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# Fault Tolerant Algorithm to Cope with Topology Changes Due to Postural Mobility

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**ABSTRACT:** The research involving in providing healthcare services to remote patients have led to the exploration of new solutions to provide effective Quality of Service (QoS) and fault tolerant network for Wireless Body Area Network (WBAN). With the growing number of diseases and percentage of elderly people, need for providing medicated assisted life to disabled or old age population has increased a lot. To deal with these conditions, there must exist a Fault Tolerant system. WBAN in the health care scenario is greatly impacted by issues related to efficient data transmission. In this paper, DV-Hop algorithm is utilized for the localization of mobile nodes in order to cope up with topology changes due to postural mobility.

**KEYWORDS:** Wireless Body Area Network; Global Positioning System; Wireless Sensor Network; Distance Vector; Turbo Product Code

## 1. INTRODUCTION

### 1.1 Localization of Nodes in WBAN

There are numerous applications of wireless sensor technology like monitoring, surveillance, communication, etc. Mostly, WSN is utilized for surveillance and health monitoring. It is the accountability of all sensor nodes to detect variations in various desired parameters which is an important indicator. Individual movement, variations in body temperature or blood pressure, other changes are periodically relayed to the collection center or the chief host. The central host or the aggregation server recognizes the person using the position reference provided through the device nodule. WSNs are affordable, simple to set up, and self-configurable [1]. Therefore, these networks offer a variety of industrial applications like as a dispersed fundamental well-being observer and ecological controller, consumer applications like goal tracking and identification, as well as military applications like patient monitoring, smart houses, and emergency rescue.

It is essential to develop well-organized localization procedures. Localization is the process of locating knobs in a linkage. A node can locate itself in the network with the help of some infrastructure by obtaining information from it; additionally, the infrastructure can also determine the node's location by forcing them to send signals on a regular basis. Global Positioning System (GPS) is a common localization system [2]. There are 24 satellites spread out over 6 orbital planes at a height of 20200 kilometers. These satellites are aware of their precise coordinates and have highly accurate atomic clocks. The GPS receiver can pick up signals from at least four satellites if its line of sight is not impeded. A receiver may calculate the time shift by comparing the code pattern of the signal and can calculate the distance to the satellite by dividing the time shift by the speed of light. After that, the GPS receiver can determine its coordinate through a localization method.

### 1.2 Constraints for Localization

Different parameters have been used in order to compare and contrast the resemblances and dissimilarities between different methods. Here, the best popular standards by which different techniques are categorized are given:

**Accuracy:** Localization accuracy is essential in a wireless sensor network. More precision is frequently needed in military installations, such as sensor networks used to detect incursions. Though, they might use geo-location to offer advertisements from local stores, commercial networks might still require the same level of precision.

**Static Nodes:** All still sensor knobs have a uniform landscape. This suggests that each node has the same sensing, computation, and communication capabilities. The nodes are being deployed by assuming that they have the same beginning battery capacities.

**Mobile Nodes:** Sensor systems have a limited moveable nodes which can use GPS. These nodes have a uniform character. They are projected to have longer battery lives than static nodes and to not completely drain their power during translation. The message series of movable sensor nodules is predicted to remain relatively constant throughout the localization process as well as throughout the function of four ideal signals through a specific still node [3] [4] [5].

## 1. RELATED WORK

L.Lazos et al. [1] SeRLoc is a brand-new localization algorithm with limited resources. It is a localization algorithm without regard to range. Sensors may impassively control their position deprived of interrelating with further devices according to the distributed algorithm SeRLoc, which is grounded on two-tier system construction. RaduStoleru et al. [2]. Each one of the current localization methods has been stated to work well under specific sets of presumptions. When dealing with challenging outside situations, these presumptions are not always true. To solve this issue and enable various localization techniques, a framework is employed. Because of its presumptions, this procedure's "multi-modality" provides resilience in contradiction of some solitary procedure letdown. The author gave the concept of the framework and demonstrated how it decreased localization error by 50% when compared to cutting-edge node localization techniques. Amitangshu Pal et al. [3] examined several approaches for detecting node positions in WSNs. A description of the methods put forth by several academics to enhance localization in WSN is also included. Additionally discussion is based on the potential study areas and difficulties in enhancing node placement in WSNs. P.K Singh et al. [4] described a list of numerous methods for discovering node positions used in WSNs. An explanation of the procedures put forth by numerous researchers to improve localization in WSN is too involved. J.Kuriakose et al. [5] suggested that there are reportedly hundreds of nodes, which raises the price of adding GPS to each sensor node. Additionally, GPS could not deliver accurate localization findings in an inside situation. In a dense network, manually adjusting each sensor node's location reference is also not possible. The sensor nodes are thereby compelled to locate themselves without the aid of specialist hardware, such as a GPS, or manual configuration. KiranYedavalli et al. [6] suggested a cutting-edge sequence-based localization method for WSNs and demonstrated how the localization planetary could be distributed into various sections, each of which might be wholly acknowledged by arrangements that showed the position of distances from the orientation nodes to that area. As of the multipath and surveillance belongings of wireless passages, the author created a localization approach that makes advantage of these location sequences and is resistant to random errors. Z. Luo et al. [7] discussed about a Wireless sensor networks with chosen sensors which were used to offer a unique energy-based target localization technique. In this approach, sensors convey judgments to the fusion Centre using Turbo Product Code (TPC). In the event of communication channel faults, TPC can lower the risk of bit mistakes. A heuristic approach is also used in this technique to determine thresholds for energy-based target localization. This threshold design approach works well with sensors that are evenly dispersed and targets that are typically distributed. A strategy for selecting sensors is also offered in order to conserve sensor energy. The outcomes of the model specify that the performance of localization might be enhanced by using TPC rather than Hamming coding to transmit sensor choices to the fusion Centre. Additionally, the energy may significantly be lowered by the use of target localization approach and by carefully choosing the sensors. With the chosen sensors, this target localization technique also offers acceptable localization performance. Lo et al. [8] describe a novel method for wireless body area networks to automatically locate wearable sensor nodes (WBAN). Actual space map nodes are contrasted with instantaneous atmospheric pressure values. This development makes it possible to autonomously deploy sensor nodes, offering a useful way to determine and continually track node positions without anchor nodes or beacons. Samaneh Movassaghi et al. [9] centered on the best current criterions and journals, analyses the current state-of-the-art of WBANs. The unresolved problems and difficulties in each industry are also considered as possible sources of innovation for WBANs in the future. Xu Chun-Xia et al. [10] discussed about a remedy to resolve the issue of

