International Journal of Advanced Research in Engineering and Technology (IJARET)
Volume 10, Issue 5, September-October 2019, pp. 166-173. Article ID: IJARET_10_05_017
Available online at http://www.iaeme.com/IJARET/issues.asp?JType=IJARET&VType=10&IType=5
ISSN Print: 0976-6480 and ISSN Online: 0976-6499

FAULTY NODE DETECTION USING RBM IN UNDERWATER SENSOR NETWORKS

Indira K
School of Computing
Sathyabama Institute of Science and Technology, Chennai, India

Gomathi
School of Computing
Sathyabama Institute of Science and Technology, Chennai, India

Anandhi T
School of Computing
Sathyabama Institute of Science and Technology, Chennai, India

Sivasangari A
School of Computing
Sathyabama Institute of Science and Technology, Chennai, India

Brumancia E
School of Computing
Sathyabama Institute of Science and Technology, Chennai, India

ABSTRACT

Underwater wireless sensor networks play a prominent role in monitoring continuously the undersea oil fields. To find varying changes in reservoirs of oil and gas, we are having many seismic methods. For continuous monitoring of marine environment (or) undersea oil fields (or) offshore surveillance, the deployed nodes whose energy got depleted should be replaced. Replacing a node individually when energy is depleted, the replacement cost will be very high. So, by replacing all the nodes at a time by using an integrated routing and node replacement scheme is the best thing to minimize the node replacement cost. This paper developed RBM based faulty node detection approach that can be applied to underwater sensor networks to increase lifetime of UWSN and maintenance of network with minimal cost by identifying determined rate of failed nodes.

Keywords: seismic monitoring, combined routing, node replacement

Cite this Article: Indira K, Gomathi, Anandhi T, Sivasangari A and Brumancia E, Faulty Node Detection Using RBM in Underwater Sensor Networks, *International Journal of Advanced Research in Engineering and Technology (IJARET)*, 10 (5), 2019, pp 166-173.
http://www.iaeme.com/IJARET/issues.asp?JType=IJARET&VType=10&IType=5

1. INTRODUCTION

The Sea is a engaging massive region of water that has consistently allure people who wanted to resolve their problems. For centuries the access of human beings to the sea was restricted to the surface or the nearby water, because the researchers had to utilize wire-line instruments and sampling equipment positioned at the sea surface. Due to this certainty the technological investigation operations were restricted. Now a days there is a growing need of monitoring the undersea resources, marine incidents like chemical pollution, but the current technologies do not add up to challenging demands. So, because of this there has been a noteworthy technology rise in underwater sensor networks.

Underwater sensor networks are the rising technology for a number of oceanic applications such as marine environment monitoring, pollution monitoring, off shore exploration. As many applications began to be using underwater sensor networks, operating cost of this kind of network has now became an great difficulty measure. Underwater sensor networks are very expensive than terrestrial sensor networks. In submarine territory, it is very difficult to recharge or changing the batteries powered sensor nodes. The communication among deployed nodes and high error probability in an underwater leads to maximize the consumption of energy level in Underwater Sensor Networks than in traditional sensor networks. So energy saving becomes an important issue in UWSNs. Now days, networks are connected with network (i.e) IoT environment [20][23][25] which generate numerous data is needs protect from data loss due to inactive sensor node because of lower energy level.

Also, for uninterrupted surveillance from all the node locations, it is mandatory to change the energy deficient sensors on the ocean ground. Replacement of an individual node will be very difficult and cost also very high. This could be improved by changing all the sensors at the same time by using integrated routing and node replacement strategy. The routing scheme used here is ME-H (Minimum energy- hybrid) Routing i.e., the combination of two types of routings. In one routing each node will send all its routing packets to neighbouring node in upcoming below level. In another routing each node will send its routing packets to farthest node in next below level. Using this hybrid routing the energy consumption by all the nodes will be minimum so the network survivability will be increased. Coming to the node replacement policy that have used here is Fixed interval replacement (FI) i.e., here the time interval across the replacements will be constant. Hence by using the combination of ME-H routing along with FI replacement scheme we can minimize the node replacement cost to some extent.

