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A Review on Reduction of Localization Error in Techniques in WSN

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Abstract: Wireless Sensor Networks (WSNs) have gained worldwide awareness in recent years. WSN technology becomes popular in all areas of applications along with military, medical, process and electronic industries due to its easy implementation and maintenance. Wireless sensor network (WSN) represents a collection of wireless sensor nodes that coordinate with each other in order to perform a particular task. Localization is the process of finding the position of nodes as data and information are ineffectual if the nodes have no idea of their geographical positions. In this paper, a survey on various aspects or techniques of localization like localization error, parameters of localization, accuracy, bit error probability, energy consumption has been studied.

Keywords: Wireless Sensor Networks, Localization, Multidimensional Scaling.

I. INTRODUCTION

A sensor is a device that estimates a physical quantity and converts it into a signal which can be read by an observer or by an instrument. Sensor in wireless network acquires input information, store the information, transform and transmit the data to other devices. For example, a thermocouple converts temperature to an output voltage which can be read by a voltmeter. A Wireless Sensor Network (WSN) be composed of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, being temperature, sound, vibration, compression, motion or pollutants. The evolution of wireless sensor networks was motivated by military applications such as battlefield surveillance and is now used in many industrial and civilian utilization areas ,including industrial process supervision and control, machine health record, environment and habitat monitoring ,healthcare applications, home automation and traffic control .Since most applications depend on a successful localization, that is to determine their positions in some fixed coordinate system, it is of great significance to design efficient localization algorithms [5].

APPLICATIONS: Wireless sensor devices have a wide range of application in surveillance, monitoring etc. Most of the devices in wireless sensor network be composed of off- the shelf materials and deployed in the area of surveillance and monitoring. Their responsibility of each sensor node is to identify the changes in its particular region or area. The changes are as mobility of animals, decrease or increase in temperature, rainfall etc., and these changes are periodically recounted to the aggregation point or the central server. The aggregation server identifies the area with the help of the location indicating sent by the sensor node [6]. Wireless ad hoc Sensor Networks (WSNs) are anticipated to be low-price, self-configurable with no pre-deployed infrastructure, or easy to deploy. Hence, such networks provide a range of client applications like emergency rescue, disaster relief, smart homes, or patient monitoring in addition to industrial applications such as distributed structural health record and environmental control, and military applications such as target identification and tracking [1].

Sensor nodes collect and forward data about specific application. Sensor nodes usually induce output when some kind of physical change occurs, like change in temperature, sound, and pressure. WSNs have many applications just as military, civil, and environmental applications. Some significant applications are discussed below

(a). Area Monitoring: Sensor nodes are installed in the area where some actions have to be monitored; for instance, the location of the enemy is monitored by sensor nodes, also the information is sent to base station for further processing. Sensor nodes are also used to monitor vehicle movement.

(b). Environmental Monitoring: WSNs have several applications in forests and oceans, and so forth. In forests, such networks are employed for detecting fire. WSNs can detect when fire is started and how it is spreading. Senor nodes also detect the movements of animals to observe their habits. These networks are also used to observe plants and soil movements.

(c). Industrial Monitoring: In industries, sensors examine the vehicle, sensors detect whether the process is going right. A response is created if there is any manufacturing fault. Sensor nodes also monitor the grasping of objects by robots.

(d). Medical and Healthcare Monitoring: Medical sensors are used to observe the conditions of patients. Doctors can monitor patients' conditions, blood pressure, sugar level, review ECG, and change drugs according to their conditions. Personal health monitoring sensors have special response is created if any health risk is detected.

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Medical sensors store health information and analyze the data obtained from many other sensors like ECG, blood pressure, and blood sugar.

(e). Traffic Control System: Sensor nodes observe traffic flow and number plates of travelling vehicles and can locate their positions if needed. Wireless Sensor Networks are used to monitor activities of drivers as well such as seat-belt monitoring

(f). Underwater Acoustic Sensor Networks: Underwater special sensors can monitor unlike applications of numerous oceanic phenomena; for instance, water pollution, under water chemical reactions & bioactivity. For that purposes, different types of 2D and 3D static sensors are used. 3D dynamic sensors are used to supervise autonomous underwater vehicles (AUVs) [8].

