Review to the optimized localization for wireless sensor network

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Abstract: Adding of the positioning and location values of sensor nodes, the localization adds to the aspects of wireless sensor network (WSN). The WSN which being an integral part of human lives providing multifunctionality in real time sensing and monitoring of various activities weather to be indoor, outdoors or the deployment of the wireless sensors in the hostile region or disaster prone area. The localization brought in consideration with the received signal strength indication (RSSI) has proved to be high in accuracy in contract to the others. The path planning of the mobile sink in the WSN has proved to be energy efficient for a long run of the network. The virtual anchor node has reduced the indeed utilization of the anchor nodes removing of line of sight problem. The study of different localization techniques and particle swarm optimization (PSO) and h-best particle swarm optimization (HPSO).

Index Terms **– HPSO, PSO, localization, RSSI.**

I. INTRODUCTION

Wireless sensor networks (WSNs) are established by hundreds of small inexpensive devices. These devices are called as sensors. Sensors are mannered in terms of processing capacities, energy and memory. [1]. Broad scale of applications of WSNs areas such as military targets, monitoring, automated warehouses and disaster relief and it provides solution for variety of utilization [2]. In numerous of these applications, awareness of the location of unknown node is valuable or even vital location. undeniably, with no knowledge regarding the position of sensor node, gathered information is valueless [3]. Localization is a standout amongst the most imperative subjects in light of the fact that the location and area data is regularly valuable for scope, sending, directing, area benefit, target following, and protections [4]. Thus, location and area estimation are a noteworthy specialized test for the scientists. In general, localization plays a key role to design efficient procedures in sensor network [5].

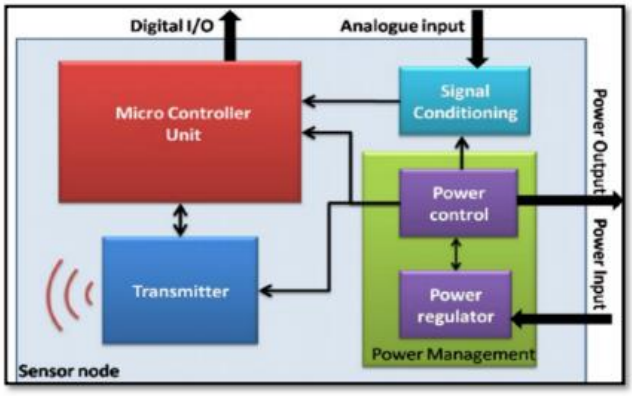

Fig. 1.1 Sensor Node internal structure

Fig 1.2 Sensor Node [6]

1.1. Sensor Node

Sensor Nodes Sensors nodes are commonly worked off couple of sensor units in effective manner and association with bits of units such as transceiver unit, conditioning unit, microcontroller unit with indulgent of a power management unit shown in Figure-1.1 [6]. Sensor device detects the data and pass it to mote. The sensor nodes are usually an energy efficient, multi-functional device as shown in Figure 1.2 [4]. Sensors play major work to quantify the progressions in map with different parameters like temperature, weight, stickiness, sound, pressure of environmental condition etc. Data being collected from all the sensor nodes and are then forwarded to the sink node then via gateway it reaches the destination nodes [7].

1.2. Applications of Wireless Sensor Network

Currently, WSN scientific development in a low-power usage, communication and processors of embedded computing devices has standardizes its commercial and industrial services employed [2]. WSN's new distributed embedded systems generation with a broad range of real-time applications. Various real-time applications can be performed by these nodes for various tasks. Listed in Table 1.1. are the applications of wireless sensor network spread in different areas.

Table 1.1 Application of WSN

S. No.	Application area
1	Natural disaster prevention
2	Water quality monitoring[8]
3	Landslide detection [9]
4	Air pollution monitoring [2]
5	Forest fire detection and monitoring [10]
6	Environmental/ Earth sensing[11]
7	Health and medical care monitoring [12]
8	Area monitoring [13]
9	Industrial monitoring [14]
10	Military and border surveillance [15]

1.3. Design Goals of a WSN

The randomly deployed nature of the SNs in wireless sensor network makes maintenance and grouping not viable. It is necessary to understand the challenging design parameters of WSN so as to build an efficient network protocol. Some of the design challenges are listed below [16]:

• Deployment:

- Deployment is related to the design of WSN in many perspectives. It specifies the minimum number of SNs needed to build the network.
- It also specifies the placement of SNs that satisfy the preset coverage and lifetime requirement. - A better deployment specifies how much area the network can cover with in the number of deployed nodes.

• Security:

- Security is important design aspect in terms of acceptance and use of WSNs for many applications.
- Resource constrained SNs cause the network to be highly susceptible to different kinds of attacks. - Example for security attacks: Attacks on data transfer, rejection of service, black hole attacks.
- Therefore, securing the network should consider availability, integrity, authenticity and confidentiality.

