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ADAPTIVE ERROR CONTROL OF FUZZY MODELING IN LIEU OF ITERATIVE LOCALIZATION FOR WIRELESS SENSOR NETWORKS

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Abstract

The node localization problem in mobile sensor networks has received significant attention. While using GPS, it produces a trivial solution and higher cost in some environments. Localization results are very easy to find the errors like range error and localization error. While using GPS, it gives a insignificant solution and higher cost in some environments. The existing work on localization is splits into range based and range free localization methods. This paper focuses on the enhancement of localization method using fuzzy modelling. In the proposed method, first find the reference nodes which are connected to the node to be localized, and then develop the fuzzy membership function**.**This paper focuses on the fuzzy rules for solving and removing the errors in localization for wireless sensor networks. The main factor in localization is error and accuracy. Based on the fuzzy rules used before the localization algorithm is focused to overcome the errors like range and localization.

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

1. Introduction

Wireless Sensor Network is a network which contains of autonomous devices called nodes. These nodes include of sensor device, battery, transceiver or receiver antenna, etc. The network monitors the environmental changes by using these nodes.

The Sensor network sends the data to the neighbour node or base station. Since the data has no meaning without its location information, the nodes need to know their own location. If there are large numbers of nodes, the base station finds it difficult to know the location of each and every node for transferring or receiving the data. In order to achieve this, each node has to send its location information to the gathered data.

Localization is the process of finding the exact location of the node in a geographical area. This can be done using two methods: Manual localization method and GPS system method. The manual localization method is the process of deploying the nodes by humans in a particular position. The GPS system method is the method of using the satellite for finding the position of the nodes. This method increases the usage of battery power since it has to transfer the signal to satellite. Hence the lifetime of networks is also reduced.

The major problem in wireless sensor networks is the positioning of the nodes. It must be in a place where other nodes do not interfere its process. To increase the node's positioning error, the coverage of the nodes must be considered before their deployment.

The Wireless Sensor Networks have several applications. Mostly they use their location information for interpreting the meaning of the sensory data obtained. It is also used as battlefield surveillance in military, habitat monitoring, environmental monitoring, and in health application etc.

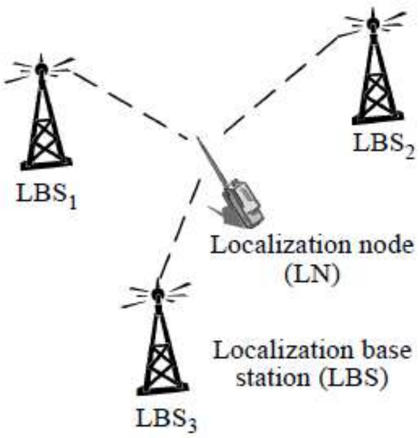

Figure 1: Localization Network

Since the static sensors are fixed, there is no problem of changing the position in this type. Thus the localization problem for this type of networks is reduced. In dynamic or mobile type of networks, the sensor nodes move from one position to another. Hence it is difficult in finding the exact location of the nodes. So this method takes time and energy and also uses the other resources for sensing the applications.

A centralized processor is needed for finding the exact position of the nodes in the localization of mobile. This takes more time to run or make assumptions about the environment.

Fuzzy means "not clear, distinct, or precise or blurred". It is defined as 'A form of knowledge representation suitable for notions that cannot be defined precisely, but which depend upon their contexts'. Many packages such as Java, Mat lab have fuzzy logic. It can be implemented in hardware, software, or a combination of both.

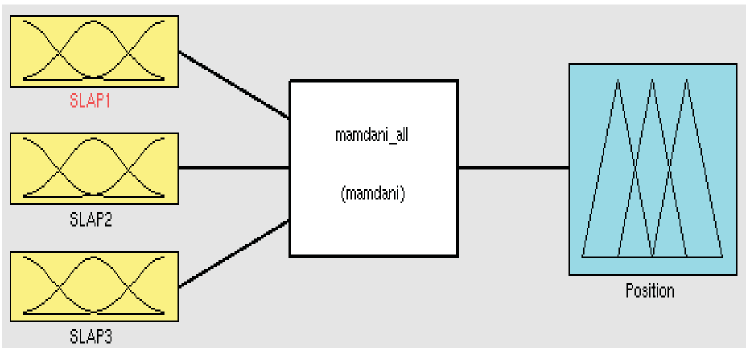

Figure 2: MAMDANI Fuzzy System

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 position of centre, when there are no nodes of anchor. The signal strength is measured from multiple base stations to track and locate users by the help and follow of RADAR [2].