II. LOCALIZATION

Localization means to find location of nodes in a network. With the support of some infrastructure, a node can discover its position in the network by extracting information received from the infrastructure; also, by making a node to send signals at intervals, the infrastructure can calculate the location of the nodes [5]. Localization is the method of finding the position of nodes as data and information are unusable if the nodes have no idea of their geographical positions. GPS (global positioning system) is the simplex method for localization of nodes, but it becomes very expensive if many nodes exists in a given network. Many algorithms have been proposed to solve the issue of localization; although, a large number of existing algorithms are application specific as well as most of the solutions are not suitable for wide range of WSNs. Ultrawide band techniques are convenient for inward environment while acoustic transmission-based system requires extra hardware. Both are exact techniques but expensive in terms of energy consumption and processing. Un localized nodes approximate their positions from anchor nodes beacon messages, which requires much power. Many algorithms have been proposed to reduce this communication cost. If one node estimates its wrong location, then this error propagates to overall network and further nodes; consequently, wrong information of anchor nodes location is propagated. To determine the position of nodes is mainly depend on distance between anchor node (with known location) and un localized node (with unknown location). Sensor nodes are employed in industrial, environmental, military, and civil applications [8].

Concepts and Properties of Localization

Localization of a sensor node is implemented with the help of neighboring nodes. Several localization techniques are discussed in this paper. Fig. 1 illustrates the various techniques or methods used to identify the location of the nodes

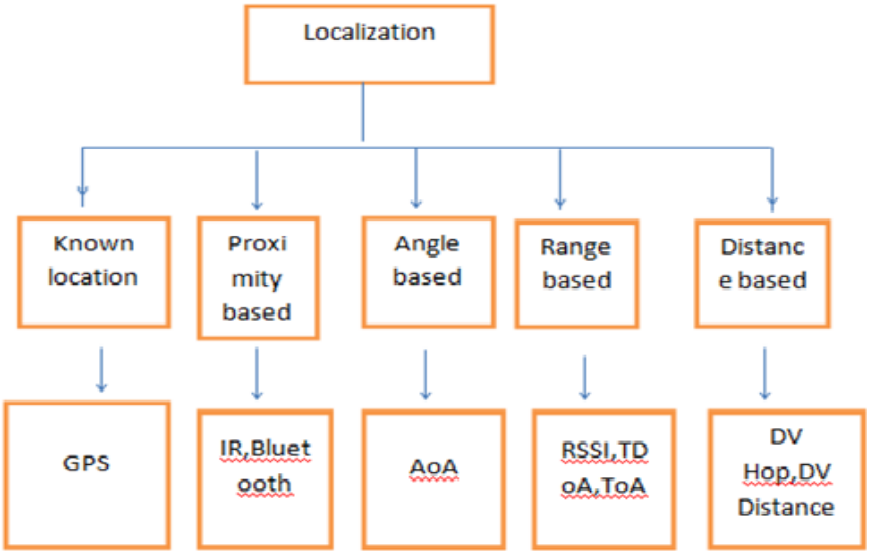

Figure 1. Overview of Localization

The localization can be categorized as known location-based localization, proximity-based localization, angle-based localization, range & distance-based localization. In fig. 1the range and distance-based localization are categorized individually, though both are same. For range-based localization, special hardware is required to find out the range, however itis not required for distance-based localization.

(a). Known location-based localization: In this kind of localization the senor nodes recognize their location in prior. This is done either by manually configuring or utilizing a GPS [8 - 12] device. Manual configuration of the sensor node is done with the help of GPS. The GPS devices are more effective when there are no referral nodes available to get localized. It has a good accuracy with a standard deviation of 4 to 10 meters.

(b). Proximity based localization: In this kind of localization the WSN is divided into several clusters. Each cluster has a cluster head that has a GPS device. By use of Infrared (IR), Bluetooth, et al. the nodes find out the nearness or proximity location.
(c). Angle based localization: Angle based localization utilizes the received signals angle or Angle of Arrival [14 - 16] to identify the distance. This method necessitate special antenna's that are expensive. Because of this reason AOA is mostly used in Base Station's (BS).D. Range based localization This localization is implemented based on the range. The range is calculated using the Received Signal Strength (RSS) or Time of Arrival (ToA) and Time Difference of Arrival (TDoA) [13, 20]. In RSSI based localization the receiver sends the signal strength regarding the sender ,and sender calculates the distance based on the signal strength. ToA and TDoA utilize timing to calculate the range. Time synchronization is an important factor when using ToA and TDoA.
(d). Distance based localization: Distance based localization method uses hop distance with each node to localize the node. It uses DV-hop propagation approach or DV-distance propagation method for localization [6].