2. RELATED WORK

The conventional approach of ocean data acquisition, used the battery operated stations with sensors for data recording. But it has several downside like it is restricted to one point of survey, the examining of data quality during the mission is not allowed, it has limited storage capacity and the beginning of the operation itself acquisition parameters must be established and should not change until the end of the mission. All these can be overcome with the use of Underwater Sensor Networks (UWSN) [1].There are so many methods used for monitoring the marine environment using UWSNS.

Some they have used wired based connections of underwater sensor network where in sensors are interconnected by fiber optic cables on the ocean floor[2]. But in this approach installation,operational and maintenance costs are very huge. It also causes significant damage to the marine environment. Using the autonomous data storage nodes we can collect the data regularly from the nodes [3]. Unlike the wired-based acquisition, the inefficacy of this approach is to access seismic information in real time is a crucial constraint. But it gave intention of using wireless communication to transfer data. The techniques in [11] employs a fixed network of sensors which collects the gathers data from different sensors in its Zone of Reference (ZOR) region and send this accumulated data to AUV when it arrives 3-D ZOR, by this approach minimizing the energy consumed for communication. Thus, the idea of using sensors with wireless data communication potentiality has currently acquired attentiveness in seismic monitoring application [4]. In an submarine passive seismic network, all sensors should consistently sense, acquire and transfer the information to the base station via wireless communication [6][7][8][26]. In sensor networks energy is main resource which decides life time of the network. In method [12], they identify the cumulative value of energy pertaining to a joined sensor and also for the forwarding process, which sensor is has the maximum energy is being selected to redirect information to the surface node. If suppose surface node is busy with communication, then it will give an upgraded instruction to the next neighbor node to becoming a substitute for surface node in order to prevent loss of information. To extend lifetime of the network in secured way with energy efficient is presented in [14][17][18][24].In [15][21][22], these papers deals with the prediction and classification using supervised learning approaches. In [19] they categorize the users as spammers, content promoters and authorized users by building a test collection of real YouTube users using SVM-KNN which is an active learning approach. As the life time of the deployed nodes and energy is limited, As well as to ensure uninterrupted investigation from each and every node locations, it is need to replace the sensors on or before it becoming dead due to zero energy level. As these sensor replacement rates are too high over the time of operation of the network, to minimize this they have introduced integrated routing and node replacement method. We propose an effective methods to reduce the node replacement cost in generic wireless sensor networks. Also, have developed methods that can apply to the networks that can work with determined rate of failed nodes. This can be achieved by using additional re-routing routines.

3. PROPOSED METHODOLOGY

In the architecture diagram (Fig.1) the energy level analyzer will analyze energy levels for all the underwater sensor nodes by transmitting the hello packets to each neighboring nodes in the form of circular radio waves. If the energy level of the particular node reaches the threshold, that nodes should be replaced by another nodes whose energy levels are maximum. All the information i.e., collected during the monitoring of marine environment by each node is send to the sink node via UDP routing. Sink node will perform data gathering operation.

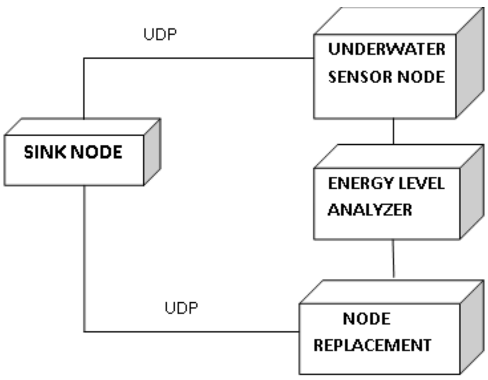

Figure 1 Architecture diagram

3.1. Node Deployment

In this step, all the nodes in the ad hoc network communicates with its neighbors within its communication range for neighbor node formation. The nodes are placed randomly at some positions using random function.

