International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.960

Enhancing Coverage and Connectivity using Energy Prediction Method in Underwater Acoustic WSN

Raj Priyadarshini R , Sivakumar N
[1]Research Scholar, Department of Computer Science and Engineering, Pondicherry Engineering College, East Coast Road, Pillaichavadi,Puducherry-605014, India
[2]Assistant Professor, Department of Computer Science and Engineering, Pondicherry Engineering College, East Coast Road, Pillaichavadi,Puducherry-605014, India

Received: 10 April Revised: 18 April Accepted: 26 April

Abstract

In a Mobile Underwater Acoustic Wireless Sensor Networks (MUAWSN), one of the most important challenging issues is coverage and connectivity during data transmission. It is very difficult to access and cover the monitoring region due to less coverage in underwater environments. Various algorithms, strategies and mechanisms have been proposed by researchers around the world to solve these problems. By applying a new method in Mobile Underwater Acoustic Wireless Sensor Networks which will enhance to maximizing coverage and connectivity of the cluster networks depends on node coverage. In this paper, we propose a random cluster deployment of sensors in MUAWSN to randomly dropping the sensors in water surface. The coverage hole problem is realistic in the MUAWSN due to node damage or active node count goes to below the threshold limit. We proposed an energy prediction algorithm by using Markov Chain Monte Carlo (MCMC) process which will enhance maximum coverage and connectivity during data transmission by analysing the sample value of known parameter in water surface. The topology gets altered due to water mobility caused by several factor such as waves, winds, currents and network coverage and connectivity performance. In addition to improve Hop-by-Hop Dynamic Address Based (HH-DAB) Routing Protocol can be gets changed by predicting energy consumption can be reframed as Modified Hop-by-Hop Dynamic Address Based (Modified HH-DAB) Routing Protocol the random mobility of the node get stretched in 2-D space which will leads to maximizing coverage and connectivity in 3-D along with energy prediction. Theoretical analysis and experimental simulation results are evaluated based on performance metrics such as Residual Energy Consumption (REC), Packet Delivery Ratio (PDR), (iii) Network Coverage Ratio (NCR) and Network Lifetime. The results shows that the proposed Modified HH-DAB system has maximum residual energy consumption of 14.28%, maximum increasing packet delivery ratio of 50%, maximum increasing network coverage ratio of 50% and maximum increasing network lifetime of 50%. The results are encouraging and our proposed method is found to be more efficient than the HH-DAB protocol. The proposed protocols of Modified HH-DAB mechanism performs to improve coverage, connectivity and network lifetime.

Keywords:MUAWSN, Cluster Head, WSN, Modified HH-DABRP, MCMC.

1 Introduction

In Mobile Underwater Acoustic Wireless Sensor Network (MUAWSN), large number of wireless sensor nodes are randomly deployed in underwater environment. It is very useful for oceanographic data collection related to explosion in deep sea ocean, leakage in oil and gas exploration, seismic earthquakes and tidal waves that leads to tsunami formations. Underwater acoustic sensor network consists of large number of sensor nodes, surface buoys and anonymous vehicles. Acoustic link were used for underwater communication which sends data to base station. The radio signals and optical signals are not suitable for underwater communication as radio waves does not propagate through long distances with high frequency and optical waves are scattered waves that does not travel long distances.

Mobile Underwater Acoustic Communication (MUAC) is a method of transmitting and receiving information's in under water surface. The underwater communication is very difficult due to various factors such as multi-path propagation model, channel capacity, bandwidth and transmission delay. Underwater communication have low data rates during data transmission from source node to destination node.In existing work, the Underwater Acoustic Wireless Sensor Network (UAWSN) is adopted only in sparsely deployment under the water surface. Now-a-days UAWSN is adopted in random dense deployment of sensor network in under deep sea ocean which is used to collect the oceanographic informations. Coverage and connectivity are the two important basic issues in MUAWSN which crash the performance of MUAWSN. The main challenge encountered in MUAWSN is that it is very difficult to monitor the underwater sensor region. To overcome this drawbacks, to enhance coverage and connectivity in 3-Dimensional random deployment space of MUAWSN.During data transmission, the variety of coverage hole problem can be detected in sensor network such as target coverage, area coverage, node coverage, path coverage and barrier coverage. In that node coverage problem is one of the unsolvable problem in 3-D space of MUAWSN. This problem arises when active sensor node goes to below threshold level or else node damage caused by the corrosion in water surface.

