An Improved Calibration Specific Self Localization Routing Protocol in Wireless Sensor Networks

Hazeena A J, Sumimol L

Abstract*: *Localization problem is inevitable to maintain flawless performance of the Wireless Sensor Networks (WSN) which are typically based on accurate location of the sensor nodes. Sensor nodes are distributed randomly and there is no supporting infrastructure to manage after deployment. Various localization algorithms were implemented to empower the optimized discovery of the node with Maximum Likelihood (ML) and high degree of precision in routing protocols. Typical strategies were employed to improve the sensor location information by discarding the structural errors generated during the position estimation via calibration schemes in localization algorithms. Certain technologies are concentrated on either implementing calibration methods or optional error detection schemes by using Maximum likelihood methods. The proposed scheme uses a calibration method in self Localization algorithm with an augmented routing protocol to obtain the optimized location of the sensor nodes. This method is enhanced from the AODV Routing Protocol provided with an iterative calibration method which accurately estimates the localization information based on the likelihood calculated previously and comparing the relative location with the reference node position. After ascertaining the minimal error in relativity parameter the routing protocol updates the optimal location and then establishing normal routing with other nodes. The efficiency and throughput analysis is estimated using the network simulator version 3.24. The proposed calibration scheme is efficient for sensitive sensor platforms to improve the performance characteristics of sensor networks.

Index Terms*: *WSN, Decentralized localization, RSSI, TDoA , AoA , ML, Calibration Scheme ,Node Filtering, AODV

I. INTRODUCTION

Recent technologies in wireless communication and adhoc networks forth come many intelligent services for smart environments in an order of incentively immense technologies which collaborates real world entities into digital information. Wireless Sensor Networks (WSN) fall under the category of data centric adhoc networks, in which sensor nodes gather and transform actions like, seismic, thermal, visual etc from varied ambient(Magnetic, Thermal, Infrared etc) environments to the world. These actions require different mechanism for processing physical parameters which are integrated with sophisticated computing and hardware requirements than adhoc networks [12].WSN is an autonomous system comprises of indefinite number of nodes with the capability of delivering real-time data by several dedicated sensors which are typically constrained with sensing, processing and communicating units[7]-[12]. Unlike to adhoc networks the entire wireless sensor nodes are deployed randomly over a geographic region depending upon the sensory application from the environment of interest. Hence such networks pursue an infrastructure-less, multi-hop communication structure [13] which does not follow any regular topology and there is no supporting mechanism to manage the nodes once deployed i.e. the nodes are not known until a location discovery mechanism is enabled to configure the entire network.

Sensor networks stretched the existing IoT into a significant level of abstracting various core technologies which are deliberately concentrate on smart environment services. A typical WSN is an information paradigm [4] were sensor nodes are empowered through a digital environment in which physical variables are identified and processed from a critical area of interest into a real-time information entity. Depending on the application type sensor nodes are densely deployed over dynamic environments, the software architecture for deployment [15] should be co-related to the information processing architecture hence the events are typically real time and dynamically distributed with global properties. The entire network is evaluated solely on the performance of the distributed sensor nodes, which are collaborated specifically by certain software applications as well as hardware to foregather the sensitive information with time and spatial attributes. A typical source to sink communication were achieved by nodes based on data fusion methods in WSNs[9]-[14] which follow the fundamental standard IEEE 802.11 mode of operation to guarantee reliable and robust delivery of the local data. The standard can be varied further based on the behavior of application implemented.

Wireless Sensor Networks are designed for global information extracting [8] and transferring of physical data. Each individual node within the network follow several fundamental properties which includes Connectivity, Transmission Range, Network-lifetime, Reliability, Quality of Service (QoS),Scalability, Security and Power control[17]. The network is self configuring and autonomous with which each node act as peers to one another thereby transmitting local information to any other node over multiple hops. Consequently the network topology will affect rapid impact resulting in topology ambiguities and there are no specific or universal routing protocols or communication services to the

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sensor networks and the individual nodes act both as router and an application host [13]. The rest of this paper is organized as follows: We provide the Related Work in section II. Then the paper describes the proposed system model in section III and provides the problem definition and simulation results in section IV and V. Finally the conclusion of the overall work is provided in section VI.

