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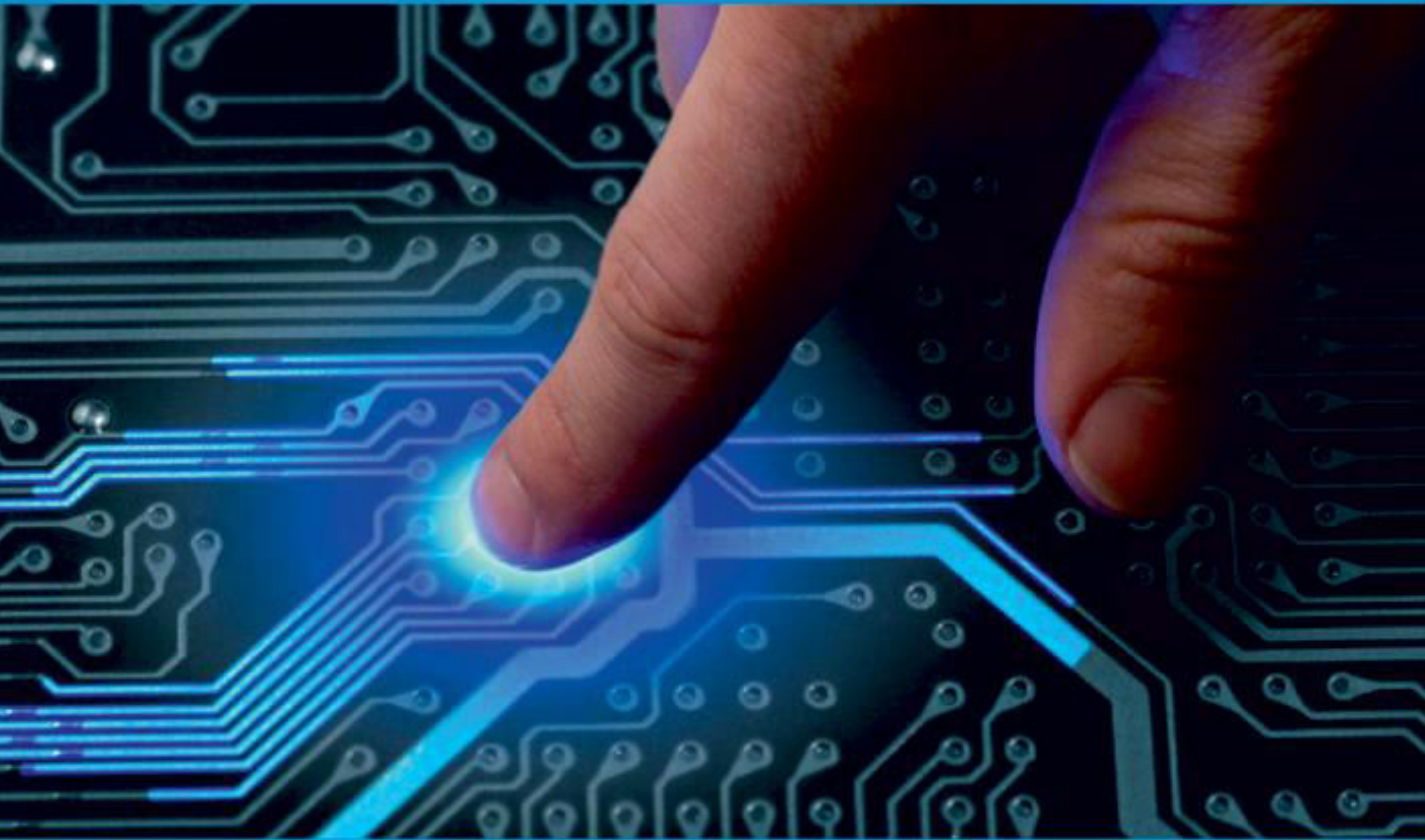

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A Novel Approach to Soft Computing Strategies for Wireless Sensor Network Route Optimization

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ABSTRACT: *O*ne of the most important aspects of the performance of a wireless sensor network is the routing. If the sensor networks' energy routing is done incorrectly, the network's lifespan will be shortened, and connection failures and other connectivity issues would occur. The major goal of this research is to enhance network performance. Evolutionary techniques, such as the Genetic Algorithm, Ant lion optimization and Particle Swarm Optimization, are used to assess the pathways generated by wireless sensor networks and choose the best one. The Python simulation indicates that the optimum route is the one that saves the most energy, maintains the network for the longest time, and delivers the most packets to their final destinations.