In Terrestrial Wireless Sensor Networks (TWSN) many routing protocols have been proposed but those routing protocols is not suitable for Underwater Wireless Sensor Networks (UWSN) because of some specific characteristics. In the existing Underwater Routing Protocols (URP) are receiver-based URP and sender-based URP. The receiver-based and sender-based URP in wireless sensor networks can be classified into three categories namely a) Energy-based routing protocols b) Geographic Information-based routing protocols and c) Hybrid routing protocols [1]. In this paper, the Geographic Information-based routing protocols namely Hop-by-Hop Dynamic Address Based Routing Protocol (HH-DABRP) is proposed which is used to handle node mobility and node coverage problems occurred in ocean environments. The coverage problem has been interpreted in various way in the previous works. To protect the coverage hole problem in UWSN. Then automatically which will improve coverage and connectivity over the cluster UWSN. The coverage not only depends on the sensing capability of the sensor node but also the nature and characteristics of event occurred in the environment. Before going to proceed with coverage and connectivity firstly determine how sensors are deployed over the sensing field. There are two fundamental way to deploy sensor nodes namely a) Deterministic deployment of sensor nodes b) Random deployment of sensor nodes in 3-D space. In Deterministic deployment of sensors is very risky and infeasible to find degree of coverage over a sensing field why because the few number of sensor nodes are placed to achieve a desirable degree of node coverage without overlapping of sensor node and less coverage and connectivity issues occurs in deterministic deployment. In Random deployment of sensor nodes, the large scale of sensor networks monitoring the sensing field and inaccessible area can also access neither homogeneous deployment nor heterogeneous deployment of sensors. When Random deployment of sensor node which enhance to maximizing the node coverage and connectivity in UWSN 3-Dimensional space. Here, when we compared with deterministic deployment of sensor is worst rather than random deployment of sensor in 3-Dimensional MUAWSN.

The rest of the paper is organized as follows. Sections 2 discusses about the related works Section 3 discuss about system overview in detail. Section 4 presents the proposed work and algorithm in detail. The simulation and performance evaluation results for the proposed algorithm are presented in Section 5. Conclusion is finally presented in Section 6.

2 Related Works

The Underwater routing protocols are responsible for discovering, maintaining the route information in the networks. Most of the routing protocols are available in the literature survey and working priniciple of underwater sensor network have been formulated. Many of the challenging issues can be solved by applying various algorithm, mechanism, stratagies have been followed to improving the energy efficiency and lifetime of network in the existing systems.

Honghai Zhang and Jennifer C. Hou [1] reported a theoretical and simulation results for the problem of determining the critical node density for maintaining k-coverage of a given square region. To achieve k-coverage under three deployment strategies are: (i) nodes are deployed as a Poisson point process, (ii) nodes are uniformly randomly distributed, (iii) nodes deployed on regular grids. Chun-Hao Yang and Kuo-Feng Ssu [2] proposed an energy-efficient routing protocol in underwater sensor networks which is used to reduce the number of packets transferring in the network, minimizing packet loss due to propagation delay and also decreases the needed energy consumption. Heungwoo Nam and Sunshin An [3] proposed EADA-RAT (Energy Aware Data Aggregation via Reconfiguration of Aggregation Tree) routing protocol. This routing protocol of data aggregation tree is reconfigured using dynamic pruning and grafting function. According to the literature reviews of existing algorithms the proposed EADA-RAT routing algorithms performs better efficiency in terms of energy consumption and delay minimization in underwater environments. Ji Li, Lachlan L.H. Andrew, Chuan Heng Foh, Moshe Zukerman and Hsiao-Hwa Chen [4] presented distributed routing protocols for UWSN. Here, Pre-Contact routing is used in underwater requirements. The HH-DAB routing protocol achieve high packet delivery ratio for both dense and spars networks. Muhammad Ayaz and Azween Abdullah [5] proposed Hop-by-Hop Dynamic Addressing Based (H2-DAB) routing protocol which provide a high scalable and time efficient systems. The main advantages of routing protocol which creates multiple-sink architecture and it does not requires any dimensional location information or special hardware devices and it also maintains complex routing table information. Paul Balister and Santosh Kumar [6] presented how to identify the placement errors and failure of the node. To achieve the Quality of coverage the three main strategies have been followed by comparing with the three deployment area. First identified the sensing range, 50% of failure probability and 10% of high density.

Muhammad Ayaz, Imran Baig, Azween Abdullah and Ibrahima Faye [7] briefly described about the literature survey of the existing routing protocols under the UWSN environments. To control the network topology, Mobility prediction is an important issue even more critical for clustered base routing. The mobility models like Gauss-Markov Mobility Model and Boundless Simulation Area Mobility Model are used for evaluating different ground based algorithms. Rabun Kosar, Ilir Bojaxhiu, Ertan Onur and Cem Ersoy [8] proposed different approaches is used to mitigate the hole problem in surveillance WSN. Firstly, the hole problem can be identified and MaxDQM redeployment process gives good coverage unit than random deployment.

