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A Review of Distributed Cooperative Localization Of Sensor Network

M.Tech. Scholar Aamir Khan Prof. Manoj Singh Tomar
Dept. of Electronics & Communication Engg.
People's University
Bhopal, M.P., India

Abstract- **The technique of finding physical co-ordinates of a node is known as localization. importance of localization arises from the need to tag the sensed data and associate events with their location of occurrence. location information of a sensor node can be obtained by using gps. but, installing gps in every node is not a feasible solution. this is because: *(i)* sensor nodes are deployed in a very large number. installing gps at every node will increase the cost as well as size, *(ii)* gps consume power, which will eect the network lifetime. moreover, location cannot be pre-programmed as it is un-known where nodes will be deployed during their operational phase.**

Keywords- **GPS, localization, mdl**

I. INTRODUCTION

Wireless Sensor Networks (WSNs) has become an emerging area of interest among the academia and industry in the last one decade [1]. It consists of a large number of densely deployed nodes which are tiny, low power, in-expensive, multi-functional and have limited computational and communication capabilities. These nodes interact with their environment, sense the parameters of the interest such as temperature, light, sound, humidity, and pressure; and report it to the sink node/base station. Deployment of WSN may vary from a controlled indoor environment to a remote and inaccessible area. Therefore, a sensor node is configured with necessary extra components for on-board limited processing ability, communication, and storage capabilities. A typical WSN is shown in Figure -1.

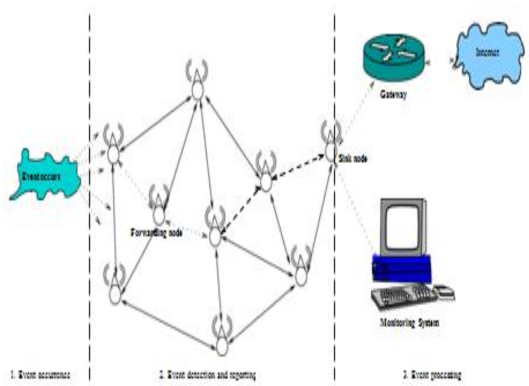

Figure 1: Wireless Sensor Network.

With the span of time, usage of WSN in diverse field have increased with the agile growth in micro-electromechanical systems (MEMS), very large scale integration (VLSI), low-power radios, and wireless communication protocols. Applications of WSN includes environment monitoring (e.g., habitat, geophysical monitoring) [2–4], traffic management [5], military applications (e.g., surveillance and battle field monitoring) [6], health monitoring (e.g.,medical sensing) [7, 8], industrial process control, context-aware computing (e.g., smart homes, remote metering), infrastructure protection (e.g., bridges, tunnels) [9] and so on.

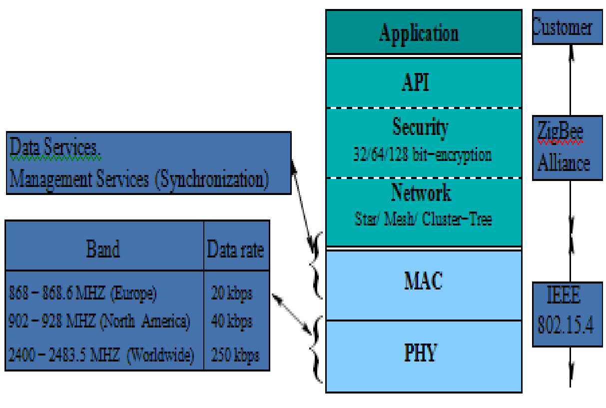

Figure 2: Protocol stack of wireless sensor network

For interoperability, sensor nodes produced by different manufacturer need to follow a particular standard. Protocol stack of WSN consists of five layers.

- Physical Layer,
- Data-Link Layer,
- Network Layer,
- Transport Layer,
- Application Layer

[10]Physical and data-link layer operations are specified by the task group 4 of IEEE 802.15, accordingly named as IEEE 802.15.4.

The remaining layers of WSN follow the ZigBee standard, developed by the ZigBee Alliance, which consists of various companies working for low-power, reliable and open global wireless networking standards focused on control, monitoring, and sensor applications. An overview of protocol stack in WSNs and the main functions performed at each layer is shown in Figure - 2.

II.LITERATURE REVIEW

On the basis of ranging method used, localization algorithms for WSNs can be broadly categorized into two types:

- Range Based,
- Range Free.

Range based localization algorithms use the range (distance or angle) information from the beacon node to estimate the location. Several ranging techniques exist to estimate an unknown node distance to three or more beacon nodes. Based on the range information, location of a node is determined. Some of the range based localization algorithm includes: Received signal strength indicator (RSSI), Angle of arrival (AoA), Time of arrival (ToA), Time difference of arrival (TDoA).

Range-free localization algorithms use connectivity information between unknown node and landmarks. A landmark can obtain its location information using GPS or through an artificially deployed information. Some of the range-free localization algorithm includes: Centroid, Appropriate point in triangle (APIT), and DV-HOP. In centroid the number of beacon signals received from the pre-positioned beacon nodes is counted and localization is achieved by obtaining the centroid of received beacon generators. DV-HOP uses the location of beacon nodes, hop counts from beacons, and the average distance per hop for localization. A relatively higher ratio of beacons to unknown nodes, and longer range beacons are required in APIT. They are also more susceptible to erroneous reading of RSSI.

Range-based algorithms achieve higher localization accuracy, at the expense of hardware cost and power consumption. Range-free algorithms have lower hardware cost and are more efficient in localization. A brief review of different localization algorithms proposed in the literature for wireless sensor networks is presented below.