II. RELATED WORK

In the literature survey a typical WSN confine with its topological area and performance of the sensor nodes which characterize the network based on the underlying parameters provided for a normalized course of network activities. Networked sensing enables unique applications [11] that are typically indented to deliver sensory information which must satisfy the underlying aspects of WSNs. In these applications the entire network relies on the sensor nodes which must perform the operation of sensing the physical properties and computing the variables. Several distributed localization [11] methods have been proposed and implemented for sensitive environments to endeavor optimized information retrieval, the outcomes were evolved with sinusoidal behavior [2]-[11]. For computing and calculating these ambient data the network must support certain schemes that will prolong the network life-time which are solely characterized on the sensor nodes in WSNs.

Node Localization refers to the problem of determining the exact position of the sensor nodes in the network defined over a global co-ordinate system. Localization is a sequential process composed of data gathering/acquisition, position estimation through location discovery approaches and neighboring node mapping [14].Position estimation in Wireless Sensor Networks is vital to thrive the network target to endeavor accurate data dissemination among the nodes hence the nodes are deployed in geographical terrains [15] where precise location is inherent[9] to avoid erroneous data propagation .Connectivity or distance information [9] is crucial in physical entity extraction considering that position of the real-world object is defined by space and time parameters which must be precise and not confine any assumption or error values, hence the delivered data is synchronized dynamically and probability measures[8] are not valid.

Unlike other positioning services like GPS(Global Positioning System) provide external infrastructure like satellite surveillance, highly expensive interferometric based devices[9] etc ,a generic sensor network utterly depend upon the sensor node attributes like lifetime, connectivity, co-ordinate frame, transmission delay and security[10].In these aforementioned positioning systems pose various impact on the local information and are directly proportional to co-linear factors like, if degree of accuracy is high then the overall cost value also become high[7]. The service is not affordable if the network is dense and deep in geographical aspects. Recently several diverse contributions have been introduced by several researchers which forth put services specifically for sensor network applications[11]. To elect an appropriate Localization algorithm one should consider several aspects like, Accuracy in range and range-free based schemes, Self organizing, Energy Efficiency, Routing protocol selection, Calibration scheme Robustness, Sensitivity parameters, Network load and lifetime of sensor nodes[14]-[17]. Routing is considered as a fundamental aspect for maintaining and managing the network connectivity to establish linear flow of communication and reliable data transfer.

Resolving the challenges [12] contingent by WSNs one must consider the energy constraint and link issues for maintaining the indented application execution in the corresponding environment. Solution for such environment should have an effective routing and localization mechanism. There was no specific routing mechanism for position estimation or location discovery of unknown nodes in wireless sensor geography. Calibration[4]-[9] in sensor network can be defined as methods for improving sensor performance by discarding structural errors[14] in the sensor output figure out the sensor co-ordinate value with minimum estimation error and precision. Most recent applications like MDV-Hop (Multi Dimension Vector)algorithm[9]are implemented using self localization since it generate local information using empirical and statistical estimation schemes[10] with calibration specific schemes which are preferably optimal than centralized localization methods.

III. SYSTEM MODEL

In distributed localization context the nodes are deployed in a geographical area of interest (forestry area, military services, seismic and acoustic applications, conjunctive real world traffic etc.) to gather ambient data and installed on the local co-ordinate frame by the sensor node itself. In these scenarios identifying the exact position of the sensor node is crucial, location estimation therefore inevitable for generating relevant results with high degree of precision. Implementation of localization paradigm includes, Position/location Estimation unit performs anchor node beaconing to identify neighbor nodes, Computation/Processing unit provide position estimating procedure or algorithm execution, The Communication unit, enables routing over the detected nodes with calibration.

The network model is considered with a random topology [1]-[6] of finite sensor nodes, a gateway and certain landmark nodes, it is assumed that the sensors are all similar except for GPS enabled anchor nodes in hardware, energy consumption, bandwidth requirement and transmission range. To implement such a system a consistent and systematic approach should be followed at each stage of development. The network model is considered with a random topology[1]-[6] of finite sensor nodes, a gateway and certain landmark nodes, it is assumed that the sensors are all similar except for GPS enabled anchor nodes in hardware, energy consumption, bandwidth requirement and transmission range.

