UNDERWATER ACOUSTIC SENSOR NETWORK & SOFT COMPUTING TECHNIQUES

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Abstract:

In today's world, Underwater Wireless Sensor Networks (UWSN) have become more and more necessary for multiple applications such as measuring water levels, tracking offshore issues, and tracking the impacts of underwater conditions. Based on surveillance records, such as the harshness of waves, salty state and ocean, the observation is based on the observation. The lack of balance in energy consumption results in some sensor nodes getting damaged, resulting in holes. In the proposed work, we compare Beetle Antenna Search Algorithm with Genetic Algorithms for optimizing USWN selection. Deep learning and optimized energy consumption with 20.83% are compared with genetic algorithms with 17.34%. In addition, protocols that classified network nodes by bandwidth and lifetime gave results of 30.76%, which is lower than existing algorithms.
Keywords: Wireless Networks, Wireless Sensor Networks, sensor data, Underwater WSN, communication.

I. INTRODUCTION

Communication among the sensor nodes can take place either in a direct or indirect way. In the former mode, the path of communication is between source and destination nodes. Presence of intermediate nodes among the source and destination is in case of indirect ones (Alablani et al. 2021). Data storage along with transmission are the major functions of the sensor nodes. Base station receives the data that is being sensed. Building blocks of sensor networks are the field of sensors, corresponding nodes and base station. The region where nodes are located is called a field and these nodes constitute electronic devices (Gul et al. 2021). The central point of control in a network is called a base station which is used for extracting information. Laptops, mobile devices can be used as a base station and internet can be used for exchange of data among them.

Due to deployment of sensors in an immediate manner, they are used in surveillance of video and also in military applications (Li et al. 2019). Tracking of objects such as vehicles can be done and users can be notified of the movement. Various target tracking operations can also be performed. Environmental conditions are monitored and users are notified based on their status. These conditions may include temperature with rainfall as well as humidity and so on. Additionally, detection of flood, spread of fire and other situations can also be monitored with the help of WSN (Yang et al. 2019). Historical data is compared with the present data and notifications are sent based on predictions. Smart homes employ sensors for proper functioning of devices such as air conditioners for fixing the temperature of the room being used. Additionally, washing machines also employ sensors and are involved in estimation of detergent quantity for washing clothes. For distant operations sensors are applied to communicate with the help of satellites. Based on the functionalities, there are various types of WSN available as discussed in the next section.

WSN can be categorized based on the region where the sensors are employed and also on their functions. Its major types are shown in Figure 1 and discussed below-

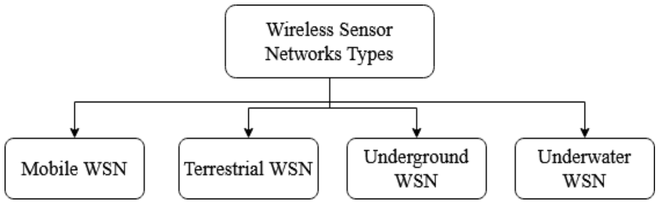

Fig. 1 WSN Types

Nowadays, there is remarkable growth in technology and wireless sensor networks. These are primarily used for the purpose of communication. Communication between devices may be wired or wireless, hence, the chance of attacks through the networks is increasing daily. For secure communication, intrusion detection and prevention are primary concerns. Thus, analyses of intrusion detection and prevention techniques have become an important part of the engineering field. With the assistance of intrusion detection and prevention system, we are able to determine and then notify the normal and abnormal activities of the users. Thus, there's a requirement to design effective intrusion detection and prevention system by exploitation machine learning and deep learning for wireless sensor networks. In this work, a comparative study and performance analysis of different machine learning and deep learning techniques are given for intrusion detection and prevention system. The performance evaluation of these techniques is done by experiments conducted on WSN-DS dataset. The comparative analysis shows that deep learning classifiers shows better intrusion detection results than machine learning techniques. In this work, Convolutional Neural Network classifier is used. Data sharing in between many communication devices is nowadays common to understand the data range, ratio, frequency and overlap issues also read from the interconnected devices only. Based on the aquatic description gathered from various underwater applications such as sensor data, water intense, node issues, energy delay or consumption related delay can be monitored frequently. Network is one of the basic needs for underwater acoustic communications where many sensors are in access and exchanging major data. There are many optimized features that bring challenges like consuming energy level, latency may increase or decrease while constructing the execution procedure based on network levels. There are many protocols applied in network interaction such as the address of each Internet protocol (IP) that gets instant updates. The UWSN environment with IP address routing challenges are responsible for network lifetime, connectivity maintenance in an efficient manner, energy in constant range, routing update adaptation.

