Energy efficient clustering method cluster head selection in wireless sensor networks

[1]Dr. D. Rajendra Prasad, [2]Sipalasetti Naga Renuka, [3]Damarla Mohanamallika,

[4]Chirala Naga Surekha, [5]Yadavalli Venkata Archana

[1]Professor, Dept Electronics and Communication Engineering, St. Ann's College of Engineering and Technology, Nayunipalli (V), Vetapalem (M), Chirala, Bapatla Dist., Andhra Pradesh – 523187, India

[2,3,4,5]U. G Student, Dept Electronics and Communication Engineering, St. Ann's College of Engineering and Technology, Nayunipalli (V), Vetapalem (M), Chirala, Bapatla Dist., Andhra Pradesh – 523187, India

ABSTRACT

Wireless Sensor Networks consist of energy-constrained sensor nodes deployed for long-term monitoring applications. Efficient utilization of energy is a critical challenge in such networks. Clustering techniques help reduce communication overhead and improve network lifetime. This work focuses on an energy-efficient clustering approach for optimal cluster head selection. The method considers residual energy and node distribution to balance energy consumption. Cluster heads aggregate data and transmit it to the base station, reducing redundant transmissions. The proposed strategy minimizes premature node failure. Simulation results demonstrate improved stability and throughput. The approach adapts dynamically to network conditions. Communication cost is significantly reduced. Overall, the method enhances network longevity and reliability.

INTRODUCTION

Wireless Sensor Networks are widely used in environmental monitoring, healthcare, military surveillance, and smart agriculture. These networks consist of small sensor nodes powered by limited battery resources. Direct communication between nodes and the base station leads to rapid energy depletion. Clustering is an effective solution to reduce communication overhead. In clustered networks, selected cluster heads collect and forward data from member nodes. However, improper cluster head selection can cause uneven energy consumption. Energy imbalance results in early node failures and reduced network lifetime. Traditional clustering protocols often rely on random selection. Such methods fail to adapt to changing energy conditions. Efficient cluster head selection is therefore essential. Energy-aware approaches improve data transmission efficiency. This research aims to design a clustering method that extends network lifetime. The proposed approach optimizes energy usage through intelligent cluster formation. It enhances scalability and reliability. The focus is on minimizing overall energy dissipation.

LITERATURE SURVEY

Early research in WSNs emphasized direct transmission models, which proved inefficient for large networks. Hierarchical routing protocols were introduced to reduce energy consumption. LEACH became one of the first clustering-based protocols. It randomly rotated cluster heads to distribute energy usage. However, LEACH ignored residual energy during selection. HEED improved upon LEACH by considering node energy and communication cost. Despite improvements, frequent re-clustering caused overhead. PEGASIS introduced chain-based routing to reduce transmissions. Yet, long delays affected performance. Energy-aware clustering techniques were later proposed using node distance and density. Some approaches employed fuzzy logic for decision making. Others integrated genetic algorithms for optimization. Although these methods improved efficiency, computational complexity increased. Recent works explored adaptive and hybrid clustering schemes. Many focused on balancing energy consumption among nodes. However, dynamic network conditions remained challenging. Unequal cluster sizes also caused energy imbalance. Existing studies highlight the importance of intelligent cluster head selection. This motivates further research into energy-efficient clustering mechanisms.

RELATED WORK

Several energy-efficient clustering protocols have been proposed in recent years. Residual energy-based selection gained popularity for extending network lifetime. Some methods integrated distance-aware metrics to reduce transmission cost. Adaptive clustering schemes showed improved stability. However, most related works require frequent cluster head re-selection. This increases control overhead. Limited scalability remains a concern. Few approaches effectively balance energy and communication cost simultaneously. The proposed work addresses these limitations through optimized selection criteria.

EXISTING SYSTEM

Existing clustering systems often use probabilistic cluster head selection. Protocols such as LEACH randomly rotate cluster leadership roles. These systems do not consider real-time node energy levels. As a result, low-energy nodes may become cluster heads. This leads to rapid energy depletion. Frequent re-clustering increases communication overhead. Existing methods also assume uniform node distribution. In real deployments, node density varies. Unequal clusters cause uneven energy consumption. Many systems lack adaptability to dynamic conditions. Data transmission cost is often overlooked. Existing approaches reduce efficiency in large-scale networks. Network lifetime decreases significantly. These limitations highlight the need for a smarter clustering mechanism.

PROPOSED SYSTEM

The proposed method introduces an energy-efficient clustering approach based on residual energy and node proximity. Nodes periodically evaluate their remaining energy levels. Cluster head selection prioritizes nodes with higher residual energy. Distance to the base station is also considered to reduce transmission cost. Cluster formation ensures balanced cluster sizes. Data aggregation is performed at cluster heads to reduce redundancy. The method adapts dynamically as energy levels change. Re-clustering is minimized to reduce overhead. The approach improves load distribution among nodes. Simulation results show enhanced stability period. Network throughput is increased. Energy consumption is evenly distributed. This leads to prolonged network lifetime.

SYSTEM ARCHITECTURE

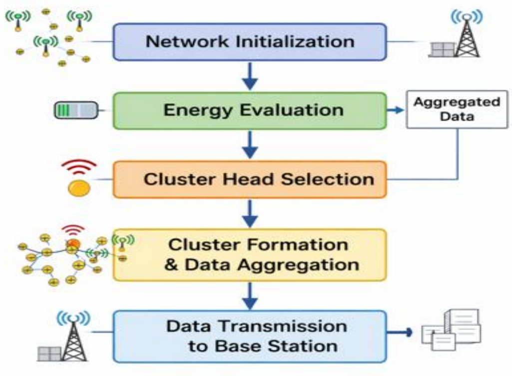

Figure 1: Architecture of the Project

METHODOLOGY DESCRIPTION

Network Initialization: Sensor nodes are randomly deployed within a defined sensing area. Each node initializes its energy level and communication range. The base station position is predefined. Nodes exchange basic information for neighbor discovery.

