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Techniques of Node Localization in Wireless Sensor Networks: A Review

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ABSTRACT- Wireless sensor networks (WSNs) are widely used in many environments and adverse terrains. The common problem in the wireless sensor network technology is localization problem. Most of the applications, the network collects the data without location information which is not very useful. Location information plays a vital role in both networking and in other domains of wireless sensor network. In this paper, review has been done on the localization algorithms and different taxonomy based on basic features. As wireless sensor networks are becoming an emerging technology, it is being used in many applications. We have also reviewed the important and fundamental factors which can validate the performance of node localization techniques.

KEYWORDS: Wireless Sensor Networks; Localization Algorithm; Learning; Range.

I. INTRODUCTION

Wireless Sensor Network-As wireless Sensor Networks is an apparent technology it is being used in various applications. It is monitoring the physical real world entities by having communication without devices i.e. wireless known as sensor nodes. WSN techniques are useful for creating locate sensor nodes by taking the help of reference and beacon nodes. Beacon Nodes are the nodes which know their positions coordinate [10]. Some other nodes are localized by taking measurements like distance, Time of Arrivals (ToA), Time Differences of Arrival (TDoA), Angle of Arrival (AoA), Direction of Arrival (DoA) [11].However, position computation techniques like multilateration are getting used for computing the position of a node. Hence, some localization algorithms or technique is used for locating WSN nodes. There are many scenarios of WSNs applications which are present including military purposes, industrial purposes, household works, medical applications, natural disasters monitoring, and other emergency situations.[4]

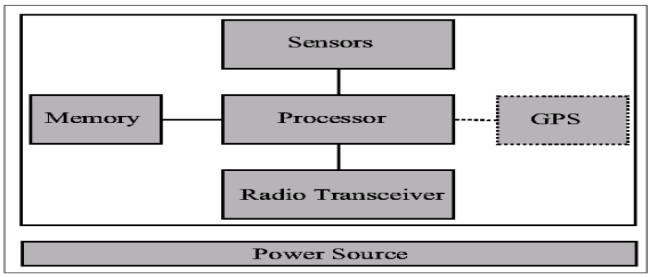

Figure 1.1 Components of WSN [3]

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II. LOCALIZATION

Since WSN concept was introduced, localization of sensor nodes and location tracking applications has been an important study. Nowadays so many techniques and technologies have been developed till now for the off-the-shelf location systems. The location systems can be made more specific for meeting different needs and environments such as precision, indoor/outdoor environment, position techniques, ranging schemes, security, devices available, WSN deployment restriction, network scaling, implementation cost and healthy consideration. Classification of the location systems is divided into tree structure from technology point of view. It is shown in the figure 1.2 below

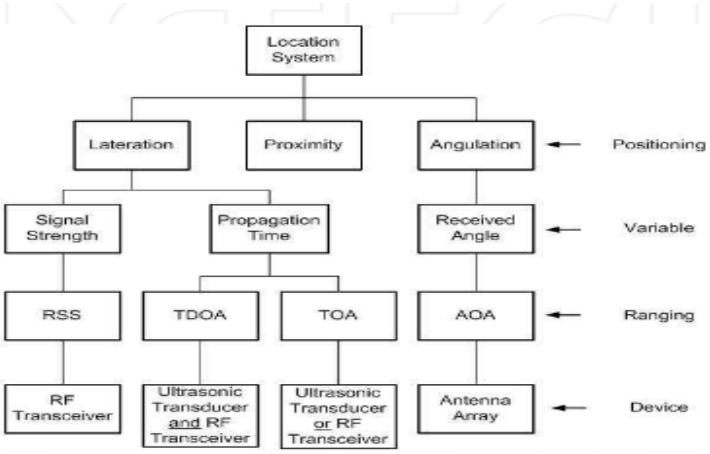

Figure1.2 Location Tracking [3]

Localization is most prominent research field in wireless sensor networks (WSN) and it is usually defined as the process of determination of positions of unknown nodes which are intended nodes by using information of some known nodes that are called anchor nodes dependent on measurements like distance, time of arrival (TOA), time differences of arrival (TDOA), and angle of arrival (AOA). As WSN require the awareness of sensing information that is giving rise to the issue of localization in most of the applications that are recently proposed. The localization estimation approach is a 2-step process:

1. **Ranging step:** In the ranging step, nodes are supposed to estimate their anchors by using signal propagation time or strength of the received signal. There is need to measure the parameters precisely which is not possible because of noise and some other factors; therefore their consequences are localization algorithms are not accurate [1].
2. **Position Estimation step:** In the position estimation step, it is done using ranging information. This can be done either by solving a set of simultaneous equations or with any optimization techniques that will reduce the localization problem. This is a repeating method where some nodes i.e. anchor and localization process is iterated unless all nodes are settled or no more can be localized.