Problems related to design in the field of engineering are based on requirements of the design finding process thereby satisfying the provisions for code along with the limitations associated with it. Material type needs to be analyzed while producing the product along with the dimensions of the materials used. In this regard, product expenditure will also be considered. Designers can use either their experience or their ideas for developing a method to solve the problem. Additionally, optimization also helps in achieving the objective where the resources are effectively utilized. The solutions obtained from optimization selects a specific value for the parameters used in the objective function.

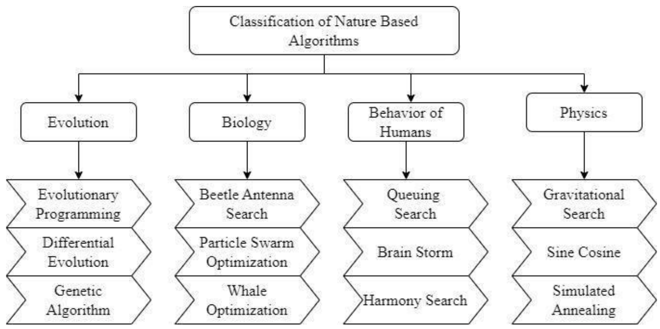

Fig. 2 Classification Category

Due to flexible nature and simple procedures, the researchers are attracted towards Meta heuristic approaches. They also play a major role in various applications including several engineering domains. Natural phenomena are being simulated based on the behavior of either animals or environmental factors. Further classification of these algorithms (Shaikh et al. 2022) is shown in Fig. 2.

Beetle Antennae Search (BAS) Optimization Algorithm

The working of the algorithm is based on the beetles with antennae which are longer in length. From the beetle family, the ones with long horns are long compared to the body of a beetle. Their antenna is one of the important organs of the body. The presence of receptor cells makes these species unique among all and the main functionality includes identification of prey along with pheromone generation. The area of detection is enlarged with the help of these antennas and also acts as a mechanism for warning. During the movement of beetles, there is wobbling of their antennas for receiving the odor of prey and also for identification of partners. The neighboring areas are detected in a random manner. One of the antennas identifies the prey and the other one finds the direction of movement. The optimization of objective function is performed depending on the behavior of searching for beetles. This makes an effective optimization algorithm for obtaining optimum results.

II. MOTIVATION OF WORK

The digital environment always handles the data transmitting sensors where many images and data is captured for understanding the data gathering steps based on several needs. Generally, the protocols used for the purpose of routing, help in connecting the source with the destination node with the help of various intermediate nodes. Devices and sensors are technical working systems working in various environments like shipping, marine, underwater environment, military applications etc. If there is a failure in these natural events there can be a huge loss. so, to avoid the failure the network and routing protocol are together involved such that the core network and its mechanism based on distributed sensors can work effectively.

III. OBJECTIVES

The main objective of the proposed work is to enhance the lifetime of underwater acoustic conditions and improve the energy consumption which can customize the transmission range. In order to reduce the data gathering time and to fix the nodes and holes in short time and multi hop communication surveillance is also noted. The main objective is to consider the packet exchange without disturbing the existing nodes in a short time. Also, the successful multihop communication leads to better transmission as well. In order to identify the research with innovative ideas the underwater wireless sensor network-based problem statement is considered. The proposed new approach is based on three important aspects such as

- A comparison of the Beetle Antennae Search Algorithm and Genetic Algorithm for optimizing features of USWN in the selection process.

