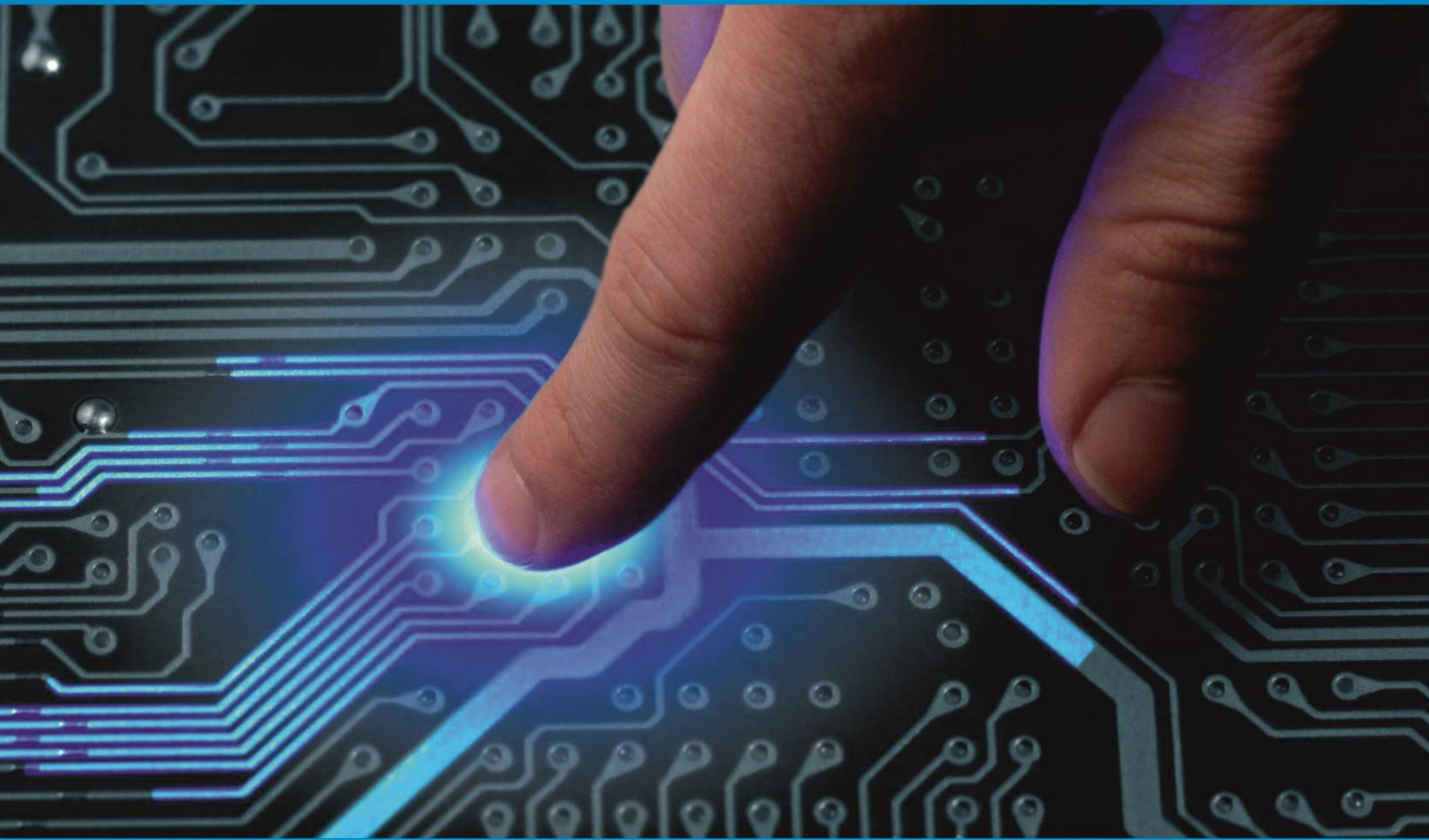
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 4, April 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.488

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 4, April 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0904149 |

An Energy-Efficient Clustering Routing Protocol Based on Data Fusion and Genetic Algorithms

Jodir Ayyappan V M[1], Mohan Raj E[1], Naresh Kumar G[1], Sai Vikram S[1], N.Hemavathy[2]

UG Student, Dept. of ECE, Velammal Engineering College, Tamil nadu, India[1]

