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Malicious Anchors Voting Based Error Specific Localization Algorithm In Three Dimensional Underwater Acoustic Sensor Network

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Abstract

Due to malicious anchor nodes in the three dimensional underwater sensor nodes, effective localization based routing algorithm under malicious anchor has been considered as importance of the particular research. Many traditional localization based routing model has been implemented for monitoring activities on the acoustic network, despite of many advantage of the location based routing technique, still many challenge has been continuing in terms of coverage and connectivity. In order to tackle those challenges, a new localization based protocol named as Malicious Anchors Voting based Error Specific Localization Algorithm has been proposed to Underwater Acoustic Sensor Network under Doppler Effect and multipath propagation. In this work, error specific localization of the nodes has been applied as one of the important technique that increases system scalability and reduces attacks propagating in the sensor nodes. The proposed model decide the proper detection and communication of events of interest in UWSN due to unstable underwater environment by reducing irrelevant attack features in the trace file on utilizing multiple voting mechanism on the nodes such as Clock Synchronization , motion of the sensor nodes, distance between the sink node and sensor node. On computation of those information's, malicious anchor nodes have been localized. Those localized node are further processed using Cooperative localization for determining maximum localization coverage ranges for data communication on association weight using reputation mechanism. Trust based authentication has ability to adapt to the changes of the distance value during data communication on multi hop communications using localization function on weighted average of nodes Reputation scheme. On simulation analysis on Matlab, proposed model has been compared with existing schemes to demonstrate the effectiveness of the proposed scheme especially in detecting and preventing malicious anchor node and providing good communication and networking performances in terms of Average Localization Error with Inconsistent Malicious Anchor, Average Localization error with inconsistent distance threshold, Localization coverage Ratio and program running time. Finally it has been proved that proposed model attains better benefits on both localization coverage ratio and Localization Error with Inconsistent Threshold node to produce the effective localization in underwater environment.

Keywords: Underwater Acoustic Wireless Sensor Network, Robust Localization, Voting, Transmission Distance, Malicious Anchor, Reputation, Coverage, Trust Analysis

1. Introduction

Underwater Acoustic Wireless Sensor Network has made great progress and attracted more and more researcher's attention due to growth of the wide application demands, such as the environmental monitoring, pollution control, disaster forecast and military activities. In underwater environments, the electromagnetic wave signal will be affected by the strong attenuation caused by the propagation medium[1]. Fortunately, by using the acoustic wave, we can achieve a reliable data transmission over a long distance at a relative low frequency [2]. However, due to the high complexity of the underwater environment and the slow propagation speed of the underwater acoustic wave, there are still lots of problems about the quality of the communication need to be solved, such as limited frequency bandwidth, long communication delay, and so on. Furthermore, the cost of node localization is high in order to maintain a good communication performance for the underwater acoustic sensor networks.

At present, many traditional techniques have employed towards data communication in underwater acoustic sensor network. However, in practice, the localization of the underwater sensor nodes is limited under malicious activities, and it is difficult to handle Doppler Effect which requires large amount of anchor node planning. To improve the localization coverage ratio of the Underwater Acoustic Wireless Sensor Network, reputation based algorithm has been proposed on utilizing Trust analysis and Clock Synchronization techniques. Nodes of the particular network are adopted with multi hop communication in which the end to end communication over long distance is assisted by sink nodes which is considered as relay nodes[3]. It is considered as most efficient way to realize the localization optimization for the multi-hop sensor network. In addition, it keeps good communication performance and achieves the goal of a minimizing the localization error.

The rest of the paper is organized as follows In Section 2, the related work about the Detection and elimination algorithm for the underwater acoustic sensor networks against malicious anchor has been presented. The related models mentioned in this paper. In Section 3, we present the proposed Malicious anchor Voting based Error Specific localization scheme for the multi-hop underwater acoustic sensor network. The simulation results of the proposed model are presented in Section 4. Finally, a conclusion of the work is provided in Section 5.

2. Related work

In this section, various existing model enumerating localization techniques on underwater acoustic wireless sensor network has analysed on basis of localization error and coverage aspects towards efficient data communication between nodes in detail as follows

2.1.Reputation Specific Unequal layered Localization Algorithm

In this method, Reputation scheduling scheme has been analysed in depth as sensor nodes and autonomous underwater vehicles in this network can dynamically choose to malicious activities or work to adapt to the environmental change [4]. It dynamically determines a sufficient number of active nodes in the UASN at different times, such that the targets required to be detected are covered for effective data communication using improved reputation balanced unequal layered localization algorithm. Multi-population of the localization specific algorithm determines the normal anchor node against malicious anchor node through distance based localization.