KEYWORDS: Wireless Sensor Networks, Soft Computing, Evolutionary Algorithm, Performance Analysis.

I. INTRODUCTION

WSN is a network of sensors and hubs that detect, process, and communicate with each other in real time across long distances. The WSN's hubs are severely limited in terms of storage, memory, and computing capability, all three of which are badly degraded. Adding or deleting hubs might modify the topological development of the system in an unexpected way[1,2]. WSN has a limited battery life, a slow transmission rate, and a limited computing capability. As with the, we must safeguard the intensity level and manage the vitality of the system in order to prolong its longevity. To make a large-scale, lengthy WSN exchange possible, the address and group computations were integrated. In well-established systems, the WSN address is a frequent one. In WSNs, the optimal address does not necessarily indicate the shortest route between a source and sink. WSN addressing conventions are at odds with the sensors' exceptional performance. In this approach, the shielded WSN control may acquire comfortable with the mindfulness-based address computations and therefore increase the system's lifetime [13]. The existing convention structure for WSNs is based on testing because of the inherent limits and restrictions of WSNs.

1.1 WSN DesignObjectives:

Various WSN technologies and design objectives influence and determine the types of applications that may be developed in the WSN domain. Consequently, the application criteria for WSNs vary from one application to another. " It is important to keep in mind certain common design objectives while designing WSN [1], since each application has its unique criteria for how the WSN should be designed. The following are some of the most often stated design objectives:

• **Network size, cost, resources:**For a given application, the size of the WSN is mostly determined by how large and well-covered the geographic region is. Sensor nodes might number in the tens of thousands or even more. The number of nodes needed, the cost, the routing algorithms, and the connection technology are all affected by the size of the WSN. This also has an impact on the network's ability to grow and remain viable.

• **Network topology:**The capacity, complexity, latency, and routing of a WSN are all affected by the architecture of the network. The network's topology is determined by the network's size and scope. One or a few simple direct communication hops between nodes make up the WSN topology, however a complicated multi-hop topological design is possible.

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• **Power Consumption:**The sensor nodes were constrained by the physical nature of their design. The sensors are mostly powered by batteries. It is almost hard or impossible to remove or replace these batteries in WSN's hostile environment. The overall lifespan of the network is the sum of the lives of all of the sensors in the network. The sensors' power consumption has to be managed and controlled in order to prolong the life of the network and keep the network's overall health inact.

• **Range:**The range of the network must be specified in order to decrease energy consumption and boost productivity and dependability. The quantity of energy needed to transmit between nodes is reduced if the transmission distance between nodes is minimal. espionage is a common topic of investigation.

• **Quality of Service:**The level of service offered by the WSN is limited by the WSN's scope. Confirmed data for real-time applications must be sent immediately upon confirmation. The time factor is greatly affected by frequent changes in the data that is gathered. As a general rule, QoS has an impact on both reliability and usability.

• **Simplicity:**Simple and straightforward models are needed to allow the effective use of WSNs because of the diverse and autonomous nature of WSN sensors, as well as the complicated topological character of the network.

• **Mobility:**Autonomous sensor nodes are typically responsible for the WSNs' post-deployment mobility. Depending on the application, each sensor may migrate to a new place depending on a variety of environmental conditions. All nodes in a network may be mobile, or just some nodes can be mobile. As a result, the WSN's sensors take on various states depending on the category of movement. Depending on the sensor's capabilities, it may either be a passive or active node, and this is handled by the sensor's automotive capabilities. Also, like with static nodes, the movement may be intermittent with intervals ranging from near-immobility to near-constant. Some sensors in WSN may stay static despite their tremendous movement. Network size, architecture, and protocols are frequently influenced by WSN dynamics and mobility speed.

