Energy Efficient Routing Protocol in Wireless Sensor Network

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Abstract
Wireless sensor networks (WSNs) have today become an integral part of our lives as they may be utilized in a wide range of application areas, including environmental monitoring, healthcare, industrial applications, football stadiums, military, civilian, and homeland security. However, the reliability of WSN communications faces significant problems in hostile and complicated situations. The longevity and energy consumption of a WSN have consequently emerged as challenging research areas. To conserve energy and lengthen the lifespan of the network, an energy efficient routing protocol, EERP, for wireless sensor network systems must be developed. A node's limited power supply presents a problem, as the node's battery cannot be changed. The lifespan of each sensor node has a significant impact on the lifetime of the WSN. The main issue in the field of WSN is an energy efficient routing mechanism. Hierarchical routing is one of the strategies being developed by researchers to improve the lifetime of WSNs. The suggested approach in this work can increase the lifespan of a WSN and decrease the energy consumption of sensor nodes. In this paper, we propose an energy efficient routing protocol (EERP) that can save energy in the sensor while the node is in sleep mode for wireless sensor networks (WSN). The method is sleep mode and active mode (flip, flop). The simulation results show how the system's energy efficient routing protocol (EERP) improved battery energy performance in the network. The proposed routing method's performance was significantly enhanced through a comparison experiment between it and the existing techniques. As a result, it was established that the technique suggested in the paper performed better than the existing method.

Keywords: Energy, Efficient, Routing Protocol, Wireless Sensor Network

1.Background
The main aim of this research work is to come up with intelligent ideas that can improve the energy capacity of the battery in the wireless sensor network node. Because of the importance of the network in the world today, energy efficiency is one of the major issues and problems in the WSN. The computational and memory resources available to sensor nodes are extremely constrained because of their tiny size and energy consumption. To minimize the use of power resources and increase the network's lifespan, energy-efficient routing techniques are necessary.

The WSN node is made up of numerous parts, including a power supply, circuit, communication, and sensing component, a memory component, and a CPU component, all of which are packed together in a compact space. WSN utilizes low-power circuitry and networking technology that draws power from the device's source. Different solutions must be added based on real-time concerns to provide a general protocol suitable for applications including the environment, health monitoring, animal tracking, and home automation. The best technology is wireless sensor networks with energy efficient routing techniques. Finally, severalprotocols'performance

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characteristics, including longevity, scalability, and packet delivery ratio are compared and discussed (Behera et al., 2022a).

The wireless sensor network can be used in a variety of global industries. When the fundamental structure of a sensor network is formed, the wireless sensor nodes organize themselves to the network infrastructure by interacting through multiple hop connections. The seismic, infrared, auditory, or magnetic information from the environment will be collected by the sensor nodes that make up the WSN. The GPS is located or positioned by itself (Wu, 2011).

Poor performance and a short network lifetime might result from an imbalance in power usage. We suggest an energy-balanced routing protocol with depth control to address these problems. This protocol will be able to switch out lower energy nodes for higher energy nodes as needed to maintain constant energy usage. The proposed evolutionary algorithm and data fusion approach are the foundations of the energy-efficient routing protocol. An existing genetic algorithm is improved in the proposed energy-efficient routing protocol by including an encoding approach, a crossover technique, and an improved mutation operation that aids in determining the nodes (Lilhore et al., 2022).

There are numerous protocols used by these sensor nodes to communicate with one another. sensor nodes and Base Stations make up the two primary parts of the Wireless Sensor Network (WSN), a specialized network. The nodes keep track of numerous environmental factors (such as temperature, humidity, pressure, and sound) that wirelessly transmit the information they gather to the base station and other nodes (Rina et al, 2016). The additional traffic from multi-hop communication drains the energy of nodes close to static sinks. According to Mosavifard & Barati. (2020) Energy consumption in WSNs can be both efficient and inefficient. Reduced energy waste will enable the network to operate more effectively and extend battery life, which will increase energy efficiency (Kumar et al., 2019). The wireless sensor network (WSN) is a basic sort of network that is now heavily utilized and integrated into our daily lives. In a variety of fields, including agriculture, forecasting, health, patient monitoring, security, industry, sports, and others, use of the networks is growing. The clustering routing technique is crucial for cutting down on energy use and extending network lifespan (Navarro et al., 2022).

The fact that the majority of sensor nodes in wireless sensor networks (WSNs) are powered by energy-constrained batteries is one of the main problems with these networks, as it significantly affects the effectiveness, dependability, and durability of the system. As a result, numerous clustering strategies have been created to improve WSNs' energy efficiency (Dogra et al., 2022). Through internet routing from the base stations, also known as sink nodes, users would be able to obtain data from the sensor network. Base stations act as a sort of conduit between users and sensor nodes.