Initially all the nodes are deployed under a common co-ordinate frame [9]-[17] of finite value so that the computation bounds can set antecedently. The proposed system follows beacon based distributed algorithm in which distance estimation is calculated using ToA [6]-[12]method.

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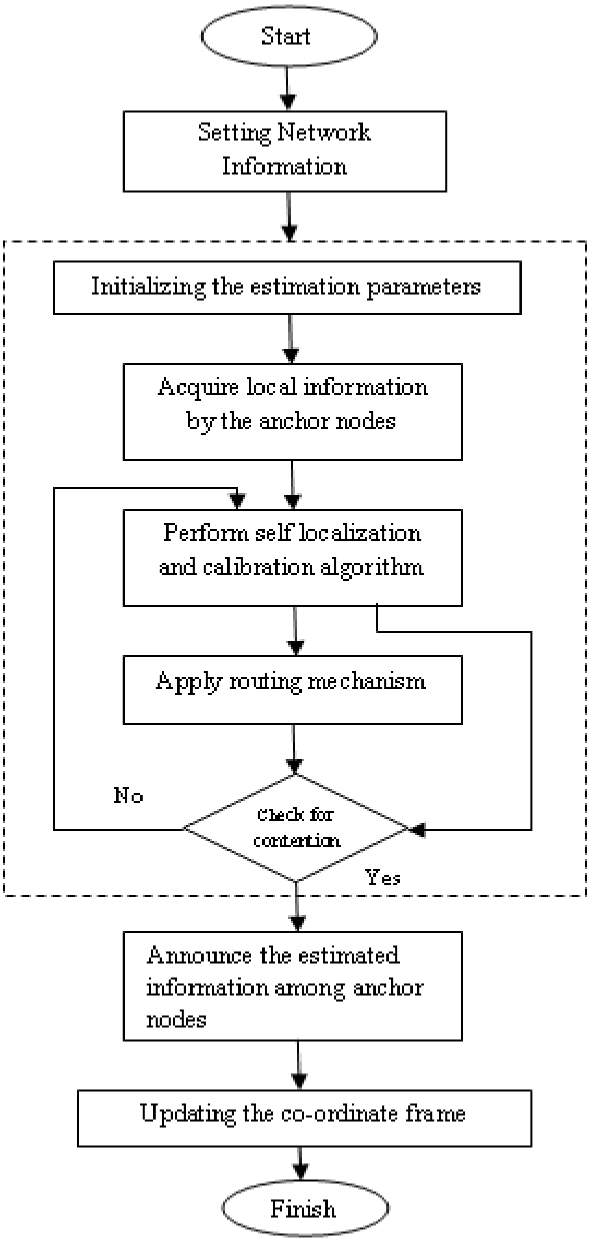

Fig.1 Self localization paradigm with routing and calibration.

The computation component is maintained with contention free using Gaussian distribution [12] method provided with iterative estimation scheme. Each anchor node is having fixed data about their position, topology frame, transmission range and link details with others.

Communication between nodes takes place in multi-hop hierarchical manner[4] in which each neighboring node generates estimated value of its own by the corresponding RTS and CTS[5]-[8] replies of the routing protocol Figure 1 depicts the overall localization paradigm of the proposed work. The selection of node by the anchor node is carried out by the proposed routing protocol which is enhanced from AODV a reactive routing protocol [14]l widely used among all variants of adhoc networks. The routing mainly focus on error free distance measurement between anchor nodes and unknown nodes which is implemented using MAC design approaches to deliver reliable data about the node. Each sensor node maintains a tolerable memory space which is used to store and update the data gathered. The proposed system model shown in the fig. assure low latency in computation as well as communication overhead since it perform routing based on MAC design of approach and collaborative localization algorithm.