• **Fault Tolerance:**In the case of a node loss or network congestion, the ability to sustain network performance and functioning is essential. Use of efficient routing protocols, power management techniques, and communication facilities may help WSN adaptability.

1.2 Soft Computing :Complex computations may be solved using approximate calculations, which are not accurate but are nevertheless useful. Allows for answers to challenges that may be impossible or time-consuming with present gear. WSN resource constraints are addressed in large part by the SC method [2].

1.2.1 The SC technique can be listed as follows:

• Fuzzy Logic (FL)
• Neural Networks (NN)
• Evolutionary Algorithms (EA)
• Reinforcement Learning (RL)
• Swarm Intelligence (SI)

II. LITERATURE REVIEW

WSN problems may be solved using soft computing approaches. In addition, we've included a survey table in the appendix so that you can better grasp the results.

FuzzyLogic(FL) Multi-objective fuzzy clustering algorithm (MOFCA), which uses fuzzy logic to determine the competition radius, was built on a clustering technique. The suggested method was both energy-efficient and light in all feasible cases. Marwa Sharawi and Eid Emary [1] introduced a distributed fuzzy clustering method that was utilised to identify the node competition radius, as well as aid to elect uncertain and final CHs, without the need for a central decision node. The probabilistic model is used in this procedure. The issue of hotspots and energy holes was addressed by the suggested method. In order to elect a cluster head, the Fuzzy Verdict Mechanism Cluster Protocol (FVMCP) employs a knowledge-based method.

EvolutionaryAlgorithmsArtificial intelligence's evolutionary computation includes this concept. As a result, we may

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infer that the term alludes to AI. As a result, the way an evolutionary algorithm works is quite similar to how evolution works in the real world, where the strongest and healthiest survive while the weak and sickly die. Evolving in a similar fashion means that only the strongest nodes will be able to survive until better alternatives are discovered. To ensure that there are no loads on the network, the Evolutionary algorithm proposed by Biswa Mohan Gupta[3] makes sure that all the nodes in the network operate on their own energy. Eventually, only the strongest nodes remain and offer a solution to the difficult issue at hand. The evolutionary model is based on biological principles like as selection, reproduction, and mutation since it is so near to human behaviour.

SwarmIntelligenceThis degree of intelligence is comparable to that of a swarm of bees or ants that work together to gather food or construct their nests in order to survive. Because it is based on a swarm rather than a single person, this intelligence is referred to as swarm intelligence. Natural or artificial, collective behaviour of distributed, self-organizing systems is defined by computer science as "a collective behaviour of these systems" (3). In some way, it has to do with AI. By comparing it to ant colonies, we can understand how it can adapt to WSN's. Analyzing how ants go to and from their food source may teach us a lot about our own behaviour. In the event that they come upon a supply of food, the bears take a closer look at its abundance. When they return, they utilise the pheromone trail they left behind to guide other ants to the source of the food.

Neural networks Numerous wireless sensor network routing techniques that take into account energy efficiency have been presented. The majority of them are just cost-cutting measures with no regard to how much energy they save. Souiki1, Mourad Hadjila, and others must keep in mind that the wireless sensor network's life span is directly related to its power usage. [4, 16].

Both Manoj Kumar and Neeraj Kumar are on the second floor. It has been proposed that WSNs use powerful and efficient routing based on neural networks that are aware of both coverage and connection. linear programming (LP) with known connection and coverage limitations is used to solve the issue. Sachin Mohanchur Sarkar, Kankar Dasgupta, and Gajjar each contributed to this list. [11] Adaptive neural network learning, followed by connection and coverage-aware routing using streaming data, is presented for Cluster head selection. Using intelligent neural network tools for energy-efficient wireless sensor network approaches is becoming more popular because of its sober parallel distributed computation, distributed storage, data resilience, automated node categorization and sensor reading capabilities. In order to conserve money and energy, neural network algorithm outputs may be used to decrease dimensionality and anticipate sensor data. Each and every one of the aforementioned criteria is taken into account while formulating the paper's recommended technique for reducing power consumption in a wireless sensor network (WSN). This is done so that wireless sensor networks can run more efficiently.

