An Improved Pulse Based Localization Algorithm for Wireless Nanosensor Network

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Abstract: A Wireless sensor framework may be a portrayed with an arrangement of wireless devices which can pass the information collected by a watched field through remote associations. The information is sent by various center points, and along a gateway, the data is related with various frameworks like remote Ethernet. There are five types of WSNs Terrestrial WSNs, Underground WSNs, Underwater WSNs, Multimedia WSNs, Mobile WSNs. There are various challenges in WSN like, Power, cost, security, system architecture etc. In the nanotechnology, Remote nanosensor systems (WNSNs) are substitution ages of detecting component systems found in nano scale, which are suppose to be made inside the returning years. Each nanonode is inside the shift of a little too few nano meters in measure. The nanoscale property of nanonodes opens energizing new applications inside to detecting space. In this paper we propose an improved pulse based accumulation localization error by which we can reduce the average delay for the nodes and improve normalized residual energy. Simulations are performed on MATLAB for the better results.

Keywords: WSNs, PBDA, femto second-long pulse, on-off keying (OOK) modulation.

I. Introduction

A. Background

Rapid advancements in electronics have created technology very popular and technology spurred the event of wireless communications [1]. Nanoscale devices can give exceptional technological solutions in an exceedingly sort of fields, particularly the biological, industrial, military, and food security fields [2][5]. New nanomaterials and nanoparticles at the model level exhibit distinctive properties critical those of the macro level. the aim of technology is not solely in developing ultra-miniaturized classical machines, but conjointly taking advantage of the distinctive characteristics of nanomachines and realizing new practicality resulting in innovative applications. as an example, a nanosensor will discover chemical compounds or microorganism agents in concentrations as low as one half per billion.

Wireless device networks (WSNs) are, to date, relatively sophisticated; researchers have usually shifted their focus to wireless nanosensor networks (WNSNs) [6]. Although a single nanosensor will notice correct event knowledge, it is subject to restricted transmission distance (less than 1m). Information interactions among multiple nanosensors will expand the communication capability of the one nanosensor, to this impact, permitting WNSNs to execute additional complicated tasks; nanosensors are ready to share info and work with one another during a multi-hop fashion. WNSNs incorporates nano-sized communication devices which are equipped with nano-transceivers, nano-antennas, and alternative useful modules. A nanosensor is Associate in Nursing integrated device starting from ten to a hundred m square in size. The nano-antenna ought to be factory-made all the way down to many hundreds of nanometers to figure on very high operative frequency bands (0.1-10.0 rate (THz)). Nanosensor nodes will effectively notice network communication and information sharing through femtosecond-long pulses within the THz band.

Infrared, GPS, and supersonic locomote technologies need additional hardware. Considering the characteristics of nanodevices, including extraordinarily tiny size, restricted energy, limited communication capability [7], it's effectually not possible to equip them with further locomote hardware. Most ranging techniques in WSNs use carrier-based communication schemes, as well, that square measure ineffective in WNSNs as nanoscale transceivers square measure unable to get carrier signals. Consequently, pulse-based communication schemes square measure additional feasible because of the extraordinarily high speed communication system in WNSNs. Existing ancient localization algorithms and protocols for WSNs square measure merely not suited to WNSNs.

B. CONTRIBUTION

This paper proposes a localization algorithmic program for WNSNs designed to enhance their move accuracy whereas at the same time truncating their average delay and reducing their energy consumption. supported previous work by Tran-Dang et al. [8], we have a tendency to propose additional precise and sensible solution to resolve he WNSN localization drawback. The main contributions of this paper are often summarized as follows.

1) We have a tendency to propose a cluster institution mechanism to reduce the energy consumption and average delay. A node becomes a cluster head during a circle if it's the largest residual energy; this extends the period of time of the whole network.

2) Communication among nanosensor nodes relies on on-off keying (OOK) modulation to enhance localization accuracy. The OOK modulation transmits a pulse to gift a logic ``1" and keeps silent to gift a logic ``0". during this case, incorporating the feature of WNSNs (encoding info by pulses), the receiver device equipped with nano-devices analyzes the worth of the received pulse and estimates the space between nodes.

3) Because the low-energy nanosensor nodes cannot operate complicated protocol, we have a tendency to propose a PBDA localization algorithm consisting of 4 phases. part 1: Nodes are classified into 3 classes as well as corner nodes, border nodes, and center nodes, and nodes in the network communicate through peculiar packets. Phase 2: Clusters square measure developed and nodes with the most residual energy square measure chosen because the cluster heads. Phase 3: Packets square measure transmitted and forwarded via cluster heads. part 4: once packets square measure transmitted, the distance between the previous node and gift node is accumulated, that the nal distance is that the distance from one facet of the network to the opposite facet.