3. Proposed model

In this section , a new frontier approach named as Malicious Anchor voting based error specific localization algorithm based on the trust analysis and Reputation of localization mechanism has been developed to identify the malicious anchor node in the network of interacting with normal anchor nodes on specific topology has been designed using various localization specific constraints as follows

3.1. Network Model

In this work, underwater sensor nodes deployed to monitor the underwater environment and the activities of the marine life[5]. Network deployed with n sensor including base station and AUVs which is randomly deployed. Each sensor is associated with a sphere sensing range.[6] A base station (BS) is set up above the sea level or in a neritic zone to collect the transmitted messages**.** The AUV is utilized to assist the communication between each underwater sensor node and the sink node**.** Sensor node varies on four modes such as active, asleep, malfunctioned, and dead[7].

Only active sensors serve to detect targets and consume their battery power. To save power, sensors that are not active can be turned off, said to sleep. In practice, sensors may be temporarily malfunctioned, and could be recovered later. A sensor may be dead due to battery power depletion, or get lost due to external factors (e.g., flushed by ocean currents) . Due to different sensor modes, the number and IDs of active sensors vary at different times. According to the UASN, configuration, the proposed scheme decides a sleep schedule[8]. Sleep schedule is decided for using the updated information of survival sensors.

3.2.Clustering of Underwater Acoustic Wireless Sensor Network – Distance and Coverage

In this section, Leach [9] based Clustering model is applied to arrange the sensor nodes in cluster on basis of localization of the anchor nodes. Further it identifies the cluster head on basis of residual energy of the node and number of neighbour nodes. Cluster head selection is carried out to ensure uniform distribution of energy among the sensors, and consequently increasing the lifespan of a sensor network. After selection of the cluster head, the cluster head periodically collect, aggregate, and forward data to the BS using the minimum energy (cost) routing.

AUV in the UASN can always collect the data of each CH node correctly as long as the AUV can be close enough to the CH node due to the powerful energy supply of AUV. The optimal design of AUV data collection path among the CH nodes carried out using principle component analysis which is described in detail in next subsection. Sensor node consumes most of its power on communication, especially when it needs to transmit its data to the BS which is located far away from the WSN.

In the clustering algorithm, each underwater sensor node firstly counts the number of neighboring nodes within d transmitting hops, which is called the potential number of n CH nodes based on d-hop for each underwater sensor node. Then the node with maximum potential number of n CH nodes based on d-hop is selected as the CH node in each locality. It means that if an underwater sensor node can connect with more neighboring nodes within its effective communication range, it is more likely to become the CH node.

3.3.Trust Analysis against Malicious Anchor

In this part, Trust Analysis of the anchor node has been decided on basis of various factors to node for data communication on localization and reputation mechanism. Especially connectivity and localization coverage considered as primary factor. In acoustic network, trace file collects ambient noise, water temperature, Phase velocity, Wave Number, residual energy of the node, queue length, energy density of neighbour nodes, motion of the sensor nodes, distance between the sink node and sensor node and data traffic for classifying the anchor node on basis of the reputation trust . Figure 1 represents the localization of proposed work.

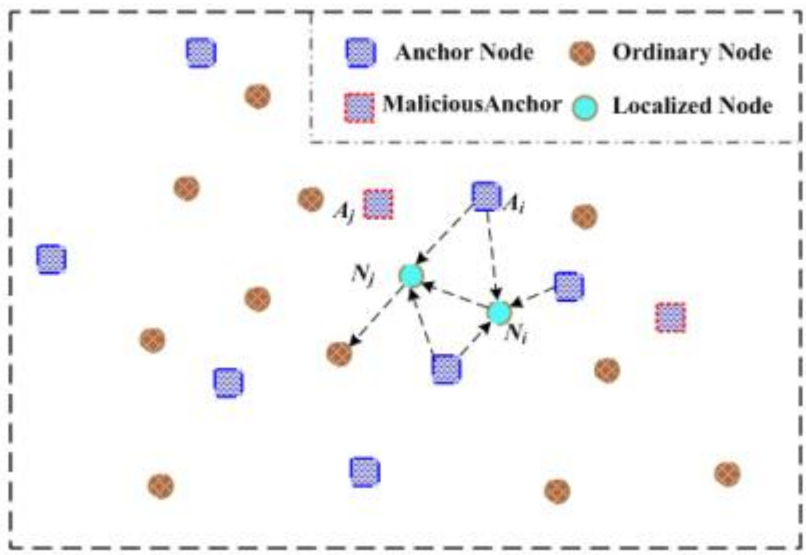

Figure 1: Localization of UASN

Employment of localization reduces the energy consumption and increase the data communication speed on uniform distribution of nodes to the network [10]. Further trust analysis reduces the attribute set of trace file on elimination of irrelevant attributes. Finally it predicts the effective anchor node against malicious node