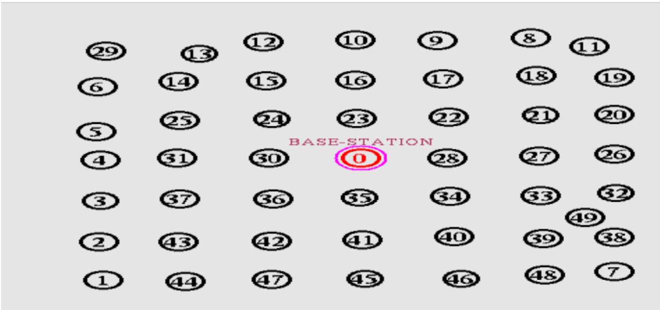

Figure 2 Nodes deployment

3.2. Neighbor Node Discovery

In this stage every source node detects its direct neighbor sensors by broadcasting control packet HELLO packets. By this way every sensor identifies its neighbor nodes corresponding to location and distance. Based on the neighbor discovery phase each node forms a stable path to base station.

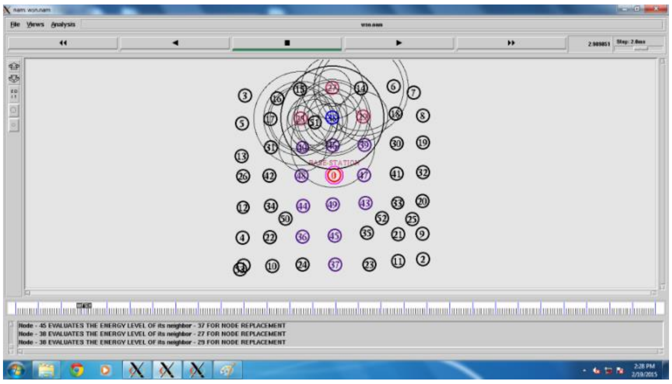

Figure 3 Neighbor discovery phase.

3.3. Data Routing

In this phase we experiment new approach for routing both control and data packets in the UWSN. Our objective is to reduce the rate of node replacement chances and also to reduce the total number of sensors replaced in every attempts. Therefore, an appropriate routing mechanism should have two main characteristics. First, it must have collection of maximum number of sensors having nearly same possible energy dissipation range so that the sensors in these collections may be changed at all in one time. This will confirm a minimal rate of replacement possibilities. Second, the routing must be energy saving mechanism to diminish the total number of sensor replacements.

3.4. Faulty node Detection

Proposed methodology uses Restricted Boltzmann Machine (RBM) algorithm to find faulty nodes to maximize network lifetime and minimize node replacement cost. RBM is a machine learning technique which is used to classify nodes as normal or faulty node. It takes input as energy level metrics and trained with data traffic model of numerous only working sensor nodes. It uses the hidden layer units (H) to construct model for joint distribution of visible layer units (V). To get efficient and accurate model, RBM is always using more number of hidden layer units than visible layer units. These layers can be represented by $V=(v_1,v_2,\ldots.v_m)$ $H=(h_1,h_2,\ldots\ldots h_n)$ given n >m. The energy configuration of RBM [13] is represented as follows:

$$E(V,H) = -\sum_{i=1,j=1}^{i=m,j=n} v_i W_{i,j} h_j - \sum_{i=1}^{i=m} a_i v_i - \sum_{j=1}^{j=n} b_j h_j - (1)$$

W is representing weight factor between visible and hidden layer, a is representing offset or bias value of visible layer and b is representing bias value of hidden layer.