4) To relax the necessity of correct synchronization for police investigation a awfully low energy pulse, we have a tendency to transmit multiple pulses during a burst instead of one pulse. Channel convict doesn't occur as a result of the duty quantitative relation of pulse is incredibly little. It is not clear whether or not anchor nodes yield their absolute positions via GPS [9] or alternative devices which will be deployed in WNSNs. If the network doesn't have anchor nodes,

the node can solely accomplish the move method. PBDA may be a move method which will be wont to accurately estimate the space between 2 nodes. Nanosensors will communicate with every other and store significant info (e.g., RFID tags). They are integrated on the merchandise at the start of the manufacturing method. One potential application of PBDA is to observe the standing (e.g., size, health) of intelligent products that square measure equipped with nanosensors throughout their life circle. The intelligence level of the merchandise is disclosed by the power to observe their dimensions or localizations continuously; these talents are often enforced by WNSN ranging algorithms.

C. PAPER ORGANIZATION

The remainder of this paper is organized as follows. Section II, provides a review of the connected work. In Section III, we have a tendency to introduce the THz band pulse-based system and construct the system model. Section IV presents the PBDA localization algorithmic rule. Our simulation and numerical analysis results area unit conferred very well in Section V. Section VI concludes the paper and discusses future analysis directions.

II. RELATED WORK

A multitude of localization algorithms are planned for WSNs up to now [10]. they will be roughly divided into range-free and range-based classes. the foremost well-known range-free algorithmic program is distance vector (DV)-Hop [11]. DVHop does not need any point-to-point distance or angle estimation. Its localization accuracy relies exclusively on the network property quality. Range-based localization algorithms embody angle of arrival (AoA) [12], time of arrival (ToA) [13], time distinction on arrival (TDoA) [10], and received signal strength indicator (RSSI) [14]. Researchers specializing in WNSNs have extended the traditional localization algorithms specic to WSNs to the nanoscale.

DV-Hop was planned by Niculescu and Nath [11], [12]. Anchors area unit equipped with GPS and broadcast their location information to any or all the nodes via a ooding mechanism. Nodes with unknown positions area unit set supported the hop counts from the anchors. DV-Hop depends on a dense and uniform network to enhance location precision; it's appropriate for WNSNs in sure aspects because the network atmosphere is in accordance with WSN characteristics. It remains to be seen whether or not anchors with GPS will be deployed in WNSNs, however.

AoA is Associate in Nursing rule that estimates and maps relative angles between neighbor nodes to find unknown nodes. Angle data is received from Associate in Nursing spatial relation antenna. The theme is hardware-constrained, because it desires Associate in Nursing array of RF antennas to find nodes with unknown positions; it is not appropriate for WNSNs. ToA uses the signal propagation time to estimate the distance between nodes; dear electronic devices are necessary to realize precise time synchronization among different nodes. Low-power nanosensors will solely perform simple tasks, however as mentioned higher than, nano-sized communication devices cannot be equipped with additional hardware. Therefore, ToA can not be applied to node localization in WNSNs.

In TDoA, the gap between two communication nodes is measured supported the distinction in propagation times of two radio or acoustic signals that ar originally sent at Associate in Nursing identical purpose. almost like the ToA technique, TDoA needs extensive hardware and consumes excessive energy. These disadvantages of TDoA limit its application for localization in WNSNs. RSSI measures the gap between 2 nodes by translating signal strength into distance estimates. Localizations based on RSSI are sensitive to channel models. RSSI also depends on carrier-based communication schemes that cannot be provided by WNSNs in terahertz channels, rendering it impossible for WNSNs. Jornet and Akyildiz [15] planned a femtosecond long pulse based modulation for terahertz band communication in nano networks supported the transmission of 100-femtosecond-long pulses following an OOK modulation. The planned technique will be applied to inter-node communication in WNSNs. Tran-Dang et al. [8] planned two localization algorithms supported hop count, namely, the flooding-based hop-counting (FBHC) rule and cluster based hop-counting (CBHC) rule for WNSNs. FBHC uses a flooding mechanism to broadcast packets to any or all nodes in the network and counts the quantity of hops between two boundaries of the network; CBHC introduces the construct of clusters on the premise of FBHC to classify all sensing element nodes into completely different clusters. The quantity of hops is counted via an election Associate in Nursingd cooperation method within the cluster heads. Flooding packets are solely passed forward through cluster heads, thus, CBHC reduces the energy consumption caused by duplication within the relay of broadcast packets. This prolongs the whole network life cycle. To the simplest of our data, the algorithms planned by Hoa Tran-Dang et al. are the sole schemes that presently exist for WNSN localization. During this study, we built an rule (PBDA) supported FBHC Associate in Nursingd CBHC to realize more precise WNSN localization. within the planned theme, communications among nanosensor nodes are supported OOK modulation, packets are transmitted through pulses, and the distances between nodes are calculable by the value of the received pulse, which boosts the localization accuracy.