Assistant Professor, Dept. of ECE, Velammal Engineering College, Tamil nadu, India[2]

ABSTRACT: Underwater Wireless Sensor Networks (UWSNs) are finding different applications for offshore exploration and ocean monitoring. In most of those applications, the network consists of many number of sensor nodes deployed at different depths throughout the world. The sensor nodes located at the ocean bed cannot communicate directly with the nodes near the surface level; they require multi-hop communication assisted by appropriate routing scheme.All these factors provide a platform where a resource-aware routing strategy plays an important role to satisfy the various application requirements with dynamic environmental conditions. Realizing the very fact , significant attention has been given to construct a reliable scheme, and lots of routing protocols are proposed so as to supply an efficient route discovery between the sources and the sink. In this paper, we present an effective multi-hop transmission path between the CHN and the SN which is determined through the enhanced GA, thereby improving transmission efficiency and reducing energy consumption. Moreover, the GA and the BPNN employed for data fusion is improved by adopting an searching method, which may reduce energy consumption through the elimination of redundancy and therefore the decrease of the quantity of transferred data.

KEYWORDS: UWSN, Routing, GA, Neural network.

I. INTRODUCTION

The ocean is vast as it covers around 140 million square miles; more than 70% of the Earth's surface, and half of the world's population is found within the 100 km of the coastal areas. Not only has it been a serious source of nourishment production, but with time it's taking an important role for transportation, presence of natural resources, defense and adventurous purposes. Even with all its importance to humanity, surprisingly we all know little or no about the Earth's water bodies. Only less than 10% of the whole ocean volume has been investigated, while a large area still remains unexplored. With the increasing role of ocean in human life, discovering these largely unexplored areas has gained more importance during the last decades. On one side, traditional approach used for underwater monitoring missions have several drawbacks and on the opposite side, these inhospitable environments aren't feasible for human presence as unpredictable underwater activities, high water pressure and vast areas are major reasons for un-manned exploration. Due to these reasons, Underwater Wireless Sensor Networks (UWSNs) are attracting the interest of many researchers lately, especially those working on terrestrial sensor networks. Sensor networks used for underwater communications are different in many aspects from traditional wired or maybe terrestrial sensor networks [1-2].

Firstly, energy consumptions are different because some important applications require great deal of knowledge , but very infrequently. Secondly, these networks usually work on a standard task rather than representing independent users. The ultimate goal is to maximise the throughput instead of fairness among the nodes. Thirdly, for these networks, there's a crucial relationship between the link distance, number of hops and reliability. For energy concerns, packets over multiple short hops are preferred instead of long links, as multi-hop data deliveries have been proven more energy efficient for underwater networks than the single hop [3]. At the same time, it is observed that packet routing over a greater number of hops ultimately degrades the end-to-end reliability function especially for the harsh underwater environment. Finally, most of the time, such networks are deployed by one organization with economical hardware, so strict interoperability with the prevailing standards isn't required. Due to these reasons, UWSNs provide a platform that supports to review the prevailing structure of traditional communication protocols. The current research in UWSNs aims to satisfy the above criterion by introducing new design concepts, developing or improving existing protocols and building new applications (Fig. 1).

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 4, April 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0904149 |