Algorithm 1: Detecting Malicious Nodes

Input: Revocation and Resilience Constraints of Anchor Node

Output: Malicious Node

Process:

Compute Maximal transmission Distance R on inconsistent malicious Degree D

Determine Confidence Value of the Gaussian Random Variables

Ce=λe

Variance is the factor of node with same direction of another node

Where λ is the Transmission value of the dist(X,Y) of position Coordinates

Transmission Value Corresponds to variance of each anchor nodes

Extract Top 10 transmission values of the Localization C**e**

Trust analysis computes effective anchor node set of the position Coodinates for effective data commuication on strong connectivity and coverage. Moreover, due to the changes of the inferences among the sensor nodes and the distance to the sink node for each sensor node, the selection of the node will not change mobility of the underwater sensor node caused by the ocean currents. In order to properly simulate the malicious anchor node among the normal anchor nodes in actual situation, voting mechanism has been employed.

3.4. Node Reputation Computation using Voting mechanism

The reputation of Node of each underwater sensor node can be obtained using voting based scheme to compute effective anchor node among other malicious node using probability density function. Node Localization calculates the motion of the node with respect to the position coordinates. On establishing the coordinates for the reputation of node on the particular surface of sea and assuming the location of sensor node as L(p,q). Distance between the Sensor node on x axis is given as D_x and y axis as D_y computed as

$$D_x = x = \frac{\delta(p,q,t)}{\delta y} \quad \text{Computation for x axis}$$

$$D_y = x = \frac{\delta(p,q,t)}{\delta x} \quad \text{Computation for y axis}$$

Further probability density function is given as

Probability Density function μ (p, q, t) = tanh[$\frac{q-B(t)\sin k(ct)}{\cos K(ct)}$]

In above equation, c represents the phase velocity of the measured coordinates of the sensor node, k represents the wave number and B(t) means the amplitude function of the anchor and malicious node. By using the Probability Density function, time synchronization of each underwater sensor node can be calculated under various clock domains. Cluster structure of the proposed model is built in a decentralized way by which each underwater sensor node only needs to communicate with neighbour nodes using distance measurements. This avoids the large amount of global update information produced by the central controller to identify the malicious anchor node, which will cost much energy resource for data transmission.

In the voting based approach, complex situation brought by the data transmission collision and long delay in the network can be reduced and efficiently mapped to the weight from node x following to node z. More importantly, it is not necessary for the distributed clustering approach to obtain the exact locations of each underwater sensor nodes but just need the relative locations of them, which avoids the localization problem for each underwater sensor node in a centralized clustering approach. Voting based node reputation and Localization error is optimized using coverage ratio through output activation function

Coverage ratio p = $\frac{\text{Neighbour Node n}}{\text{Number of sensor node N}}$

On Computation of p, the larger the covering ratio is, the higher the probability of becoming the CH node for the underwater sensor node. However, the CH node needs to consume more energy due to the data aggregating and relaying operations, which leads to the prematurely die of the underwater sensor node with largest covering ratio, and then causes the energy hole problem. ANN using forward propagation eliminates the node selection problem.

Algorithm 2: Voting based mechanism

Input: Transmission model, Communication Hops H, Probability Density Function B, Phase velocity, Anchor Signal N, Euclidean Distance ED

Output: Reputation Node for Data Communication

Process

While ED> 0 do

Anchor Node broadcast information Init_msg

For each Node N_i do

Calculate Positive Vote against Transmission Distance L_i with Respect to Transmission Delay T_i

Endfor

While Threshold Based Confidence Value T_i> 0 do

Receive the Malicious node information on basis position coordinates

If (ID<M L_i) Inconsistent Malicious degree

Then \\ If the number of Anchor Node A from an underwater sensor node N_i to the neighbor node identified by eliminating the malicious anchor node on location references

forward Anchor node information to neighbour

\\ the node will forward the broadcast information of the node n\\

for each N_i do

Send Mean Square Error of node based on Reputation Value in identity matrix I_m

Voting function on iterative localization ()

$$\varphi(\nu) = \mathrm{Im}\tanh(x1-x2)(y1-y2)$$

endfor

endif

endwhile

On the broadcasting phase, the anchor node will broadcast a short package to each underwater sensor node, which contains the transmitting time of localization scheme. Hence localization reputation mechanism for the underwater sensor node has been employed using voting mechanism to implement a unified control of each underwater sensor node. On one hand, the underwater sensor node will maintain a large effective communication and Coverage range when its localization algorithm is sufficient.

