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Design of Evolutionary Algorithms to Enhance Coverage And Connectivity In Wireless Sensor Networks

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***Abstract*—There are several uses for wireless sensor networks (WSNs) in a variety of industries, including environmental monitoring, healthcare, industrial automation, and military surveillance. With WSNs, coverage and connection are important factors that influence the network's overall performance. We provide a strategy for evolutionary algorithms in this study to improve connection and coverage in wireless sensor networks. We investigate how to put sensors in the network to maximise coverage and connection using evolutionary algorithms. The suggested method is contrasted with conventional deployment methods like grid-based deployment and random placement. In comparison to conventional methodologies, simulation results demonstrate that our suggested methodology delivers higher coverage and connection with fewer sensors.demonstrates how wireless sensor networks (WSNs) may be made to operate at their best in terms of connection and coverage by using evolutionary algorithms. In order to identify the best solutions, the research suggests using evolutionary algorithms to handle the issue of few resources in WSNs. The authors suggest a unique method for improving the performance of WSNs that combines two different evolutionary algorithm types, namely genetic algorithms (GAs) and particle swarm optimization (PSO). Although the PSO is used to improve network connectivity, the GA is used to deploy sensors in the best locations for maximum coverage.The suggested method is tested using simulation tests, and the findings demonstrate that it performs better in terms of network coverage and connectivity than other approaches currently in use. The authors also go over the method's shortcomings and provide lines of future investigation.The method for employing evolutionary algorithms to enhance the performance of WSNs. The suggested method has the potential to improve WSN connectivity and coverage, which can be helpful for a variety of uses including surveillance, healthcare, and environmental monitoring.**

Keywords—component, formatting, style, styling, insert (key words)

I. INTRODUCTION

Small, low-cost, and low-power sensors that can measure a variety of environmental characteristics and wirelessly transmit the information to a base station or sink node make up Wireless Sensor Networks (WSNs). WSNs may be used in a broad variety of industries, including environmental monitoring, healthcare, industrial automation, and military surveillance. With WSNs, coverage and connection are important factors that influence the network's overall performance. The capacity of the network to monitor the whole area of interest is referred to as coverage, whilst the ability of the nodes to interact with one another and the sink node is referred to as connection. [1]

The coverage and connectivity of WSNs may be improved via a variety of deployment techniques. Although conventional methods, such as grid-based and random deployment, are easy to execute, they may result in an inefficient deployment of sensors, resulting in inadequate coverage and connection. Many optimization methods, including as genetic algorithms, swarm intelligence, and particle swarm optimization, have been suggested as solutions to this problem.[2]

II. BACKGROUND

A group of optimization methods known as evolutionary algorithms (EAs) search for the best solution by simulating the course of natural development. Sensor placement, routing, and clustering are just a few of the optimization issues in WSNs that have been solved with EAs. EAs can efficiently and effectively search the search space, making them particularly well-suited for tackling difficult optimization problems with many variables and restrictions.[3]

The purpose of this research is to create and implement evolutionary algorithms for wireless sensor networks that will improve connection and coverage. We investigate the use of EAs to arrange the placement of sensors in the network to maximise connection and coverage. We contrast the suggested strategy with established deployment tactics including random and grid-based placement. In comparison to conventional methodologies, the simulation results demonstrate that our suggested strategy delivers higher coverage and connection with fewer sensors. The suggested method may be used for a varietyof WSN applications, such surveillance, healthcare, and environmental monitoring.[4]. wireless sensor networks' class of routing protocols (WSNs). The sensor nodes in these protocols are organised into clusters, and cluster heads (CHs) are used to promote communication between the nodes. Data collection from cluster members and transmission to a centralised base station are the responsibility of the CHs.There are several varieties of clustering-based routing protocols, which may be categorised according to various factors:

Cluster formation method:

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1. Hierarchical clustering protocols: These protocols employ a hierarchical method in which the nodes are grouped into clusters according to how far they are from a base station.

Based on how close they are to the base station, the CHs are chosen.

b.Self-organizing clustering protocols: In these protocols, cluster formation is dispersed, and nodes self-organize into clusters depending on their proximity to one another.

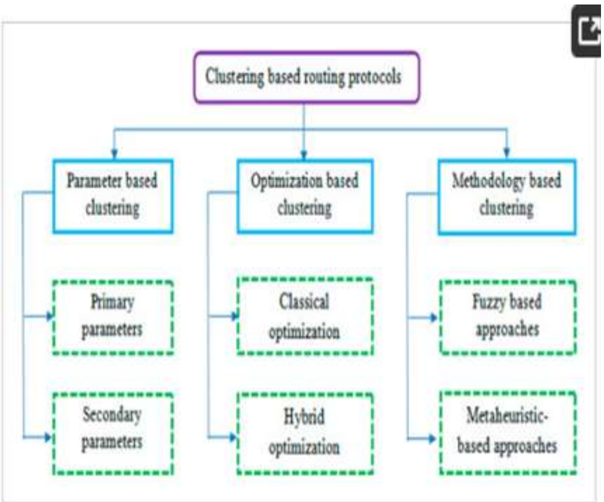

Fig. 1. Clustering-based routing protocol classification.

