Analyse The Different Routing Algorithms For Energy Efficiency In Wireless Sensor Networks: A Review

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Abstract: In Wireless Sensor Networks, energy efficiency is the most difficult problem to solve (WSN). Many research has been conducted in recent years on these topics because to the rising needs of diverse applications and the limitations of WSN nodes in terms of energy, memory, and processing capacity. Proposals for new protocols have been put out by researchers such as LEACH and PEGASIS. As a vital part of today's communication infrastructure, wireless sensor networks (or WSNs) are becoming more popular in business and academics alike. A major problem in extending the lifespan of WSNs is the consumption of node energy, which has been a major focus of research into WSN architecture. Charge or replacement of used batteries may be prohibitively expensive or perhaps impossible due to the harsh conditions. It is hoped that this paper will shed light on various ways to reduce energy usage, enhance network performance and extend network life.

Keywords- Energy efficiency, Wireless Sensor Network, Routing Algorithms, LEACH, PEGASIS, HEED

I. INTRODUCTION

Because of their cheap cost, compactness, and ability to perform several functions, wireless sensor networks (WSNs) have become more popular in a variety of industries thanks to advances in wireless communication and electronic information technology. Most WSN nodes, however, are powered by batteries and placed in risky or unattended outdoor locations, making it difficult or impossible to recharge the batteries. Additionally, the costs of redundant deployment and node replacement are generally substantial. An effective routing strategy is thus required to reduce network energy consumption and extend network life. Traditionally, sensor nodes' energy is utilised mostly for data receipt and transmission, therefore the typical routing approach focuses on finding the shortest way to get data from the source to the destination as rapidly as feasible. A huge volume of data is transferred from the source node to the sink in "many-to-one" mode, which easily generates major "funnel effect" and "energy hole" difficulties in an energy-constrained sensor network. When nodes are close to one another, they use more energy than other nodes, leading to an imbalance in energy consumption and a shorter network lifespan. Congestion in the network may also be caused by the "many-to-one" data transmission mechanism. Because of the high volume of data that has to be sent in a short period of time when an important event occurs, congestion may arise. Data transmission reliability may be compromised if a substantial number of data packets are dropped due to congestion. Energy consumption and transmission delays due to data retransmissions will grow as a result of the network generating excessive energy usage. The upstream node has difficulty controlling the data rate flowing into the downstream to prevent congestion in certain studies on congestion after congestion has been discovered and certain strategies have been applied to reduce intake. Many routing algorithms prefer to idle nodes to alleviate congestion, although diversions may cause the nodes to waste more energy as a result of this strategy.

1.1 Wireless Sensor Network

Small, self-contained devices known as sensors make up the WSN network, and they collect various kinds of physical or environmental conditions, such as temperature and sound and vibration and weight and movement, at various locations, process information, and then transmit the detected data to clients. WSN is a network. Data from the environment is collected and sent to the base station through these sensors. A base station establishes a connection to the real world by storing, processing, and distributing the data collected to useful applications. A significant number of these sensor hubs may be found in WSNs, and the data collected by these sensors can be shared among them or sent directly to a remote base station. Numerous sensors may be used to detect different events, such as the movement of an item or a blaze, in a wide range of applications Figure 1 depicts the sensor node's basic architecture (Rawat & Chauhan, 2021).

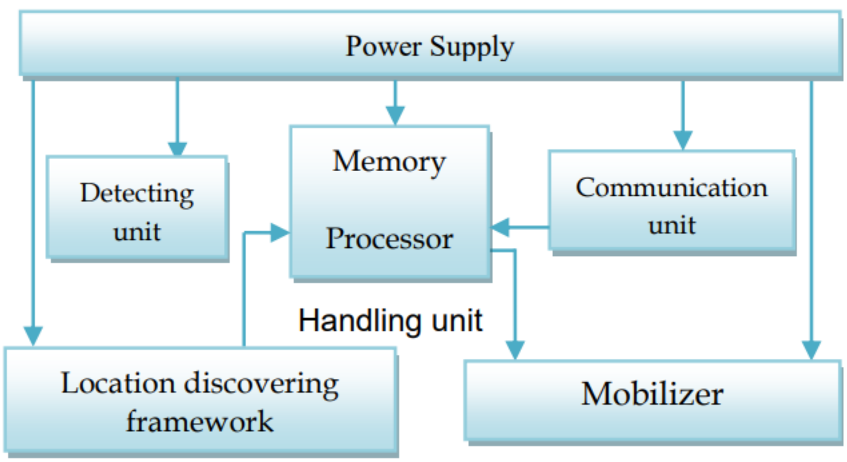

Fig.1: Framework of sensor hub

There are four main components in the sensor hub: sensing (detection), processing (handling), communication, and power supply.

