A Perspective Study on Calibration of Self Localization methods in Wireless Sensor Networks

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Abstract— Optimized calibration methods in localization algorithms of a Wireless sensor Network is an inevitable aspect to endow various application provided by the sensor networks. Self-localization is being a pervasive innovation to provide power-efficient performance characteristics by empowering optimized position estimation of a node. Mostly localization algorithms in WSN resolve the problem of location discovery by combining different measurement methods with low complexity and an optional calibration scheme. Ascertaining the node position is a crucial issue to be considered for the wireless sensor network, since several calibration methods provide inferior measurements and poor throughput. This paper provides a perspective study and a comprehensive review of calibration in self-localization algorithms and summarizes various network parameters for optimized location estimation in static Wireless Sensor Networks.

Index Terms— WSN, Decentralized Localization, RSSI, TDoA, AoA, ML, Calibration, Node Filtering.

I. INTRODUCTION

Wireless sensor networks (WSN) composed of widely distributed autonomous sensor nodes which are capable of sensing, computing and communicating, physical phenomenon over a geographical area. Sensor nodes were developed in such a way to adapt the impact delivered by the sensing field i.e. they pose self-communication and computation capability. Unlike the current information services wireless sensor networks promises to provide processed data with time and special entity. Many research activities were conducted to realize various application heights for solving real world problems. The problem of extracting the position [1] of unknown nodes in a network whose location is undefined during the deployment phase i.e. assessing or estimating the state of a physical entity (node, object of action) from a set of measurements. Synchronizing with the dynamic environment requires highly accelerated computations with time dependent [7] and location specified network characteristics [2] communicating strictly at high degree quality [3]. Potential growth in Wireless sensor technologies promises to provide such intelligent services to real-time physical environments with complex computation algorithms and protocols [5].

Sensor nodes are deployed randomly i.e. their positions are not known in advance and there is no supporting infrastructure to manage after deployment. Localization problem is the underlying fact for the sensor network to maintain the network course based on the accurate location of the sensor node. Various localization algorithms were implemented to empower the discovery of the node with maximum likelihood (ML) [3] and high degree of accuracy. Typical strategies employed in location algorithms fall into many classifications like range and range free based, centralized and distributed localization, relative and absolute localization etc.[2]-[7]. Centralized localization algorithms are migration type with a central processing node (base station) to calculate the entire positions of node by ranging and connectivity methods. Whereas distributive localization is power efficient in which node is responsible for refining its location with respect to some reference nodes. Both algorithms maintain a different perspective of location estimation by means of range based and range free based classification schemes. Determining the accuracy of localizing algorithms and precision of the estimated results provide the quality of the network for the future and establish significant services in real world environments.

II. SELF LOCALIZATION ALGORITHMS

Self-localization algorithms are also known as distributed, decentralized or collaborative algorithm, achieved by each node in the network by means of certain procedures and parameters which are pertinent for the estimation process. Identifying the optimal localization algorithm is also relevant for the progress of the calibration techniques in WSN. In decentralized localization algorithms a node is responsible for computing the position using various location discovery approaches like, Received Signal strength Indicator (RSSI), Time of Arrival (ToA), Time Difference of Arrival (TDoA) and Angle of Arrival (AoA) to incorporate with the self-localization schemes[1]-[6]. Decentralized localization strategy typically fall into, Beacon based, Relaxation based, Co-ordinate system stitching based, Hybrid localization algorithms provided with two alternatives, Infer metric ranging based and Error propagation aware based distributive localization algorithm [7].

Most renovating WSN applications promote self-localization in order to rely on the fundamental fact that sensor network prolong their lifetime by energy constraint [5] of the entire network and corresponding nodes. Based on the theoretical and physical analysis this paper provides necessary elements for considering the estimation of self-localization. The measurement approaches like RSSI and AOA [1] where poor and imprecise for location estimation, also the maximum likelihood (ML) may be insufficient for scarce networks. Belief propagation and particle filtering in Bayesian networks [1] are sufficient for optimized estimation. Distributed Bayesian based method of localization [7] is mostly prefer for iterative calibration in WSN.

III. STUDY OF CALIBRATION METHODS IN SELF LOCALIZATION ALGORITHMS

Sensor calibration is a disciplined method to improve the sensor performance by discarding the structural errors in the output of a sensor node. Localization calibration is decisive in WSN to achieve optimal position of a node and it is an active course of research. Distributive localization algorithms guarantee power-efficient characteristics like precise data, fault-tolerant, self-calibration, data integrity etc.[4]-[6] which improves the performance and lifetime of the network, similar tradeoffs must be maintained for selecting the calibration method for location discovery. In self-localization problem the nodes are maintained with a self-calibration scheme to avoid the propagation of erroneous data [2] all along the network. Ascertaining a high degree calibration [4]-[6] method mainly consider low complexity and quality measurements in location discovery of the sensor network services. In calibration mechanisms the underlying fact of having the sufficient anchor nodes with known position co-ordinates is inevitable for the exact measurement, neither the source location nor the orientation of the unknown nodes are available for reference, if a biased information is available the calibration scheme can be less complex or highly erroneous [5]. In Centralized algorithms, localization calibration [7] is made optional hence the central node consumes more energy, lead to poor performance and the depletion of the entire network. Based on the study provided by this paper the necessary and sufficient condition for obtaining optimal calibration in self-localization algorithms there must have definite number of anchor nodes with a confined co-ordinate system for the maximum likelihood domain of the unknown sensor nodes [4].

Self-calibration of the nodes can be renowned as a filtering method by the nodes in the network, filtering is permitted to the nodes with some inbuilt protocols [4] for improving the accuracy of the determined data. Sensor calibration or node filtering involves evaluating the parameters of estimated results from each node and iteratively relate them with histories of likelihood measurements. The crucial component in calibration schemes [5] was to invalidate the physical parameter with the theoretical assumptions of the estimated results. Basically localization with optional calibration includes only local filtering where the measurements were propagated to the network to validate each node position in the network. Critical calibration method concentrates on iterative filtering [2] by at least two types of estimation mechanisms within the sensor node for optimal value of the node position. Distributed localization algorithms[1]-[5] are enclosed with several low complexity tradeoffs which include non-Gaussian or non-linear space matrix calculation, Sequential Monte Carlo methods (SMC) [7], Hidden Markov Model (HMM), Bayesian probabilistic model etc.[1]-[4]. These computation paradigms are effective in determining the optimal solution of localization in complex WSN, but high computation requires memory modules [3] and energy constraint parameters. As a result the self-localization promotes an upper and lower bound for the calibration schemes in sensor nodes by inducing algorithms with parameters of complex computations and comparing the results with relative likelihood rather than maximum likelihood[5]-[7].

IV. Conclusion

This paper presents a thorough review and comprehensive study on calibration methods used particularly in distributed localization algorithms of WSN. By considering the fundamental aspects of the design and implementation of WSN, the studies concentrate on improving the network characteristics of the sensor nodes with precise data related to estimate the location discovery. For choosing an optimal calibration method for self-localization algorithms the scheme must satisfy the necessary as well as the sufficient conditions available with the underlying data. Once defining the upper and lower bound for the parameters of inference with precise, the calibration scheme can be generated with high accuracy and low complexity.

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