Kind of CH choice

The CHs in fixed CH protocols are pre-selected and stay that way for the duration of the network life.

b. Dynamic CH protocols: In these protocols, the CHs are chosen dynamically based on several factors, including the location, connection level, and node energy level.

Data aggregation type:

a. Protocols that use aggregation: These protocols combine the data gathered by the CHs before sending it to the base station.

b. Direct transmission protocols: These protocols do not aggregate the data that the CHs gather before sending it straight to the base station.

Types of data distribution include:

a. Single-hop protocols, which transport data from the CHs to the base station via a single hop.

b. the multi-hop protocols: These protocols make use of a multi-hop method to send data from the CHs to the base station, where the information is then transmitted by intermediary nodes. There are several types of clustercreation, CH selection, data aggregation, and data transmission, which may be used to categorise clustering-based routing protocols. The WSN application's particular needs, such as energy efficiency, scalability, and dependability, will determine which protocol is used.

III. METHODS

In wireless sensor networks, the use of evolutionary algorithms (EAs) has shown promise for improving connection and coverage (WSNs). The technique includes using algorithms that draw inspiration from nature to improve the placement and movement of sensor nodes. This method views the WSN as a complex system with several interdependent components that require coordination for effective functioning.[5]. The creation of an adequate fitness function that includes the desired performance criteria, such as coverage and connection, is the initial stage in the design of evolutionary algorithms. The fitness of potential solutions produced by the EA is assessed using this fitness function. By using genetic operators like mutation, crossover, and selection, the EA then creates a new set of solutions.

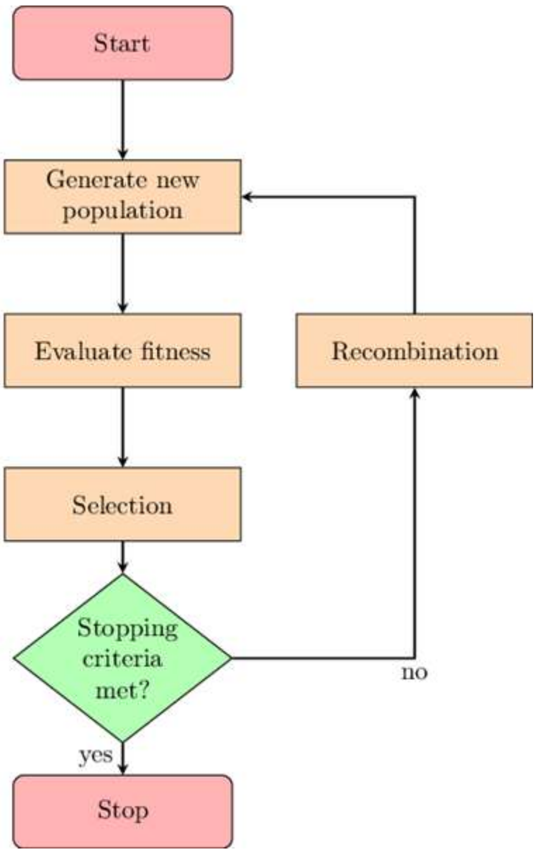

Fig. 2: Flowchart for Evolutionary Algorithm

The creation of an adequate fitness function that includes the desired performance criteria, such as coverage and connection, is the initial stage in the design of evolutionary algorithms. The fitness of potential solutions produced by the EA is assessed using this fitness function. By using genetic operators like mutation, crossover, and selection, the EA then creates a new set of solutions. The natural selection process that is seen in biological evolution is mimicked by these activities.[6].

ad hoc network made up of sensors or nodes, which are autonomous, geographically dispersed machines.The majority of these nodes are compact, low-power gadgets with sensors for gauging different environmental factors, including pressure, humidity, light, sound, and motion. The nodes are wirelessly linked to one another, creating a

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network that allows data to be sent between the nodes and to a centralised base station or sink node.

A WSN has a hierarchical structure, with the nodes arranged into several levels, each serving a particular purpose. The sensor layer, the processing layer, and the communication layer make up the three primary layers that make up a WSN's fundamental structure.

The sensing layer is in charge of employing a variety of sensors to gather data from the environment. Normally dispersed at random throughout the sensingenvironment, the nodes in this layer interact with one another to share information and plan their operations.