An input feature vector (ifv) for visible layer of RBM is ifv = { Energy level of node, Transmitter status, Receiver status}. From these input features node status can be identified as normal or dead node. Hidden layer will construct model based on visible layer units using training data and it will be applied for upcoming network data traffic. For that RBM will apply Joint Probability Distribution function of visible layer and hidden layer on training data is represented as:

$$P(V,H) = \frac{\exp^{-E(V,H)}}{Z} \quad (2)$$

Z is representing Normalizing factor and find it out by

$$Z = \sum_{v,h} \exp^{-E(V,H)} \quad (3)$$

Here V is representing visible layer feature vector 'f' for known traffic and H is representing predicting model for unknown traffic. The values of hidden units are calculated from visible units by using Gibbs sampling method as follows:

$$P\,(h/v) = \sum \text{sigm}\,(a_i + W_i v). \quad (4)$$

Nodes can be classified as dead or normal using following procedure:

if (TS ==”less”) or (EL == “poor”) or

(RS == “less”)

then node is dead node

else

node is normal node.

TS is representing Transmitter Strength, EL is representing Energy Level of the node, and RS is representing Receiver Strength at particular time t_i.

3.5. Node Replacement

Fixed residual energy—percentage dependent on substitution (FRP) with this approach, a replacement endeavor is made just when a sensor fails and every sensors with residual energy level is littler than a constant threshold level. Here, we characterize this energy threshold as some rate of starting energy level E.

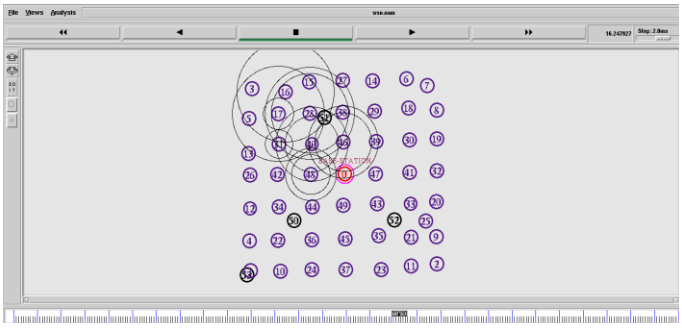

Figure 4 After the fault node identification, the re-routing process

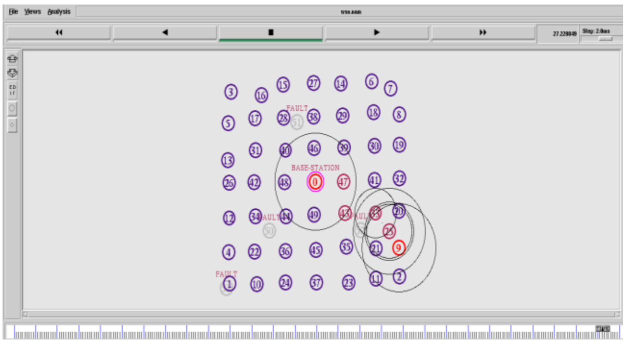

Figure 5 Node replacement process.

4. PERFORMANCE ANALYSIS

In graph (fig.6), we have shown the energy consumption in the underwater sensor network. The x-axis represents time and y-axis represents energy consumption. By observing the graph the energy consumption in our proposed system (green- line) is very less when compared to existing system (red line).Thus the network survivability will be increased because of the less energy consumption.

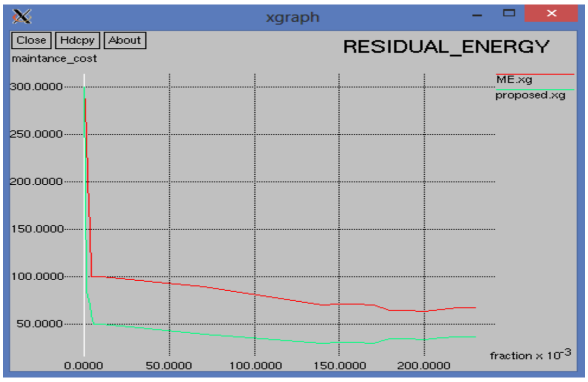

Figure 6 Energy consumption VS time

The Fig.7 shows the maintenance cost in underwater sensor networks. In the graph, the x-axis is represented in terms of time and y-axis is maintenance cost. By observing the graph the maintenance cost in our proposed system(green line) is very less when compared to existing system(red line).