Sensing unit: Sensors and A2A converters are the two most common components (ADC). Data is collected by sensors as analogue signals, which are converted to digital signals by an ADC before being sent to a processing unit.

Handling unit: In order to fulfil the assigned detecting tasks, it collaborates with other sensor hubs through a tiny memory and employs various tactics.

Communication unit: It connects the network's hubs to each other.

Power source A sensor hub's most critical components. Cells driven by the sun could be able to hold it up. In addition, many application-subordinate components exist. The vast majority of routing and detection tasks need very precise information about the region to be monitored. As a result, a sensor hub is expected to include a location-discovery system.

1.2 State-of-the-art of Routing Techniques for Wireless Sensor Networks

Data-centric, hierarchical, and location-based wireless sensor network routing techniques exist. All of the routing protocols are based on these three categories: source, shortest route, and hierarchical-geographical techniques.

1.3 Data-centric protocols

It's common for sensor nodes to make their data accessible to interested sinks through a public ad, and then wait for the request. In wireless sensor networks, flooding is a simple technique that can be used to broadcast information but it requires significant resources because each node that receives a message must rebroadcast it until the maximum number of hops for the packet is reached, or the packet's destination is the node itself. There is no need for costly topology maintenance or complex route-discovery algorithms when flooding is used. Implosion, overlap, and resource blindness are just a few of the flaws that plague it. Gossiping is a kind of flooding in which nodes do not broadcast their messages. Instead, arriving packets are sent to a neighbour who is chosen at random. By providing negotiation and resource adaptation, sensor protocols for information via negotiation (SPIN) address the shortcomings of classic flooding However, the SPIN data advertisement mechanism cannot guarantee data delivery on its own. Three different kinds of messages are used by SPIN to communicate:

Publicity for fresh data An ADV message with meta-data may be sent by a SPIN node when it has data to distribute.

REQ - a request for information has been made. When a SPIN node wants to receive data, it sends a REQ message.

DATA - a message in the form of data. The meta-data header is attached to the sensor data in DATA packets.

A sensor node does not need to be identified in order to function (e.g., an address). Instead of focusing on a single sensor's output, applications look at a variety of sensor data. Because data is recognised by its properties, apps employ these features to request data. Direct diffusion is a prominent data-centric protocol method that uses the shortest route as the basis for its routing decisions. With the use of direct diffusion, each sensor node labels the data it creates with one or more qualities, and other nodes may express interest based on these attributes. Network nodes then disseminate these interests. The dissemination of information is guided by interest gradients. A gradient may be thought of as a scalar quantity in its simplest form. A route with a negative gradient prevents the transmission of data, while a road with a positive gradient encourages the flow of data (Chakrapani & Babu, 2021).

Using just one route at any one moment, Energy-Aware Routing seems to be very similar to source routing. It is a destination-initiated reactive protocol. A variant of direct dispersion, rumour routing is designed for situations in which geographic routing is not an option at all. Direct diffusion may also take the form of gradient-based routing. It is important to remember the number of hops when interest is dispersed across the network in gradient-based routing. Constraint Direct diffusion (CADR) and Active Query Forwarding in Sensor Networks (ACQUIRE) are two methods for distributing information throughout a network, which may be further broken down into sub-queries.

1.4 Hierarchical protocols

For many distributed sensor coordination tasks, hierarchical protocols are based on clusters because clusters can contribute to more scalable behaviour as the number of nodes increases, provide improved robustness, and facilitate more efficient resource utilisation for many distributed sensor networks. The Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol uses a random selection process to pick sensor nodes as cluster leaders in order to decrease energy consumption in sensor networks. It's a chain-based protocol called Power-Efficient Gathering in Sensor Information Systems (PEGASIS) [18]. Allowing only the nearest neighbours to speak with each other and adopting a turn-taking technique to communicate with the Base Station are the primary goals of the protocol (BS). For time-sensitive applications, the Threshold-sensitive Energy Efficient protocol (TEEN) and the Adaptive Periodic TEEN (APTEEN) have been developed. Sensor nodes in TEEN continually detect the media, while data transfer occurs less often. It is a hybrid protocol that may vary the frequency or threshold values of the TEEN protocol, according on the user's demands and application type (Khan et al., 2021).