4. Simulation Results

Simulation of the proposed malicious anchor node detection and elimiation algorithm for underwater acoustic sensor network is experimented and it is performed using Maltab 2013 simulator [11]. In this way, the uncertainty of the underwater acoustic communication environment [12] is simulated. In this deployment of the sensor node and its various configuration of the network with parameter setting has been provided in the table1

Table1: Network Configuration Setting

Parameter	Configuration Value
Network Coverage Area	1000*1000m^2
Number of underwater Acoustic Sensor Nodes	50
Initial Energy of Node	1000 Joules
Signal Frequency	12khz

Modulation mode	OFDM
Maximum Wind Speed	15m/s

Based on the above configuration setting, network results for proposed and existing scheme has presented respectively in terms of Average Localization Error [14] and Average Localization Ratio against inconsistence distance threshold. Figure 3 represents the performance analysis of the Localization error schemes of UASN.

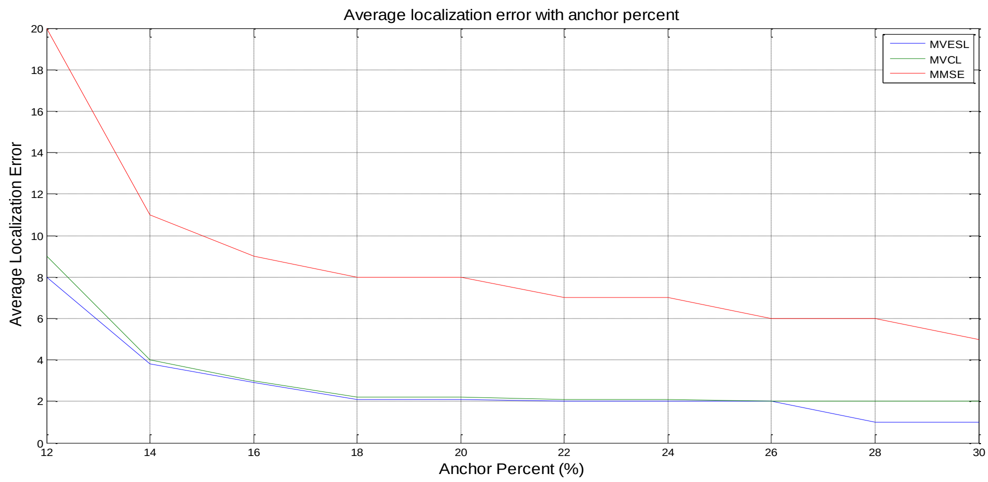

Figure 2: Performance of Average localization Error with Anchor Present

On analysis, the Malicious anchor identification and elimination through trust and reputation analysis using voting scheme in proposed scheme produces localization accuracy than that in existing scheme. Localization coverage ratio denotes that the percent between the number of localized nodes and all sensor nodes at certain percent ratio of anchor nodes is represented in the figure 3.

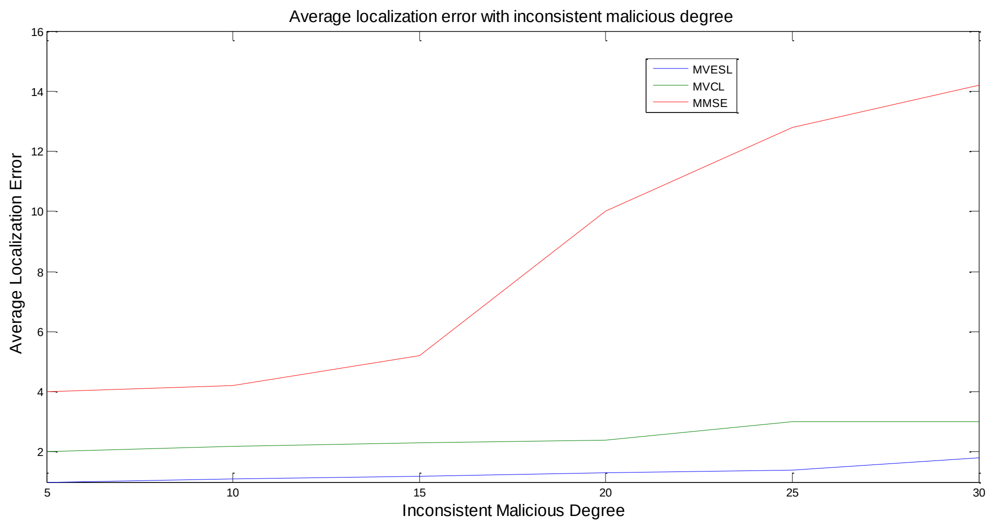

Figure 3: Performance Analysis of Average Localization Error against Inconsistent Malicious Degree

Obviously, localization coverage ratio will increase when the number of anchor nodes and sensor nodes increases. The proposed is gradually more than that in the existing scheme. The package delivery ratio is defined as the ratio of the packages successfully received by all underwater sensor nodes to the total transmitting package. Figure 3 represents the performance analysis of the energy efficient scheme of UASN.