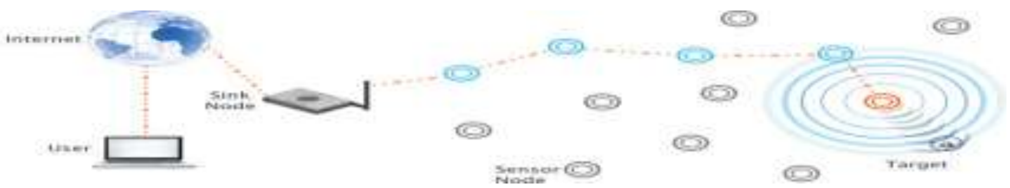

Figure.1.1.WSN through the internet
(Senouci et al., 2016)

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The fixed sensor network (FSN) is a wireless sensor network that is installed on a fixed infrastructure and uses wired transmission to send packets from a source to a destination from a node to an endpoint. However, if the sensor networks are linked to wireless infrastructure, they are referred to as wireless sensor networks (WSNs), as radio waves and satellites are used for communication. These devices work in challenging conditions where it is difficult to supply electricity, whereas fixed sensor networks have a sufficient and consistent power source (Y. Liu et al., 2019). A wireless sensor network's (WSN) ability to function typically depends on the battery's capacity. Each sensor must cooperate with the other sensors in the network to share data locally as required by the application because of the limited power source (Raghunandan et al., 2023).
The highest challenging factor in the wireless sensor network (WSN) is battery energy. The battery capacity that is being designed and developed in the device is not lifetime techniques, low power battery is the problem with this sensor node device. They're yet to develop a strong and forever usage battery capacity for wireless devices (Radhamani & Priya, 2021). There is a problem with energy efficiency in the network because the sensor nodes devices are deployed in antagonistic environments and densely to collect the sensing data from the environment, wireless sensor networks (WSNs) are experiencing problems and challenges with performance in the transmission of the data (Chehri et al., 2020).

The problem is stated in the point below.

- The feasibility and accessibility of routing protocols for wireless sensor networks (WSNs)
- WSN performance evaluation of routing protocols for batteries.
- Performance evaluation of different WSN power capacities and energy efficiency.

Research Questions

i.How to make comparisons of existing energy-efficient routing protocols for WSN.
ii.How to improve energy-efficient routing protocols in WSN.
iii.How to simulate the performance of the proposed techniques.

Research Objectives

The purpose of this work is to investigate the problems and difficulties that are jeopardizing battery life and network lifespan due to the high demands placed on wireless sensor networks (WSNs) for data processing and transmission from sensor node devices.
i.To implement comparisons of existing energy-efficient routing protocols in WSN using NS2 simulation techniques.
ii.To develop an evaluation model to examine the performance of energy-efficient routing protocols for WSN.
iii.To propose an improved technique for energy efficient routing protocol

2.Related Work

Wireless Sensor Network (Wsn)

Due to their relevance in their respective fields, the wireless sensor network (WSN) applications sectors of today are linked to monitoring and surveillance of the environment. A battery unit, processor unit, and memory unit are some of the communication components included in the network, along with an interface and sensing devices (Zheng & Jamalipour, 2008). Almost all remote monitoring applications that require gathering data from far places and sending it wirelessly to the control base center employ wireless sensor networks. The integration of the Internet of Things, which efficiently assists in the transfer of real-time data and multimedia information, has received widespread importance and attention. The energy of nodes is a crucial issue, especially in the transmission of multimedia material, as the power supplied to the nodes is finite in nature (Ezhilarasi & Krishnaveni, 2019).

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Sensor nodes with an integrated CPU are utilized to control and keep an eye on a specific area's environment. They are linked to the Base Station, which serves as the System's processing hub. To perceive and communicate data, a base station in the system is connected via the Internet. WSNs are made up of hundreds or even thousands of communication nodes with constrained energy supply, sensor, processing, and computation capabilities (Alnuaimi et al., 2013). Energy efficiency should receive a lot of attention to extend the lifespan of the network (Kumaran & Chinnadurai, 2021).

Wireless Sensor Network

Routing Protocol Low Power

The main purpose of the routing protocol low power (RPL) is to control the energy consumption of the sensor node. RPL is an IPv6-based distance vector routing mechanism. The traffic is routed upwards until a common ancestor of the source and destination is identified by RPL, at which point it is directed downwards to the destination.

Figure 2.1. Routing Protocol Low Power for wireless sensor node. (Varshney et al., 2018).