1.5 Location-based protocols

If a node uses location-based routing, it bases its packet forwarding choice on the position of both the packet's final destination and its nearest one-hop neighbour. The packet's header contains information about the packet's final destination. Prior to forwarding, a node may opt to adjust the packet's position to reflect its more precise location. A one-hop broadcast beacon is the most common method for determining the location of your neighbours. Whenever a node sends out a beacon, the location of the transmitting node is included.

For position-based routing, there are three basic techniques: greedy forwarding, constrained directional flooding, and hierarchical approaches. Nodes pass a packet to one or more one-hop neighbours that are positioned closer to the destination than the forwarding node itself in the first two examples. The algorithm's optimization criteria determine which neighbour is chosen in the greedy situation. In order to accommodate a high number of mobile nodes, a third forwarding technique is to build a hierarchy.

Low-power geographic positioning systems (LPGPS) are used to create and maintain a low-energy network for wireless networks (GPS). MECN's major goal is to locate the subnetwork with the fewest number of nodes that needs the least transmission power between any two specific nodes (shortest path). Extending from the original MECN, the Small Minimum Energy Communication Network (SMECN) was created. Assuming that all nodes can communicate with each other, which is not always feasible, is a key flaw with MECN. SMECN has the benefit of taking into account impediments that may exist between nodes. For sensor networks, Geographic Adaptive Fidelity (GAF) serves as an energy-conscious location-based routing algorithm. GAF saves power by shutting down nodes that aren't needed, yet this has no effect on the integrity of the routing. Finally, Geographic and Energy Aware Routing employs energy-awareness and geographically informed neighbour selection heuristics to route a packet toward the target area (Das et al., 2021).

1.6 Zig Bee Protocol

Lower layers defined by the IEEE 802.15.4-2003 standard include the physical and medium access control (MAC) sublayers. APS, ZDO, and manufacturer-defined application objects are all part of the foundation provided by the ZigBee alliance. The NWK layer and framework for the application layer are also provided by the ZigBee alliance. Both the 868/915 MHz and 2.4 GHz PHY layers in IEEE 802.15.4-2003 operate at different frequencies. Broadcasting mode defines a 32-bit Spread Spectrum modulation method. Offset-QPSK modulation and a chip rate of 2 Mcps allow it to handle data rates of 250 kbps. The 868/915 MHz mode defines a DSSS modulation scheme with 20/40 kbps data rates and 300/600 kcps chip rates. It uses BPSK modulation and a gain of 15 for the digital processing. The MAC sub-layer, on the other hand, employs a CSMA-CA method to regulate access to the radio channel. Beacon frames, synchronisation of transmissions, and a dependable transmission mechanism are among its duties.

It is up to the ZigBee NWK layer to ensure that all frames are properly secured and routed to their final destinations using a shortest path method. This includes joining and exiting networks. It also takes over the discovery and management of inter-device pathways. The NWK layer is also responsible for one-hop neighbour finding and data storage. A ZigBee coordinator's NWK layer is in charge of creating a new network and allocating addresses to newly connected devices as necessary (Keshtgari & Deljoo, 2011).

The APS sub-layer is responsible for keeping tables for binding, which is the ability to match two devices together based on their services and their requirements, and for passing communications between devices that have been tied together. Device roles are defined, binding requests are sent and/or responses are sent, and a secure connection between networks' devices is established using ZDO. Additionally, the ZDO is tasked with finding connected devices and figuring out what kinds of services they provide.

II. BACKGROUND

Ajmi et al. (2021), Wireless sensor network (WSN) technology real-time applications are growing rapidly these days due to the advent of smart environments. Battery power is the most important resource in WSNs. Clustering is a well-known technique for boosting the power factor in WSNs. An innovative clustering approach is proposed in this study, which is a multi-weight chicken swarm-based evolutionary algorithm for energy efficient clustering purposes (MWCSGA). There are six major parts to it. Cluster head selection and multi-weight clustering are only some of the techniques used in the system model and chicken swarm optimization. Inter and intra cluster communication are also included. This model is compared to a few older approaches, including Genetic Algorithm-Based Energy Efficient Adaptive Clustering Protocol For Wireless Sensor Networks (GA-LEACH), Low Energy Adaptive Clustering Hierarchy Approach For WSN (MW-LEACH), and Chicken Swarm Optimization based Genetic Algorithm (CSOGA). Through testing, we discovered that the efficiency, throughput, packet loss, packet delivery ratio, and energy efficiency of our suggested solution all outperformed the competition.