A. Gkikopouli, G. Nikolakopoulos and S. Manesis [9] presented an overview of UWSN technology of architecture, routing, MAC, energy consumption and security related protocols. It can also be analyzed various UWSN application like ocean sampling networks, environmental monitoring, disaster prevention assisted navigation, distributed tactical surveillance, mine reconnaissance and military purposes etc., Hai-Yan Shi, Wan-Liang Wang, Ngai-Ming Kwok, and Sheng-Yong Chen [10] presented a recent developments in game theoretical approaches for wireless sensor network. The brief description for role of game theoretical routing protocol design, topology control, power control and energy saving, packet forwarding, data collection, spectrum allocation, bandwidth allocation, quality of service control, coverage optimization, WSN security, and other sensor management tasks. Juan Luo, Jinyu Hu, Di Wu, and Renfa Li [11] proposed an Energy Saving via Opportunistic Routing Algorithm (ENS_OR) for relay node selection in 1-D WSN. This will improve the lifetime of network, minimizing energy consumption and selection of relay node automatically saves the energy by minimum power cost. The theoretical simulation results of network performance can be evaluated based on energy saving and wireless connectivity which gives better solution when compared with previous survey.

Muhammad Uzair Khan, Sarmad Feroze and Muhammad Zia [12] proposed a novel coverage control algorithm is applied in Probabilistic detection model and also control scheduling mechanism for improving network lifetime. Zhongsi Wang and Bang Wang [13] proposed two algorithm namely Network Connectivity Restoration via Adjusting (NCR-A) and Network Connectivity Restoration via Inserting and Adjusting (NCR-IA) will repair the coverage hole problem in underwater WSN. The proposed algorithms have good performance in network coverage ratio and always ensure network connectivity with a low time complexity. Maicon Melo Alves, Luci Pirmez, Silvana Rossetto, Flavia C. Delicato, Claudio M. de Farias, Paulo F. Pires, Igor L. dos Santos and Albert Y. Zomaya [14] proposed a damage prediction system for wind turbines based on wireless sensor and actuator network. Using fuzzy logic accurately determine the damage prediction states in wind turbines. From the performance analyses, we can preventing accidents, reducing maintenance costs and delays in the power generation. D. N. Sandeep and Vinay Kumar [15] presented the latest underwater acoustic clustering techniques have been studied and a comparative analysis has been done with respect to various performance parameters. The non-conventional communication techniques is demonstrated and also highlighting some of key issues.

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.960

3 System Overview

In this proposed work, we considered a some of the key terminologies in UAWSN have been used in the research paper namely a) sensor node b) Cluster head c) Relay node d) Surface Buoy e) Actuators f) Acoustic link. The sensor nodes are used to perform data collection in oceanographic environment and execute the decision making process of sensor node damage prediction. The sensor networks of cluster head is used to aggregate the collected information and transmit to the relay node. The actual relay node is identified by the weighted channel capacity with short range of communication. Based on the above condition is satisfied, then choose the relay node and transmit the collected information to the surface buoy. Here, the surface buoy is responsible for receiving the aggregated information and alarms generated from the cluster UAWSNs. The surface buoy can also act as transducer for transmitting and receiving the signal. Actuators are the one kind of sensor node. It plays a major role in UAWSN. Whenever any of the sensor node gets damage in networks, at the point of time this actuator takes a responsibility to control the predicted damage nodes(ie) actuators will acts instead of damage nodes. Figure. 1. Shows that the general Architecture of Underwater Acoustic Mobile Wireless Sensor Network. There are three types of communication takes places in underwater environment namely a) Anchor Node (AN) to Cluster member (CM) communication b) Cluster member (CM) to Cluster Head (CH) communication c) Cluster Head (CH) to Cluster Head (CH) communication. In the underwater communication environment the multiple clusters were formed in 3-D space voronoi diagram. In clustered uncovered voronoi diagram there may a loss of coverage and connectivity during data transmission. In order to solve this problem, MCMC process applied in energy consumption prediction algorithms.

