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A SURVEY ON ERROR CONTROL OF LOCALIZATION METHODS AVAILABLE IN WIRELESS SENSOR NETWORKS

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Abstract

This paper focuses on the various algorithms used for solving the errors in localization for wireless sensor networks. The major problem in the wireless sensor network is localization. Iterative localization algorithm is used to find out the exact position of the sensor nodes. Localization results are easy to measure the errors like range error and localization error. While using GPS, it gives a trivial solution and higher cost in some environments. The existing work on localization is divided into range based and range free localization. The key issue in localization is error and accuracy. Based on the survey taken on various localization algorithm is focused to overcome the errors like range and localization.

Keywords: Accuracy, Error, GPS, Localization, Wireless sensor networks

1. Introduction

Wireless Sensor Networks is the network that which consists of autonomous devices called nodes. The nodes of the network consist of sensor device, battery, transceiver or receiver antenna, etc… The wireless sensor networks are used to monitor the environmental changes using the nodes of the network. Its applications used in military as battlefield surveillance, habitat monitoring, environmental monitoring, and health application etc. Sensor network send the data to neighbour node or base station, but before it they need to know their own location, because the data have no meaning without location information from where the data is coming. If the nodes are large in numbers then it is difficult for the base station to find the location of each and every node for transferring or receiving the data, to make this each node has to send its location information with the data which it has gathered. Localization is the process of finding the exact location of the node in a geographical area; this localization can be done by using manual method or by using the GPS system.

The manual localization is the process of deploying the nodes by humans in a particular position this position is calculated by humans. The GPS is the method of using satellite for finding the position of nodes. The usage of GPS for finding the position increases the usage of battery power since it has to transfer the signal to satellite or it also reduces the lifetime of networks. The major problem in wireless sensor networks is the positioning of the nodes in a place where other nodes does not interfere the process of other nodes. The coverage of the nodes must be considered before the deployment of sensor nodes to increase the nodes positioning error. Most applications of wireless Sensor networks use location information for interpreting the meaning of the sensory data that which has been obtained.

In static sensors there is no any problem of changing the position since they are fixed, this reduces the localization problem for this type of networks. But in dynamic (or) mobile type of networks the sensor nodes move from one position to other position which makes difficult in finding the exact location of the nodes, this takes time and energy and also uses other resources for sensing the applications. Further the localization of mobile nodes needs a centralized processor for finding the exact position of the nodes which takes more time to run or make assumptions about the environment.

The existing work on localization split in two types as range based and range free localization [1]. Range-free mainly focuses on the connectivity of hop counts with the nodes. Range-based approach mainly focuses on the measurement of the Euclidean distances among the nodes.

2. Types of Localization in Wireless Sensor Networks

2.1 Localization in Static Wireless Networks

The first class category focuses in static single-hop wireless networks. The node estimates the centre position, when there are no anchor nodes. The strength of the signal measured from multiple base stations to locate and track users by the help of RADAR [2].

The second class category focuses static multi-hop wireless sensor networks. The ranging and estimation are the two phases of the development of distributed localization. In ranging phase, the distance of its neighbours are estimated by the each nodes and during the estimation phase, the position of the neighbours and the ranging information are determined.

2.2 Localization in Mobile Wireless Networks

Among the few existing errors, this is the first localization method for mobile localization. The Monte Carlo Localization (MCL) method is used to localize the mobile sensors in a sequential order [2]. The possible current coordinates found out by the previous location of the nodes. Then the current connectivity information filters out the localization in infeasible. MCL extract the information of nodes either to the direct neighbours. The information from the neighbours coordinates used to speed up convergence and improve accuracy.

3. Survey on Localization Algorithms

3.1 Quasi Newton Optimization

In wireless sensor networks, knowledge to locate the node is critical. The researchers motivated to develop the localization schemes based on cheap hardware and wireless because of the limitations of GPS. To determine the accurate location in mobile networks, three novel schemes are developed. (i) Low Rank based Localization (LRL), it exploits the rank structure in mobility as low. (ii) Temporal Stability based Localization (TSL), it leverages the stability of temporal. (iii) Temporal Stability and Low Rank based Localization (TSLRL), it emerges the both of stability of temporal and low rank structure in mobility. And apply a Quasi Newton Optimization algorithm [2] to find the local optimization. This algorithm is used to find the stationary point and the objective function. It is mainly used to analyze the traces of real and synthetic mobility. For achieving the better scalability, quasi-Newton method do not directly compute with the Hessian matrix. In lieu the analysis of success gradient vectors automatically update the Hessian matrix.