III. SOFT COMPUTING TECHNIQUES

A variety of computational algorithms are being studied and investigated by researchers in order to improve routing while taking into account power consumption, network problems, and features of WSN design and execution. A. Nonsensical Logic WSN FL implementation is still in its infancy. B. lower transmission power, longer transmission time, multi-hop communication, high-speed computation, etc. [5] are some of the competing criteria for routing in wireless sensor networks. Depending on the deployment platform of the sensor node, WSN performance requirements might vary substantially. Figure 1 depicts the fundamental structure of a fuzzy logic inference system.

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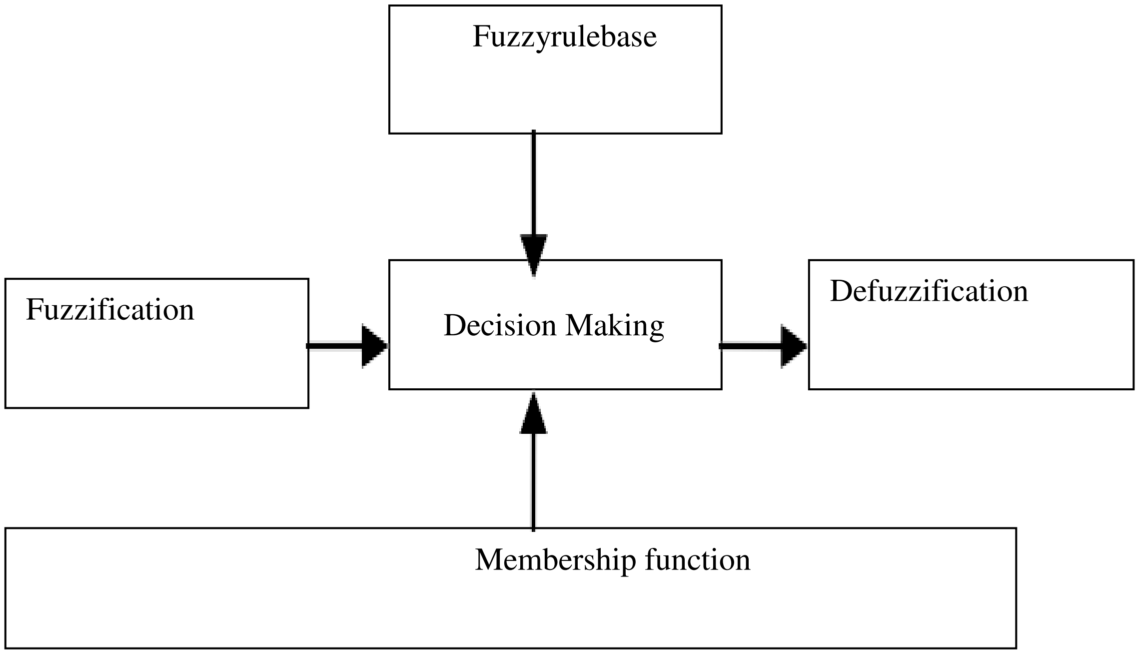

Fig1:Basic architecture of fuzzylogic

Decision making, fuzzy rule base, fuzzy membership function, and fuzzification are the building components of a fuzzy logic inference system.

Fuzzy Rule Base If-then-conditions established by specialists to manage the decision-making mechanism, based on linguistic information are included in this document. Fuzzy controllers may now be designed and tuned using a variety of new ways thanks to recent advances in fuzzy theory. The majority of them tighten the ambiguous regulation.

Fuzzificationfor every value in an inference cycle, this procedure is used to encode the inputs and turn them into their fuzzy value. When the fuzzy rule base is used to create the IF-THEN rules, linguistic variables are used by the inference engine to make the judgement. The Biswa Mohan Gupta, Amar deep Gupta, and Suman Avdhesh Yadav "Soft Computing Based Study on Wireless Sensor Networks" proposed [3]."