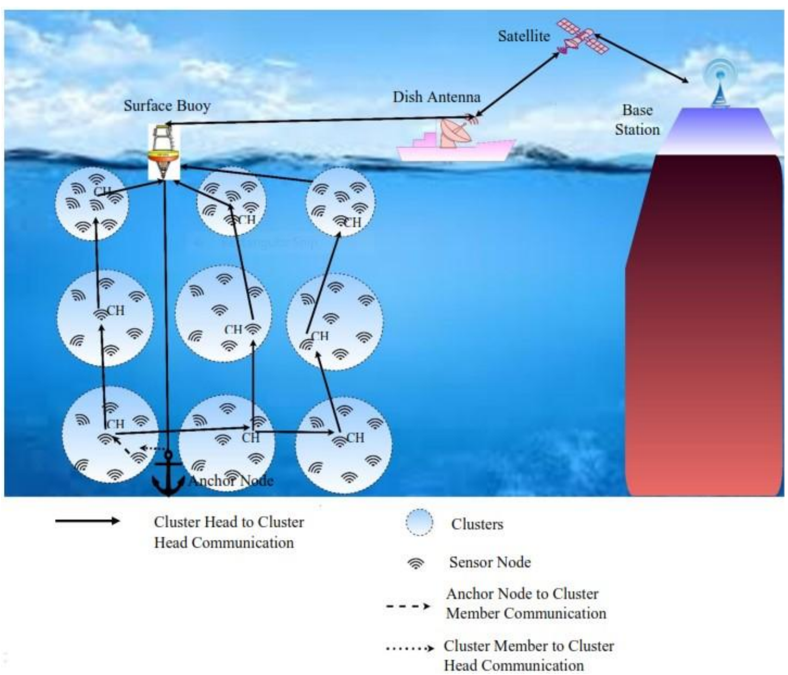

Figure 1: Architecture of Underwater Acoustic Mobile Wireless Sensor Network

4 Proposed Work

In the section, the Mobile Underwater Acoustic Wireless Sensor Networks (MUAWSN) which is normally deliberated in random deployment in 3-Dimensional underwater environment. The sensor node are randomly dropping in water surface and to manage large number of sensor nodes in term of cluster and each cluster consists of cluster head (CH). All the member sensor node is locally managed by the cluster head. When the oceanographic data collection takes place in under water surface, then the sensor node monitor the sensing region and collect the information. After collecting the information, the data transmission took place from the member sensor node to cluster head, cluster head to relay node, relay node to surface buoy and surface buoy to base stations. Suppose due to corrosion or internal problem occurs in the sensor node which leads to failure of sensor node. So that less coverage and connectivity occurs in 2-Dimensional during data transmission. In order to maximizing coverage and connectivity in 3-Dimensional space using Hop-by-Hop Dynamic Address Based Routing Protocol (HH-DABRP). Based on the deployment the coverage and connectivity problem occurs. Coverage of each sensor is determined by the kind of sensing. Multiple coverage and connectivity requirements need to guard against single node or link failure in network. The communication range of sensor is greater than atleast twice the sensing range. Probability to find the optimal sniff path to achieve the optimal detection probability and determine the number of sensor nodes needed to cover the entire area. So there is no communication hole and coverage hole exists in the sensor network. To improve Multiple coverage and connectivity of WSN by selecting the dynamic sink mobility. To implementing by introduces three schemes dynamic mobility algorithms is proposed.

4.1 Energy consumption Prediction algorithm using Markov Chain Monte Carlo (MCMC) process

In this section, we describe the proposed method used to predict the energy consumption in underwater is formed in water surface. Here, the surface buoy connected with anchor sensor node under the deep sea ocean. The anchor sensor node detect the earthquakes, tsunami or any natural disaster occurred in the water environments. And it must identified and transmit the sensed information to the Cluster Member (CM) node then multi-hop information carried out the task and communicate the sensed information to the Cluster Head (CH). There are three level of communication takes place in underwater environment. During data Communication process, the sensor nodes spend much more energy while transmitting and receiving data purpose. At this point of time, the remaining node goes into idle or sleep state. For each and every cycle of data transmission process the energy level of sensor nodes gets changed. It happens, because due to the amount of energy spend in the first cycle of data transmission. Because of this reasons, we are in need to predict the energy of the sensor node for entire cycles. Here, we are introduces the Markov Chain Monte Carlo (MCMC) process for predicting the energy resources. The main goal of MCMC, we have likely determine the known parameters as temperature, pressure, humidity etc.,From this work, we analysis the water temperature level of underwater WSN. Based on the various boundary conditions termed as low, high and moderate. By applying MCMC algorithm in UW-AMWSN. Initially taken the sample values from the probability distribution function P. In voronoi diagram, select the sample generated point has been taken in voronoi region or voronoi cell. According to the sampling values, we find out the approximate value of expected output Ef(x).

Where,

E is a Expected output.

f is a complicated/complex function.

x is a distributed some complication distributed function P. (i.e)$x \sim P$

The MCMC process can be mainly suitable for solving the problem in higher dimensional space. And it can also be suitable for 2-D and 3-D space. In order to get an approximation value Ef(x), particularly identify the sample mean value for single voronoi region is given by,