Gupta et al. (2021), In order to manufacture more energy-efficient NoCs, the 3D design of NoCs is constantly evolving. In order to produce EE-NoCs, it is essential that the engineering process and policies be continuously monitored with significant effort using machine learning methods (energy-efficient NoCs). neural network systems use learning as a way of operation. Better manufacturing was achieved by using machine learning art in making EE-NoCs. Power Gate Deployment, voltage instant changeovers, and scaling in the frequenting simultaneous decrease in power are the three pillars of the internal architecture. The introduction of multiprocessor architecture and platform has made Moore's law more widely applicable. Application-specific NoC architecture is developing as a major technique for multiprocessor system design. There are various uses for the NoC, such as inter-process communication, bandwidth, deadlock prevention and routing structure. First order power constraints have necessitated early-stage estimations of NoC power (as well as performance and area). Designing the NoC's topology, switching, and routing mechanisms is essential. The n-dimension hypercube network on chip topological structure is the subject of this article. It is used to improve the efficiency and dependability of data transmission. The router pipeline and routing deadlock are just two examples of the many ideas we'll be discussing in this article.

Lipare et al. (2021), It takes a lot of energy for the sensor nodes to send the information they have gathered to the base station (BS). By using methods like as clustering and routing, the direct transmission's energy usage may be reduced. Fuzzy logic-based energy-efficient two-phase clustering and routing algorithms are presented in this study (EETPF). The input values of the clustering and routing algorithms are linked together using rule-based fuzzy logic. Remaining energy of sensor nodes, distance from the BS, and number of nodes in the communication range are all taken into consideration by the fuzzy system. The input variables' crisp values are transformed into a variety of fuzzy values. A centroid defuzzification approach is used to de-fuzzify the fuzzy output values. With the output values in mind, the cluster heads (CHs) and routers are chosen. The sensor nodes are assigned to certain CHs based on the capability of those CHs to handle a given amount of load. Router capacity determines the generation of the routing path. Evaluation parameters include energy usage, the number of active sensors every cycle, and the network's lifespan. EETPF surpasses current state-of-the-art algorithms on these assessment variables, according to our findings.

Yong et al. (2021), It's critical to figure out how to develop effective hierarchical routing algorithms for wireless sensor networks (WSNs) to balance network resources and increase network life owing to the limited energy of sensor nodes in WSNs. This research provides a multi hop routing algorithm based on path tree (MHRA-PT) to maximise network energy consumption in order to address issues such as random cluster head selection, redundancy of working nodes, and creation of cluster head transmission paths. In the beginning, several nodes that are near to the base station and have a high amount of leftover energy are chosen to build a cluster head set. Nodes having residual energy larger than the average residual energy of the cluster are then chosen for use as working nodes. To complete data transmission from the working node to the base station, a route tree with a root at the base station is built by sorting the cluster heads according to their distance from the base station. Each cluster head is then assigned a hop node in turn. It has been shown in simulations to minimise network energy consumption, balance resources, and lengthen the life cycle of networks thanks to this algorithm's implementation.

Bhushan et al. (2021), Using a wireless sensor network (WSN), the environment is sensed and data is sent to the base station (BS) for processing. To gather data from several sensors in a WSN context, a synchronised tree-based technique is the most effective method. It is, nevertheless, difficult to achieve energy efficiency in a tree-like structure Using fuzzy logic and a heterogeneous network, this study proposes a new approach for tree building and parent node selection, dubbed the "fuzzy attribute-based joint integrated scheduling and tree formation" (FAJIT). For aggregating diverse kinds of data packets to save energy, FAJIT focuses primarily on the parent node selection issue in the heterogeneous network. Candidate nodes with the fewest dynamic neighbours are prioritised in the process of choosing parent nodes. When there are two or more dynamic neighbours, fuzzy logic is used. Fuzzy logic is initially applied to WSN in the suggested approach, and then min–max normalisation is utilised to extract normalised weights (membership values) for provided graph edges. The degree to which an element is a member of a set is indicated by this membership value. As a result, the node with the lowest sum of weights is considered the parent node. Different parameters, such as average schedule length, energy consumption data interval, total number of transmission slots, control overhead, and energy consumption during the control phase, are compared between FAJIT and DICA's distributed algorithm for Integrated Tree Construction and Data Aggregation (DICA). The findings show that the suggested algorithm has a higher energy efficiency.

