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A SURVEY ON VARIOUS OPTIMIZATION TECHNIQUES IN WSN BASED ON IOT APPLICATIONS.

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ABSTRACT:

Optimization challenges like as energy consumption, clustering, routing, node maintenance, and node localisation may all be solved with WSN technology today. The primary goal of this strategy is to reduce energy consumption while also broadening the network's reach. However, in order to arrive at the best option, it is necessary to assess a collection of potential nodes. Energy-efficient strategies, such as numerous optimization-related ones, have emerged in order to improve the lifespan of networks and task associates. This article provides an introduction of topics related to optimization approaches that assist minimise energy usage and routing overhead.

Keywords: WSN, Optimization, Routing, Clustering, base station

INTRODUCTION:

Using a wireless sensor network, a large number of sensors may communicate with each other in a shared environment. Many researchers in the field of (area) of a lot of application like medical, scientific, habitat monitoring, and military [11] have been captivated by WSN's development of the microelectromechanical system. It also helps in wireless settings for bidirectional communication between peoples. In literature, a growing number of methods developed in the last two decades are used. A WSN is a network of wireless nodes that can detect a parameter of interest, connect with other nodes and collect data, rather than a network of nodes that use a lot of power in order to keep up with the demands of the network. Because sensors integrated with batteries can't be swapped out when a node expires, if development is greater, sensors must be observed for longer periods of time, necessitating more energy consumption.

In the Internet of Things concept, wireless sensor networks (WSNs) are one of the upper layers (IoT). It connects data from the physical world to the IoT-powered computational systems. For long-term IoT monitoring, WSN enables universal access to location and the state of unique environmental elements. There are several energy-efficient protocols that have been developed in recent years as a result of recent advancements in WSN architecture. Routing data necessitates a significant quantity of energy. The threshold ensures a constant flow of energy between the nodes of the member and the CH. According to initial energy supply, the sensor nodes are grouped into three distinct categories of nodes: normal, intermediate, and advanced.

Optimization:

Wireless sensor networks rely heavily on optimization. One way of approaching issues that defy deterministic solutions is via optimization, which involves finding a solution by either increasing or decreasing the objective function in order to achieve an optimal solution. WSN optimization may be divided into two basic categories: single-objective optimization and multi-objective optimization. One of the primary goals of a single objective optimization is to minimise or maximise a single objective under diverse restrictions. There are numerous goals being optimised concurrently in multi-objective optimization. The vast majority of real-world situations include numerous goals that must be concurrently optimised. MOO is a difficult problem and a popular study area for theorists and engineers because to this fact alone.

Metaheuristic optimization is another name for optimization, as metaheuristic techniques are used to solve optimization issues. A heuristic is a "solution or technique" that may be applied to a problem. That entails a more advanced approach to the issues that cannot be solved deterministically. Single- or multi-objective issues are possible in these cases.

It is becoming more common to use metaheuristic algorithms to address multi-objective optimization issues related to data clustering in wireless sensor networks because of their higher performance in terms of convergence to the optimality and avoidance of being caught in local optima. The article presents a nomenclature for clustering and discusses some of the difficulties in putting the concept into practise. The purpose of network optimization is to reduce energy, consumption, and network lifespan. Routing in wireless sensor networks is complicated by issues such as network longevity, security, energy consumption, and node distribution.

Optimization problem:

A WSN's lifespan may be extended by clustering its nodes. Our sensor nodes are grouped into multiple clusters, each of which elects a Cluster Head (CH) who is responsible for collecting the data (data aggregation) from their cluster and passing it to the base station. This is an NP-hard issue because the complexity increases exponentially as the network size increases. The primary motivation for experimenting with different clustering algorithms has been to improve the network's energy efficiency. Heinzelmantal's low-energy adaptive clustering Hierarchy (LEACH) employs randomised rotation of CH to spread the energy burden equally across the sensors, and this is only one of several famous methods. Kale et al. developed a hybrid cluster head selection for WSN that uses an unique FGF algorithm to pick an ideal cluster head in order to maximise network lifespan and energy efficiency. When Pal and colleagues introduced the LEACH,GA Genetic Algorithm for WSN longevity, the fitness function included residual energy, number of cluster heads, intra-cluster communication distance, and distance from the base station to the cluster. Roulette wheel selection and one-point crossover were employed to pick the starting population, which was created at random. All nodes are assigned to clusters based on their proximity to their base station. Ahmad et al. suggested a new energy-efficient method based on the ABC optimization approach. The fitness function was based on residual energy, inter-cluster distance, and distance to the sink station in this case. Practical Scenario's sink station may not always be located at the network's core, limiting its ability to function at its optimum. Gupta has presented an enhanced cuckoo search-based clustering protocol in order to solve the issue of imbalanced energy clustering. We've developed a new fitness function that may be used to determine the starting fitness value. WSN long-distance communication relies on the usage of Relay Nodes. These nodes are very expensive, but their primary function is to extend the life of the network. The goal is to decrease the number of node placements without sacrificing network performance or transmission reliability, because the cost is limited. Xingchan et al. provide a heuristic technique for solving this optimization issue. Jose M et al. suggested a Gravitational Search Algorithm to address the relay node issue.

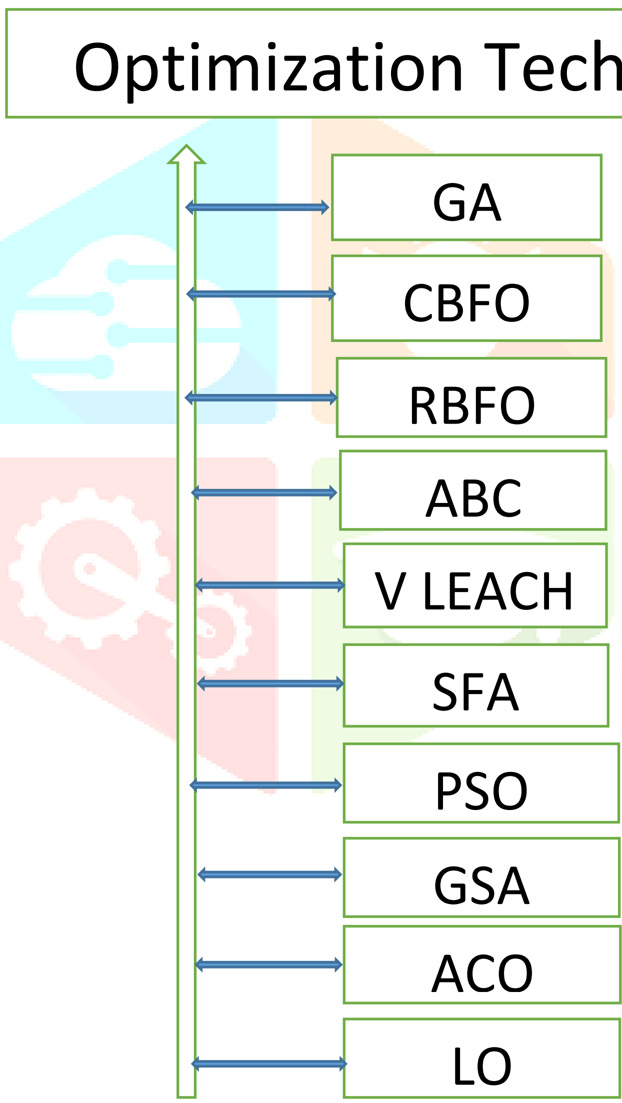

Fig 1.0 Various Optimization Techniques in WSN.

Genetic Algorithm (GA)

Vipin pal et al[4] suggested a genetic algorithm to maximise the WSN lifespan based on a clustering approach[5]. The genetic algorithm has two stages: the initial set-up stage and the steady-state stage.

Phase one of the set-up process: A pre-determined number of sensors are assigned as cluster heads based on the distance from non-CH nodes, and this is the initial step that can only be conducted once, since it shows the number of clusters in the network.