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III. LOCALIZATION TECHNIQUES

A. Particle Swarm Optimization (PSO):

PSO is a resilient stochastic optimization method which is dependent on the movement and logic of swarms. Particle swarm optimization has the basic concept of social interaction for solving the problem. PSO developed in 1995 by James Kennedy (social-psychologist) and Russell Eberhart (electrical engineer). It has number of agents i.e. particles that consists of a swarm which is moving around in the search space and finds the best solution. Every particle is keeping track of its coordinates in the solution space which are associated with the best optimal solution (fitness) that has been achieved by that particular particle. This values are called personal best i.e. pbest. The best value which is tracked by the PSO is the best value that they got so far by any particle in the next to that particle and this value is known as gbest. The key concept of PSO lies in acceleration of each particle for its pbest and the gbest positions, with a random weight acceleration at every time slot [1].

B. Biogeography-based optimization:

Biogeography-based optimization (BBO) is an evolutionary algorithm (EA) which will optimize a functions or activity by stochastically and repeatedly improves candidate solution regarding to a given measure of standard or fitness function. Biogeography based optimization is owned to the class of metaheuristics and it is including so many variations and it is not making any assumptions about the situation and therefore it will be applied to a vast class of situations. BBO is basically used for optimizing many directional real-value function or activities, but it never uses the gradient of the functions, that means there is no requirement the function for being different as needed by classic optimization techniques like gradient descent and quasi-Newton methods. Therefore BBO can be used on discontinuous functions.

Biogeography Based Optimization is a problem for optimization by the maintenance of a population or enlargement of candidate solution, and creates current candidate solutions by the combination of available ones accordingly with a simple formula. Hence, the objective function is taken as a black boxes that is providing a size of quality from a given candidate solution, and the function's gradient is not required. Like many other EAs, BBO was inspired by a natural process and also BBO was put forward from the idea by biogeography that is the study of the distribution of different biological species through varying time and space. BBO was originally prompted by Dan Simon in 2008.[1]

C. Trilateration Method

The trilateration is very widely used method used for localization. The key principle of this method is usage of three or more anchors node. The evaluated or calculated distances from known points to the unknown entity are called the radiuses of these circles. The intersection of these three circles is the positions of the unknown entity and the intersection or cross section of these circles cannot be a one point and Modification of trilateration method is needed. [4] Basic trilateration is the method of determination of absolute or relative locations of points by the measurements of distances.

D. Bee Optimization Algorithm

Bee Optimizations Algorithm (BOA) is useful for localizing the nodes of the wireless sensor networks (WSN) is investigated. Next is the conduction of different tests from different topologies which is based on normal allocation for

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Time of Arrival (TOA) measurements and received signal strength (RSS) measurements. There is a comparison between the BOA algorithm performance and the Cramer-Rao Bound (CRB), which is finding that the estimated location or position error is near to that of the CRB.[4]

E. Received Signal Strength Indicator (RSSI)

RSSI-based localization algorithm is a ranging dependent methodology that consumed in RSSI circuitry that involves the sensor's transceivers chipsets [3]. Further, RSSI technique is the measurement commonly which necessitates light computations that do not cause the processing power of the sensor nodes. Therefore, this is very reasonable and cost effective localization technique that is getting an increasing acceptance as an easy technique for resolving the localization problem.[2]

IV. RELATED WORK

Satvir[1] (2013) et al. in the paper have addressed the applications of different migration variants of Biogeography-Based Optimization (BBO) algorithms and Particle Swarm Optimization (PSO) for distribution of optimal localization of randomly deployment sensors. Biogeography is collection of learning of geographical share of biological particles. This algorithm has a new inclusive vigor which is based on the study of biogeography and it is employing a migration operator for allotting information between different places or habitats, i.e. issue solution. PSO models have fast convergence but it is less mature. A survey has been done on the distributed iterative localization. Hence the nodes which will get localized in repetition act as anchor node. In this paper, they have compared the performance of PSO and different migration variants of BBO with number of nodes localized; localization accuracy and computation time is shown.

Mary [2](2013) et al. in the paper have proposed RSSI (received signal strength indicator) range based localization paradigm which will relies on the measurement of the received signal strength indicator for estimating the distance. In this work, experiments have been conducted in outdoor and indoor environments for deriving the path loss model. The conclusion is showing that the outdoor environment has some good distance estimation than an indoor environment. Therefore they investigated the cause of varying the anchor node density on localization error.