The second class mainly focuses on static multi-hop wireless sensor networks. The range and estimation are the two important phases used to develop the distributed localization. In range phase, the distance of its neighbours is estimated by the each and every node and during the estimation phase, the position of the neighbour nodes 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 method Monte Carlo Localization (MCL) is used to localize the mobile sensors node in a sequential manner [2]. The possible coordinates found out by the old location of the nodes. Then the present connectivity information filters out the localization is infeasible. MCL extract the information of nodes either to the direct neighbours. The coordinates of the neighbour's information are used to speed up convergence and improve accuracy.

2.3 Iterative Localization

This method is used to control the localization errors and range errors [1] and gives an 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 iteration process. This gives that the location is estimated by using the non-linear square residuals, and proposed an error control during the iterative localization process.

3. Related Work

In wireless sensor networks, found the knowledge to locate the node is critical. All the researchers motivated to develop the localization schemes based on cheap hardware and wireless to overcome the limitations of GPS. The main problem to face in localization is security and for verifying said to be location verification [11]. The ultimate aim in wireless sensor network is having the knowledge of placing the nodes in a exact position. Almost all previously work denotes that localization only for the trusted place. But these localization techniques can be easily attacked by external attacks and outdoors.

The distance has been localized by referring the information and connectivity [11]. It produces the good relative map when there are no anchor nodes. In the later time, very large numbers of nodes are needed to work with sensor over the physical environment. It is very tough and insufficient of these big networks to transfer and send the data at a given location.

To locate the mobile station, measurement of the time-of-arrival [5] from more than two base stations is considered. The difference between the new position of the nodes and the current position gives the residual value. This paper proposes the test for residual to point out and determine the number of line-of-sight.

The mobile phone operations used to determine the position of mobile station (MS). The mobile terminal attention has received a good attention in current days. The errors basically caused by the non-line-of-sight (NLOS) [7] mainly proposed into two things as error identification and rectifying techniques for the mobile user location.

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 high 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 follow the calculated 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 remove. The bad ranges errors are taken for the further calculation and the good ones are removed. The problem in this algorithm is compared this with some computation for accuracy and perfection [11].

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

4. Fuzzy Modelling

Fuzzy model is a more popular system and used to approximate the value of any nonlinear function to arbitrary accuracy with only a small number of fuzzy rules. The meaning of the rule is that when is constrained to the fuzzy range categorized by the 'IF' part of the rule, the output is a linear function of the input variable. Therefore, the fuzzy system can be mentioned as a somewhat piece-wise linear function, where the change from one piece to the other is smooth rather than changed immediately. Actually fuzzy system is employed to estimate the weights of edge points by combining partial information.

$$R\text{: } IF\ x\ is\ A\ THEN\ y = B \quad (1)$$

First, develop the fuzzy membership function by considering the information between the node and reference nodes. For calculating more perfect edge weights, optimize fuzzy membership function. The self-localization method based on a fuzzy grid is fed by the local map of fuzzy segments generated by the perception system. This method presents the following advantages; i) it only needs an correct sensor model, ii) it is able to denote the different aspects of uncertainty that affect to the measures, and iii) it is able to handle the ambiguity in location avoiding to deal with the data association problem. Logically, the main disadvantage of this method is the fact that the environment is tested, and despite of the difficulty is reduced using some simple calculations, the overall cost is high in comparison to other techniques, especially local methods. This disadvantage is largely compensated by the stability of the method and its robustness, which are critical points in local methods with high uncertainty.

That is, the IF parts of the rules are the same as in the ordinary fuzzy IF_THEN rules, but the THEN parts are linear combinations of the input variables.

5. Fuzzy Self-Localization

This section describes the method based on a fuzzy grid that is used to locate the nodes in an indoor known environment. The method fix the set of fuzzy segments and the estimate the distance travelled, sensing and acting respectively, to estimate the nodes location on the given metric map. This fuzzy self-localization method was proposed by Buschka and extended in to deal with the ambiguity without the description of data association problem. Because different types of uncertainty may affect the location information, such as vagueness, imprecision, ambiguity, unreliable, and random noise, the formalism used to represent the location information should be able to represent all of these types of uncertainty and account for the differences between them. Fuzzy logic techniques are suitable in this aspect, thus location information of an object is represented by a fuzzy subset μ of the set X for all the possible locations present in the environment.

A fuzzy rule contains only two logics. A Fuzzy localization system has been developed to represent with the uncertainty derived from scale variations. In classical logic only two crisp values are applicable (0/1, false/true, negative/positive, etc), it is a strong limitation when dealing with real-world complex problems where there are many important details which are usually vague. FL is a useful tool to represent with these problems, because dealing with FL everything is a matter of degree and strong.

