's: Security and Surveillance, Environmental Monitoring, Agriculture, Disaster Response, Automotive/Vehicular, Health (Body Area Networks), Monitoring Health of Structures, Supply Chain Management, Underwater Sensor Networks.

LITERATURE REVIEW

Koriem et al. The Author in the paper reviews about a new routing protocol CRP (Circles Routing Protocol) is proposed and has presented to enhance the performance of WSNs, where the network nodes operate on limited battery energy. To evaluate the performance of the proposed routing protocol, the comparison of its performance results made with those obtained from LEACH and PEGASIS routing protocols. Based on these comparisons, it is found that the results of the developed protocol are more efficient in terms of Network Life Time, Energy Consumption, Throughput, Transmission Delay, and Average Delivery Ration. The author has concluded that this clustering technique minimizes the communication process between neighbouring nodes and the computation process on the network nodes.[1]

Akhtar et al. The Author in the paper reviews and provides an overview of prominent cluster-based energy-efficient routing protocols based on some primary performance metrics. This work highlighted a few clustering approaches and characteristics considered in energy-efficient routing protocols. Based on primary performance metrics, i.e., energy efficiency, algorithm complexity, delay in data delivery, Scalability, and clustering approach, a comparative analysis has been done among prominent cluster-based energy-efficient routing protocols used in WSNs. This study concludes that there is not any single protocol that can perform excellently considering all metrics. [2]

Mehta et al. The Author in this paper provide a taxonomy of hierarchical routing protocols and look to envision a hybrid hierarchical routing protocol that may embed characteristics of intelligent routing protocols. The authors have proposed and concluded to use swarm intelligence based concepts in cluster formation and their hierarchical routing to enhance the Scalability, adaptability, and robustness of hierarchical routing protocols. [3]

V & Rajendra et al. The Author in the paper has proposed energy-efficient routing techniques called reliable minimum energy cost routing (RMECR) and comparing with reliable minimum energy routing (RMER), which are used by the nodes in the most efficient manner. The proposed RMECR protocol is also used to decrease the cost of communication in a wireless networking environment. The author has concluded that Further, intended to enhance the performance of the energy-efficient routing protocol by using cluster-based routing in WSN. [4]

Krishna et al. The Author in the paper discuss a comparison of two routing protocols for wireless sensor networks with different simulation times. AODV over WSN is simulated with different topology changes. With the trace graph results, it is concluded that in the case of flooding, the throughput of delivered packets is quite less than the throughput in the case of directed diffusion. The nodes' energy is a constraint in wireless sensor networks, a fixed amount of energy given to the network in both cases. The author has concluded that further investigation can be done for the behaviour of other WSN routing protocols such as – SPIN, LEACH, and PEGASIS. [5]

Ambekari et al., the author in the paper reviews and discusses developing an energy-efficient system using clustering. Determining an optimal amount of clusters in WSNs gives a superior improvement in system scalability, increases energy competence, and enhances network life span in the network. For a significant WSN lifetime of a network depends on the cluster distance and amount of hops. The energy

cost of a network is directly proportional to the number of clusters. The clustering technique balances the load distribution in a network and reduces traffic transmission. The author has concluded that, Thus, clustering techniques aim to minimize the number of clusters and energy consumption per cluster.[6]
Oladimeji et. al. The paper proposes a novel Heuristic Algorithm for Clustering Hierarchy (HACH), which successively performs a selection of inactive nodes and cluster head nodes at every round.
Inactive node selection employs a stochastic sleep scheduling mechanism to determine the selection of nodes that can be put into sleep mode without adversely affecting network coverage. The author has concluded that further experiments demonstrated that our protocols can perform even better under different heterogeneity levels of wireless sensor network settings and still maintain acceptable performances.[7]
G Reddy et.al. In this paper, the author describes a well-known protocol in wireless sensor networks called LEACH. LEACH is the first low energy protocol introduced in WSN, which saves energy and increases sensor networks' lifetime. With the number of advantages of the LEACH protocol, it also comes with some drawbacks. To overcome those drawbacks and make LEACH more efficient many descendants of LEACH protocol are introduced. Some of them like E-LEACH, LEACH- B, HEED, LEACH-F, TL-LEACH, MULTI-HOP LEACH, LEACH-C, LEACH-M, I-LEACH, CELL- LEACH, and V-LEACH are described in this paper that how these protocols overcome the disadvantage of the LEACH protocol and make the sensor networks more efficient. [8]
More et al. The Author in the paper discuss various coverage optimization protocols. These protocols are primarily classified as clustering and distributed protocols. Further, these protocols are classified based on the type of sensing model used, node location information, and the mechanism used to determine neighbouring node information. The authors review the critical coverage optimization protocols and present open research issues related to energy-efficient coverage. The author has concluded that further research is required to handle these parameters accurately, which could improve the coverage and energy efficiency in sensor networks. This analysis can be used as a starting point for future research in WSN coverage.[9]
Alharthi et al. The Author in the paper discusses the hybrid threshold sensitive, and two-level heterogeneous LEACH (HT2HL) is proposed in this paper. The performance of the proposed protocol outperforms in the simulation. The drawbacks in LEACH are dealt with in our work. For instance, SNs can communicate directly with the BS if all CHs are far from them, and they adjust their transmission power based on the distance from CHs and the BS. Thresholds are incorporated to reduce the number of transmissions that conserves energy. The author has concluded that the work is still in progress to improve the performance by balancing the cluster size and considering multi-hop communication for farthest CHs. [10]