III. Wireless Nanosensor Network Architectures

A. Communication Mechanism For Wireless Nanosensor Networks

1) Possible Frequency Bands for WNSNs

The rate band and therefore the higher a part of the megacycle per second band (100.0-1000.0 MHz) area unit to potential operation frequency bands for WNSNs. The rate band will satisfy the communication requirement of contemporary nano-antennas [16], and the MHz band is created by Associate in Nursing mechanical device nano transceiver. The higher a part of megacycle per second has low frequency and nanosensor devices will communicate with one another over longer distances, however, the frequency efficiency of generating electromagnetic waves in megacycle per second is predictably low [17], making it unworkable for nanosensor devices to work in the megacycle per second band; nanosensor devices will, though, probably communicate with one another within the rate band.

2) Information Encoding and Modulation

WNSNs need their own encryption mechanisms to fit the THz channel and supply ultra-high frequency communication. Per the constraints of nano-engineered hardware, the encoding mechanism should be possible in bound applications. A femto second-long pulse is achieved in a very short amount of time and stay stable within the THz channel [18]. The energy of the pulses isn't reduced all the way down to zero by the THz channel. The femto second-long pulse represents a notable advantage for energy-limited nanosensor devices thanks to its simplicity and low energy consumption. The standard channel paradigm that uses a continuous wave can be replaced by a new modulation technology based on the femto second long pulse for WNSNs.

Traditional pulse-based WSN data encryption mechanisms can be split into pulse modulation, pulse phase modulation, pulse modulation, and rate modulation classes [19]. These strategies don't seem to be applicable for communication among metric linear unit device devices for a few reasons. First, the frequency of the THz spectrum is flexibly selective, so transferring information into pulse form is infeasible. Second, strict time synchronization among the nanometer device devices is needed within the method of pulse phase modulation. additionally, the provided pulse breadth is fixed and should be maintained within the THz spectrum. In short, traditional modulation strategies don't seem to be applicable for WNSNs. a unique approach is termed for to implement data code modulation. An interesting and probably practicable data writing modulation is to conduct energy exploration to find whether there are a unit signals ``1"of the pulses within the setting. The existence of a pulse represents a logic ``1", or else a logic ``0" is diagrammatic [20]. so as to find these very little pulse energies, every nanosensor device should be equipped with a matched filter; precise time synchronization and sampling preciseness are necessary. To relax this requirement, we have a tendency to assume that multiple pulses area unit transmitted in a burst at anytime purpose instead of one pulse.

IV Pulse Based Distance Algorithm

The pulse based algorithm is used for to calculate the distance between two nodes with the known positions of the nodes and unknown positions of the nodes. In this algorithm the four phase are used for the selection of cluster head.

Phase1- in this phase the flooding mechanism is used for the broadcasting of the packets and these packets are distributed in line with neighbor nodes. Every node transmits a packet and calculate the number of nearby nodes, then the amount of nearby nodes breaks them in the group of node density.

Phase 2- In this phase cluster is established and the B1 nodes are identified, the B1 nodes are broadcast and generate a clustering-broadcast packet by using the flooding mechanism. B1 nodes can transmit the forward packet and these packets are deposit when they are received by the nodes B2 and B3. Since the clustering broadcast packets are made up of four fields. First field is for the B1 node, so that B1 generate the ID, that originally generate the clustering broadcast packets. In this field we assume that each node has a unique ID. In the second field defines the type of node so that it can transmit the data packets. The third field defines the residual energy of the nodes. In this phase every B1 node selects a best node for cluster head selection on the basis of the highest residual energy of the node. The fourth field is the EDC field which checks the transmission error. Since the PBDA is based on the transmission of 100-femto long pulses by an asymmetric OOK modulation, the high bit “1” can be lost during the transmission process. When the clustering broadcasting packets are received then B1 nodes are choose the node which has highest residual energy as a cluster head. B1 node joins the cluster by replying a cluster reply packet so that it informs the cluster head. It means that the B1 node which has small residual energy transmits clustering reply packet to the CH that has highest residual energy. The clustering reply packet consists of four fields. The RXID field represents the node ID, which receive the packets.