In correct node localization in WSN, the author first examined the issues with the DV-HOP method that is currently in use. The weighted centroid method then utilizes an established sign RSS as a normal technique and updates the two-dimensional hyperbola approach for distance estimation to increase the anticipated distance, hence reducing localization errors. The results of the simulation demonstrated how much better the suggested approach is. Varsha Wahanea et al. [11] suggested a method which enables real-time wireless transmission of measured vital signals to healthcare specialists as well as wireless integration of various medical sensors. The use of many types of sensors to monitor features including temperatures, glucose levels, heartbeats, ECGs, and EEGs is studied in many different settings in this study. Qingling Liu et al. [12] offers an overview of the concepts, application domains, discoveries, and performance issues in (WBAN). The study covers a few topics relating to WBAN signal processing, in addition to network dependability, range managing, safety, and WBAN combination with additional skills for extremely operational forthcoming healthcare applications.

## 2. PROPOSED WORK

For proposed work, the network has been set-up in MATLAB and computation of the localization outcomes in direction to measure the performance of the delivered method has been done. The experimentation region is a 100 by 100 $m^2$ square, and the radio range of the sensor nodes (R) is fixed at 10 m. The network extent has been changed from 25 to 100, with the number of anchor nodes and mobile nodes set at 4 and 20 correspondingly.

**Algorithm**

**Step 1: Initialize Number of Anchors**

N = 4

**Step 2: Setup Network Size and Anchor locations**

Net_Size = 100

Anch_Location = [0 0;
0 100;
100 0;
Net_Size Net_Size]

**Step 3: Compute Euclidian distances**

Repeat i = 1 to N

Dist (n) = Sqrt ((Anch_Location (i, 1) - mob_Location (M, 1)).^2 +...
(Anch_Location (i, 2) – mob_Location (M, 2)). ^2)

**Step 4: Compute Initial guess**

Dist_Noise = Dist + Dist.*noisePow./100.* (rand (N, 1)-1/2)

Mob_Loc_Est = Net_Size*rand (1, 2)

Iterations = 5

**Step 5: Compute the estimated distances, Derivatives, Delta and Update the estimation**

Repeat i = 1 to Iterations

Dist_Est = Sqrt (sum ((Anch_Location - repmat(mob_Loc_Est,N,1)).^2 , 2))

Dist_Drv = [(Mob_Loc_Est (1)-Anch_Location (: 1))./Dist_Est ... % x-coordinate
(Mob_Loc_Est (2)-Anch_Location (: 2))./Dist_Est]; % y-coordinate

Delta = - (Dist_Drv.'*Dist_Drv) ^-1*Dist_Drv.' * (Dist_Est – Dist_Noise);

Mob_Loc_Est = Mob_Loc_Est + Delta.'

## 3. RESULTS AND DISCUSSION

For calculating the results, the network extent has been changed from 25 to 100, with the number of anchor nodes and mobility nodes set at 4 and 20, correspondingly, as demonstrated in figures from figure 1 to figure 4