Parameters for Localization

For the different ways of approximating location information, we have to name parameters to distinguish the similarities and differences amongst different approaches. In this section we present the most typical parameters to classify different techniques.
(a). Accuracy: Accuracy is very essential in the localization of wireless sensor network. Higher accuracy is typically required in military installations, just as sensor network deployed for intrusion detection. However, for commercial networks which may use localization to convey advertisements from neighboring shops, the required accuracy may not be lower.
(b). Cost: Cost is a very challenging affair in the localization of wireless sensor network. There are very few algorithms which give low price but those algorithms don't give the high rate of accuracy.
(c). Power: Power is essential for computation purpose. Power play a major role in wireless sensor network as each sensor device has limited power. Power supplied by battery.
(d). Static Nodes: All static sensor nodes are analogous in nature. This means that, all the nodes have identical sensing ability, estimating ability, and the ability to communicate. We also suppose that, the initial battery powers of the nodes are identical at deployment.
(e). Mobile Nodes: It is supposed that a few numbers of GPS enabled mobile nodes are part of the sensor network. These nodes are homogeneous in nature. But, are presumed to have more battery power as compared to the static nodes and do not drain out completely during the localization procedure. The communication range of mobile sensor nodes are assumed not to change drastically during the whole localization algorithm runtime and also not to change significantly within the reception of four beacon messages by a particular static node [5].

III. LITERATURE REVIEW

Time Period of Research Work From (2005 -2015), the author has proposed various research papers which can be briefly explained below:
Loukas Lazos and Radha Poovendran (2005): Several distributed monitoring applications of Wireless Sensor Networks (WSNs) require the location information of a sensor node. In this paper, the author address the problem of enabling nodes of Wireless Sensor Networks to find their location in an untrusted environment, called as the secure localization problem. He propose a novel range-independent localization algorithm called SeRLoc that is ably suited to a resource constrained environment just as a WSN. SeRLoc is a distributed theorem based on a two-tier network architecture that allows sensors to passively discover their location without interacting with other sensors. He show that SeRLoc is robust against known attacks on a WSNs just as the wormhole attack, the Sybil attack, or compromise of network entities and analytically compute the probability of success for each attack. He compare the performance of SeRLoc with state-of-the-art range-independent localization schemes and show that SeRLoc has better performance.
Radu Stoleru and John A. Stankovic and Sang Son(2007): The node localization matter in Wireless Sensor Networks has received considerable attention, driven by the need to obtain a higher location precision without incurring a large, per node, cost (dollar cost, power consumption and form factor). Even if the efforts made, no system has emerged as a robust, practical, solution for the node localization problem in realistic, composite, outdoor environments. In this paper, the author argues that the existing localization algorithms, individually, work effectively for single sets of assumptions. These presumptions do not always hold, as in the case of outdoor, complex environments. To resolve this problem, he suggest framework that permits the execution of many localization schemes. This protocol multi-modality" allows robustness against any single protocol break down, due to its assumptions. He presents the design of the framework, and show a 50%decrease in localization error in comparison with state of art node localization protocols. He also show that complex, more robust, localization systems can be created from localization schemes that have limitations.
Kiran Yedavalli and Bhaskar Krishnamachari (2008): They introduce a novel sequence-based localization technique for wireless sensor networks. He shows that the localization space can be divided into different regions that

can each be uniquely identified by sequences that represent the ranking of distances against the referral nodes to that region. For n reference nodes in the localization space, combinatorically, OðnnÞ sequences are possible, but he show that, dueto geometric constraints, the actual number of feasible location sequences is much lower: only Oðn4Þ.Using these location sequences, he develop a localization technique that is robust to random errors because of the multipath or shadowing effects of wireless channels. Through extensive systematic simulations and a representative set of real mote experiments ,he show that our lightweight localization technique provides comparable or better precision than other state-of-the-art radio signal strength-based localization techniques over a range of wireless channel and node deployment conditions