The complexity of time depends with the time spend for each iteration and the total number of iterations performed. The evaluation takes place a single initial solution which must be good and unique. It is critical to get a good solution in the initial stage, without the good solution it's hard to get a good accuracy solution. And so it is impossible to observe the effectives of localization.

3.2 ROPE Scheme

The next problem facing in localization is security and for verifying said to be location verification. The essential part in wireless sensor network is having the knowledge of placing the nodes in a right place. Almost all previously proposed techniques of localization for the trusted place only. These localization techniques are very easy to get attacked by external attacks. Two methods are introduced for the secure localization in wireless sensor networks. First one is SPINE [3], a secure positioning depends on the bounded distance. The performance of the location is estimated in centrally and when the sensor knows about the location, then it acts as a reference points are needed to estimate the location of sensors by calculating the distances of the reference points. Second is SeRLoc, a decentralized range independent for localization. In this method, the position of the node determines no assistance from other sensors and small numbers of reference points are enough to find the localization.

ROPE [3] means Robust Position Estimating algorithm that is mainly for the determination and verification of the location. In this algorithm it assumes with two tiers network contains the locators and the devices of sensors. The algorithm works as determine the position of the sensors and verify the initial location of the sensed information. Then data collection points are ready for serve. For the assumptions of security purpose, sensors and locators are fit to perform the basic operations of cryptographic primitives. Locators can also collect the data points since sensor nodes can communicate with at least one locator.

Wormhole attack provides false location information. Wormhole attack is a one type of attacks; it intrudes via direct link or the long range of communication channel. It does not compromise with the integrity and authenticity. The attacker can be prevented by performing the multilateration jamming. The metric used to quantify the impact of the type of attack and to classify the snoop of locations is Maximum Spoofing Impact (MSI).

3.3 MDS Method

The connectivity and the information of the distance have been localized. It yields the good relative map when there are no anchor nodes. In the future, sensor will worked with a very large number of nodes over the physical space. It is very hard of these large networks to send the data at a given location. In this paper one approach is used to compute the position of nodes by containing the basic information. The heart of the approach is Multi Dimensional Scaling (MDS) [4]. It is well suited for the node location in the communication networks.

Multi Dimensional Scaling (MDS) [4] method takes the overall advantage of connectivity and distance between the nodes. Two methods are used to represent, a simple method called MDS-MAP(C) used to build a global map using the classical MDS and the complicated method called MDS-MAP (P) used to build many small local maps to patches together to form a global map.

MDS-MAP(C) contains three steps:

- Calculate the shortest path between the pairs of the given region. To constrict the distance matrix for MDS, shortest path only used.
- In the distance matrix apply MDS, and then find the large two or three Eigen values and Eigen vectors to create a relative map.
- Transform the relative map into the absolute map by the help of anchor nodes in the absolute position.

In regular networks, random placement of nodes will give a good accuracy and not in the irregular networks. In irregular it reports poor results. The strength of this approach is worked when there are few or no anchors nodes. Optional refinement step is used further to improve the solution.

3.4 Based on Residual Testing

To locate the mobile station measure the time-of-arrival [5] from more than two base stations. The square difference between the estimate position of the nodes and the current position gives the residual value. This paper proposes the test for residual to identify and determine the number of line-of-sight. The mobile phone operations used to determine the position of mobile station (MS). The localization of the mobile station measured by the parameter is time-of-arrival (ToA), time-difference-of-arrival (TDoA), angle-of-arrival and signal strength [5]. Among all of these time-of-arrival (ToA) is most popular.

Adding the GPS with the mobile station leads to increase cost, weight, power consumption and trivial solution. Another problem is non-line-of-sight (NLOS) conditions. The signal arrives from the base station is not in line-of-sight (LOS) path and no direct. Localization with non-line-of-sight (NLOS) produces more number of position errors.

There are three ways to manage the non-line-of sight (NLOS) conditions. The location errors can be very large, when some of the measurements are taken from the NLOS. The first step is determining the mobile station location from the reflecting model. It measures the characteristics of the channel. The second way is localize by using all the measurements of NLOS and LOS, but provides the weighting and scaling to reduce the NLOS errors and effects. The weighting produced from the localization geometry or layout of the base station. The third way is identify and localize with the LOS. Identification is carried out by the time based history tests. The localization can provide the accuracy when it finds the identification and there may be a chance for the wrong identification also.