IV. SCOPE OF RESEARCH

Wireless Sensor Networks have various problems where the scope of this research focuses on energy consumption problems that can categorize the network issues. To avoid traffic multi-hop communication based on routing procedures are used here which can significantly balance the lifetime of the network and reduce accordingly. The main scope of the proposed work is organized below:

- To maximize the network lifetime via balancing the consumption of energy which can be supported in the Autonomous Data Gathering Routing Protocol.
- Mobile based routing paths simulates the performance analysis as enhanced values collected from the total number of energies consumed and

latency measures collected from sink nodes. Also considering the standard deviation that shows the node's consuming power for saving energy are improved based on the overhead time that is to be controlled.

- Various optimization algorithms were performed to improve the efficiency, latency and network lifetime in UWSN along with Deep learning based mobile edge mode.

V. PROPOSED WORK

Beetle Antenna Search Algorithm

Beetles with long horns have antennae whose length is more than the body of the insect. Few of the species have longer antennae. Patterns followed by the insects need to be identified and play a major role in sensing. Each prey has a different odour and the antennas are able to identify that. Additionally, pheromone helps in identifying area detection. Mechanisms for warning can be done by the antennae of beetles. Exploration of areas in the nearby locations is done in a random fashion using the antennas. When the insect detects the odour, its movement commences in the side of the odour.

These characteristics of beetle search help in designing the optimization algorithm.

Algorithm For Search Using BAS

Step 1: The direction of search is selected in a random fashion.

Step 2: Computation of smell difference is performed.

Step 3: Direction vector is computed.

Step 4: Movement occurs in the direction being estimated.

Step 5: The steps are repeated till the expected results are obtained.

The optimization of the objective function takes place by the behavior of searching for beetles whose antennas are longer. Beetle position is computed as a vector for the given period of time. Computation of f(x) for objective function is done based on the odour concentration. The value which is maximum is calculated based on the point of source for the odour. Two major behaviors of beetles used in algorithms are searching as well as detecting. Search occurs initially in a random fashion for exploration of prey.

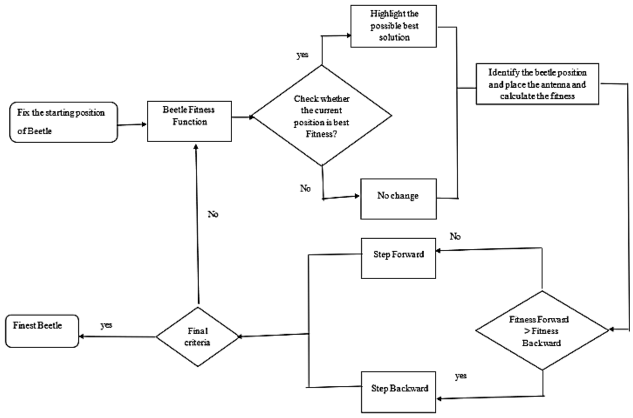

Fig. 3 Flow Diagram for BAS

Proposed Work and Its Module

Various challenges are associated with the communication occurring underwater which leads the researchers to focus towards UWSN. Monitored data needs to reach the onshore terminal with the help of routes obtained as a result of optimization. The major aim of the proposed work is development of protocol for management of energy efficiency along with maximization of network lifetime. The data gathering protocol plays a major role in collection of data along with the selection process of cluster heads in UWSN. The scheme used here is gateway discovery along with routing utilizing beetle antennae search for the purpose of optimization.

Steps In Data Gathering Protocol - Beetle Antennae Search Optimization

Step 1: Begin the process.

Step 2: Parameters of the network are initialized.

Step 3: Deployment of sensor nodes takes place.

Step 4: Selection of cluster head using data gathering protocol.

Step 5: Fitness function is computed.

Step 6: Beetle antennae search for optimizing the routes discovered.

Step 7: Transmission of data using the routes among the sensor nodes.

Step 8: If the stopping criterion has reached and simulation performance is less, the selection process is repeated again.

Step 9: End the process.