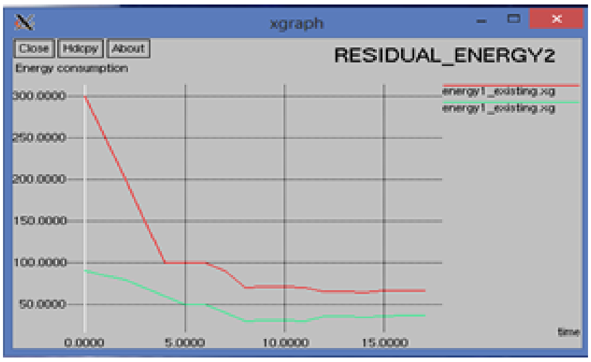

Figure.7 Maintenance cost VS time

5. CONCLUSION

This paper has reduced the node replacement cost by using enhanced combined routing and node replacement policy. Also, developed methods can be implemented in UWSN that could work with determined rate of failed nodes. Using RBM approach the failed nodes are classified properly and operational and maintenance costs are minimized.

REFERENCES

[1] D. Penteado, L.H.M.K. Costa, A.C.P. Pedroza," Deep-ocean Data Acquisition Using Underwater Sensor Networks" [online]. (2011)

[2] R. SeymourandF. Barr,"An improved seabed seismic 4D data collection method for reservoir monitoring," in Proc. Eur. Petroleum Conf., 1996, DOI:10.2118/36893-MS.

[3] SeaBed Geophysical, "Practical applications for node seismic," First Break, 2007, vol.25,pp.89–92

[4] J. Heidemann, W. Ye, J. Wills, A. Syed, and Y. Li, "Research challenges and applications for underwater sensor networking," in Proc. IEEE Wireless Commun. Netw. Conf., 2006, pp. 228–235.

[5] Y. Li, W. Ye, J. Heidemann, and R. Kulkarni, "Design and evaluation of network reconfiguration protocols for mostly-off sensor networks," Ad Hoc Netw., 2008, vol. 6, no. 8, pp. 1301–1315

[6] P.M.Duncan, "Is there a future for passive seismic?," First Break, 2005, vol. 23, pp. 111–115

[7] N. Martakis, S. Kapotas, and G. Tselentis, "Integrated passive seismic acquisition and methodology. Case studies," Geophys. Prospect. vol. 54, 2006, pp. 829–847

[8] S. C. Maxwell and T. I. Urbancic, "The role of passive microseismic monitoring in the instrumented oil field," The Leading Edge, 2001. vol. 20, no. 6, pp. 636–639

[9] B. Tong, G. Wang, W. Zhang, and C. Wang, "Node reclamation and replacement for long-lived sensor networks," in Proc. 6th IEEE Commun. Soc. Conf. Sensor Mesh Ad-hoc Commun. Netw., 2009, DOI: 10.1109/SAHCN.2009.5168950.

[10] S. Parikh, V. Vokkarane, L. Xing, and D. Kasilingam, "Node-replacement policies to maintain threshold-coverage in wireless sensor net- works," in Proc. 16th Int. Conf. Comput. Commun. Netw., 2007, pp. 760–765.

[11] R. M. Gomathi, J. Martin Leo Manickam, "Energy Efficient Static Node Selection in Underwater Acoustic Wireless Sensor Network", Wireless Personal Communications, 2019, 107(2), Pp. 709–727.

[12] R.M.Gomathi, J.Martin Leo MAnickam, "Energy Efficient Shortest Path Routing Protocol for Underwater Acoustic Wireless Sensor Network ",Wireless Personal Communications, 98(1), 2018, pp. 843–856.