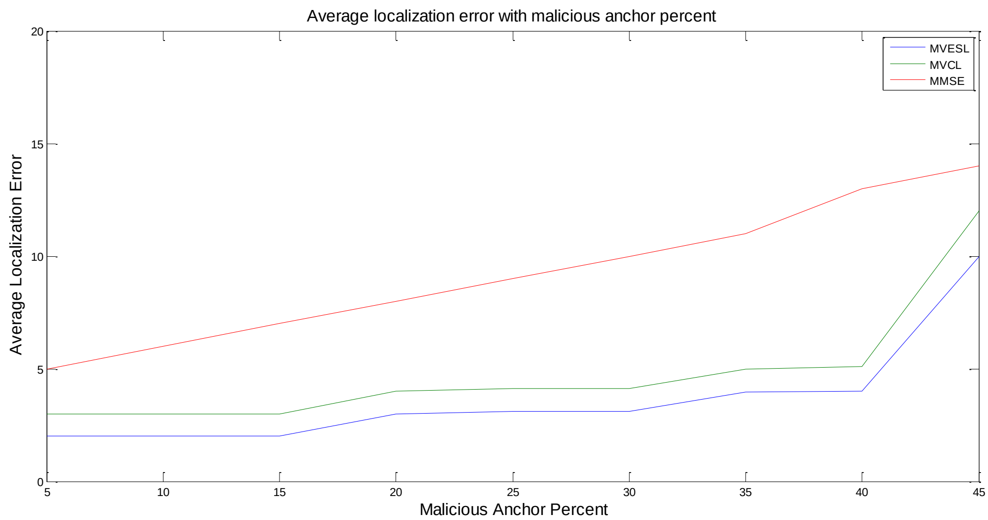

Figure 4: Performance Analysis of Average Localization Error with Malicious Anchor Percent

Package delivery ratio performance of the proposed scheme is higher than existing scheme as it produces effective coverage for the nodes. Better Connectivity of the nodes can achieve a good communication performance. Figure 4 Represent performance analysis of the average localization error with presence of malicious anchor nodes.

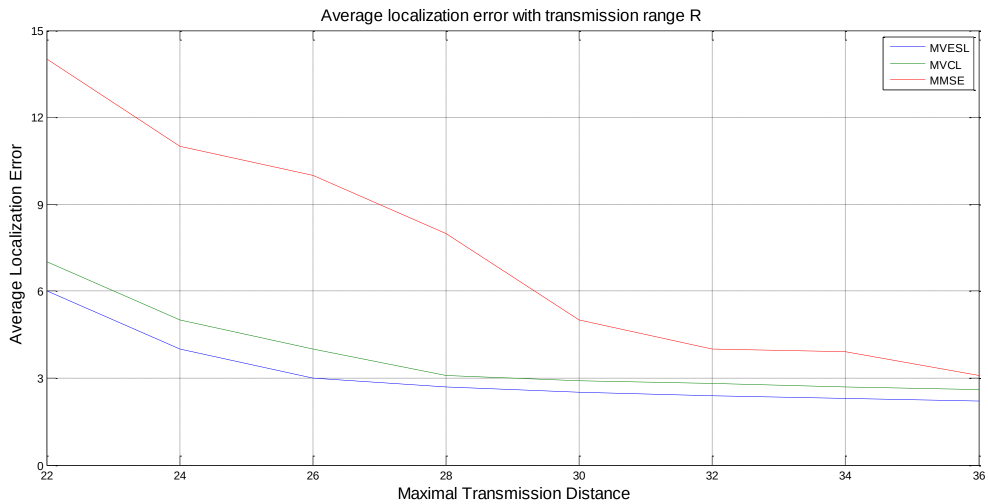

Figure 5: Performance Analysis of Average Localization Error with Transmission range

Average localization Error computation is necessary and sufficient conditions to guarantee a bounded error during 3-dimensional location of the malicious anchor node identification. Figure 5 provides the performance analysis of transmission range of localization error. Table 2 describes the performance value of the energy efficient schemes.