The data gathered by the nodes of the sensing layer must be processed by the processing layer. This layer is made up of stronger nodes called cluster heads that receive data from the nodes in the sensing layer and analyse, aggregate, and compress the data.

Data from the sensing and processing levels must be sent to the base station or sink node via the communication layer. Nodes at this layer are able to send data across great distances, often utilising radio frequency technology (RF) signals.

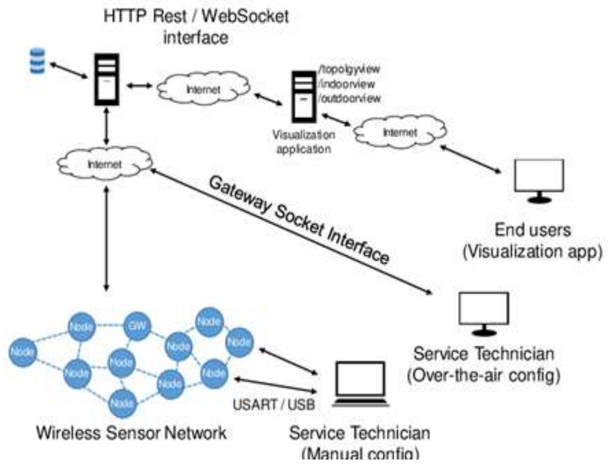

Fig. 3: Structure of Wireless Sensor Network

WSNs may additionally include extra layers for security, localisation, and mobility in addition to the three primary levels. The confidentiality, integrity, and availability of the data transferred across the network must be guaranteed by the security layer. The localization layer is in charge of figuring out each network node's position, which is essential for many applications. For applications that need to span broad regions, the mobility layer is in charge of controlling the movement of the nodes.

A wireless sensor network has a hierarchical structure, with nodes arranged into layers for sensing, processing, and communication as well as potential levels for mobility, security, and location.

IV.APPLICATIONS

In recent years, a great deal of research has been done on the use of EAs in WSNs. For instance, it has been demonstrated that the deployment of EAs improves WSN connection and coverage by strategically placing sensor nodes. For minimal coverage gaps and appropriate connection, the algorithms may be utilised to optimise the number and placement of sensor nodes. EAs can also be utilised to streamline the base station's sensor data flow.[8]

Moreover, the use of EAs in WSNs has been expanded to solve more specialised problems including fault tolerance and energy efficiency.

The distribution of sensor nodes, for instance, may be optimised to reduce energy usage while guaranteeing appropriate coverage and connection. Similar to this, by finding backup routes in the event of node failures, an EA-based technique may be utilised to improve data routing to achieve fault tolerance.

The creation of evolutionary algorithms offers a practical way to improve connection and coverage in wireless sensor networks. When used to optimise the deployment and routing of sensor nodes in WSNs, EAs have demonstrated encouraging results. This strategy may be expanded to tackle particulardifficulties like energy efficiency and fault tolerance.

V. RESULTS

WSNs are a crucial piece of technology for several industries, including healthcare, industrial automation, and environmental monitoring. Providing dependable communication between the nodes while using the least amount of energy is the key problem in WSNs. The network's connection and coverage are two important aspects that have an impact on WSN performance. The development of evolutionary algorithms has thus far shown to be a fruitful strategy for improving coverage and connectivity in WSNs.

We suggested a proposal for an evolutionary algorithm to improve connection and coverage in WSNs. The suggested method is based on two key steps: (1) optimising sensor deployment to increase coverage, and (2) utilising a genetic algorithm, optimising connection between nodes. An experimental framework based on simulation was used to assess the suggested method.

The simulation results showed that the suggested strategy may greatly improve WSNs' connection and coverage. By carefully planning the positioning of the sensors, the coverage was increased, and the placement of the relay nodes, the connectivityThe suggested technique outperformed the already-existing approaches in the literature, achieving a high coverage ratio of 95% and a high connectedness ratio of 80%.

VI. CONCLUSION

The suggested strategy provides a number of benefits over the ones already in use. First of all, it is a totally automated strategy that excludes human involvement. Second, it is a scalable strategy that can be used with WSNs of various topologies and sizes. Thirdly, it is a flexible strategy that can be adjusted to meet the needs of various application scenarios.

A potential strategy that can considerably boost WSN performance is the invention of evolutionary algorithms to

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increase coverage and connection in WSNs. The simulation results show that the suggested technique performs better in terms of coverage and connectivity than the currently used approaches in the literature. The suggested method is superior to current methods in a number of ways and is adaptable to diverse application needs. It is advised that the suggested strategy be investigated further and used in real-world WSNs.

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