$$Ef(x) \approx \frac{1}{n}\sum_{i=0}^{n} f(x_i) \quad (1)$$

Here, x_i is a distribution of all sensor nodes (i.e) $x_1, x_2, x_3 \ldots\ldots x_n$. The complex problem is analyzed using the function $f(x_i)$. In underwater wireless sensor network rejection sampling method is followed which is used to generate observations from a distribution. In Monte Carlo method, the “accept-reject algorithm” is followed. In randomly choose the point in the voronic region. From that point, dynamically move through the region. At some point of time, we can attain a higher probability value. In this way, we can find out the other point in a voronic space region by performing random walk by moving around the high dimensional region is much more efficient than other systems. According to the illustration, the markov chain has a new state of which holding the function of old states with noise representations. The main goal of MCMC is sample value of probability p or an approximation of Ef(x). To predict the energy level in underwater based on water temperature and pressure of water surface. The underwater surface is suitable for n-dimensional space. Identify the sample point in specific region and perform random walk methodology which is used to identify the higher dimensional region. Similarly, in each and every region the random walk techniques is followed and it can be explored the next higher dimensional region. Based on accept and reject proposal distribution algorithm the energy of sensor node is determined and it is implemented using aquasim in underwater environment. In 2-D region the sensor nodes are placed in X and Y co-ordinate position. similarly, in 3-D region the sensor nodes are placed in X, Y and Z co-ordinate position. By performing random walk technique in n-dimensional space, the energy of sensor node can be predicted in the region with the help of accept and reject proposal distribution algorithm and it shown in Algorithm 1. Figure. 2 shows that the level diagram of energy prediction from various region.

Algorithm 1: *Energy Prediction Algorithm using MCMC*
Input Required: $a_{(0)}, a_{(1)}, a_{(2)} \ldots ..$ *represent state of MC*
a^* *represent proposal distribution* $q(a|a^{(t-1)})$
$S = a_t$ *represent state space of MC over n-dimensional where S indicates sample path generated between the region*
$p(a)$ *represent density of given network space*
N *represent random walk number towards n-dimensional space*
β *represent acceptance probability*
Output: *Accept and Reject Proposal Distribution Energy can be predicted*
1: $Sett \leftarrow 0$
2: Generate an initial state $a^{(0)}$ *from a prior distribution* $\pi^{(0)}$ *over initial state*
3: Repeat until t = S
4: Set t= t + 1
5: Generate a^* *from* $q(a|a^{(t-1)})$
6:If $\boldsymbol{N} \leq \beta$*Then*
7: Accept the energy region
8: $seta^{(t)} = a^*$
9: Else
10: Reject the energy region
11: $seta^{(t)} = a^{(t-1)}$
12: EndIf
13: Predict the energy of the sensor node using Eq. (2).

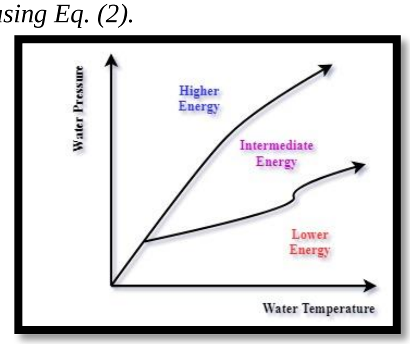

Figure 2: Level diagram of energy prediction

5 Performance Evaluation

Network Simulator (NS) version-3.26 is used to simulate the proposed protocol. NS 3.26 is a network simulator that is very widely used wireless sensor environment. The various network simulation parameters are summarized in Table 1. The topology simulation used in our model is random topology with random mobility model which are placed within simulation area.

Table 1: NS-3.26 Simulation Parameter

Parameter	Value assigned
Area	1000 x 1000
Number of sensors	500
Propagation model	Underwater propagation
Antenna	Omni-directional antenna
Traffic range	CBR
Node placement	Randomly placed
Transmission Power	60W
Receiving Power	3W
Idle Power	0.50W
Sleep Power	0.05W
Data Packet length	512 Byte
Energy consumption of sensor board	100 nJ/bit
Sensing interval	0.01msec
Simulation time	300 sec

5.1 Performance metrics

5.1.1 Residual Energy Consumption (REC)

The average energy spent by sensor node during each round throughout the network. The energy stated that the whole network of energy and the residual energy is how much energy spend for transmitting data in the network. In underwater propagation energy model [16], the residual energy of sensor device 'i' is given by Eq. 2.

$$RE_i = IE_i - CEi/TEi \quad (2)$$

The total energy consumption of the networks depends on the data transmission of sending and receiving of the packet.

$$\sum_{i=1}^{n} RE_i * IT_i * ST_i \quad (3)$$

$$RE_i IT_i ST_i \geq Thres_i^{Res} \quad (4)$$

Where, RE_i represents the residual energy, IT_i represents the ideal time, ST_i represents the sleep time and $Thres_i^{Res}$ is the residual threshold of a sensor device.

5.1.2 Packet Delivery Ratio (PDR)

The ratio of the number of packets received to the number of packets expected to be received.

$$PDR = \frac{No.of PackectReceived}{No.of PacketSend} \quad (5)$$

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.960

5.1.3 Network Coverage Ratio (NCR)

The coverage computation method using Monte Carlo simulation based on sample values generated by the sensor nodes. The coverage ratio usually determines how fit the fascinated range is observed by the sensors.

5.1.4 Throughput (TP)

Generally, throughput can be measured at any layer of the system. Throughput is denoted as data can be transmitted within a given bandwidth of the networks per unit of time represented in seconds. If there are strong coverage area in the random deployment of the sensor nodes. Automatically, the throughput efficiency get increases based on the data packet size in bytes and speed of data transmission in Mb/s.