Chi-Chang Chen, Yan-Nong Li and Chi-Yu Chang (2008):- This paper present a low-cost yet effectual localization scheme for the wireless sensor networks. There are many studies in the literature of placing the sensors in the wireless sensor networks. Most of them require either installing additional hardware or having a certain amount of sensor nodes with known positions. The localization scheme he propose in this paper is range-free, i.e., not requiring additional hardware devices, and meanwhile it only needs two anchor nodes with known position. Firstly, the author install the first anchor node at the bottom left corner (Sink X) and the other anchor node at the bottom right corner (Sink Y). Then he calculate the minimum hop counts for each unknown node to both Sink X and Sink Y. According to the minimal hop count pair to Sink X and Sink Y of each node, he can virtually divide the monitored region into zones. He then estimate the coordinate of each sensor depending on its located zone. Finally, the author adjust the location estimation of each sensor according to its relative position in the zone. He simulate our proposed strategy and the well-known DV-Hop method. The simulation results show that their proposed scheme is superb to the DV-Hop method under both low density and high density sensor deployments.

P.K Singh and Bharat Tripathi and Narendra Pal Singh (2011):- Awareness of location is one of the significant and critical issue and challenge in wireless sensor network. Knowledge of Location amidst the participating nodes is one of the crucial requirements in designing of solutions for various issues regarding Wireless sensor networks. Wireless sensor networks are being used in environmental applications to perform the number of task just as environment monitoring, disaster relief, target tracking, defences and many more. In several such tasks, node localization is inherently one of the system parameters. Node localization is required to report the beginning of events, assist group querying of sensors, routing and to answer questions on the network coverage. So, one of the essential challenges in wireless sensor network is node localization. This paper provides an outline of different approach of node localization discovery in wireless sensor networks. The overview of the schemes supposed by different scholars for the enhancement of localization in wireless sensor networks is also presented. Future research directions and challenges for enhancing node localization in wireless sensor networks are also discussed.

JerilKuriakose and Sandeep Joshi and V.I. George (2013):- Localization is generally used in Wireless Sensor Networks (WSNs) to identify the current location of the sensor nodes. A WSN be composed of thousands of nodes that make the installation of GPS on each sensor node expensive and moreover GPS may not provide accurate localization results in an indoor environment. Manually configuring location reference on each sensor node is also not realizable for dense network. This gives rise to a problem where the sensor nodes must identify its current position without using any special hardware like GPS and without the help of manual configuration. In this paper the author review the localization techniques used by wireless sensor nodes to identify their current location.

Zhenxing Luo and Paul S. Min and Shu-Jun Liu (2013) :- This paper describes a novel energy-based target localization method in wireless sensor networks with selected sensors. In this technique, sensors use Turbo Product Code (TPC) to transmit decisions to the fusion center. TPC can reduce bit error probability if communication channel errors occurs. Moreover, in this method, thresholds for the energy-based target localization are created using a heuristic method. This design method to find thresholds is suitable for uniformly distributed sensors and normally distributed targets. Moreover, to save sensor energy, a sensor selection method is also presented. Simulation results displayed that if sensors used TPC instead of Hamming code to transmit decisions to the fusion center, localization performance could be enhanced. Furthermore, the sensor selection method used can substantially minimize energy consumption for our target localization method. At the same time, this target localization method with selected sensors also gives satisfactory localization performance.

Nabil Ali Alrajeh and Maryam Bashir and Bilal Shams (2013) :- The salient function of a sensor network is to collect and forward data to destination. It is very important to know about the position of collected data .This kind of information can be obtained using localization technique in wireless sensor networks(WSNs). Localization is a method to determine the location of sensor nodes. Localization of sensor nodes is an interesting research area, and several works have been done so far. It is highly desirable to design low-cost, scalable, and systematic localization mechanisms for WSNs. In this paper, the author discuss sensor node architecture and its applications, unlike localization techniques, and few possible future research directions