Simic et al. proposed a range free distributed localization algorithm, in which each unknown node estimate its position within the intersection of bounding box of beacon nodes. Also, they found optimal number of known nodes required to minimize the localization error in WSN based on network area, number of nodes, and communication range (r). In their proposed scheme a sufficient number of beacon nodes should be deployed in order to localize entire network. Whitehouse showed that the technique proposed.

Simic et al. fails in the localization of non-convex network (nodes not present in convex-hull of beacons), and under noisy range estimate. A distributed range free localization algorithm called as DLE is proposed by

Jang et al. In this each normal nodes collects the location information of neighboring beacon nodes and then calculate the estimative rectangle (ER) to estimate its location. To improve the accuracy in location estimation DLE uses certain rules to shrink the ER by using the relative location of normal and farthest beacon nodes. Basically accuracy of node ER is improved by discarding the area included in the communication range of farthest beacon node - which does not cover the normal node. But, this approach of reducing the ER sometimes over-discard the communication area which does not cover normal node and thus result to an estimative error while calculating the estimated location.

Jang-Ping et al. proposed a distributed range free localization scheme (DRLS). DRLS uses the combinations of connectivity constraints gathered from anchors to reduce the scope of the estimative region in which a normal node resides after collecting beacons from anchors. An improved grid-scan algorithm is then used to derive a more accurate estimated location. Finally, a vector-based refinement scheme is used to further improve the accuracy of the estimated location. There are three phases in the DRLS algorithm. In the first phase, each sensor node exchanges beacons so as to collect connectivity constraints. In the second phase, each normal node uses the improved grid-scan algorithm to get its initial estimated location. In the third phase, the normal node uses the vector-based refinement scheme to improve the accuracy of its estimated location. But this accuracy in location estimation increases complexity due to high message exchanging.

Shang et al. proposed a centralized, range based algorithm called MDS-MAP. It works by using the law of cosines and linear algebra to reconstruct the relative positions of the points based on pair-wise distances. MDS operate in two stages: In first stage, relative map of nodes is formed using pair-wise distance and in second stage relative map is transformed into the absolute map using few number of beacon nodes.

MDS-MAP provides a higher degree of accuracy with a complexity of O(n3), where n is the number of nodes in the network. This method is suboptimal and it requires all pairwise distance measurements of sensors to produce the global solution. It is difficult to satisfy this requirement in sparse networks. A modified version of MDS-MAP called weighted MDS (WMDS)is presented to remove these limitations. It estimates the unavailable/missing distance (MD) measurements prior to employing the proposed method. The estimated positions are then used to update the MDs and this estimation process repeats in an iterative manner until a stopping criterion is met. However, convergence of WMDS has not been proven, and its computational complexity is high.

He et al. proposed a distributed, range free localization algorithm called Appropriate Point in Triangle (APIT). In this each unknown node receive beacons from the neighbouring anchor nodes and then construct exhaustive set of triangles using these anchor nodes. APIT repeats Point in Triangulation (PIT) test with different combination of triangles to narrow down the nodes estimative region.

It uses a grid-scan algorithm to derive the intersection region of all the triangles using the PIT test and then sets the center of the intersection region as the estimated location of the normal node. APIT performs better under the high ratio of anchors. But, as the network area is divided into large number of small square grids; a memory requirement by grid-scan algorithm to store the value of grid array is increases. Hence make it inappropriate for memory constrained sensor nodes.

Chandrasekhar et al. [38] proposed centralized, range free area based localization scheme (ALS). In this scheme, anchor nodes transmit signal at different power levels and each unknown node records the lowest power level corresponding to each neighbouring anchor node. As soon as an unknown node records power levels of four anchor nodes, it sends the recorded vector to a sink node (powerful node). Sink then decides in which region the reporting node lies and retransmit the same information to the reporting node.It provides a coarse location estimate of a sensor within a certain area, rather than its exact position.

Hasebullaha et al. proposed a localization algorithm using a single anchor node and considered both the coarse grained, fine grained scenarios. In coarse grained, anchor nodes are equipped with larger number of antennas in order to cover full network area. In fine grained, beacon node is equipped with only one antenna, which rotates at a constant angular velocity. In the technique proposed by **Kumar and Varma** sensor nodes are equipped with directional antenna in order to determine the angle (position) with respect to anchor node.

Zhang and Yu proposed a distributed, range free localization algorithm called LSWD, in which unknown nodes are equipped with omni-directional antenna and a single mobile beacon node is equipped with a directional antenna. The mobile beacon node moves through the sensor area and transmit beacons (beacon node coordinates and time- stamp when the beacon is broad-casted) to sensor nodes for localization. Based on the collected beacon messages sensor nodes determine their locations by using the geometric characteristics of the confined area. To localize nodes correctly LSWD uses three different methods which include: (i) the greatest gain direction line intersection (GDDI), (ii) radiate region of intersection (RROI), and (iii) the border line intersection (BLI). Although, LSWD localizes nodes but it increases the cost of WSN as each node is equipped with an omni- directional antennae. Its efficiency depends on the trajectory taken by the mobile beacon node. Furthermore, with omni-directional antennae energy radiated in all directions can be easily interfared by wide range of environment noise. This may result in high localization error.

III. CONCLUSION

Localization in wireless sensor networks have received increasing attention over the last one decade. It not only provides the geographical position of a sensor node but also fills the pre-requisite for geographic routing, spatial querying, and data dissemination. With the continuous research in localization of sensor networks, a number of effective algorithms have been proposed, but the stability has not yet reached. This is because of the meager resources (storage, battery, and processor) and the harsh deployment environments. Currently, none of the localization techniques is able to full-fill all these constraints. Most existing localization algorithms for static WSNs were designed to work with at least three anchor nodes except in those cases where directional antenna is used.

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