Asma[3] (2013) et al. in the paper have made categorization of localization method Wireless sensor networks (WSNs) have gained observation by scientific community. Small and reasonable appliances having low energy consumption and limited computational resources are being adopted in different application scenarios that include environmental monitoring, target tracking and biomedical health monitoring. In these applications, node localization is inherently of the system parameters. Localization process is very important for reporting the authentication of events, route and for answering questions on the network coverage, assisted group querying of sensors. Localization schemes have two categories: range-based and range-free. Therefore, it is hard to classify hybrid solutions as range-based or range-free easy, where range-based schemes and range-free schemes are categorized into two types: fully scheme and hybrid scheme. Moreover, they have done the comparison of the useful localization algorithms and discussed the future scope for wireless sensor networks localization schemes.

Avinash[4] (2012) et al. in the paper have made the Classical Approach to find the position of a node which is in the network. In this paper, they have developed three stage optimization techniques in which they proposed to reduce the estimated fault and then it will find the position of a node in a network. Wireless Sensor Networks (WSN) has applications for hunting down targets, environment supervision, and data collecting for factors such as humus, temperatures, and pressures. These kinds of networks are widely used in many applications, as their success is highly dependent on the sensor

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node positions known as network deployment. By determination of the position of sensor nodes is the key objective of deployment network which directly based on the coverage of the concerned region. For locating sensors, Global Positioning System it is also used by sensors that are aware about their positions. This method is not feasible for economic problems. So only a small part of the network can affordably be equipped with GPS, and an automatic localization process is required for the rest of the nodes in the network. They estimated random solutions and applied technique for finding the best feasible solution among all. In some cases where assumptions are fulfilled, these are very efficient techniques.

Amitangshu[5] (2010) et al. in the paper have addressed some new approaches for localization of node discovery in WSN. The methods proposed by different scholars for the improving the localization in wireless sensor networks has also presented. They have also discussed future scope for improving node localization in WSNs. Latest advancement in radio and embedded systems have also enabled the wireless sensor networks. These networks are also being useful for different platforms to perform many monitoring tasks like search, rescue, disasters relief, target tracking and some other tasks in smart platforms. Localized node is one of the system parameters. Node localization is needed to inform the starting of events, assist group sensor queries. The main challenge is the node localization of wireless sensor networks.

Xue[6] et al. in the paper have studied a tracking systems that is based on the auto regressive moving average (ARMA) model while distribution in peer-to-peer signal processing framework. In this framework, wireless sensor nodes is acting as peer that is performing target detections, feature extractions, classifications and tracking, in case of target localization required the collaboration between wireless sensors nodes for improving the accuracy and robustness of networks. Further, a progressive multi-view localization algorithm is made in distributed P2P signals processing framework that will consider the tradeoff between the accuracy and energy consumptions. Finally, a real world target tracking experiment has some illustrations. Some results from implementations have shown that this target tracking system is dependent on a distributed P2P signal processing framework is making economic use of scarce energy and communication resource and achieved target tracking.

Shi[7] (2006) et al. in the paper have proposed an applied localizations models by using linear intersections and do some concerned experiments for estimating the location computation algorithms. By knowing the positions of nodes in wireless sensor networks (WSN) it becomes very important for many useful advantages. Nodes in a WSN have number of capabilities and exploitation of one or more of the capabilities which will help for solving the localization problem. They also assumed that each node in a WSN has the capability of distance measurement and also presented allocation of computation techniques also known as linear intersections for node localization.

V. PARAMETERS FOR LOCALIZATION

i . Accuracy and Precision: The most important parameter for localization techniques is accuracy and precision. We can define accuracy as how much the estimated position deviated from the true position is. Precision indicates how often we expect to get at least the given accuracy
ii. Scalability: This is known as responsiveness or sampling and is defined as how quickly the location system outputs the location information.
iii. Self-organization: This means, the system could or may not require the help of a central entity to monitor and control the activities of the elements.
iv. Cost: We can evaluate the cost of the location sensing system in different ways; including cost in terms of time spend for installation, money, computational effort or energy.

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VI. CONCLUSION

As wireless sensor networks ia an emerging technology, it has many applications. In this paper, we discussed some localization techniques and localization algorithms were discussed based on different key features like learning, anchor existence, movement in network, etc. This survey is usable to understand the operation of varies localization methods and it is also usable for who wants to implement a new localization algorithm. There is need to investigate the effect of varying the anchor node density on localization error with minimum number of anchor nodes thereby enhancing an accuracy of the network. The different techniques have been studied in this paper to improve localization in WSNs.

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BIOGRAPHY

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