Stage of a constant state of activity: All nodes communicate with one other and with each other and with each other to form a chain of transmission. In the beginning, all nodes begin interacting with their CHs. To interact with CH, each node makes use of a TDMA schedule. In order to transmit data, TDMA uses a time-division multiple access (TDMA) technique that splits radio channels into time slots. Upon receiving data packets from all of its members, the CH merges them into a single packet and transmits it to the base station (BS). A round is complete when all CHs submit their data to BS. The BS evaluates the energies of the CHs and member nodes at the conclusion of each round. An associate CH is chosen from the cluster's member nodes if a CH's energy falls below the cluster's average energy. Nodes with the most energy are chosen as CHs, while those with lower energy are designated as members. However, the clusters are not re-created as in [4] and [9]. Each cluster has the same members, who remain in the same place. The optimal number of Cluster Heads may be determined using GA.

Advantage:

able to deal with parallelism and complicated situations.

Disadvantage:

It's challenging to work with a dynamic data collection.

Clustering Using Bacterial Foraging Optimization (CBFO)

[5] Swagatam et al[5] have introduced the BFO algorithm, which is an optimization method that was influenced by some of the other algorithms like PSO, ACO, and CBFO. The CBFO method is a novel approach to solving difficult clustering issues, rather than relying on high-speed local search. Clustering is the process of dividing data into meaningful or useful groupings (clusters) without the need for previous information.. For data mining, BF-C is a crucial approach that may be utilised to obtain high quality on a multidimensional actual data set, CBFO based CH selection strategy that takes into account residual energy and distance in its fitness function construction.

Advantage:

On a multidimensional real-world data collection, the BF-C method may provide excellent results.

Disadvantage:

Step size that is challenging to balance exploration and exploitation skills.

Bacterial weak link that puts the global optimum at risk instead than the local one.

Routing Using Bacterial Foraging Optimization (RBFO)

Distance and residual energy are taken into account while formulating the fitness function in order to give a comprehensive routing solution for multiple-hop communication between the base station and cluster head in the RBFO technique[13]. For routing, the number of CHs is equal to the number of bacterial dimensions, and an additional position is added for the BS. In the following step, the BS is determined using the mapping function. The purpose of fitness The next-residual hop's energy and the Euclidean distance from the CH to the next-hop and from the next-hop to the BS are considered in a study of routing optimization techniques for wireless sensors.

Parallel distributed processing, insensitivity to the beginning value, and global optimization are all advantages.

It is impossible to determine one's overall health by adding up one's step fitness throughout the course of one's lifetime.

Artificial Bee Colony (ABC) Optimization

An algorithm provided by Rashedi et al [6] is used to generate the best CH list. ABC has been examined for its performance in 2007. In the beginning, the sensor node sends out a "hello" packet. Each sensor node keeps a nearby table containing the id of the sensor that issued the broadcast message and the RSSI value after receiving the broadcast message. Now, the nodes communicate with the BS by sending their unique identifiers, information about their nearby tables, and any remaining energy. The BS now uses the equation to build the CH list. CH status is available only to nodes with energy levels greater than the cutoff point. According to RSSI values, the nodes in the CH list are clustered together. Then, a person's fitness level may be determined. After then, the ABC algorithm is used to choose the best CH from the remaining candidates. That signifies the list of CHs has been narrowed down to the most appropriate amount. Sending information between nodes and CHs is done via TDMA slots. In order to get the data to the BS, it is necessary to use the CDMA MAC protocol. In this case, the fitness function thinks that the CH's energy level is higher than its threshold. There should be a reduction in the number of CHs in order to save energy

Advantage:

Exploratory and implementation flexibility

Disadvantage:

Increased evaluations of the goal function will need new fitness tests.

Routing Using PSO and V-LEACH is the improvement of the LEACH protocol.

Instead of a cluster head, the V-LEACH Varshney et al[7] protocol includes a vice CH who serves in this capacity. The vice CH becomes the next cluster head if the network's cluster head dies, thereby extending the network's life span. When a cluster's energy is greater than a certain threshold, a cluster head is randomly picked from that cluster. In a situation where clusters are formed at random, one cluster may include more nodes than another, and vice versa. In order to circumvent this issue, the particle swarm optimization (PSO) method is employed to do uniform clustering. The node's energy level is used to choose the CHs once the clusters have formed. When the CHs use more energy to send data to the BS, the node may die. To maintain data transmission after a CH death, the vice cluster head assumes responsibility for the CH and uses data from other nodes to do so. Each non-cluster-head node determines its cluster head based on the intensity of the signal received; a stronger signal suggests a shorter distance between them, and a shorter distance requires less energy to transmit.