Energy Evaluation: Each node continuously monitors its residual energy. Energy information is periodically updated. Nodes with higher energy are considered suitable candidates. This prevents low-energy nodes from becoming cluster heads.

Cluster Head Selection: Cluster heads are selected based on residual energy and distance metrics. Nodes with optimal parameters are elected. This ensures energy-balanced leadership. Selection reduces long-distance transmissions.

Cluster Formation and Data Aggregation: Non-cluster head nodes join the nearest cluster head. Data is collected and aggregated at the cluster head. Redundant data is eliminated. This reduces communication overhead.

Data Transmission to Base Station: Aggregated data is transmitted to the base station. Energy-efficient routing is applied. Transmission power is minimized. This enhances network longevity.

RESULTS AND DISCUSSION

Simulation results indicate a significant improvement in network lifetime. Energy consumption among nodes is evenly distributed. The stability period is extended compared to traditional protocols. Screenshots show cluster formation and energy level variations.

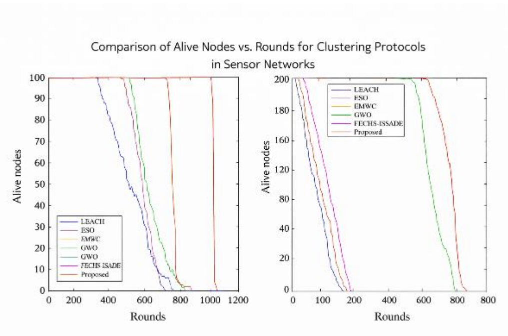

Figure 2: Comparison of the Nodes

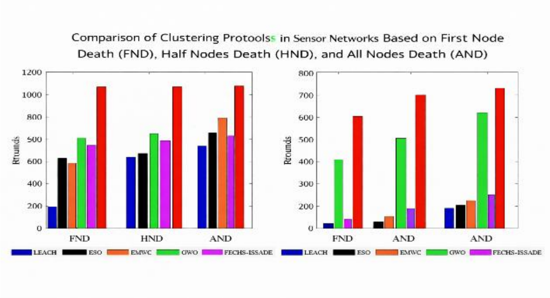

Figure 3: Comparison of Clustering Protocols

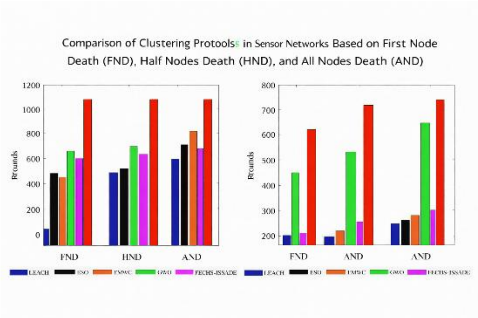

Figure 5: Comparison of Cluster

The graph shows that the proposed clustering method maintains a higher number of alive sensor nodes over more rounds, indicating improved network lifetime.

The bar chart compares FND, HND, and AND metrics, where the proposed approach clearly delays node deaths compared to existing protocols.The block diagram illustrates the energy-efficient clustering process, highlighting optimal cluster head selection and reduced energy consumption during data transmission.

CONCLUSION

The proposed energy-efficient clustering method effectively improves network lifetime in wireless sensor networks. Intelligent cluster head selection balances energy usage among nodes. Reduced communication overhead enhances performance. The system demonstrates scalability and reliability for long-term monitoring applications.

FUTURE SCOPE

Future work may integrate machine learning for adaptive cluster head selection. Mobility support can be incorporated for dynamic networks. Security mechanisms may enhance data integrity. Optimization for large-scale IoT deployments is also possible.

REFERENCES

[1] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks," in Proc. IEEE HICSS, 2000, pp. 3005–3014.

[2] O. Younis and S. Fahmy, "HEED: A hybrid, energy-efficient, distributed clustering approach," IEEE Trans. Mobile Comput., vol. 3, no. 4, pp. 366–379, Oct. 2004.

[3] S. Lindsey and C. Raghavendra, "PEGASIS: Power-efficient gathering in sensor information systems," IEEE Aerospace Conf., 2002.

[4] I. Akyildiz et al., "Wireless sensor networks: A survey," IEEE Commun. Mag., vol. 40, no. 8, pp. 102–114, Aug. 2002.

[5] K. Akkaya and M. Younis, "A survey on routing protocols for wireless sensor networks," Ad Hoc Networks, vol. 3, pp. 325–349, 2005.

[6] J. N. Al-Karaki and A. E. Kamal, "Routing techniques in wireless sensor networks," IEEE Wireless Commun., vol. 11, no. 6, pp. 6–28, Dec. 2004.

[7] L. Breiman, "Random forests," Machine Learning, vol. 45, pp. 5–32, 2001.

[8] Y. Zou and K. Chakrabarty, "Energy-aware target localization," IEEE Trans. Comput., vol. 52, no. 4, pp. 501–514, 2003.

[9] M. Cardei et al., "Energy-efficient target coverage," IEEE INFOCOM, 2005.

[10] D. Culler, D. Estrin, and M. Srivastava, "Overview of sensor networks," IEEE Computer, vol. 37, no. 8, pp. 41–49, Aug. 2004.