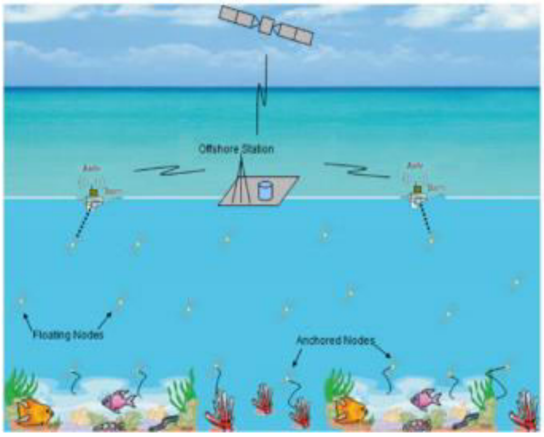


Fig.1.Underwater mobile sensor node scenery

Further, a number of the underwater applications, including detection or rescue missions, tend to be unplanned in nature, some requiring not only network deployment briefly times, but also without any proper planning. In such circumstances, the routing protocols should be ready to determine the node locations with none prior knowledge of the network. Not only this, the network also should be capable of reconfiguring itself with dynamic conditions so as to supply an efficient communication environment. Moreover, a big issue in selecting a system is establishing a relation between the communication range and rate with the precise conditions. A system designed for deep water may not be suitable for shallow water or even when configured for higher data rates when reverberation is present in the environment [4]. Manufacturer's specifications of maximum data rates mostly are only useful for establishing the upper performance bound, but in practice these aren't reachable with specific conditions. Users who are well funded have resorted to buying multiple systems and testing them especially environment to work out if they're going to meet their needs. An international effort for standardizing the tests for acoustic communications is required, but it's not so simple as private organizations or maybe government institutes performing such comprehensive tests tend not to publish their results.

II. LITERATURE SURVEY

A. Basics of acoustic communications

Acoustic signal is taken into account because the only feasible medium that works satisfactorily in underwater environments. Considering electromagnetic radiation , at high frequencies it's a really limited communication range thanks to high attenuation and absorption effect, as measured but 1 m in water (Bin et al., 2004). Propagation is suitable with low frequencies, but at the value of high transmission power and long antenna size. Recently, electromagnetic modems for underwater communication are developed; however available technical details are vague. It has been shown that the absorption of electromagnetic signal in sea water is about $45\sqrt{f}$ (dB/Km), where f is the frequency in Hertz [5], while the absorption of acoustic signal with the frequencies commonly used for underwater is lesser by three orders of magnitude.

B. Deployment and network architecture

Underwater sensor networks (USNs) contains a variable number of sensor nodes that are deployed to perform collaborative monitoring over a given volume. Similar to terrestrial sensor networks, for USNs it's essential to supply communication coverage in such how that the entire monitoring area is roofed by the sensor nodes, where every sensor node should be ready to establish multi-hop paths so as to succeed in the surface sink. Many important deployment strategies for terrestrial sensor networks have been proposed such as Tarng et al. (2009), Neelofer and Mohamed (2013), [6-7] but deployment for USNs requires more attention due to its unique 3d characteristics.

The earliest one is the lowenergy adaptive clustering hierarchy (LEACH) protocol that uses a probabilistic method to select CHNs, but the remaining energy of nodes is not considered [8]. This makes some selected CHNs die too early, which affects the balance and efficiency of the network energy. Moreover, the LEACH does not support the multi-hop transmission mechanism. Therefore, researchers proposed the improved clustering routing protocols supported the

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 4, April 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0904149 |

LEACH. Lee et al. optimized the LEACH based on expected residual energy (LEACHERE), which adopts an improved CHN selection scheme based on the LEACH protocol, employs energy predication, and distributes the network load evenly in order to extend the network lifetime [9]. Mohapatra et al. presented a partitioned-based and energy-efficient LEACH (PE-LEACH) protocol that divides the whole network into quadrants, which is energy-efficient and fault-tolerant [10]

Sun et al. presented a data fusion method based on BPNNs, and they put the input layer of the BPNNs in CMNs, and put the hidden and output layers in CHNs. Only the fused data representing the features of the input file are sent to the SN so as to enhance energy efficiency. Cao et al. developed a clustering protocol in the light of data fusion scheme by using BPNNs for TWSNs, which adopts a stable election protocol model based on the LEACH protocol to select appropriate CHNs [11]. The selected CHNs fuse the info after receiving them and send the fused data to a destination node. Yue et al. proposed a knowledge fusion scheme by employing an improved radial basis function neural network in mobile TWSNs, which improves the info fusing model so on reduce the energy consumption. (Goyal et al. 2016) introduced a fuzzy-based clustering routing protocol combined with the data fusion technique for UWSNs.Lorenzo et al. proposed an improved GA to optimize the routing paths, which encodes the paths as chromosomes and presents special crossover and mutation operations for realizing the optimal topology. Moreover, they developed the fitness function by considering power consumption, time delay, and throughput of the network.