Table 2: Performance Evaluation of the Localization Mechanism of UASN

Technique	Average Localization Error	Program Running Time
Malicious Anchor Node Voting based Error Specific Localization- Proposed	**96.87**	**6.89 MS**
Malicious Anchors voting Based Cooperative Localization – Existing 1	**91.87**	**19.56 ms**
Minimum Mean Square Error based Localization – Existing 2	**89.23**	**21.56ms**

Moreover, with the increase of the number of the underwater sensor nodes, the network life time of the scheme would be in high level. Finally proposed scheme has proved that it can achieve the goal of effectively optimizing the system energy as well as providing a good communication performance.

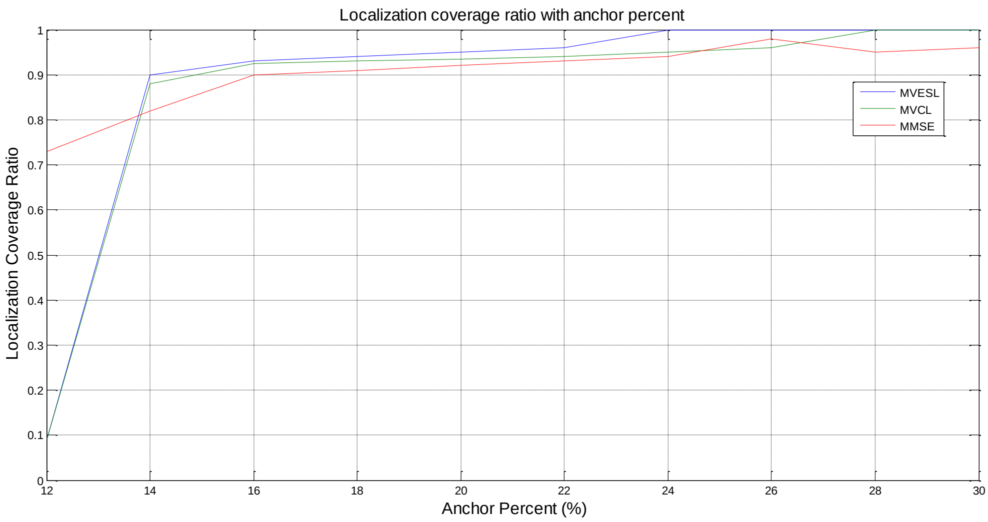

Figure 6: Performance Analysis of Location Coverage Ratio with present of Anchor node

In addition the proposed model has been demonstrates with localization coverage ratio with present of anchor nodes towards trust analysis. Finally, influence of the localization coverage area for the proposed scheme has been analysed with considering the mobility of the underwater sensor nodes.

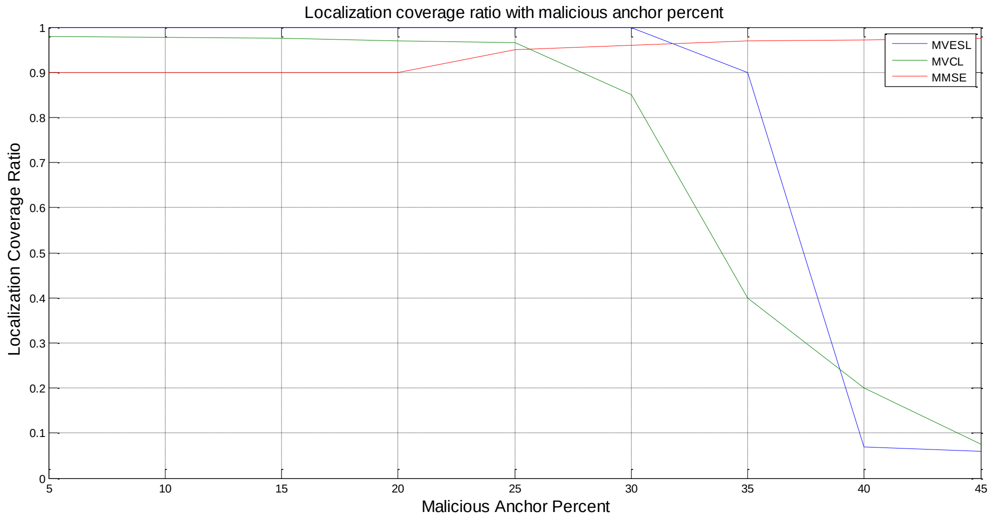

Figure 7: Performance Analysis of Location Coverage Ratio with present of Malicious Anchor node

As a result, simulation results verify that our MVCL algorithm can handle such networks case in the existence of malicious anchors. Moreover, the above result tallies with the necessary and sufficient conditions to guarantee a bounded localization error as presented in the figure 6 with respect to malicious anchor node