IV. Problem Statement

Determining the precise node position during location estimation not only depend on the localization algorithm but also the data propagating parameter i.e. an optimized routing protocol which must forecast accurate and error free data over the network. A calibration specific self localization estimation with enhanced routing can be considered with n number of sensor nodes and a sensor network platform provided with suitable estimation parameters. Each node in the network has specification to examine their value during estimation.

Consider a multi-hop network represented as G=(V,Ɛ) where V is the node set and Ɛ is the edge set. After deployment the sensor area is incorporated with a set of Landmark nodes (*L*) or reference nodes which have fixed node position (GPS enabled) and further used as reference for determining other Unknown nodes (*P*).Once a node resolute its position then it is specified as Beacon node(*B*). For a local 2D coordinate frame requires at least 2n computation variables for each m-n nodes. Let P_i denotes the position vector for i^{th} unknown node and let R_{ij} be the route between i^{th} and j^{th} nodes. Routing is updated by reception of unambiguous packets from the anchor or landmark nodes using enhanced AODV with Localization and Calibration Routing(LCRP) protocol which maintains list-routing with vector calibration based on ToA based distance estimation parameter which is set to a mean value after comparing the new position using LCRP routing. Consider the WSN as a graph G=(V,ε);

- V={ $m_1, m_2, m_3, \ldots, m_n$ } where V is the set of sensor nodes k.
- <i,j> ϵ Ɛ is the edge set, Ɛ= {V x V} specified for wireless link formed by the nodes.
- d(m_i , m_j) $\leq$ t. where d((m_i , m_j distance measure between the nodes m_i and m_j.
- $P_i = (P_i, P_j)$ is the 2D co-ordinate value of the i^{th} unknown node.

The objective of this paper is to determine the co-ordinate of all P unknown nodes with maximum precision. Let the transmission range be t, enclosed in a two dimensional square space and the sensor deployment distribution be Gaussian distribution since the mean value µ for Gaussian space G with a probability distribution factor which evenly distributes the nodes over the 2D space. Consider the wireless link between the nodes be undirected and bi-directional.

V. Simulation Results

The proposed scheme presented in this paper is evaluated using the Network Simulator release 324.1(ns3) with the following parameters summarized in the Table. I. The simulation region is a square area where sensor nodes are deployed randomly along with anchor nodes. To evaluate the accuracy and performance of the proposed work, Simulation

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parameters are initialized with appropriate values and final result is represented using Gnuplot graph representation.

In this Scenario a static real time positioning with a coordinate frame of [400 X 400] meter square is used for implementing the network localization process. This platform comprises of 3 to 6 anchor nodes (fixed position) ,9 to 90 unknown nodes with transmission range of 10 meters.The simulation results shows the impact of the enhanced routing protocol LCRP with increasing in iteration number leads to minimal normalized error.

Table . I Simulation Parameters

Simulation parameter	Value
Simulation area	400 X 400
Number of nodes	9,18,27
Wireless channel type	805.15.4 (MAC)
Topology	Distributed
Transmission range	10 m
Routing protocol	LCRP
Simulation time	300 sec