Phase-3 in this phase the cluster are established and cluster heads of B2 node is chosen. This process is similar to the phase 2. When the clustering reply packets are received, the cluster node transmits the data continuously to notify the packets. When the code is confirmed then it delivers to the node B2, so that they informing the other node to create the cluster head and choose the cluster head by using the clustering reply packet and clustering broadcasting. If B3 nodes receive the packets then they can be discarded.

Phase 4- in this phase flooding packets is forwarded by the cluster heads and calculate the distance between two nodes. The third field represents the type of the nodes which can only receive the packets and pass it forward. The DIS field reserve for the cumulative distance from the actual B1 node to the current node, initially this field is set to be "0". The flooding packet is transmitted every time and the DIS value is increases. DIS=DIS+r', where r represents the distance between the previous nodes and current nodes. Since the flooding packets are transmitting continuously with B2 node cluster so that they can reach the B2 node on another side of the network. The calculate value of DIS considered as the distance between one side of the network to another side of the network.

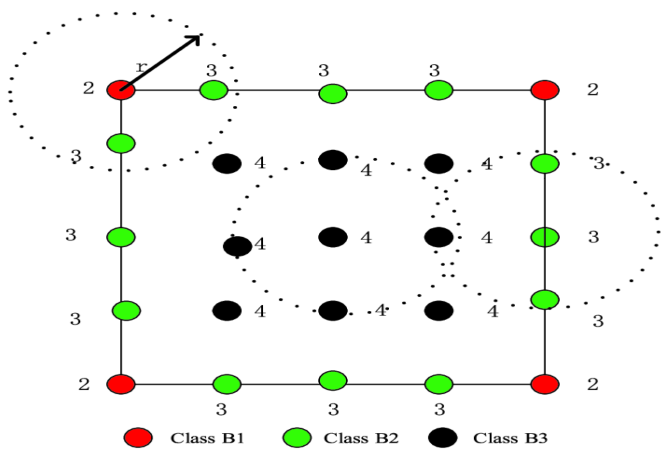

Fig. 1 network structure Model

The network structure model is shown above. In this network structure the nodes are deployed randomly in a square field. It is assumed that the due to large scale property of the WNSN the nodes are deployed randomly. There are 'N' nodes in L*L square area. The nodes are divided into three classes: corner node B1, border node B2 and centre node B3. The broken circle represents the range of communication of nodes. It is clearly shown in the figure that the centre node has the most neighbor nodes which are followed by the border nodes and corner nodes are fewest i.e.

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λ_0 is the density of node in the area of m^2 : $\lambda_0 = \frac{N}{L^2}$

λ_1 Is the density of nodes in area of $\frac{1}{4}\pi r^2$: $\lambda_1 = \frac{1}{4}\pi\lambda_0 r^2$

λ_2 Is the density of the nodes in area of $\frac{1}{2}\pi r^2$: $\lambda_2 = \frac{1}{2}\pi\lambda_0 r^2$

Assume M_i is the density in the communication range of node N_i.

V. Simulation

The simulations are performed on MATLAB 2015. The results are implemented to improve localization error, reduce average delay and improve normalized residual energy. These are achieved by using the selection of cluster head and calculate the distance between two nodes. This chapter contains the MATLAB simulation results and result validation of proposed algorithm.

Simulation Setup

Relevant simulation parameters are outlined below.

- Nanosensor nodes are randomly deployed
- Network topology is isotropic
- Region is assumed to be a square area of fixed size 100 cm x 100 cm
- Nanosensor nodes only communicate with neighbor nodes in THz band range
- The transmission radius is 1cm and each node has the identical communication range
- When varying the number of unknown nodes, the proportion of the anchor node is maintained at 20%
- When varying the number of anchor nodes, the total number of nodes in the network is 1000.

SIMULATION RESULTS

1) ENERGY CONSUMPTION

The energy consumption shown in Fig. is a function of the node density. As the node density increases, the average residual energy of each algorithm shows a different degree of decline. The process through which nodes receive and transmit packets consume greater amounts of energy as node density increases, as well. When the node density is less than $2 Node/cm2$), FBHC achieves the minimum energy consumption. Because the node density is small, even if the packets are transmitted through flooding, the process efficiently utilizes energy. For CBHC and PBDA, with a small number of nodes, cluster heads also need time to accumulate distance hop-by hop during clustering and more energy is consumed.