5.2 Simulation Results and Discussion

In this section, the simulation results demonstrate the accuracy and performance of Modified HH-DAB routing protocol which improves the energy efficiency and increases the lifetime of the wireless network with the existing methods of HH-DAB. In our investigation methodology, the deployment area of sensors is of dimension 1000 × 1000 square units. The performance of the Energy consumption prediction algorithms is applied in underwater environments. When many number of data transmission process gets increases simultaneously energy consumption automatically decreases in existing systems. In order to increases the energy consumption with prediction algorithm using MCMC process. When number of data transmission packet get increases the energy utilization of the cluster network get reduces in water environment. Here, we are maximizing the number of data transmission packet automatically with the help of MCMC prediction rule the energy is recalculated in each and every cycle.Table 2 shows the comparison of total residual energy consumption for proposed system and number of data transmission of sensor nodes (HH-DAB) given in reference for varied number of data transmission of sensor nodes. The number of data transmission of sensor nodes are varied from 0 to 500 in steps of 50. For different number of data transmission of the sensor nodes, the proposed system shows higher percentage of residual energy consumption value compared to the existing systems. For example, in number of data transmission of the sensor nodes 500 the percentage increase in total residual energy consumption of the proposed system compared to HH-DAB is 2.4% respectively. The variation of percentage of total residual energy consumption for sensor nodes (from reference and present analysis) and varied number of data transmission of the sensor nodes is shown in Figure. 3. From Figure. 3 it is clearly understood that the proposed system shows higher value compared to the existing systems.

Table 2: Comparison table for total residual energy consumption

No. of Data Transmission(kbps)	Total Residual Energy Consumption (kbps)	
	HH-DAB[4,15]	Modified HH-DAB
0	0	0
50	52	57
100	120	140
150	160	180
200	240	280
250	270	290
300	350	380
350	370	395
400	445	470
450	460	480
500	485	497

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.960

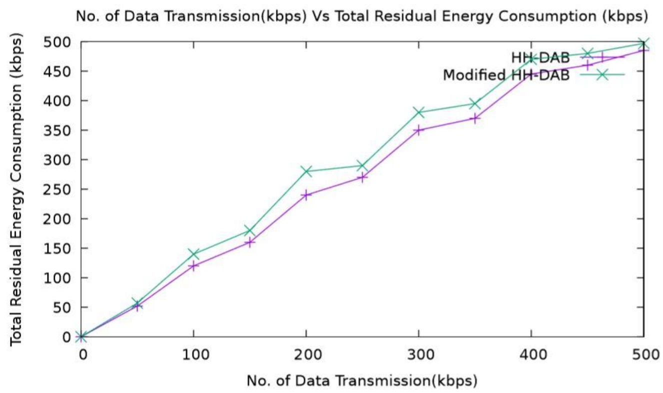

Figure 3: Performance of total energy consumption in the networks

Table 3 shows the comparison of packet delivery ratio for proposed system and number of sensor nodes (HH-DAB) given in reference for varied number of sensor nodes in the networks. The number of sensor nodes are varied from 0 to 500 in steps of 50. For different number of sensor nodes, the proposed system shows higher packet delivery ratio value compared to the existing systems. For example, in number of sensor nodes 500 the increase in packet delivery ratio of the proposed system compared to HH-DAB is 3.33% respectively. The variation of packet delivery ratio for sensor nodes (from reference and present analysis) and varied number of sensor nodes is shown in Figure. 4. From Figure. 4 it is clearly understood that the proposed system shows higher value compared to the existing systems.

Table 3: Comparison table for packet delivery ratio

No. of Sensor Node	Packet Delivery Ratio (PDR)	
	HH-DAB[4,15]	Modified HH-DAB
0	0	0
50	0.2	0.4
100	0.5	0.68
150	0.7	0.75
200	0.85	0.9
250	0.92	0.99
300	1	1.05
350	1.1	1.15
400	1.25	1.3
450	1.35	1.4
500	1.45	1.5