Yun & Yoo (2021), Weaknesses in the routing protocol's ability to recharge small sensor nodes may have an impact on the lifespan of a wireless sensor network. It is common practise in wireless sensor networks (WSNs) to decrease the quantity of data sent between nodes by combining it into a single packet in order to conserve power. The ideal route from the source to the destination is determined by energy-efficient routing, which avoids the energy-short nodes and hence saves energy for relaying the detected data. Routing route selection and data aggregation are often handled independently in traditional systems. When a node is trying to figure out the best direction to take, it's important to consider how much info it may get from other nodes. An energy-efficient routing method based on Q-learning and data aggregation is proposed. Sensor type-dependent data aggregation and transmission energy, as well as node residual energy, may be used to determine the ideal route for the proposed method based on reinforcement learning. We employed aggregation incentives that were based on the sensor type. The new routing approach was then put through its paces in computer simulations, and the results were compared to those of more traditional energy-aware routing algorithms. According to our findings, the suggested approach is effective in reducing data while also extending the useful life of the WSN.

Ding et al. (2021), Many applications of machine learning (ML), such as image identification, audio recognition, recommendation systems, and natural language processing, have proved their particular benefits. Wireless sensor networks (WSNs) have recently received a lot of attention for their potential to benefit from machine learning. It is becoming more important in WSNs to develop ways to maximise the usage of resources and achieve power-efficient load balancing. Optimized WSN routing strategies have traditionally been used to reduce energy usage and extend WSN life spans. However, issues including lack of adaptability, a single aspect of consideration, and a dependence on precise mathematical models are common. Intelligent energy-efficient routing algorithms in WSNs may benefit from ML approaches' ability to swiftly adapt to environmental changes and combine various inputs. A theoretical hypothetic model formulation of ML is proposed as a viable way for constructing a power-efficient green routing model that can overcome the constraints of previous green routing methods. Green routing systems in WSNs have made significant strides in recent years, and this research shows how far they have come and where they are going. There is a large audience for this paper's content, including those interested in ML-based WSNs.

Nguyen et al. (2021), When sensors are placed in difficult-to-reach places, the search for geographic routing algorithms for wireless sensor networks has led to a slew of creative solutions. Problems arise when the source or sink nodes are near to a specific hole, particularly in cavernous portions of big complex-shaped holes, and no solutions exist. A geographic routing strategy is proposed in this study to cope with the occurrence of complexshape holes. The (1+epsilon)-stretch of our suggested routing strategy provides paths around holes. Our routing technique has the maximum load balancing and the longest network lifespan compared to other well-known routing algorithms, according to the findings of our experiments.

Elsmany et al. (2019), The "low-energy adaptive clustering hierarchy" (LEACH) protocol is the basis for several modern wireless sensor network (WSN) routing systems. New WSN protocols face the issue of extending the network lifetime while retaining excellent scalability since LEACH's performance degrades dramatically with network size. The energy-efficient scalable routing method is a new clustering and hierarchical routing system that uses less energy (EESRA). By increasing network longevity despite network size growth, this technique aims to do just that. Randomly selecting cluster heads has been made easier by using a three-layer hierarchical structure. The EESRA WSN MAC protocol employs multi-hop broadcasts for intra-cluster communications. According to this study, EESRA is compared to various WSN routing protocols in terms of performance when the network size varies. EESRA surpasses the benchmarked protocols in terms of load balancing and energy efficiency in large-scale WSNs, according to simulation data.

Tang & Fan (2020), As a result of energy constraints in wireless sensor networks, the network's performance suffers from poor energy consumption and unequal distribution of energy. As a result, better QoS necessitates the use of effective routing methods (QoS). The Dempster–Shafer (DS) evidence theory may combine many sensor node properties with adequate theoretical reasoning and requires little previous information. A routing algorithm built on DS evidence theory and energy efficiency is the result of the above (DS-EERA). To begin, DS-EERA creates three attribute indices as evidence under consideration of the residual energy, traffic, and proximity of the route to the shortest path of the nearby nodes. After that, we'll use the entropy weight approach to figure out the relative importance of three different indices. The DS evidence theory's fusion rule is used to combine the BPA functions of each index value to determine the next hop once the basic probability assignment (BPA) function has been established. Finally, this routing mechanism is used to transfer data between all nodes in the network. It has been shown via theoretical research and computer simulations that the DS-EERA protocol has great promise for extending the lifespan of networks. In the meanwhile, packet loss may be reduced and data transmission reliability can be improved.