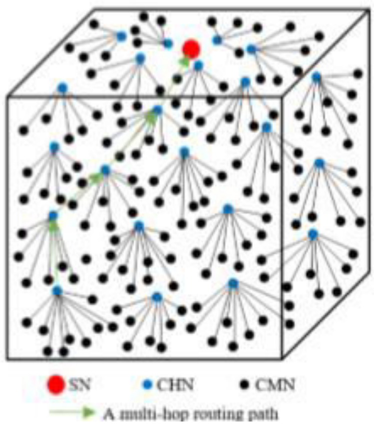


Figure. 2. Cluster three-dimensional model

III. PROPOSED METHODOLGY

1. There are two kinds of nodes: underwater sensor nodes, which are immobile and divided into CHNs and CMNs after cluster formation, and an SN, which is located on the surface of the monitoring area.
2. There is only one SN in the network, which is the destination node and has energy supplies but UWSN nodes have limited energy.
3. The ordinary underwater nodes have the equal initial energy and the unique IDs.
4. The locations of nodes might be acquired through the localization algorithm.
5. We could control transmitting power based on the different distances to receiving nodes.
6. CMNs gather data and transmit them to CHNs through a single hop. Once the CHN receives the info , the CHN fuses them and forward them towards the SN through multiple hops. If one CHN is close to the SN, it sends data towards the SN through one hop.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 4, April 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0904149 |

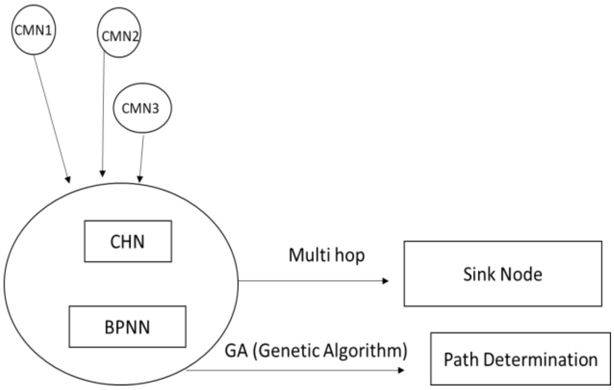


Figure. 2.(a) Block Diagram

A. Improved GA

This section presents the improved GA which is used to find the optimal multi-hop paths between the CHNs and therefore the SN, where the novel encoding scheme, also because the specific selection, crossover, and mutation operators is proposed. The optimal paths can improve transmission efficiency, reduce packet loss ratio, and minimize energy consumption, thereby prolonging the network lifetime and improving the network performance.

We assume that there are N-1 CHNs and 1 SN when implementing the GA to search for the optimal paths. The SN is the destination node. The CHN that needs to transmit data becomes the source node. There lay node is chosen from CHNs. Tti is the time duration for the node i to transmit packets and Trj is the time duration for the node j to receive packets. Dtmax presents the maximum delay of the path. The value of xij is 1 when a link exists between node i and node j. Otherwise, the value of xij is 0. We regard the search process of multi-hop paths as a combinatorial optimization problem, finding the optimal path with the minimum cost. The objective function is given by:

$$\text{minimize}: \ F_{obj} = \sum_{i=1}^{N}\sum_{j=1}^{N} c_{ij}x_{ij}$$

$$\text{where } c_{ij} = T_{ti}P_0A(l_{ij}) + T_{rj}P_0$$

$$\text{subject to}: \ \sum_{i=1}^{N}\sum_{j=1}^{N} d_{ij}x_{ij} < D_{tmax}$$

B. Improved BPNN

This section presents an improved BPNN that is used by the CHNs to perform data fusion after they receive data sent by CMNs, which can eliminate the redundant data and reduce the quantity of transmitted data, thus saving the network energy and increasing the network lifespan.

The three-layer neural network consisting of 1 input layer, one hidden layer, and one output layer is adopted in this paper, which is competent for many of the complicated problems. Figure 6 illustrates the structure of the BPNN. We assume that the input and therefore the output for the structure are U = [u1, u2, ... ,uU] and Y = [y1, y2, ... , yY], respectively. U, R, and Y denote the amount of neurons of the input layer, hidden layer, and output layer, respectively.

$$h_j = f_v(\sum_{i=1}^{U} w_{ij}u_i + b_j) \qquad y_k = f_v(\sum_{j=1}^{R} w_{jk}h_j + b_k) \qquad f_v(v) = \frac{1}{1+\exp(-v)}$$