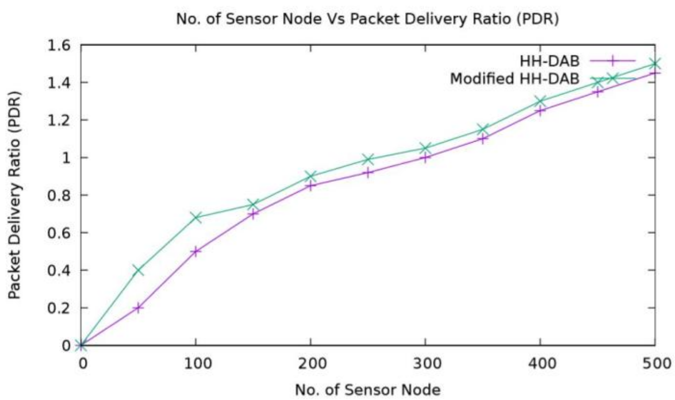

Figure4: Performance of packet delivery ratio based on data transmission

Table 4 shows the comparison of network coverage ratio of the sensor nodes for proposed system and number of data transmission of the sensor nodes (HH-DAB) given in reference for varied number of data transmission of the sensor nodes. The number of data transmission of the sensor nodes are varied from 0 to 500 in steps of 50. For different number of data transmission of sensor nodes, the proposed system shows higher percentage of network coverage ratio of the sensor nodes value compared to the existing systems. For example, in number of data transmission of the sensor nodes 500 the percentage increase in network coverage ratio of the sensor node of the proposed system compared to HH-DAB is 3.03% respectively. The variation of percentage of network coverage ratio for sensor nodes (from reference and present analysis) and varied number of data transmission of the sensor nodes is shown in Figure. 5. From Figure. 5 it is clearly understood that the proposed system shows higher value compared to the existing systems.

Table 4: Comparison table for network coverage ratio

No. of Data Transmission (Kbps)	Network Coverage Ratio	
	HH-DAB[4,15]	Modified HH-DAB
0	0	0
50	0.05	0.1
100	0.18	0.22
150	0.3	0.35
200	0.38	0.4
250	0.45	0.5
300	0.6	0.65
350	0.74	0.78
400	0.82	0.85
450	0.91	0.95
500	0.96	0.99

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.960

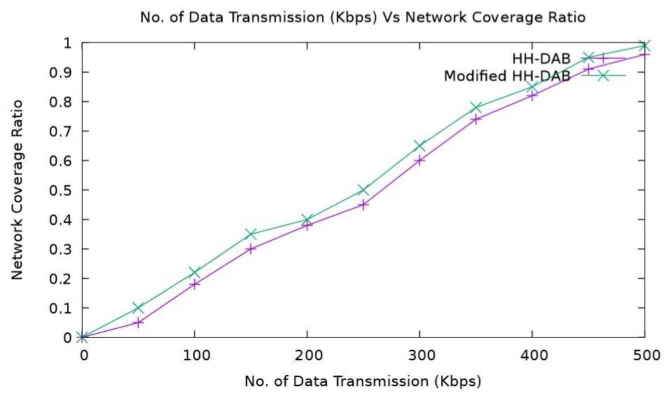

Figure 5: Performance of network coverage ratio in the entire network

Table 5 shows the comparison of throughput for proposed system and number of data transmission of the sensor nodes (HH-DAB) given in reference for varied number of data transmission of the sensor nodes. The number of data transmission of the sensor nodes are varied from 0 to 500 in steps of 50. For different number of data transmission of sensor nodes, the proposed system shows higher percentage of throughput value compared to the existing systems. For example, in number of data transmission of the sensor nodes 500 the percentage increase in throughput of the proposed system compared to HH-DAB is 12.72% respectively. The variation of percentage of throughput for sensor nodes (from reference and present analysis) and varied number of data transmission of the sensor nodes is shown in Figure. 6. From Figure. 6 it is clearly understood that the proposed system shows higher value compared to the existing systems.

The results shows that the proposed Modified HH-DAB system has maximum residual energy consumption of 14.28%, maximum increasing packet delivery ratio of 50%, maximum increasing network coverage ratio of 50% and maximum increasing network lifetime of 50%.

Table 5: Comparison table for throughput of the networks system

No. of Data Transmission (Kbps)	Throughput (bps)	
	HH-DAB[4,15]	Modified HH-DAB
0	0	0
50	400	800
100	900	1500
150	1600	2500
200	2000	3000
250	2500	3200
300	2800	3800
350	3400	4200
400	4000	4800
450	4200	5000
500	4800	5500