The scheme used for selection of paths for routing in UWSN is gateway discovery. The gathering protocol collects the data from all the sensor nodes. The lifetime of the network can be improved with the protocol depending on the selection of cluster heads along with the selection of optimized routes using BAS. The nodes collect information in UWSN and transmit them to the sink on the surface. The workflow is represented in the Fig. 4.

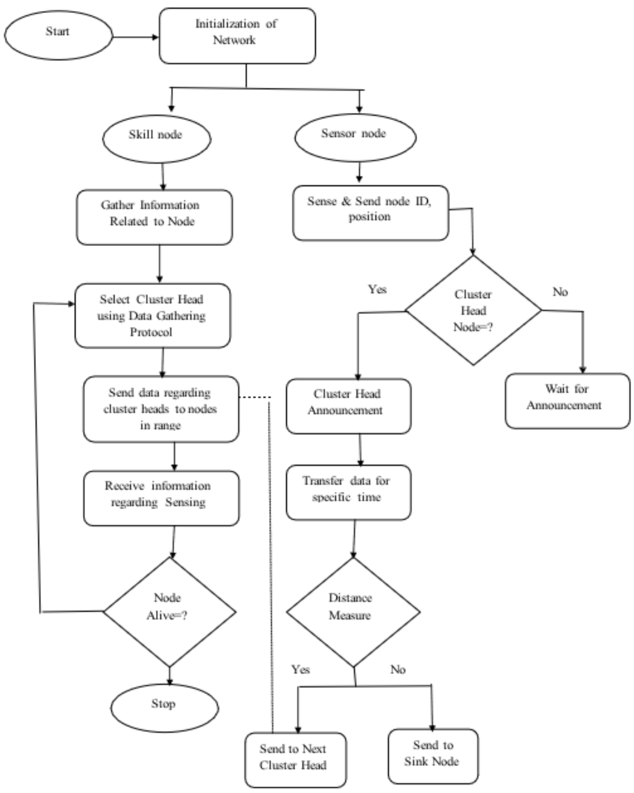

Fig. 4 Proposed Model Workflow

VI. RESULTS & DISCUSSION

The results obtained from the simulation are explained here. The analysis of the proposed model based on various parameters is discussed. The existing models based on genetic algorithms and the proposed work based on BAS are analyzed.

- **The Lifetime of the Network -** The number of nodes that are alive are taken into consideration for computation of the lifetime of UWSN. In order to achieve a longer lifetime, the consumption of energy needs to be of a minimal value. Comparison among the existing and the proposed models is shown in Fig. 4. There is an increase in the lifetime of the network employing data collection protocol with BAS compared to the one with the GA. The reasons behind these better results are, (i) selection of cluster head and (ii) identification of paths (short) while transferring data among the nodes. As the path of transmission is also available with the distance that is lesser, the consumption of energy is minimized. This in turn improves the lifetime of UWSN as shown in Fig. 5.

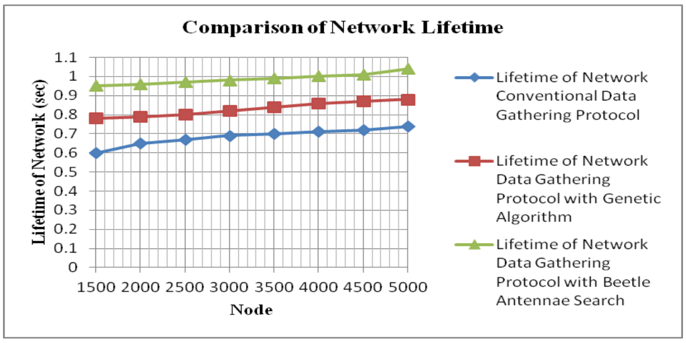

Fig. 5 Comparison of Lifetime of Network for Proposed and Existing Works

- **Consumption of Energy-** The energy level held by every node at the initial phase is noted along with the level of used energy for them after completion of the processes. Their difference constitutes the measure termed as consumption of energy. Comparison among the existing and the proposed models is shown in Fig. 6. The path identified for transfer of information is short so that the data reaches the destination nodes easily. This in turn minimizes the consumption of energy while performing packet transmission.