1. Methodology

Research Framework

The major objectives of this research study are to leverage techniques from routing protocols to increase battery capacity, energy efficiency, and lifetime wireless sensor nodes in the network. Any research methodology must include a conceptual framework that is either quantitative or qualitative, or both, depending on the situation. Because of the outcome of the evaluation process, the qualitative method is necessary for the majority of information technology research. Information technology uses perspective research to acquire knowledge of a specific subject in terms of descriptive and perspective techniques (Rana et al., 2014).

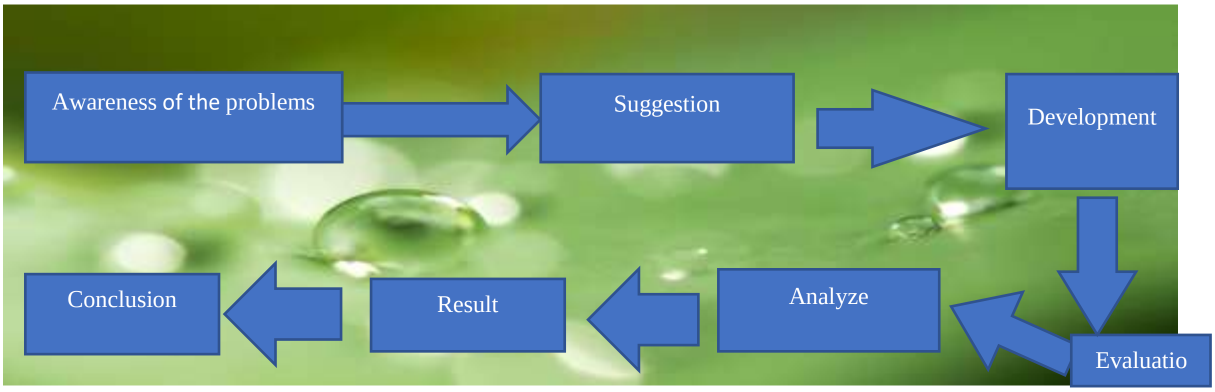

Figure 3.1. Research Design Phase

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Implementing The Proposed Protocol

The suggested flip (Active) – flop (Sleep) protocol will be evaluated for results integrity and quality to optimize battery performance with effective sensor node transmission and communication over the network lifetime. It is essential to pick a simulator that generates outcomes that are closely semblable to those of the actual node battery. NS2 software was carefully selected for the experimental simulation setting of our study since it produces accurate results that are highly equivalent to those seen in reality.

Network Simulator Version 2

Network Simulator Version 2 (NS2) is a network emulator that enables event-driven tools to mimic network protocol activity and provides simulation behavior for wired and wireless network protocols like TCP, HTTP, and UDP routing algorithms. To ascertain the capacity and duration of energy within a wireless sensor network node, NS2 uses simulation methodologies.

NETWORK SIMULATOR VERSION 2 window makes up the interface of the NS2 network simulator. The physical configuration of the motes is seen in the network window. The sink mote has a green color and the transmitter mote has a yellow color in the network window, respectively, to indicate their functional differences (Amirinasab et al., 2020).

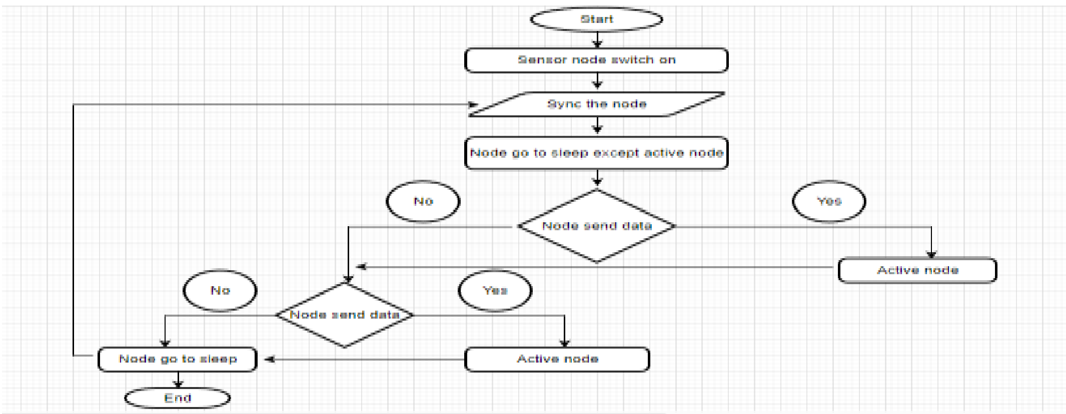

Figure 3.2. Flowchart for Active (Flip) – Sleep (Flop) Procedure

The steps below demonstrate the Flip (Active)-Flop (Sleep) procedure

Step 1: Start to initialize the process, all node is awake to communicate and synchronize data using energy in the sensor node device.

Step 2: Sensor node switch on, the active node consumes battery energy.