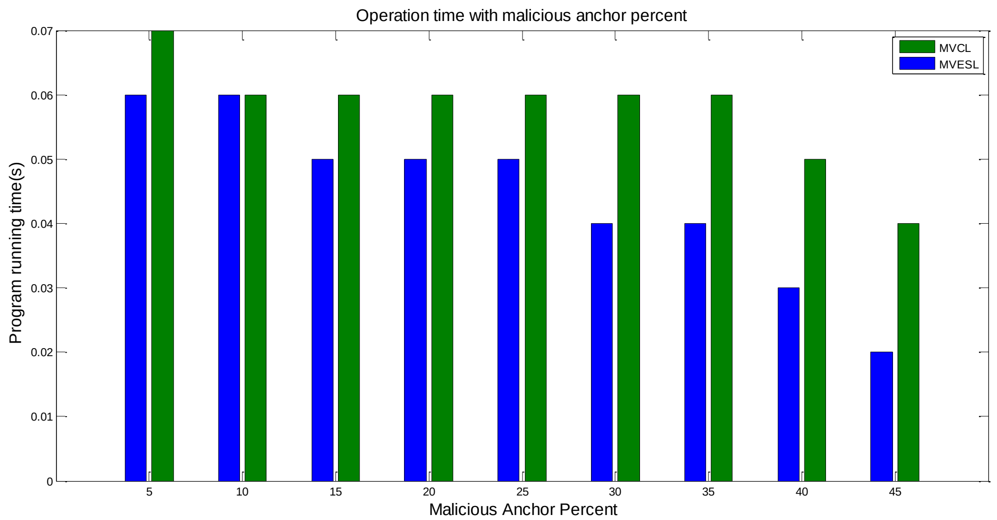

Figure 8: Program running Time analysis of Malicious Anchor Present

Moreover, with the increase of the number of the underwater sensor nodes, the malicious node identification time would be in high. Finally proposed scheme has proved that it can achieve the goal of effectively optimizing the system energy as well as providing a good communication performance as presented in the figure 8.

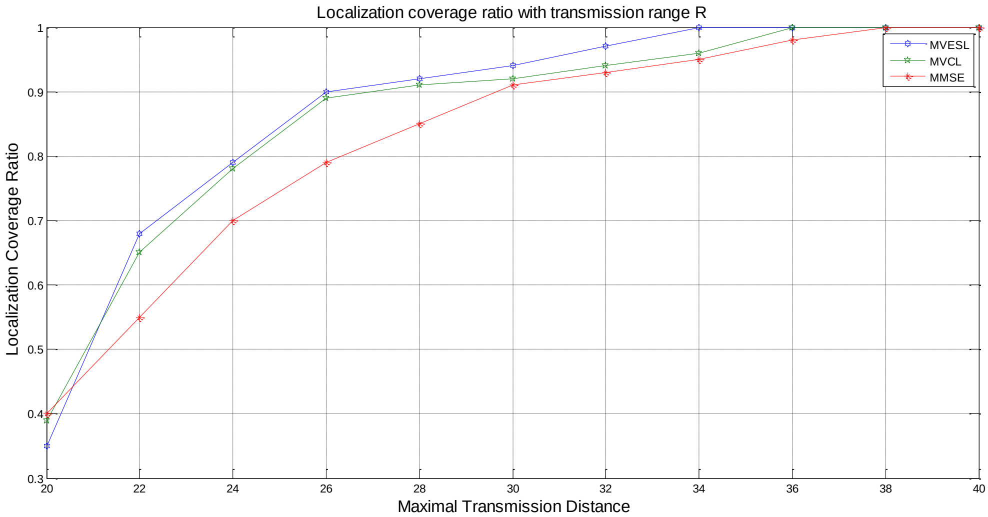

Figure 9: Localization Coverage Ratio with Transmission Range

It can be concluded from results that localization coverage ratio of MVCL is larger than that of MMSE and proposed model along with different anchor percents, while average localization error of MVCL is much smaller than that of MMSE and proposed model under different anchor present has represented in the figure

Conclusion

Malicious Anchor Voting based Error Specific localization Algorithm for Underwater Acoustic Sensor Network has been designed and simulated in this work. Proposed model utilizes the trust analysis for malicious anchor node elimination. The voting based scheme has been computed using reputation of node for malicious node prediction under various threshold and transmission range. As a consequence, the simulation results demonstrate that the system can effectively on localization of position coordinates of the anchor node. Finally proposed model has been analysed on terms of connectivity and coverage on various aspects of the scheme using Average localization ratio and programming time.