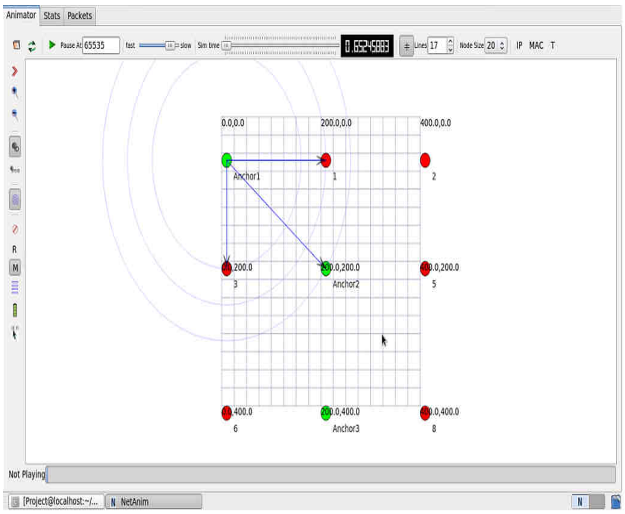

Fig. 2 Simulation Scenario

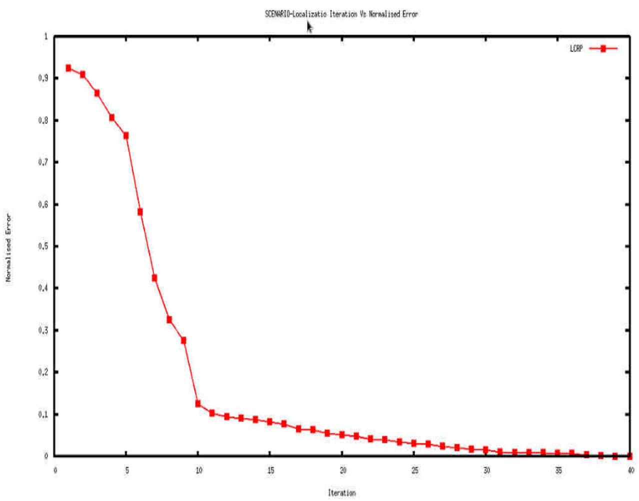

Fig. 3 Normalized error margin versus iteration number

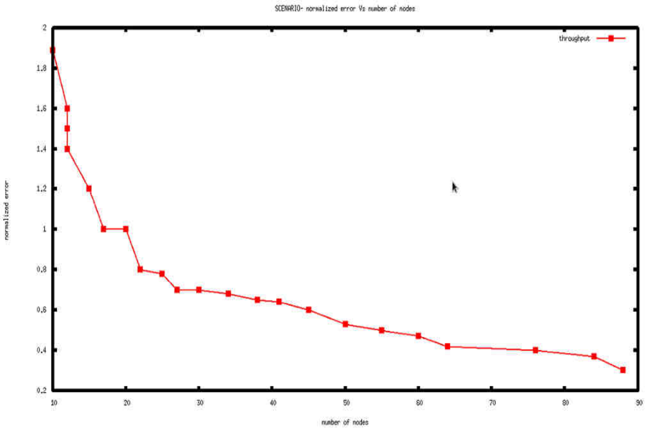

Fig. 4 Normalized error versus number of nodes.

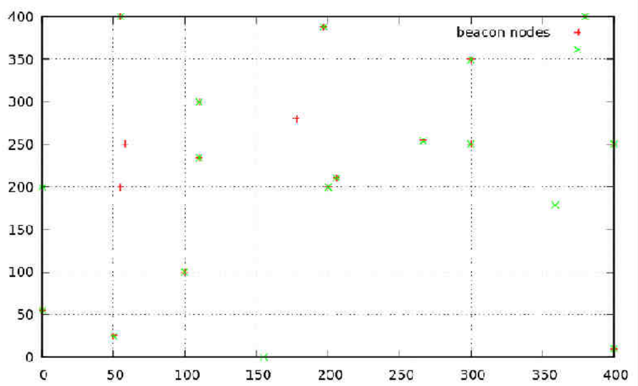

Fig. 5 Position estimation after location discovery of the unknown nodes are determined in the coordinate frame of 400 X 400 square area with beacon nodes.

The simulation results show a perspective for WSNs to endeavor specific routing protocol and calibration scheme for node discovery with high degree of precision. The results are shown in figures with Fig 2 shows the simulation scenario, Fig 3 shows the accuracy with normalized error rate and number of iterations and Fig. 4 shows throughput for increased number of rate, finally the localized positions of the nodes. Further analysis with values chosen for number of nodes shows that the proposed work improves contention free localization as the network is provided with dense number of nodes.

VI. CONCLUSION

Localization in WSNs is inevitable for the flawless execution of the network to emphasis a physical scenario of interest or an explicit application. Self localization schemes in WSN achieve desired accuracy with low latency and high precision in computing the node position. The problem of node localization can be addressed through various empirical methods which provide truthful estimation results based on underlying factors. This paper present a sensor calibration method which iteratively computes the optimal node position based on the routing information of the reference nodes. It is shown in the simulation results that the enhanced routing protocol can improve the node location with minimum contention and maximum degree of precision.

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