Step 3: synchronization of the node in active and sleep. Actively consumes energy but in sleep saves energy.

Step 4: Node goes to sleep except when active node the protocols switch to the node active to receive data, sleeping mode to save power.

Step 5: Node communicates to the base station if the node is active else idle waiting time to save energy in the battery.

Step 6: Node sends data, the node sends information if yes active else no save power idle period.

Step 7: The node can be active to communicate or sleep mode for a waiting period to save battery energy.

4.Analysis

Simulation Wireless Sensor Networks In Ns2

Network Simulator Version 2 is a useful tool for simulating Ad Hoc networks, as was mentioned in Chapter three of this research work. However, additional

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modules that represent wireless sensor network-specific applications and protocols are needed to simulate wireless sensor networks in NS2.
(Sameer Jabbar et al., 2023).

Performance Metrics

The suggested energy efficient routing protocol is described in this section. Energy is one of the most important aspects of WSN nodes; hence energy consumption must be kept to a minimum while still meeting the demands of the schedule to prolong longevity (Raghunandan et al., 2023).

Typically, a wireless sensor node will use the following amount of energy:

$$\sum \sum total = \sum Active + \sum Sleep$$

Where ∑Active is the quantity of power spent when the node is in active mode and ∑Sleep is the quantity of power saved in the nodes before it comes back to an active mode for communication.

The quantity of power spent by a node in active mode can additional be separated into ∑Tx the amount of energy consumed for data receipt. The equation above can therefore be expanded and written as

$$\sum \sum total = \sum Tx + \sum Rx + \sum Sleep$$

Compared to the sum of the energy requirements for data receipt, scanning the air interface, and sleep mode, the energy demand for data transfer is significantly higher.

However, no nodes can be in a state of inactivity while still being able to communicate and nodes can sleep to save more energy, which can improve the network performance therefore no energy is lost in the procedures in this situation. Therefore, it is crucial to lengthening the time a node spends in sleep mode to conserve more energy before turning it on. The lifespan of the sensor nodes in the network will grow by optimizing energy performance while they are sleeping (Obi et al., 2023).

Performance metrics are necessary because this study must quantitatively measure the parameters. The performance parameters listed below were conventional measures cited by this EER protocol.

Energy Consumption: The amount of energy a node uses when it is active and when it is sleeping. Calculations of the WSN nodes' energy efficiency must be made in light of all this information.

Average Energy Consumption = Total Energy Consumption / Number of Nodes

AEC = TEC / Nn

Joules (J) is the unit used for energy consumed. These performance metrics get affected by all major sources of energy wasted in wireless sensor network nodes such as in active mode schedule drifts and latency.

Latency: It is calculated as the time between a ready frame to transmit from a node and deliver the frame to the destined node which is elsewhere in the network.

Packet Delivery Ratio: The average packet delivery ratio is calculated as the total number of packets received to the number of packets sent over all nodes.

Packet Deliver Ratio = (No. of packets received / No. of a packet sent) * 100

PDR = (NPC/NPS) * 100

Delay: It is the total time taken during the transmission of a packet from one node to another. It is calculated by taking the difference between the sending and receiving time of the data.

Delay = Packet Receive Time – Packet Send Time

D = PRT – PST

Throughput: It is the total number of packets delivered at the sink node per unit. Amount of error-free data transferred successfully between the nodes. Usually in seconds.

Throughput = Total Amount of Data Received / Total Time.

THp = TADR / Tt

Dropping Ration: It is the average number of packets dropped during the

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transmission from one node to another divided by the total number of packets transmitted multiplied by 100.
Dropping ratio = (Total number of packets transmitted – Total number of packets received) / Total number of packets transmitted * 100
DR = TNPT – TNPR / TNPT * 100

Normalized Routing Overheads: Overhead is the cost that is incurred when nodes change their location within the network. The routing table needs to be updated accordingly which leads to unnecessary routing overhead.
Normalized Routing Overhead = Control Overhead / Received Packets
NRO = CO / RP

5. Conclusion

Conclusion

Despite the sensor network's ability to closely monitor the real-time condition, setting up such networks is expensive and time-consuming. It can also be challenging when real-world occurrences result in energy efficient performance in the device battery degrading problems. As a result, it's crucial to research wireless sensor networks in a virtual setting to see any potential issues before they arise during deployment. Wireless sensor network deployment issues may be found during pre-deployment testing using a simulator like NS2.
Using the network simulator version 2 (NS2), an energy efficient routing protocol with low energy consumption was proposed to developed, implemented, and examined. We assessed the effectiveness of the energy efficient routing protocol and contrasted it with industry-accepted practices. The effective scheduling system employed to cut down on the battery's idle listening times is what leads to energy savings.

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