Panigrahi et al. This paper aim to provide a trust management scheme to address the packet drop attack or black hole attack made by a compromised sensor node inside WSNs. Along with the security feature against the above attack, it is implemented by DIJKSTRA shortest path algorithm to regain the speed efficiency, which may have been degraded due to trust computation in various phases of the routing inside and outside of clusters in the network. The proposed model is confined up to 100 nodes. In the future, the above can experiment for an extensive network consisting of more than 100 nodes. With the exclusion of the above cases, the model gives efficient results in terms of various parameters of routing as well as security in comparison to that of the LEACH protocol. The author has concluded that the proposed model is confined to up to 100 nodes. The above can experiment for an extensive network consisting of more than 100 nodes [11]
Various Research Gaps were identified from the above Literature review. Performance enhancement of WSNs with the focus on energy efficiency was considered a vital challenge of the Research Work.

RESEARCH GAPS

1. Real-World Protocols requirement for handling real-world problems by considering the theoretical concepts and synthesizing novel solutions into a complete system-wide protocol for real-world applications and High real-time transmission.
§ Invent new protocols that account for the communication realities of real-world environments.
§ Test the individual solutions on real platforms in real-world settings and Synthesize novel solutions into a complete system comprehensive protocol stack for real applications.
§ Energy-efficient MAC Protocol for WSN's: A suitable MAC protocol should comfortably accommodate such network changes. Other essential attributes include fairness, latency, and throughput and bandwidth utilization. These attributes are generally the primary concerns in traditionally wireless voice and data networks; however, they are secondary in sensor networks.
§ work on the different layers on the WSN protocol stack.
§ Design and develop better MAC layer protocols and come up with a unified framework for performance enhancement.
2. System Architecture: Need for Non-Unified System and Network
Architecture framework having System qualities and Architecture divergence.
§ Challenges and Future Standardization needs.
§ Disunity: Communication, coordination, and centralized planning are not available from different standard organization.
§ Incompatibility: Standards are complex and diverse. Different standards developed by different standard organizations are not compatible.
§ Design and develop efficient Routing Algorithms and, if possible, using Cross-Layer Approach.
3. Restricted Security and Privacy: As most of the attacks that are performed on WSNs are insertions of false information by compromised nodes within the networks.
§Recent Advances in WSNs include the need for Topology and Coverage Control, Quality of Service (QoS) Provision, Security, and Privacy Concern.
§ Key Factors that influence Sensor Network Design like Fault Tolerance, Scalability, Production costs, Sensor Network Topology, Environment, Transmission Media, Power Consumption.
§ development of enhanced WSN node deployment strategy to optimize network performance.
§ Design and develop algorithms for performance enhancement of Wireless Sensor Networks.
4. Power Consumption has always been a challenge for WSNs' designs.
§ Power: It has always been a challenge for WSNs' designs. One way to prolong the network lifetime is to design the energy-efficient algorithms and hardware that uses power intelligently.
§The main drawback of the sensors is the resource-constrained nature, especially concerning energy storage. WSNs use battery-operated computing and sensing devices.
§The key constraints in the development of WSNs are limited battery power, cost, memory limitation, computational capabilities, and the physical size of the sensor nodes.
§Transducer Design: Developing new sensor transducers design that is compact, low power, and cost-effective. Bio-degradable and environment-friendly sensor design.
§ An Electronic system design: Integrating sensors with the appropriate electronic circuitry to extract digital data using sensor feedback to enhance the data collection with the electronics and providing low noise outputs using sensor arrays.
5. Reducing Hardware cost by producing low cost and tiny sensor nodes.
§ The Hardware cost: To produce low cost and tiny sensor nodes. It can be achieved by recent and future progress in the fields of Micro-Electro-Mechanical Systems (MEMS).
§ The minute structure is an attractive feature of the sensors. They can be easily accommodated in sensing or monitoring devices; however, energy storage, processing, and memory capabilities are drastically reduced.
6.The Performance Enhancement WSN Techniques are linked with the routing techniques classified based on the network structure. Many factors are taken into account for the maximization of the lifetime of wireless sensor networks, such as minimizing the power consumption,

low-cost operation, optimal routing algorithms, forwarding of residual power to every node to avoid the abbreviating of power in nodes, using an improved version of protocols and also communication models.
§ Investigate on optimized protocols to cater to specialized WSN application requirements.
§ Investigate new WSN applications where the new algorithms can be efficiently utilized.