Wang et al. (2019), Widespread interest in wireless sensor networks (WSNs) has recently arisen. Sensors that are autonomously structured and work together to gather, analyse, and communicate data around targets might be considered as a network of autonomous sensors. As a result, sensors may be used in settings where battery replacement is impractical. As a result, WSN-based applications need energy-efficient routing. Using clustering and sink mobility, we provide an energy-efficient routing scheme in this study. Once the sensor field has been divided into sectors, the Cluster Head (CH) of each sector is elected based on the weight of its members. In order to choose the most energy-efficient scenario, member nodes compute the energy consumption of various routing pathways. It is then used to link together all the clusters together in an inter-cluster communication chain. For example, in a simulation, the proposed schema outperforms other related efforts, such as CCMAR and Energy-efficient Cluster-based Dynamic Routing Algorithm (ECDRA) (ECDRA). The network's performance may be further improved by examining how various network parameters affect its performance.

Li et al. (2019), A sort of self-organizing network, Wireless Sensor Networks (WSNs) have a limited energy supply and communication capabilities. The implementation of an energy-efficient routing protocol is critical in

WSNs since it extends the life of the network. For this reason, we present the innovative Energy-Efficient Ant-based Routing Algorithm (EBAR) for WSN load balancing. Energy consumption of sensor nodes is balanced by using a pseudo-random route-finding approach and an enhanced pheromone trail updating mechanism. A heuristic updating technique based on the greedy estimated energy cost measure is used to optimise the creation of the route in this algorithmic design process. Finally, EBAR employs an energy-based opportunistic broadcast strategy to decrease energy usage caused by control overhead. For the purpose of evaluating EBAR's performance in terms of energy consumption, efficiency, and expected network lifespan, we run simulations of WSNs under a variety of different conditions. EBAR outperforms the current state-of-the-art techniques EEABR, Sensor Ant, and IACO, according to this thorough analysis.

Wan et al. (2019), Premature node death and decreased energy efficiency in underwater acoustic sensor networks cause excessive energy loss. Instead of each node sending data alone, network-based clustering approaches may employ a cluster head to combine data from the cluster members for forwarding, substantially reducing the overall energy loss during transmission. An energy-efficient adaptive clustering routing system for underwater acoustic sensor networks has been suggested as a result (ACUN). Calculating the competition radius is done using a multi-level hierarchical network structure based on distances between clusters' heads and the sink node as well as residual cluster head energy. Due to an enormous competition radius and hence high energy costs, a cluster head located far from the sink node may live longer. The method may choose a cluster head with higher residual energy while still optimising network energy usage by taking into account node residual energy and the energy loss of a transmission line. Remaining energy conditions of nodes are taken into consideration when deciding whether a single-hop routing node or a multi-hop routing is more energy efficient. The ACUN algorithm, when compared to the AFP protocol and the DEBCR algorithm, saves more energy and extends the life of network nodes, according to simulations.

Table 1: Review Table

S. No.	Author (Year)	Methods	Conclusion
1.	Ajmi et al. (2021)	Multi-weight chicken swarm-based evolutionary algorithm	Compared to a few older approaches, including Genetic Algorithm-Based Energy Efficient Adaptive Clustering Protocol For Wireless Sensor Networks (GA-LEACH), Low Energy Adaptive Clustering Hierarchy Approach For WSN (MW-LEACH), and Chicken Swarm Optimization based Genetic Algorithm (CSOGA).
2.	Gupta et al. (2021)	energy-efficient NoCs	Proposed the n-dimension hypercube network on chip topological structure
3.	Lipare et al. (2021),	energy-efficient two-phase approach using fuzzy logic (EETPF)	EETPF, rule-based fuzzy logic is used to associate the input values of clustering and routing algorithm.
4.	Yong et al. (2021)	Multi hop routing algorithm based on path tree (MHRA-PT	proposed algorithm can effectively reduce network energy consumption, balance network resources, and prolong network life cycle.