The adjustments for the weights and therefore the biases are often obtained by:

$$w_{ij}(t+1) = w_{ij}(t) - \eta\frac{\partial e_{err}}{\partial w_{ij}(t)}$$

$$w_{jk}(t+1) = w_{jk}(t) - \eta\frac{\partial e_{err}}{\partial w_{jk}(t)}$$

$$b_j(t+1) = b_j(t) - \eta\frac{\partial e_{err}}{\partial b_j(t)}$$

$$b_k(t+1) = b_k(t) - \eta\frac{\partial e_{err}}{\partial b_k(t)}$$

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 4, April 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0904149 |

where η is that the learning rate that ought to be set appropriately so on speed up the training process, and t denotes the amount of training times. The training does not cease until the error is decreased to a certain value or the preset number of training times is reached. However, the fixed learning rate sometimes cannot achieve high efficiency during the training. Accordingly, this paper employs an adaptive adjustment method for η as described in next section
.

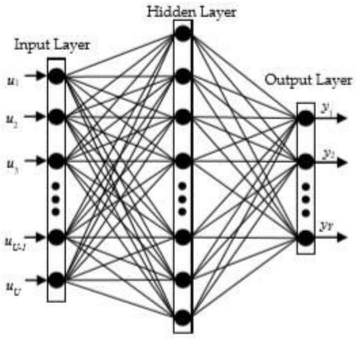


Figure 3 : BPNN Model

IV. SIMULATION TOOL

MATLAB is a simulation software, which can be applied to sensor networks, data analysis, deep learning, image processing, computer vision, risk management, control systems, communications, signal processing and so on. It is an abbreviation of matrix and laboratory and it is developed by MathWorks. The MATLAB settles the high-tech computing problems such as scientific computing, visualization, and interactive programming. It integrates many powerful functions like numerical analysis, matrix calculation, scientific data visualization, and nonlinear dynamic system modeling and simulation in an easy-to-use software environment.

V. RESULT AND DISCUSSION

In this section, the result of the project has explained with respect to operation node per transmission, energy consumed per transmission, Underwater sensor node deployment, operating node per second, average energy per node transmission, and recognition curve.

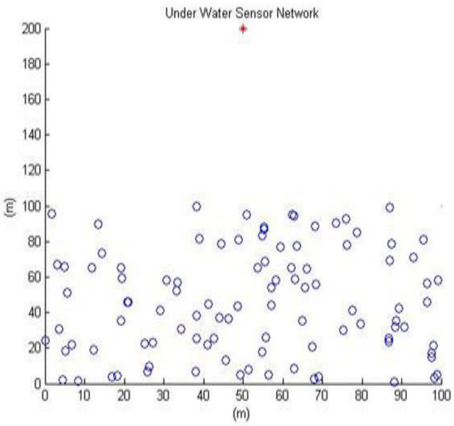


Figure 4: Under Water Sensor Node Deployment

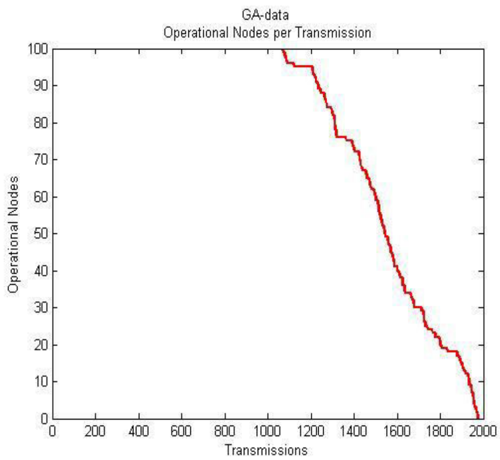
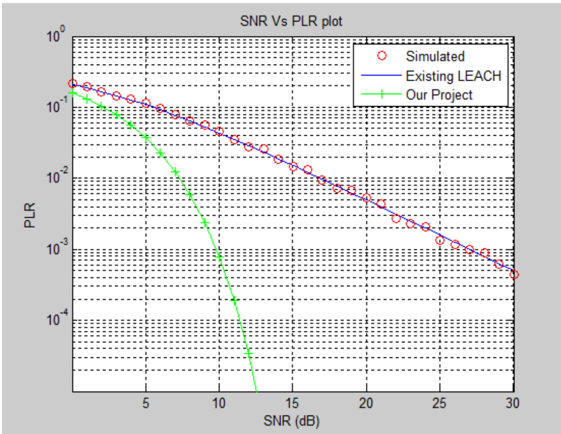