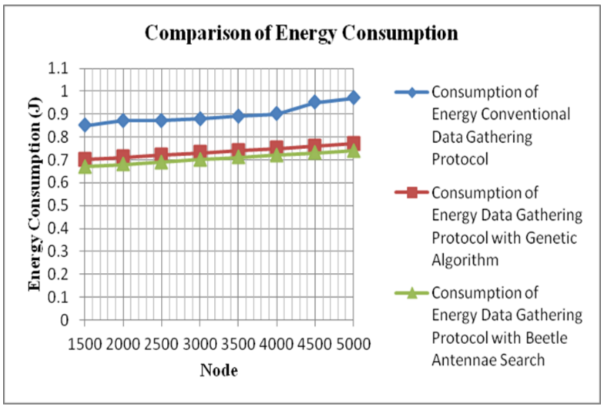

Fig. 6 Comparison of Consumption of Energy for Proposed and Existing Works

- **Computation of Overhead-** The packets that are forwarded along with the packets that are received are being taken into account for computation of overhead. The ratio among the above two values forms the overhead value. Comparison among the existing and the proposed models is shown in Fig. 7. The overhead of the proposed work is less while compared with the traditional models. The conventional systems transfer more data without any control over the speed of transmission. The above factors are governed by the fitness function utilized in the BAS algorithm.

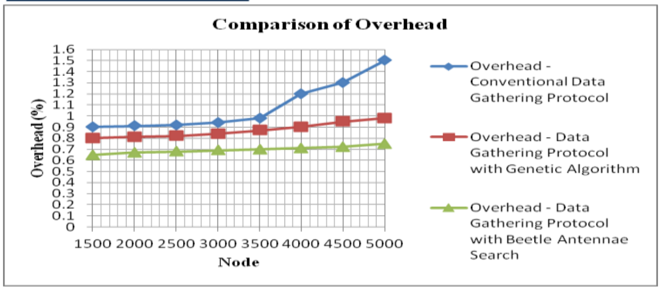

Fig. 7 Comparison of Overhead Computation for Proposed and Existing Works

- **Computation of Throughput-** There may be a loss in packets while they are being transferred among the UWSN environment. The packets that reach the destination without any problem help in determining the throughput of the network. Comparison among the existing and the proposed models is shown in Fig. 8. The proposed model shows higher throughput compared with the existing ones. Increment of throughput in the proposed technique is achieved as the consumption of energy for every node is minimal. Loss of packets occur in UWSN when there is exhaustion of energy consumed by the nodes. The fitness function usage in BAS algorithm prevents the failure of a node while routing takes place. Hence, there is an increase in the measure of throughput when the failure of nodes is prevented.

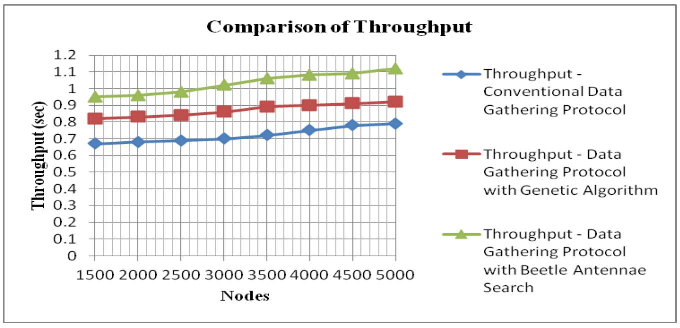

Fig. 8 Comparison of Computation regarding Throughput for Proposed and Existing Works