PARAMETERS FOR EFFICIENCY IN WSNS: Generic parameters based on Routing Protocols for the performance metrics: Query Based, Usage Power, Scalability, Network Lifetime, Optimal Route Data Overhead, QOS, Data Aggregation, and Delivery Model.

PROPOSED WORK

The Proposed work is framed based on the Problem Formulation detailed in Proposed Framework. The Proposed Framework is designed on the foundation of the above mentioned Proposed Workflow. The proposed Energy Efficiency Wireless Sensor Network-Framework (EEWSN-F) is classified in Phases I through V implementing the proposed methodology. The EEWSN-F is elaborated in the figure1.

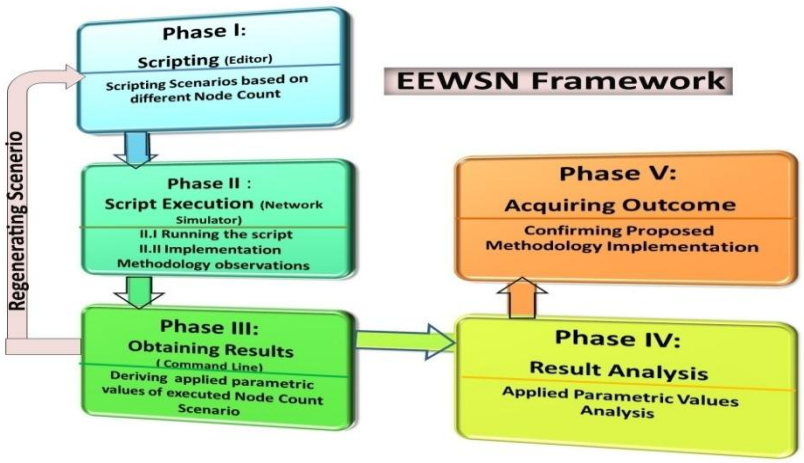

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Figure 1: Energy Efficiency Wireless Sensor Network-Framework (EEWSN-F)

The EEWSN-F is described below in detail.

Phase I: Scripting (Editor) – In this phase, various scenarios are scripted in an editor based on different Node counts.

Phase II: Script execution (Network Simulator)

- In this phase, the above Node count wise generated script is executed, and there are two stages, as mentioned below.

Stage II.I: Running the script – The script is run through command prompt and executed in Network Simulator.

Stage II.II: Implementation Methodology Observation – The observations of the proposed implementation methodology of

Source to Destination Data Transfer Initiation, Selection of Center node base on Trust and Thresholding Mechanism, Data Transfer from selected Center Node to a Destination node, Data packet loss due to Node movement

out of Threshold range, selection of new

Center node base on Trust and Thresholding Mechanism and the process completion till the Data Transfer is accomplished from Source to Destination is recorded.

Phase III: Obtaining Results (Command Line) – The results of the particular scenario is derived in the form of applied parametric values of executed Node count scenario.

The process is repeated by regenerating different Node count scenarios from Phase I to Phase III.
Phase IV: Result Analysis – After completion of all the Node count scenario observations, the applied Parametric values obtained are analyzed, and the similarity behaviour pattern is observed.
Phase V: Acquiring Outcome - The Phase Confirms the Proposed Methodology Implementation of Energy Efficiency to enhance the performance of WSNs.

CONCLUSION

In this paper, the work is focused on optimizing node energy based on optimal clustering in wireless sensor networks using Trust factor and Thresholding Factor. The Implementation of the above-proposed methodology is performed using a Network Simulator (NS2). Various Research Gaps are identified in the form of challenges. They focus on the further and future research directions of the researcher endeavouring Research in WSNs and its allied domain. The EEWSN–F Implementation based on applied parameters gives outcomes inform values, which are analyzed in Phase IV, followed by Phase V. The conclusion is derived from the analysis of the values obtained according to the proposed Framework EEWSN–F and its Implementation proposed methodology. The values obtained justifies that, by using the proposed mechanism of EEWSN Framework, there will be an increase in energy efficiency that leads to Performance Enhancement in WSNs, therefore fulfilling the intended research objectives.

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