Figure 5 : Operational Nodes per Transmission

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 4, April 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0904149 |



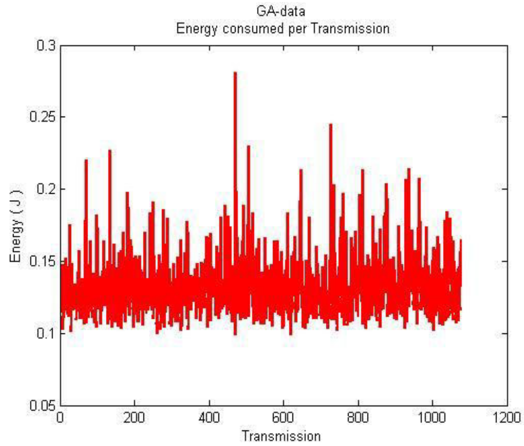


Figure 6. Energy Consumed Per Transmission **Figure 7 : Packet Loss Rate**

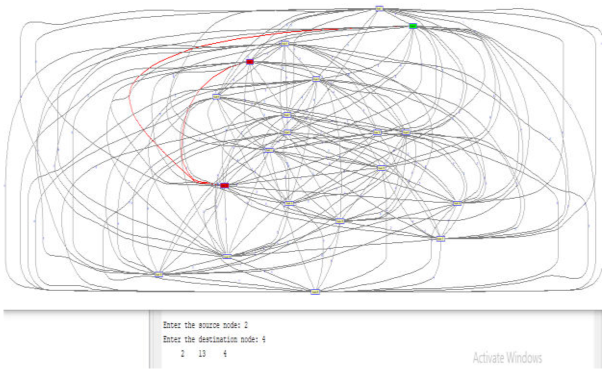


Figure 8 : Genetic Algorithm

VI. CONCLUSION

In this paper, we have presented an overview of state of the art of routing protocols in underwater wireless sensor network. Routing for UWSN is an important issue, which is attracting significant attention from the researchers. The design of any routing protocol depends on the goals and requirements of the application, as well as appropriateness, which depend on the availability of network resources. The development of routing techniques suitable for these environments is therefore regarded as an essential research area, which will make these networks much more reliable and efficient.

REFERENCES

[1] Akyildiz IF, Pompili D, Melodia T. Underwater acoustic sensor networks: research challenges. Ad Hoc Networks 2005;3(3):257–79.
[2] Heidemann J, et al. Research challenges and applications for underwater sensor networking. In: Proceedings of the IEEE wireless communications and networking conference, WCNC; 2006
[3] Jiang Z. Underwater acoustic networks—issues and solutions. Int J Intell Control Syst 2008:152–6113 2008:152–61.
[4] Chitre M, et al. Underwater acoustic communications and networking: recent advances and future challenges. In: Proceedings of the OCEANS; 2008.
[5] Quazi A, Konrad W. Underwater acoustic communications. Commun Mag, IEEE 2012;20(2):24–30.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 4, April 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0904149 |

[6] Tarng Jenn-Hwan, Chuang Bing-Wen, Liu Pei-Chen. A relay node deployment method for disconnected wireless sensor networks: Applied in indoor environments. J Network Comput Appl 2009;32(3).

[7] Neelofer Tamboli, Mohamed Younis. Coverage-aware connectivity restoration in mobile sensor networks. J Network ComputAppl 2010;33(4):363–74

[8] Heinzelman, W.R.; Chandrakasan, A.; Balakrishnan, H. Energy-Efficient Communication Protocol for Wireless Microsensor Networks. In Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, Maui, HI, USA,7 January 2000; pp. 3005–3014.

[9] Lee, J.; Cheng, W. Fuzzy-logic-based clustering approach for wireless sensor networks using energy predication. IEEE Sens. J. 2012, 12, 2891–2897.

[10] Mohapatra, H.; Rath, A.K. Fault tolerance in WSN through PE-LEACH protocol. IET Wire. Sens. Sys. 2019, 9, 358–365.

[11] Cao, Y.; Zhang, L. Data Fusion of Heterogeneous Network Based on BP Neural Network and Improved SEP. In Proceedings of the 2017 9th International Conference on Advanced Infocomm Technology (ICAIT), Chengdu, China, 22–24 November 2017; pp. 138–142.