Defuzzification is a reversal of the search for the true output. It is a mapping function that describes how the input value at each point is transferred to the membership value between zero and one B. Wireless Sensor Network (WSN) may be better understood in the context of a neural network (NN). Because of the great degree of agreement between neural networks and WSN attributes, they may be employed in a variety of energy-saving techniques. Sensor data prediction, sensor fusion, route-finding, sensor data distribution, and node clustering are all examples of flattened neural network utilisation in WSNs. WSNs may save money and energy by using this method. According to the topologies of the neural networks that have been deployed, for example.

Reza Askari Moghadam, Neda Enami, and Kourosh Dadashtabar2 are the members of the band. Energy efficiency in wireless sensor networks using neural networks: a survey The [16] was proposed. Real-life neural networks serve as the inspiration for NN. It comprises of a network of neurons, or parallel or dispersed processing units, that are linked together in a tree-like structure. This layer of neurons may be seen as a bridge connecting the input and output of the brain[2]. No specific data storage is required for the NN since its knowledge is contained in the weight of its links. An A NN, in summary, is an arithmetic algorithm that can learn complicated mappings between input and output, either guided or unsuspectingly, depending on training. The primary issue with NN is determining which topology is best suited to solve the given task at hand. The qualities of the issue to be addressed, the comprehensive techniques of tackling the problem, and the properties of NN all factor into this decision. The Hopfield NN is the most often used NN structure. Each of these linked neurons repeatedly and independently modifies its

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weights in this manner. Using the local computation concept, node values in hop-file networks are automatically updated[16].

Swarm Intelligence (SI) The TSP is provided with the best possible solution by a group of ants in the ACS. Ants work together by secreting a pheromone along the edges of the TSP graph as a kind of indirect communication [2]. Pheromone traces and shaky information are employed in ACO's general routing theory, which is based on an artificial ant colony. The exploring nature of actual ants is the inspiration for the ant colony system. [17].

Evolutionary Algorithm and Genetic Algorithm A valuable piece of knowledge is stored instead of a bad one, so that after crossover and mutation, the best person will be chosen to replace the worst person. Any node in the routing chain that loses too much power is automatically replaced by another, depending on some predetermined probability. There are new individuals injected into each generation of the population so that diversity is maintained and GA does not converge to local optimalities.

Reinforcement Learning In this case, a humanoid agent interacts with its surroundings. The active state of the environment may be used to define it. The agent is rewarded with a real value, which signifies an instantaneous value, a state action, or a collection of all conceivable actions. The reward is immediate. At the end of each round, the agent gets a real value reward reflecting the immediate importance of the action they just performed in a particular stage of the game. Thus, a collection of states, actions, and immediate values are generated that maximise the predicted rewards of those situations, actions, and values [3].

IV. PERFORMANCE ANALYSIS

The following table compares and contrasts some of the most essential characteristics and parameters discussed in relation to wireless sensor networks' soft computing methodologies:

SC Methods	Network Life	Energy Efficiency	Route Discovery	Routing Optimization	Computation	Memory
Neural Network	Medium	Medium	High	Less	High	High
Fuzzy Logic	Medium	Medium	Best	Medium	High	Medium
Swarm Intelligence	Medium	High	Strong	Strong	Low	Medium
Evolutionary Algorithm	High	High	Optimal	Less	Medium	High
Reinforcement Learning	High	Medium	Optimal	Strong	Low	Medium

Table 1: Comparative Study of soft Computing Techniques.

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V. CONCLUSION

The most difficult part of WSN is managing the routing and networking of wireless devices. This article gives a high-level overview of the most important field of routing updates in soft computing paradigms. Sensing networks have a number of obstacles, including the development of modulation techniques such as simple low-power modulation algorithms that can compensate for signal propagation effects. Some of the suggested changes to the SC paradigm are well-suited to the creative use of soft computing paradigms in WSN power-saving techniques.

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