References

[1].Muhammad Toaha Raza Khan, Syed Hassan Ahmedy, Dongkyun Kim," AUV-aided Energy-efficient Clustering in the Internet of Underwater Things", IEEE Transactions on Green Communications and Networking, DOI 10.1109/TGCN.2019.2922278.

[2].Mohammad Ali Khalighi , Hassan Akhouayri, and Steve Hranilovic , Senior Member, IEEE," Silicon- Photomultiplier-Based Underwater Wireless Optical Communication Using Pulse-Amplitude Modulation", IEEE JOURNAL OF OCEANIC ENGINEERING, Digital Object Identifier 10.1109/JOE.2019.2923501.

[3]. Linfeng Liu, Ye Liu, and Ningshen Zhang," A Complex Network Approach to Topology Control Problem in Underwater Acoustic Sensor Networks", IEEE TRANSACTIONS ON

PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 25, NO. 12, DECEMBER 2014, Digital Object Identifier no. 10.1109/TPDS.2013.2295793.

[4]. Mohammad Ali Khalighi , Hassan Akhouayri, and Steve Hranilovic , Senior Member, IEEE," Silicon- Photomultiplier-Based Underwater Wireless Optical Communication Using Pulse-Amplitude Modulation", IEEE JOURNAL OF OCEANIC ENGINEERING, Digital Object Identifier 10.1109/JOE.2019.2923501.

[5]. Peng Chen, Yue Rong , Senior Member, IEEE, Sven Nordholm , Senior Member, IEEE, and Zhiqiang He , Member, IEEE," An Underwater Acoustic OFDM System Based on NI CompactDAQ and LabVIEW", IEEE SYSTEMS JOURNAL, Digital Object Identifier 10.1109/JSYST.2019.2919112.

[6]. Farhad Akhoundi, Mohammad Vahid Jamali, (Student Member, Ieee), Navid Bani Hassan, Hamzeh Beyranvand4, Amir Minoofar2, And Jawad A. Salehi2, Cellular Underwater Wireless Optical CDMA Network: Potentials and Challenges", IEEE Explore.

[7]. Fangyuan Xing, Student Member, IEEE, Hongxi Yin, Xiuyang Ji, Student Member, IEEE, and Victor C. M. Leung, Fellow, IEEE," Joint Relay Selection and Power Allocation for Underwater Cooperative Optical Wireless Networks", IEEE Transactions on Wireless Communications, DOI 10.1109/TWC.2019.2943867.

[8]. En Cheng, Longhao Wu1,Fei Yuan, Chuanxian Gao1, Jinwang Yi," Node selection algorithm for underwater acoustic sensor network based on particle swarm optimization", IEEE Access, DOI 10.1109/ACCESS.2019.2952169.

[9]. Guangjie Han, Xiaohan Long, Chuan Zhu, Mohsen Guizani, Wenbo Zhang," A High-Availability Data Collection Scheme based on Multi-AUVs for Underwater Sensor Networks", IEEE Transactions on Mobile Computing, DOI 10.1109/TMC.2019.2907854.

[10]. Yuan Zhou, Hongyu Yang, Yu-Hen Hu , and Sun-Yuan Kung Cross-Layer Network Lifetime Maximization in Underwater Wireless Sensor Networks", IEEE SYSTEMS JOURNAL, Digital Object Identifier 10.1109/JSYST.2019.2920681.

[11]. Zhong Zhou, "Handling Triple Hidden Terminal Problems for Multichannel MAC in Long-Delay Underwater Sensor Networks", IEEE Transactions On Mobile Computing, VOL. 11, NO. 1, JANUARY 2012, Digital Object Identifier no. 10.1109/TMC.2011.28.

[12]. En Cheng, Node Selection Algorithm for Underwater Acoustic Sensor Network Based on Particle Swarm Optimization", Received October 9, 2019, accepted October 27, 2019, date of publication November 7, 2019, date of current version November 21, 2019. Digital Object Identifier 10.1109/ACCESS.2019.2952169.

[13]. Shaochen The Localization Algorithm Based on Symmetry Correction for Underwater Acoustic Networks", Special Section On Emerging Trends, Issues And Challenges In Underwater Acoustic Sensor Networks, Digital Object Identifier 10.1109/ACCESS.2019.2937106.

[14]. YOUGAN CHEN, Selective Dynamic Coded Cooperative Communications for Multi-Hop Underwater Acoustic Sensor Networks", Received March 28, 2019, accepted April 19, 2019, date of publication April 23, 2019, date of current version June 11, 2019. Digital Object Identifier 10.1109/ACCESS.2019.2912917.