6. Fuzzy logic Vs Neural Networks

Fuzzy systems can be represented as networks. The computing units must implement fuzzy operators. The idea of fuzzy logic is to approximate human decision making using natural language terms instead of quantitative terms. Fuzzy logic refers to fuzzy sets, which are sets with blurred boundaries and it is also a logical system which aims to formulize approximate reasoning. Whereas the neural networks have a different paradigm for computing. They cannot be programmed to perform a specific task. They can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computing techniques.

Fuzzy Logic is mainly used in control systems. They can b divided into two categories: Temperature Controller and Anti – Lock Brake System (ABS)

Fuzzy Logic is also used in other fields like business, hybrid modeling etc.

7. Imprecise Data and Imprecise Rules

Fuzzy logic can be described as a generalization of logic in the classical formation. Modern fuzzy rules was developed by Lotfi Zadeh in the mid-1960s to model those problems in which imprecise data must be used or in which the rules of inference are formulated in a very general way making use of diffuse categories. In fuzzy logic, which is also sometimes called diffuse logic, there are not just two alternatives but a whole continuum of truth values for logical propositions. A proposition A can have the truth value 0.4 means and its complement *Ac* truth value is 0.5. According to the type of negation operator that is used, the two truth values must not be necessarily add up to 1.

8. Fuzzy Membership Functions Generation

The membership function of a fuzzy set is a generalization of the indicator function in classical sets to represent in the form of X and Y location. In fuzzy logic, it represents the degree of truth as an extension of valuation. The well denoted data need to be categorized into a set of fuzzy membership functions in order to quantify the raw crisp values of the RSSI of the APs into linguistic labels: "*Close*", "*Medium*", "*Far*" and "*No Detected*". The fuzzy sets "*Close*" and "*Far*" are described by left and right shoulder membership functions, respectively. The fuzzy set "*Medium*" is described by a triangular membership.

Introduction of fuzziness is not only defined, but in most cases it is also unavoidable one. The values of continuous inputs taken from tests or experiments have finite accuracy. Finding fuzzy system that is equivalent to crisp rule system applied to uncertain feature values allows for controlled introduction of fuzziness. Fuzzy logic can be used as an interpreted model for the properties of neural networks, as well as for giving a more precise description of their effective performance. The various types of membership functions are

- S-shaped function
- Z-shaped function
- Triangular Membership Function
- Trapezoidal Membership Function
- Gaussian Distribution Function
- Pi function
- Vicinity function

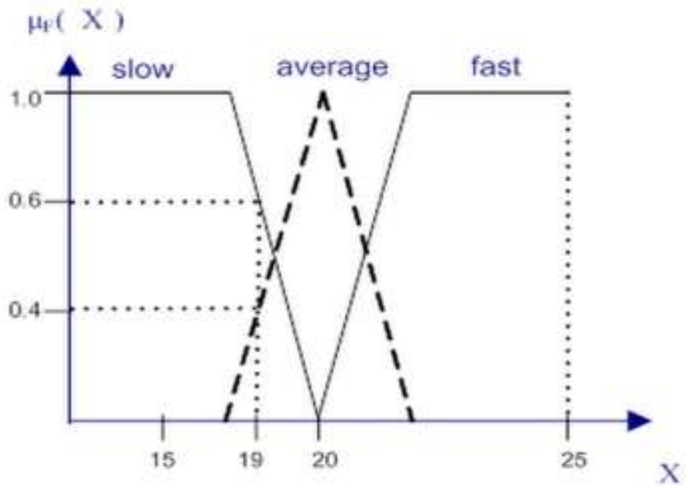

Figure 1: Example of Membership Function

The Figure shows the membership functions of three fuzzy sets, “slow”, “average”, and “fast”, for a fuzzy variable *Velocity*. The universe of discourse creates all possible values of *Velocity*, i.e., $X = 19$. For *Velocity* value 19 km/h, the fuzzy set “slow” has the membership value 0.6. Hence, $\mu_{slow}(19) = 0.6$. Similarly, $\mu_{average}(19) = 0.4$, and $\mu_{fast}(19) = 0$.

9. Conclusion

This paper provides us with good understanding about the various techniques that are available for localization in wireless sensor networks environment. Fuzzy Logic provides a completely different method. One can give more attention on solving the problem rather than trying to model to solve system mathematically, if that is even possible. This almost leads to fast and cheaper solutions. Most of the existing methods have not considered the performance factor. This paper shows that, fuzzy rules gives a effective solution to localize the nodes in exact and used to reduce the error rate in wireless sensor networks.

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