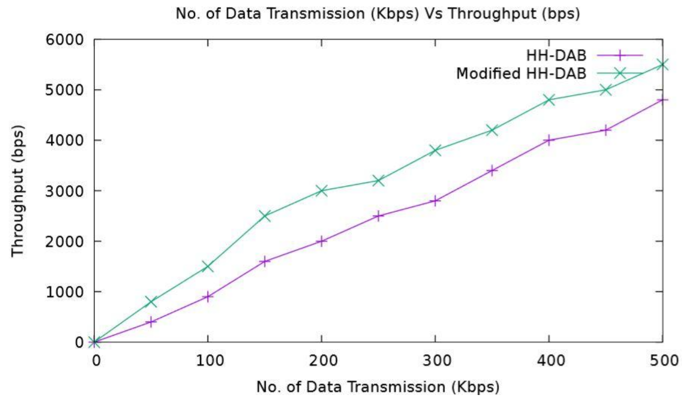

Figure 6: Performance of throughput of the network system

6 Conclusions

In this work, we proposed an energy consumption prediction algorithm using MCMC process is achieved maximum coverage and connectivity in 3-D and high Dimensional space during data transmission in cluster Mobile Underwater Acoustic WSN. With the help of MCMC process previously generated sample value of known parameter is identified with probability distribution function P. In next state of energy prediction is very closer to the probability value Q. In each and every states of Modified HH-DAB routing protocols depends on data transmission and number of sensor nodes in networks the total amount of energy consumption is 50% higher than compared with the existing HH-DAB. The results shows that the proposed Modified HH-DAB system has maximum residual energy consumption of 14.28%, maximum increasing packet delivery ratio of 50%, maximum increasing network coverage ratio of 50% and maximum increasing network lifetime of 50%. The results are encouraging and our proposed method is found to be more efficient than the HH-DAB protocol. The proposed protocols of Modified HH-DAB mechanism performs to improve coverage, connectivity and network lifetime.

To conclude that the proposed scheme of Modified HH-DAB automatically generate the dynamic address of each sensor node in every cycle of transmission which enhance the energy efficiency, network lifetime and maximizing coverage and connectivity in 3-D space environment based on performance evaluation metrics.

References

[1] H. Zhang and J. C. Hou, "Is deterministic deployment worse than random deployment for wireless sensor networks?," tech. rep., 2005.

[2] C.-H. Yang and K.-F. Ssu, "An energy-efficient routing protocol in underwater sensor networks," in *Sensing Technology, 2008. ICST 2008. 3rd International Conference on*, pp. 114–118, IEEE, 2008.

[3] H. Nam and S. An, "Energy-efficient routing protocol in underwater acoustic sensor networks," in *Embedded and Ubiquitous Computing, 2008. EUC'08. IEEE/IFIP International Conference on*, vol. 2, pp. 663–669, IEEE, 2008.

[4] M. Ayaz and A. Abdullah, "Hop-by-hop dynamic addressing based (h2-dab) routing protocol for underwater wireless sensor networks," in *2009 international conference on information and multimedia technology*, pp. 436–441, IEEE, 2009.

[5] J. Li, L. Andrew, C. Foh, M. Zukerman, and H.-H. Chen, "Connectivity, coverage and placement in wireless sensor networks," *Sensors*, vol. 9, no. 10, pp. 7664–7693, 2009.

[6] P. Balister and S. Kumar, "Random vs. deterministic deployment of sensors in the presence of failures and placement errors," in *IEEE INFOCOM 2009*, pp. 2896–2900, IEEE, 2009.

[7] M. Ayaz, I. Baig, A. Abdullah, and I. Faye, "A survey on routing techniques in underwater wireless sensor networks," *Journal of Network and Computer Applications*, vol. 34, no. 6, pp. 1908–1927, 2011.

[8] R. Kosar, I. Bojaxhiu, E. Onur, and C. Ersoy, "Lifetime extension for surveillance wireless sensor networks with intelligent redeployment," *Journal of network and computer applications*, vol. 34, no. 6, pp. 1784–1793, 2011.

[9] A. Gkikopouli, G. Nikolakopoulos, and S. Manesis, "A survey on underwater wireless sensor networks and applications," in *Control & Automation (MED), 2012 20th Mediterranean Conference on*, pp. 1147–1154, IEEE, 2012.

[10] H.-Y. Shi, W.-L. Wang, N.-M. Kwok, and S.-Y. Chen, "Game theory for wireless sensor networks: a survey," *Sensors*, vol. 12, no. 7, pp. 9055–9097, 2012.

[11] J. Luo, J. Hu, D. Wu, and R. Li, "Opportunistic routing algorithm for relay node selection in wireless sensor networks," *IEEE Transactions on Industrial Informatics*, vol. 11, no. 1, pp. 112–121, 2015.

[12] M. U. Khan, S. Feroze, and M. Zia, "Coverage control algorithm for node scheduling in wireless sensor networks," in *Frontiers of Information Technology (FIT), 2016 International Conference on*, pp. 17–22, IEEE, 2016.

[13] Z. Wang and B. Wang, "A novel node sinking algorithm for 3d coverage and connectivity in underwater sensor networks," *Ad Hoc Networks*, vol. 56, pp. 43–55, 2017.

[14] M. M. Alves, L. Pirmez, S. Rossetto, F. C. Delicato, C. M. de Farias, P. F. Pires, I. L. dos Santos, and A. Y. Zomaya, "Damage prediction for wind turbines using wireless sensor and actuator networks," *Journal of Network and Computer Applications*, vol. 80, pp. 123–140, 2017.

[15] D. Sandeep and V. Kumar, "Review on clustering, coverage and connectivity in underwater wireless sensor networks: a communication techniques perspective," *IEEE Access*, vol. 5, pp. 11176–11199, 2017.

[16] R. R. Priyadarshini and N. Sivakumar, "Cluster head selection based on minimum connected dominating set and bi-partite inspired methodology for energy conservation in wsns," *Journal of King Saud University-Computer and Information Sciences*, 2018.