

# Advanced Wireless Sensor Networks in Energy-Efficient Routing Cluster-based Techniques By Using Artificial Intelligence

## OPEN ACCESS

Volume: 13

Special Issue: 1

Month: March

Year: 2025

E-ISSN: 2582-6190

Citation:

Bharathi, P., and  
G. Vijaiprabhu.  
“Advanced Wireless  
Sensor Networks  
in Energy-Efficient  
Routing Cluster-Based  
Techniques By Using  
Artificial Intelligence.”  
*ComFin Research*,  
vol. 13, no. S1-i2,  
2025, pp. 22–25.

DOI:

[https://doi.org/10.34293/  
commerce.v13iS1-i2-  
Mar.8727](https://doi.org/10.34293/commerce.v13iS1-i2-Mar.8727)

**P. Bharathi**

*Research Scholar, PG and Research Department of Computer Science  
Erode Arts and Science College (Autonomous), Erode*

**Dr. G. Vijaiprabhu**

*Research Supervisor & Assistance Professor  
PG and Research Department of Computer Science  
Erode Arts and Science College (Autonomous), Erode*

## Abstract

*Introducing The Wireless Sensor Networks In Artificial Intelligence can Make Sure in Possible To Recover data from all local environment. that AI Technology can using high level Accuracy ability to give sense of Physical Change of Environment and Transmitting to Base Station. that Data was More Efficient and Valuable for Processing the result is better then Normal Wireless sensor networks. The AI System based Cluster based Routing Technology approach is self SOM Techniques. its Sensing the data was high accuracy In WSN. and AI Consuming very low energy while sensing and transmitting the data. so it gives more Life Time to All nodes. so the nodes working is more fast and Efficiently. So the AI Technology Cluster based system was Highly successfully mode in wsn.*

**Keywords:** Artificial Intelligence, Wireless Sensor Networks Technology

## Introduction

This Types WSN mostcommonly utilize some of software's, such as Smart limited, Road Networks, and smart Medical Company. these Types software's are commonly enhanced for WSN area.. so it gives more Life Time to All Sensor nodes. so the sensor nodes are working is more fast and Efficiently so the AI Technology Cluster based system was Very use full of modern data transition system in Future

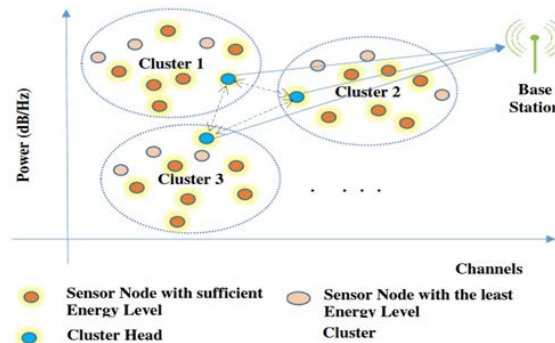
## Literature Survey

Our research area is must utilize various software's, , Road Networks, and smart Medical Industry. Routing in a critical challenge due to limited energy levels, and researchers have explored cluster-based and artificial intelligence (AI) techniques to optimize energy efficiency. This literature survey reviews existing studies AI routing in WSNs.

1. Benefits: Achieves better energy distribution compared to LEACH.
2. Drawbacks: Increased computational complexity.

3. Designed for reactive networks where nodes respond to threshold values.
4. Advantage: Suitable for time-critical applications.
5. Limitation: Complexity in managing thresholds.

### Cluster-based Routing in WSNs



In this types of WSN system are mainly focused on sensing the change of physical environment that should be awareness of finding the values of all the parameters is evaluated on the base station and finally prepped the data for analyzed and use the process by IOT applications.

### Key Approaches

#### Artificial Intelligence in Routing

Role of AI in WSN Routing AI techniques, including machine learning (ML) and optimization algorithms, are used to enhance decision-making in routing protocols. These methods help predict network conditions, optimize resource allocation, and improve adaptability.

#### Key AI Techniques

- Machine Learning Approaches
- Reinforcement Learning (RL): Utilized for adaptive routing by learning optimal paths based on rewards.
- Example: Q-learning for energy-efficient routing.
- Limitation: High training time and computational overhead.
- Supervised Learning: Used for anomaly detection and energy prediction.
- Metaheuristic Optimization
- Example: PSO for CH selection and route optimization.
- Advantage: Finds near-optimal solutions efficiently.