Advantage:

In addition to saving energy, it does not need any input from the user

Disadvantage:

There is no utility for a cluster if the cluster leader dies, hence the clusters are randomly split apart.

Synchronous Firefly Algorithm (FA) for Routing ,

Using the Firefly method, the path from CH to BS of each cluster may be found out. To begin, we must initialise the firefly. In this diagram, each firefly symbolises a path from the CH to the BS. The firefly's size is determined by multiplying the number of CHs and BS positions together. To get the data to the BS, each point indicates a hop in the CH's path to the next-hop location. Each iteration updates the positions of the fireflies, with the one with lower brightness moving toward the one with higher brightness. For as many generations as possible, the procedure is repeated. To calculate the fitness function, the next-residual hop's energy, the Euclidean distance from CH to BS, as well as the number of CH members in the next-CH hop's are all taken into account. There is a unique ID assigned to each sensor node. Local packet monitoring, local detection engine, cooperative detection engine, and local response engine are all components of the IDs. By listening to the surrounding nodes, local packet monitoring is employed to acquire the data.

This method is similar to PSO in that it is used to pick the cluster head. Clustering is one of the most important aspects of WSNs in terms of performance metrics like packet delivery ratio, energy consumption, and so on. Swarms of fireflies inspired this design.

In terms of reproduction, the most highly rated firefly are the best. As a result, only the most desirable features are handed on to future generations. This method offers a good rate of convergence and avoids having numerous local maxima at the same time.

Advantage:

Effective in multi objective optimization

Disadvantage:

Works for only randomly deployed nodes.

Particle Swarm Optimization:

Akyildiz et al[8] developed a particle swarm optimization (PSO) patterned on the behaviour of a flock of birds in terms of how they seek and exploit the multi-dimensional search space for food and shelter, i.e., the choreography of the birds. PSO's goal is to locate particle placements that provide the best assessment of the specified fitness function. Each particle is given a random starting location and velocity in the search space during the setup phase of PSO. Each particle has its own personal best, which is termed Pbest, throughout each generation (iteration). CH selection and cluster creation are the first two stages of the method. PSO informs the CH decision. Remaining energy and distance parameters are used to choose CHs in the CH selection algorithm First, all of the sensor nodes communicate their position and residual energy to the base station, which checks to see whether the average energy of the sensor nodes is high enough to be eligible for a CH. Once the CH selection procedure has been executed at the base station, the cluster creation step is completed. We develop the weight function for cluster formation using different characteristics such as the distance, energy, and degree of the nodes of CHs. Our suggested PSO approach for CH selection and the cluster formation phase are described in depth here before we give the Linear programming formulation of the cluster head selection issue.

Advantage:

Inherently continuous no overlapping and mutation calculation

Disadvantage:

Not works for non-coordinated system

Gravitational Search Algorithm:

Rashedii et al[9] developed a nature-inspired programme, the Gravitational Search Algorithm (GSA), to handle optimization challenges. The Newtonian laws of gravity and motion serve as inspiration for the design of GSA. It includes a quick introduction to GSA, as well as a list of prior GSA-based optimizations. For the vast majority of optimization issues, it is capable of offering a more accurate, effective, and sturdy high-quality solution.

There are several applications for the method, including power system design, controller design, network routing, sensor networks, software design, and many more areas of optimization. Parameter, setting and strategy optimization have all benefited from the addition of GSA to the process. Optimizing microgrids, controllers, software, and antenna designs have all been made possible because to modifications to the algorithmic formulary. Based on prior studies, GSA outperforms PSO, ACO, and ABC when it comes to addressing complex optimization issues. Many more research based on GSA are planned in the future, since this technique offers a lot of promise for solving a wide range of optimization issues in numerous fields.

The law of gravitation[4] served as an inspiration for this method. Newtonian physics is used to describe the search agents as a collection of objects that interact with one other. All masses are solutions, and the algorithm must balance between gravitational and inertial mass, and the heaviest of them all will provide an ideal solution in the search space. The heaviest item is separated from the rest of the population by the force exerted on it, which is the best solution. The non-linear optimization issue of WSN localisation is solved using GSA. WSN relay node placement issues and energy efficient multi-sink placement issues are also handled utilising this technique.