Biljana Risteska Stojkoska (2014):- In the recent years, there has been a vast advancement in wireless sensor computing technology. Today, wireless sensor network (WSN) has become a key technology for unlike types of smart environment. Nodes localization in WSN has arisen as a very demanding problem in the research community. Most of the applications for WSN are not useful without a priory known nodes positions. Appending GPS receivers to each node is an expensive solution and inapplicable for indoor environments. In this paper, we executed and evaluated an

algorithm based on multidimensional scaling (MDS) technique for three dimensional (3D) nodes localization in Wireless Sensor Networks using improved heuristic method for distance calculation. Implementing extensive simulations we investigated our approach concerning various network parameters. We compared the results from the simulations with different approaches for 3D WSN localization and showed that our approach outperforms other techniques in terms of accuracy.

Xu Chun-Xia and Chen Ji-Yu (2015):- To solve the incorrect node localization in WSN, this paper first analyzes the problems in current DV-HOP algorithm, takes the received signal RSS as a referral standard through the weighted centroid algorithm, effectively reduces the localization errors and adopts the enhanced two dimensional hyperbola algorithm in the distance estimation to make the estimated distance more precise. The simulation results show that presented algorithm has been significantly improved compared to the algorithms in literature & enhanced the localization accuracy to a certain extent.

Chandirasekaran D and T. Jayabarathi (2015):- Wireless sensor networks (WSN) have become famous in many applications area including environmental monitoring, military and offshore oil & gas factories. In WSN the sensors are randomly deployed in the sensor field and hence estimation of the localization of all deployed node has drawn more attention by the recent researchers, It's a unique problem to recognize and maximizing the coverage where the sensors need to be placed in a position so that the sensing capability of the network is fully employed to ensure high quality of service. In order to keep the cost of sensor networks to minimum, the use of additional hardware like global positioning system (GPS) can be avoided by the use of effective algorithms that can be used for the same. In this paper we tried to use both the shuffled frog leaping (SFLA) and firefly algorithms (FFA) to approximate the optimal location of randomly deployed sensors. The results were compared and published for the usefulness of further research.

IV. COMPARATIVE ANALYSIS OF LOCALIZATION TECHNIQUES

AUTHOR	YEAR	TECHNIQUE	MERITS
Loukas Lazos and Radha Poovendran	2005	Novelrange-independent decentralized localization algorithm called SeRLoc	Better performance, robust against known Attacks, provides accurate location estimation even in the presence of these threats
Radu Stoleru and John A. Stankovic and Sang Son	2007	Execution of multiple localization schemes.	50% decrease in localization error
Kiran Yedavalli and Bhaskar Krishnamachari	2008	Novel sequence-based localization technique	Provides comparable or better accuracy than other techniques.SBL performs well and better than other state-of-the- art localization techniques in both indoor and outdoor environments.
Chi-Chang Chen, Yan-Nong Li and Chi-Yu Chang	2012	range-free localization technique	Low-cost yet effective, superior to the DV-Hop method under both low density and high density sensor deployments, improve the performance of location estimation of sensors.
Zhenxing Luo and Paul S. Min and Shu-Jun Liu	2013	novel energy-based target localization method	Reduce bit error probability, localization performance could be improved, reduce energy consumption for our target localization method, provides satisfactory localization performance.
Biljana Risteska Stojkoska	2014	Algorithm based on multidimensional scaling (MDS) technique	This approach outperforms other techniques in terms of accuracy
Xu Chun-Xia and Chen Ji-Yu	2015	Improved DV-HOP Localization Algorithm	Enhanced localization accuracy to a certain extent
Chandirasekaran D and T. Jayabarathi	2015	shuffled frog leaping (SFLA)& firefly algorithms (FFA).	FFA offers less error value in comparison to SFLA, Both the algorithms are effective in their own way

V. CONCLUSION

In this paper, we studied a no. of techniques namely Novel range-independent decentralized localization, Novel sequence- based localization technique and range-free localization technique etc. In this paper we studied Novel range-independent decentralized localization algorithm called SeRLoc provides better performance and accurate location estimation even in the presence of threats, execution of multiple localization schemes shows 50% decrease in

localization error, Novel sequence-based localization technique provides comparable or better precision than other techniques, range-free localization technique is low-cost yet effective, superior to the DV-Hop method under both low density and high density sensor deployments, improve the performance of location estimation of sensors.

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