### Related Work

The Open AI WSNs was generation advanced data sensing system. These applications are remembered as the reports are using some Physical environment changes and rectifying the dates are empowered by the additional software techniques. Finally these types of AI sensing was most advanced predicting power that should be effective high impact on Open Ai field in WSN.

### Proposed Work

The proposed work on “Cluster-based Energy-Efficient Artificial Intelligence (AI) Routing for Wireless Sensor Networks (WSNs)” aims to challenges of scalability, and reliability in using advanced AI techniques and cluster-based routing mechanisms. Below is an outline of the proposed work:

$$Energy = EbitTx/Rx + EsecTx/Rx*(lb) + Ebtsq.m*(d2)$$

In which case of energy level is maximum controlled by the data communication but regarding the wireless sensor networks are combined to determine the indication level in such case thesis types of sensor networks are regarding with independent data values are very useful to the environment and research process industry's

$$EnergyMultipath = R*Energy (2)$$

## Proposed Algorithm

The proposed efficient energy AIC- algorithm for wireless sensor networks consigns superlative routing with clustering, and using the minimum energy utilization for communication in the networks is shown in Figure 3.

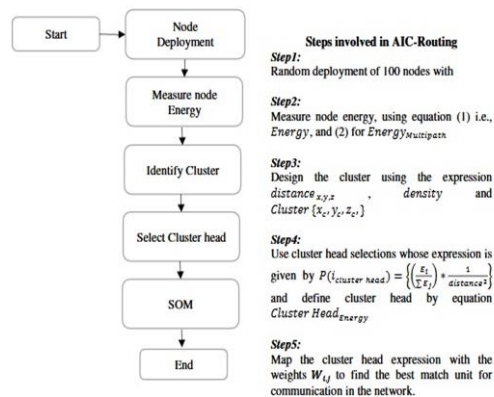


Fig. 3. Proposed AIC-Routing method.

## Problem Statement

In WSN where Probably of exposeddata collect. Traditional routing protocols often fail to optimize energy consumption effectively, especially in dynamic and large-scale networks.

This work proposes AI to create a cluster-based energy-efficient routing protocol that prolongs network lifespan, optimizes energy usage, and ensures robust communication.

## Result

### 4.1. Energy

Energy is a critical aspect in the design and operation of wireless sensor nodes. These nodes typically have limited energy resources, and rely on energy-efficient design and operation to prolong their lifespan. This is important because sensor nodes are often placed in remote or hard-to-reach locations and may not have access to a power source for charging or replacement. By minimizing energy consumption, the sensor node can operate for longer periods without needing maintenance. As Figure 4 illustrates, the power consumption of the network is not evenly distributed, with certain nodes consuming significantly more power than others. It is observed that the implementation of AIC utilizes less power consumption when compared with the LEACH and conventional methods. The improvement in the performance of the AIC method is due to the increase in the simulations round, which enhanced the neural network intelligence in identifying the shortest route path that consumes minimal power in the network. It is evident from the graph that there is an exponential increase in power consumption as more nodes are added to the network.

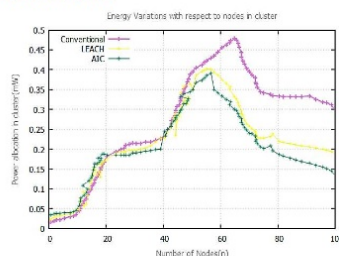


Fig. 4. Energy variation concerning nodes in a cluster. In a network, the presence of residual energy and its depletion over time define the system's energy occupancy. At the time of dynamic clustering, as Fig. 5 depicts a graph of normalized residual energy with varying time. The graph indicates that the AIC method energy occupancy decreases over time as

## Conclusion

Cluster-based energy-efficient AI routing in WSNs is a promising approach for addressing energy constraints and improving network performance. Combining traditional clustering protocols with AI techniques offers significant potential, but challenges such as computational complexity and resource limitations must be addressed. This focus on lightweight AI models and hybrid approaches tailored for real-world applications.

## References

1. Heinzelman, W. B., Chandrakasan, A., & Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Microsensor Networks." "Proceedings of the 33rd Annual Hawaii International Conference on System Sciences".. (2000).
2. Younis, O., & Fahmy, S. "HEED: A Hybrid, Energy-Efficient, Distributed Clustering Approach for Ad Hoc Sensor Networks." IEEE Transactions on Mobile Computing.(2004).