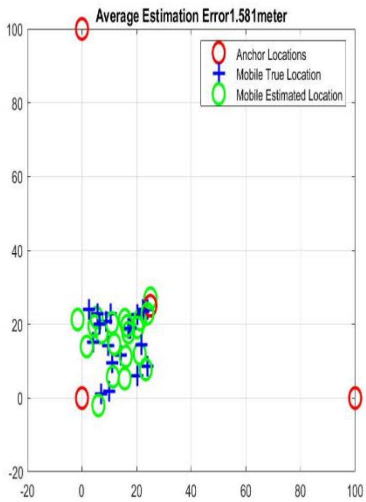


**Figure 1. Network Size 25 with 20 Mobile Nodes**

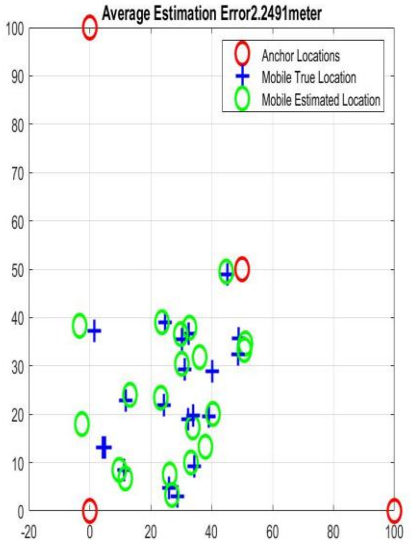


**Figure 2. Network Size 50 with 20 Mobile Nodes**

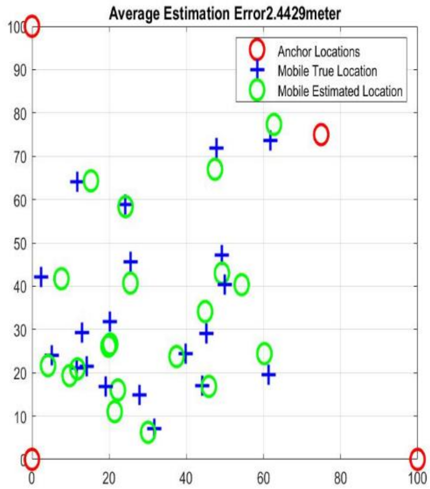


**Figure 3. Network Size 75 with 20 Mobile Nodes**

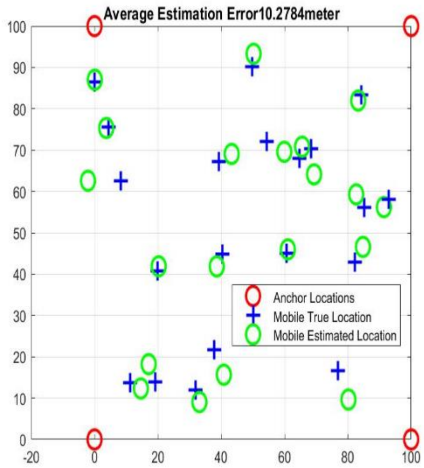


**Figure 4. Network Size 100 with 20 Mobile Nodes**

Average estimation error has also been calculated for different network sizes ranging from size 25 to 100 as shown in Table 1. Here, mobile nodes has been kept at 20 for each network size and least estimation error of 1.581 has been obtained for the smallest network size, i.e, 25.

**Table 1. Average Estimation Error**

| Network Size | Mobile Nodes | Estimation Error (mts) |
|---|---|---|
| 25 | 20 | 1.581 |
| 50 | 20 | 2.249 |
| 75 | 20 | 2.442 |
| 100 | 20 | 10.278 |

The variation of the estimation error can also be seen by the means of a graph as shown in figure 5. The estimation error ranges from 1.581 to 10.278 by keeping the constant mobile nodes of 20 in each network size ranging from 25 to 100. It is observed from the graph that as the network size increases, there is a simultaneous increase in the estimation error by keeping the mobile nodes at 20 instead for each case.

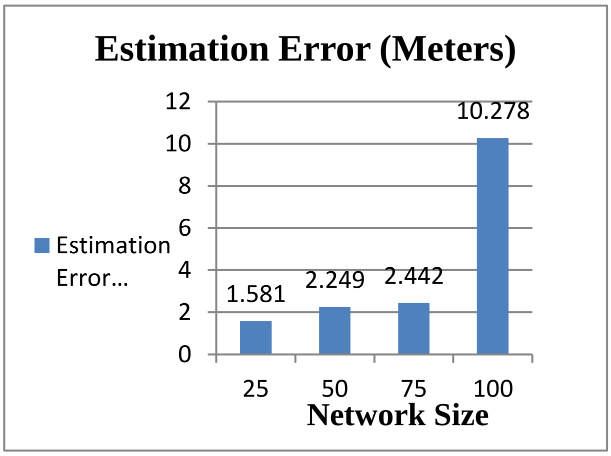


**Figure 5. Average Estimation Error**

## 5. CONCLUSION AND FUTURE SCOPE

The average localization error is used as the evaluation criterion for the localization issue. It can be concluded that without the need of additional equipments, the utilized technique produces precise and more accurate results. But, somewhat the expense of the system has been enhanced which can be called as the minor shortcoming of the algorithm. The average estimation error of the proposed method is 10.278, which is obtained by increasing the network size to 100 but it is still smaller than the average estimation error of the traditional method, which is 21.38. It can be concluded that the utilized method is superior to the original DV-Hop algorithm. Latest soft computing techniques could be used in the near future with this proposed technique to further enhance the system and computational expenses can be reduced.

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