Advantage:

It provides Effective and robust high-quality solution for most of the optimization problems

Disadvantage:

Search space identification, randomized initialization

Ant Colony Optimization:

WSN capabilities can be extended using Darigo's ant colony optimization (ACO) method, which is commonly used to improve routing, energy efficiency, and energy consumption (ACO behaviour that is able to construct optimal routing path from source node to destination node which eventually improves the energy efficiency). An ant's capacity to communicate between sensor nodes by utilising pheromone values to determine the position of the target node allows the ACO algorithm to adapt to a wide range of topologies. According to the conditions of each sensor node, the optimal path constructed by ACO in WSN can change from time to time.

ACO algorithm can also improve packet submission where packets are only sent to destination nodes by using the optimal path, which is based on remaining energy, distance, and pheromone value. Before packets are sent, Ant will travel about the WSN environment to identify the best route (Jabbar et al., 2015). Additionally, this strategy may decrease packet loss and eliminate dead nodes if only high-capacity sensors are used for routing determination.

There are situations when more than one ant may be deployed simultaneously to watch and determine which route is optimum for sending a packet from the source node to the destination node using the ACO algorithm (Zhu et al., 2010). To maximise the likelihood of finding an alternate ideal route quickly in the event that the present optimal path becomes less desired, this strategy may be used.

Advantage:

Can be used in dynamic applications.

Better for travelling salesman problem .

Disadvantage:

Local search is not sufficient.

Consumes large amount of energy if more number of paths

Lyapunov Optimization:

It's the energy collecting mechanism of renewable energy devices that this technology C. Qiuc et al[10] addresses. Average power level and error rate are two requirements that must be met to optimise the number of accurate bits in packet transmission. To tackle the Lyapunov optimization issue, virtual queues are introduced. Adapting the transmission power and modulation type while taking the channel and battery status into account is necessary to accomplish an objective function. Energy harvesting wireless communication systems have a longer battery life. Managing gathered energy is difficult because of the uncertainty of how much energy will be harvested in the future Energy harvesting sensor communications have a fundamental challenge: how to maximise the use of the renewable energy that is captured. To change the long-term average optimization problem into a drift-plus-penalty optimization problem. Our online approach, which only considers the current time slot, finds an upper limit on the drift-plus-penalty.

Advantage:

The battery lifetime of an energy harvesting wireless communication system is maximized.

Disadvantage:

Delay and power consumption are jointly optimized.

SR/ No	Optimization technique	Energy Consumption	Time Synchronization	Routing	Dead node	Delay	Network lifetime
1	Genetic Algorithm	✓	✓	✓	×	×	✓
2	Clustering using Bacterial Foraging Optimization	✓	×	✓	×	✓	×
3	Routing using Bacterial Foraging Optimization	✓	×	✓	×	×	✓
4	Artificial Bee Colony Optimization	✓	✓	×	✓	✓	✓
5	Routing using V Leach	✓	×	✓	×	×	✓
6	Synchronous Firefly Algorithm	✓	✓	×	✓	×	✓
7	Particle Swarm Optimization	✓	✓	✓	✓	×	✓
8	Gravitational Search Algorithm	✓	×	✓	✓	✓	×
9	Ant Colony Optimization	✓	✓	✓	×	✓	✓
10	Lyapunov Optimization	✓	✓	×	×	✓	✓

Comparison of various Optimization technique in WSN

CONCLUSION:

With the development of numerous optimization strategies, the relevance of WSN has been shown, which includes power consumption, fault tolerance, topology dynamics, transmission medium, and scalability in terms of WSN's overall performance. The study explains wsn optimization strategies in order to discover the ideal number of cluster heads in order to minimise energy consumption while enhancing network life span. Each method may be seen as a milestone in a particular field, a new approach to an old problem. Sensor nodes in a WSN may work together to accomplish a variety of tasks. Disaster preparedness, healthcare, and the military all make use of it. In order to improve services, a routing system that relies on energy consumption may be needed. Each node's life duration was increased by using and enhancing its leftover energy.

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