The residual test works when all the measurements are in the line-of-sight path. The residual can produce the accuracy of over 90% [10] at the time. The localization of mobile station has the significant errors when the NLOS are present.

3.5 NLOS State Estimation (NSE) Algorithm

The mobile terminal attention has received a good attention in these days. The errors basically caused by the non-line-of-sight (NLOS) [7] mainly proposed into two things as error identification and correction techniques for the mobile user location. Based on this, two mitigation algorithms proposed to solve these errors.

Based on the localization, generally two different schemes have been extensively investigated. One is time based scheme, to measure the time of arrival (TOA) of the input signals and the other is measure the angle of arrival (AOA), it involves with the antenna array.

To achieve the good accuracy and reduce the cost of the mobile station receivers, the scheme for location combines the TDOA measurements from forward link with the AOA measurements from the reverse link pilot signal.

Depend upon the priori information the NLOS error prior probabilities and distributions categorized three number of cases:

- Ideal case: with known NLOS statistics
- Limited priori information
- Worst case: without knowledge of the NLOS error

Assuming no knowledge for the NLOS errors, the residual is calculated for each base by station using the mobile station as reference. The algorithm only needs the Gaussian noise statistics knowledge. It can be effective for small number of NLOS base stations only. It demonstrates the location is possible in severe NLOS conditions also.

3.6 Light-Weight Iterative Algorithm

The knowledge of the location nodes is more essential in the tasks such as routing, sensing and delivery in sensor networks. This paper [8] introduces the iterative method for node placement. For the each iteration, a least based square algorithm is used to localize the nodes. To control the error from propagating and accumulating during the process of iteration, use the mechanism of error control. The iterative localization uses for the accuracy. When GPS is not assist with the location technology due to cost, the inexpensive iterative localization approach developed. This approach is mainly used for control the error.

The idea of the iterative localization [8] is to use the known anchor nodes to localize the free nodes. To keep track the estimation error determines which neighbour has reliable information about the location. The neighbour selection step used by calculating whose measurement to use and who's to discard. The bad ranges errors are taken for the further calculation and the good ones are left out. The problem in this algorithm is compared this with some computation for accuracy.

3.7 SISR Method

The problem will occur in localizing the nodes in outdoor or open-space environment. Ranging measurements are often subject to errors due to multipath signals, unreliable hardware and variations in path loss. The errors in the measurement obviously produce the inaccurate solutions. The new error tolerant localization method, snap inducing shaped residuals (SISR). It is used to find the bad ranges and bad links automatically [9]. SISR snaps the good nodes for the accuracy and gives less priority for the remaining nodes.

A new kind of residual function for used in optimizes based localization. The shaping function increases with a small slope when the number of residuals are large is said to be wring-shaped section [9]. By discerning bad nodes easily find out the good nodes to improve the accuracy. By applying the method often it can achieve greater accuracy in the localization of the nodes which are in the category of good. The drawback is this algorithm does not present the TDOA results because of limited space.

3.8 SDP Method

The problem of optimization is set to minimize the sensor positions to fit the correct distance. The performance of this technique is highly satisfied when compared with the other methods. Less amount of anchor nodes are enough to estimate all other unknown nodes in the network.

In lieu of using GPS system, the technique semi definite programming (SDP) [10] used to measure the neighbour nodes. This report motivates to use the SDP relaxation method for the estimation of position in sensor networks. The common idea behind this technique is convert the non-convex quadratic distance constraints into linear constraints. First find the quadratic formulations of the problem then implement the semi definite programming method to solve the problem. Optimization is set up to minimize the errors.

3.9 Iterative Localization

This method is used to control the localization errors and range errors and gives a accuracy result. The methodology used to control the propagation of error. By determining the neighbor information, it provides the reliable location. The algorithm used to solve the error is error control of iterative localization [1]. Bad range errors are taken and it should resolve by using the iterative localization. This shows that the location is estimated by using the non-linear square residuals, and proposed a error control during the iterative localization process.

4. Conclusion

This survey provides us with good understanding about the various techniques that are available for localization in wireless sensor networks environment. Both time and space are the most important performance factor that has to be considered. Some of the methods that are based on static mobile networks focused on the exact location of the nodes. By reducing the errors using iterative algorithm, we can easily obtain the accuracy in the localization. Most of these previous methods have not considered both the above performance factor that has resulted in an unsatisfied solution. This survey shows that the futuristic methods should provide a balance between the error reductions and find the correct position to place the nodes in the wireless sensor networks.

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