5.	Bhushan et al. (2021)	fuzzy attribute-based joint integrated scheduling and tree formation (FAJIT)	The result of FAJIT is compared with the distributed algorithm for Integrated tree Construction and data Aggregation (DICA) on various parameters: average schedule length, energy consumption data interval, the total number of transmission slots, control overhead, and energy consumption in the control phase. The results demonstrate that the proposed algorithm is better in terms of energy efficiency.
6.	Yun & Yoo (2021)	Q-learning-based data-aggregation-aware energy-efficient routing algorithm	proposed routing method and compared it with that of the conventional energy-aware routing algorithms. Thgeir results indicate that the proposed protocol can successfully reduce the amount of data and extend the lifetime of the WSN.
7.	Ding et al. (2021)	propose a theoretical hypothetic model formulation of ML as an effective method for creating a power-efficient green routing model	provides an overview of past, present, and future progress in green routing schemes in WSNs. The contents of this paper will appeal to a wide range of audiences interested in ML-based WSNs.
8.	Nguyen et al. (2021)	Geographic Routing Scheme	proposed routing scheme achieves routes around holes with the (1+\epsilon)-stretch. results show that our routing scheme yields the highest load balancing and the most extended network lifetime compared to other well-known routing algorithms as well.

III. EXISTING COMMON HIERARCHICAL CLUSTERING ALGORITHMS

To be a cluster leader, every node has an equal chance. Due to the high energy consumption of cluster heads situated distant from the base station, single-hop routing is not appropriate for large-scale applications. In addition, since cluster leaders are chosen at random, LEACH may not provide an equitable and equal distribution.

PEGASIS - The data aggregation approach via a chain is used to reduce the amount of data transfers in this algorithm. It does need energy, though, to gather sensor position data in order to determine the next hop. Due to the number of nodes involved in the transmission of data, there may be a delay in response time.

TEEN - In order to conserve energy, it minimises the number of transmissions depending on the interest and degree of change. For large-scale networks, this algorithm can balance energy economy with data accuracy, therefore it is ideal. However, if the threshold values of interest and change are not received, the network would slow down. A delay is likely to occur if the data needs are too large, particularly when the data is needed on an ongoing basis.

HEED - It can use and monitor residual energy to balance the energy load among multiple sensor nodes. A little quantity of energy will be needed to transmit the information about how much remaining energy and where the nodes are located.

3.1 Criteria of a Robust Wireless Sensor Network

Due to the variety of applications for which a wireless sensor network may be used, the relevance of each criterion might vary.

Efficient power usage - Reduce the energy usage of each sensor node and increase the network's lifespan.

Scalability - Due to the many uses for wireless sensor networks, the number of sensor nodes in a wireless sensor network might be tens, hundreds or even thousands. This means that routing algorithms must be able to handle a wide range of network sizes while constructing them.

Reliability - This is also an important consideration in determining whether or not a wireless sensor network has been a success. As a result, if the sensor nodes expire soon, the sensor node will be unable to send data, which in turn affects its dependability. As a result, if the dead node is a cluster head, the whole cluster's performance would be adversely impacted. Because the percentage of successful deliveries decreases, the reliability of the service decreases. The routing algorithm's congestion management technique also has an effect on dependability.

Self-organization - Sensor nodes in the network should be able to reorganise themselves in the event of a node failure or network alterations.

Adaptability - Nodes may join or depart clusters in various iterations, which will alter the network topology and node density of the newly formed cluster in sensor networks. Since cluster membership varies often, sensor networks' network routing algorithms must be able to adapt to these variations in cluster membership.

IV. CONCLUSION AND FUTURE WORK

Energy efficiency is the most difficult challenge to tackle in Wireless Sensor Networks, and it is also the most expensive (WSN). Many studies have been carried out on these problems in recent years, owing to the increasing demands of varied applications and the constraints of WSN nodes in terms of energy, memory, and processing capability, among other factors. Researchers from organisations such as LEACH and PEGASIS have proposed new methods for consideration. Wireless sensor networks (also known as WSNs) are becoming more popular in both the corporate and academic worlds as a critical component of today's communication infrastructure. The use of node energy, which has been a key focus of study into WSN design, has been identified as a significant barrier to prolonging the lifetime of WSNs. It is likely that charging or replacing worn batteries may be excessively costly, or perhaps impossible, owing to the extreme environmental conditions. It is believed that this study will shed light on different methods for reducing energy consumption, improving network performance, and extending the life of networks.

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