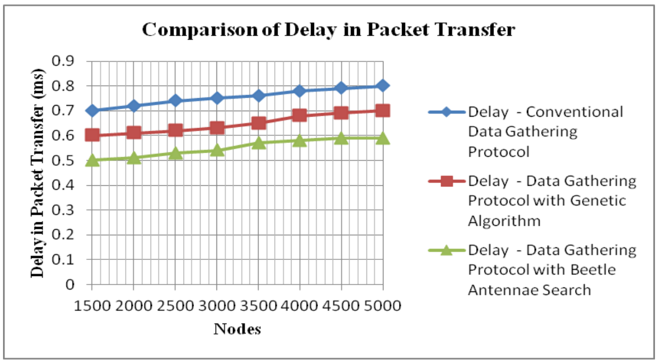

Fig. 9 Comparison of Delay in Packet Transfer for Proposed and Existing Works

- **Computation of Delay in Packet Transfer-** The transmission of packets occurs in UWSN among the source node as well as the sink nodes. This time taken for completing the entire process mentioned above contributes to the delay. Comparison among the existing and the proposed models is shown in Fig. 9. As the routing path is optimized by usage of BAS, transmission takes place in a proper manner without any delay. The delay in processing as well as transmission is also lesser.

- **Ratio For Delivery of Packets-** Information sent in the form of packets is used for transfer of data among sources as well as destination. The computation of the ratio among them gives the ratio of packets delivered in a proper manner. Comparison among the existing and the proposed models is shown in Fig. 10. As the lifetime of the network is increased, the delivery ratio of packets also keeps on increasing. The loss of packets is reduced as the failure of nodes is prevented by usage of the fitness function of BAS.

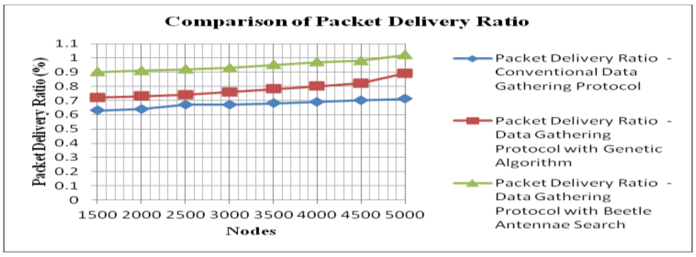

Fig. 10 Comparison of Ratio for Delivery of Packets for Proposed and Existing Works

Table 4.1. represents the comparison among the existing and the proposed models. These results after simulation represent the efficacy of the proposed model.

Table 4.1 Comparison of Performance Parameter for Existing and Proposed Model

Parameters	Existing Models	Proposed Model
Network Lifetime	Low	High
Energy Consumption	High	Low
Overhead	High	Low
Throughput	Low	High
Delay in Packet Transfer	High	Low
Ratio of Packet Delivery	Low	High

VII. CONCLUSION

The sensor networks are having various applications nowadays and have emerged as a wide area of research. In the case of WSNs, their base station is located at a particular distance from the nodes and is employed for monitoring of the environment as well as military works. Due to various advancements, UWSNs have gained huge importance along with advancements. These sensors are smaller in size and use either radio waves or acoustic waves for communication. The main purpose of these sensors is collection of data and relaying the collected data to desired locations. In order to transfer data in a reliable way, there is a need for routing protocols to help the transmission. The literature review presents the issues present in UWSN along with the survey of various routing protocols available for transfer of data. This identifies the pitfalls in existing works and necessitates the novel model for data transmission in UWSN. In the proposed work, we compare Beetle Antenna Search Algorithm with Genetic Algorithms for optimizing USWN selection. Deep learning and optimized energy consumption with 20.83% are compared with genetic algorithms with 17.34%. In addition, protocols that classified network nodes by bandwidth and lifetime gave results of 30.76%, which is lower than existing algorithms.

VIII. FUTURE SCOPE

In real time communication the factors based on environment, acoustic and various terrestrial features can be considered for efficient network and advanced routing protocols can also be introduced that can obtain the fast results using mobile platforms that keep updates about transceivers that are interconnected with sensors. With latest mobile technologies such as 5G network the quality of communication along with underwater UWSN can be also improved based on throughput and delay time. The Proposed work has the limitation on Certain Parameter such as Node Drop, Energy Consumption linking to EECOR Existing Protocol Only Specifically in 4000 Nodes. The issue may be rectified through Literature survey analyzing through my Future Work.

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