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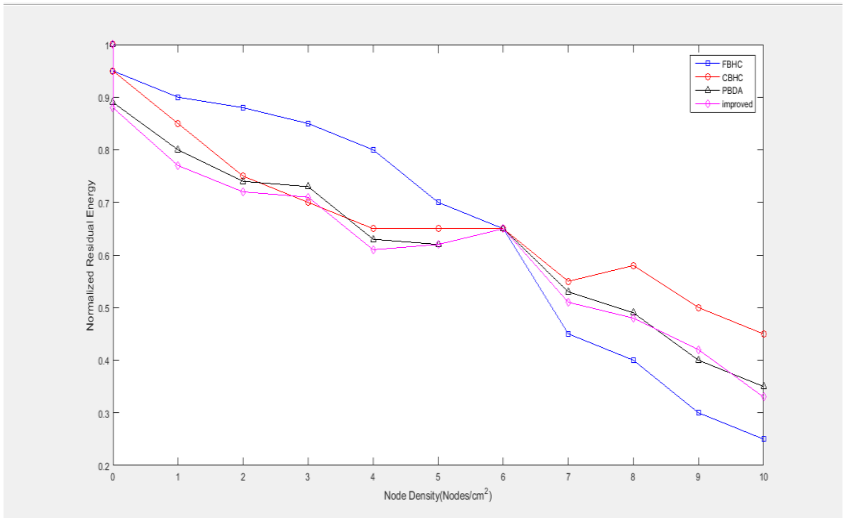

Fig. 2 normalized residual Energy

2) Average Delay

Fig. shows the average delay as a function of node density for different algorithms. The three algorithms show similar energy consumption in terms of average delay as the node density (i.e., neighbor node quantity) increases. The communication radius remains unchanged, so the process of flooding broadcast nodes or creating clusters takes time. We also found that when the node density is less than (5*Node*/*cm*2), CBHC and PBDA have a larger delay than that of FBHC. This is because when the node density is small, simply flooding the broadcast nodes is inappropriate while CBHC and PBDA undergo an additional clustering process. Distance calculation causes a processing delay in PBDA, but the delay is tolerable compared to the transmission delay of flooding. Overall, PBDA outperforms the other algorithms in a high node density environment.

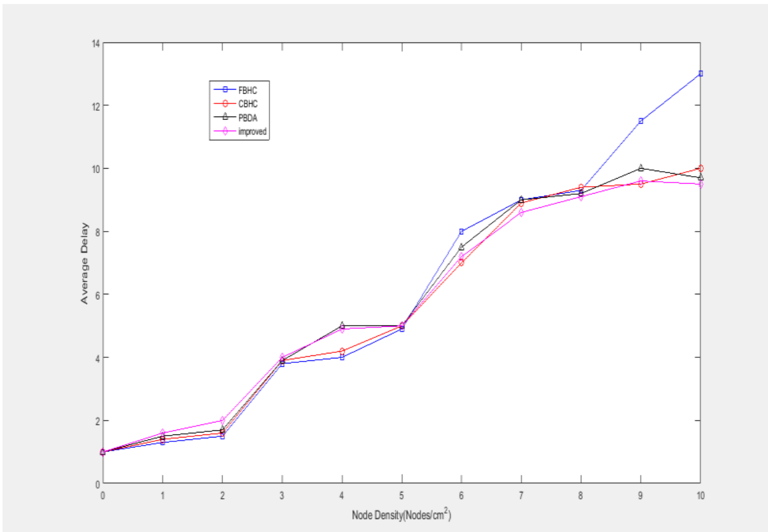

FIG. 3 Average Delay

Summary of Simulation Results

The simulation results are quite improved from the existing results , as the number of nodes increase then the normalized residual energy is increase. By increasing in energy the cluster head selection possibilities is high and when the node density is decreases the average delay is decrease so the transmission of data can be transmitted without any loss.

Conclusion

WSN operates using small, low power, limited capacity nodes that are deployed over the region of interest. Sensors perform all the data aggregation, computation and communication work that consumes energy, residual normalized energy, average delay. By considering all factors, the purpose of this thesis is to reduce localization error so that the network lifetime will be increases. For achieving that localization error as well as number of nodes, average delay parameter has been considered in this thesis. Considering proper selection of cluster head at the corners and center is the basic idea behind the thesis work which helps to achieving the goal of localization error and average delay. For this purpose PBDA algorithm is used to make selection process of CH iteratively done which helps in choosing the best possible cluster head selection. By the modulation scheme which we use in this thesis that is called on-off keying modulation scheme. The proposed algorithm is compared with PBDA simulated in MATLAB. Simulation result shows that the proposed algorithm has given improved results in comparison to other basic ones. The proposed algorithm worked for 100 nodes randomly deployed over sensing area 100*100. The simulation shows that there is decrease in localization error with increase in number of nodes. The proposed algorithm outperformed with other PBDA, DV-hope protocol.

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