[13] MohanaPriya P, Mercy Shalinie S, Pandey T, “Restricted Boltzmann Machine based energy efficient cognitive network”, Proc. Int. Conf. on Innovations in Bio-Inspired Computing and Applications, Kochi,India,vol.424, 2016, pp. 463-472

[14] Indira K, Christal Joy E, "Energy Efficient IDS for Cluster-Based VANETS", Asian Journal of Information Technology, vol 14(1) ,2015, 37-41

[15] P. Ajitha, Dr. G. Gunasekaran., Semantic Based Fuzzy Inference System(SBFIS) Prediction of Patient Emotion and Prescription using support vector machine” in the Journal of Medical Imaging and Health Informatics, Vol.6,No.3,June2016, PP 769-773 ISSN: 2156-7018,

[16] E Brumancia, SJ Samuel, LM Gladence, K Rathan,"Hybrid data fusion model for restricted information using Dempster–Shafer and adaptive neuro-fuzzy inference (DSANFI) system", April 2019, Volume 23, Issue 8, pp 2637–2644.

[17] Sivasangari. A and Martin Leo Manickam. J, “Energy Efficient and Security based Data Communication in Wireless Body Sensor Networks” Journal of Pure and Applied Microbiology, ISSN NO: 0973-7510, Vol.9, 2015, pp.701-711.

[18] Sivasangari. A and Martin Leo Manickam. J, “A Light Weight Cryptography Analysis for Wireless Based Healthcare Applications, “Journal of Computer Science”, ISSN: 1549-3636, Vol.10, No. 5, 2014, pp.2088-2094.

[19] Indira K, Christal Joy E, "Prevention of Spammers and Promoters in Video Social Networks using SVM-KNN", International Journal of Engineering and Technology, Vol 6, No.5, Oct – Nov 2014, Pg 2024-2030.

[20] Ramya Venkatesan,Anandhi Tamilvanan "A Sustainable Agricultural System Using IoT" International Conference on Communication and Signal Processing, 2017, April 6-8, India IEEE.

[21] P. Ajitha, Dr. G. Gunasekaran.,”Semantic Based Intuitive Topic Search Engine”., International Review of Computers and Software, Praise Worthy Prize, Vol.9, No.12 Nov 2014, PP 1964-1970

[22] A.Sivasangari, P.Ajitha, K.Indira,"Air Pollution Monitoring and Prediction using Multi View Hybrid Model", International Journalof Engineering and Advanced Technology (IJEAT)ISSN: 2249 –8958,Volume-8, Issue-2S,pp.1370-1372.

[23] P.Ajitha, A. Sivasangari, K.Indira,"Predictive Inter and Intra Parking System",International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-8, Issue-2S, December 2018.

[24] Indira, K., Ajitha, P., Reshma, V., Tamizhselvi, A, "An efficient secured routing protocol for software defined internet of vehicles",2nd International Conference on Computational Intelligence in Data Science, Proceedings, oct 2019.

[25] Ramya Venkatesan, Anandhi Tamilvanan "A Sustainable Agricultural System Using IoT" International Conference on Communication and Signal Processing, April 6-8, 2017, India IEEE.

[26] E. Brumancia, S. Justin Samuel, R. M. Gomathi and Y. Mistica Dhas,"An Effective Study on Data Fusion Models in Wireless Sensor Networks ", Journal of Engineering and Applied Sciences Vol. 13, No. 2, January 2018.

[27] Anil C.B., Vani Sreekumar and Manjari Joshi, A Survey on Various Time Synchronization Techniques in Underwater Sensor Networks, International Journal of Computer Engineering & Technology, Volume 5, Issue 12, December (2014), pp. 116-122.

[28] Prathap P and Manjula S, To Improve Energy-Efficient and Secure Multipath Communication in Underwater Sensor Network, International Journal of Computer Engineering & Technology, Volume 5, Issue 2, February (2014), pp. 145-152.

[29] Karthik. V, Mohan Kumar S.and Karthikayini, A Novel Survey on Location Based Node Detection and Identifying the Malicious Activity of Nodes in Sensor Networks, International Journal of Computer Engineering & Technology (IJCET) Volume 8, Issue 2, March-April 2017, pp. 61–72.