• Coverage:

- How to cover the SNs monitoring region flawlessly is a crucial challenge in WSNs.
- It can be considered as quality of service (QoS) measurement offered by the network.
- It specifies how efficiently an occurrence can be sensed within a given time frame.

• Quality of Service (QoS):

- Owing to the complex structure and futures of WSN it completely differs from traditional networks and hence QoS requirement for the WSN need to be addressed carefully during the design.
- The major requirements for WSNs are accuracy, data aggregation, network lifetime, coverage and fault tolerance.
- The main contrasting factors in QoS for WSN are the limited resources of SNs and vibrant topology of the network.
- The challenges InDesign and implementation of an efficient QoS by preserving the network energy is still need to be an interesting research issue.

• Energy and Lifetime:

- The lifetime expectation is a serious factor of consideration in the network deployment. It is expected to operate the WSN for years or months.
- The main factor which limits the life of a WSN is the power supply. Each SN is equipped with a battery having power.
- In many of the cases the deployment of SN's are in the hostile areas were the battery recharging and replacement are not possible.
- Each part of the network consumes some of the sensor battery capacity for its operation and due to this it shortens the lifetime.
- Hence, prolonging of the life-time of the WSN should be major aspect to be kept in mind while designing a network while designing a network the major aspect to consider is to prolong the life-time of the WSN.

1.4. Localization in Wireless sensor network

The approach to define the positioning and the location value to the sensor node is known as Localization [17]. For the estimation of location and area, where directions and location value are not known at first. It should be possible by the assistance of the absolute position values of a couple of sensors with its respective estimations. The sensor whose coordinate's information is known then it is referred as reference nodes or anchor nodes. The different criterion forms a sensible categorization for location awareness algorithms are shown in Fig. 1.3. The localization on the bases of time of arrival (TOA) , time difference of arrival (TDOA), angle of arrival (AOA) and received signal strength indication based localization are under the range based localization having the feature of self-localizing itself. RSSI stands out in contrast to others as it has no requirement of additional hardware. The range free localization brings up distinctively the larger extent to reach but the accuracy in not up to that order of others.

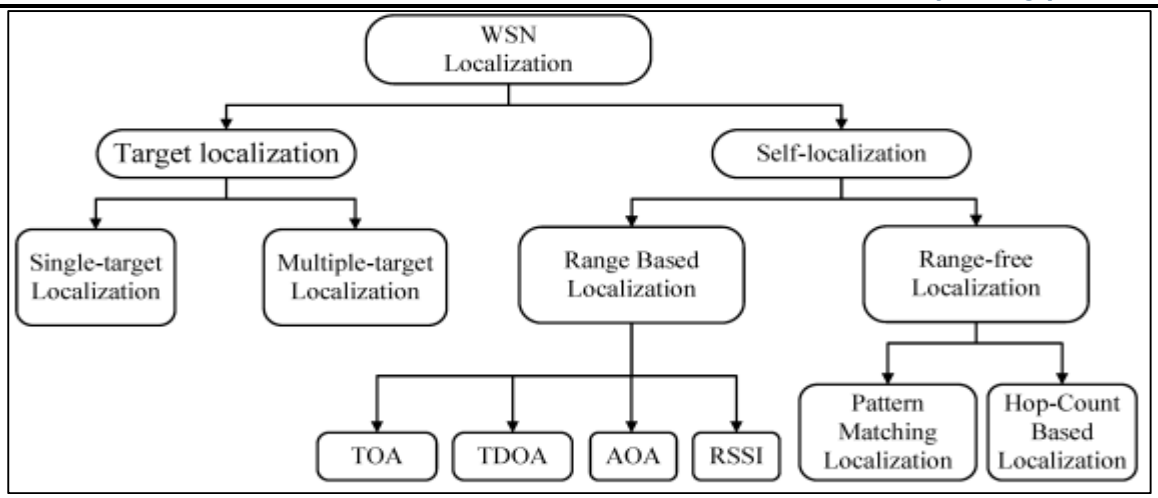

Fig. 1.3 WSN Localization methods [3]

1.5 Importance of Node location

The importance of determining the node location is as follows:

- Layout the node origin and its events occurrence in point of occasions
- Support and find aggregate questioning of sensors
- Sensor node routing and answering the sensor system scope during sensing the data.
- Target and event tracking
- Emergency rescue
- Geographic routing

1.6 Issues and difficulties in restriction of Localization in WSNs

In sensor network many researches has been proposed and grows new strategies for localization. The major issue of WSN is to reduce the error in their estimations and placing of the nodes in the network. Location finding algorithms may be classified based on many criteria, in terms of basics of designs and choices of implementation.

II. LITERATURE SURVEY

In a literature review of state-of-the-art techniques have been studied. It is essential to study these techniques as they help in formulating problem definition and objectives to fill the research gaps highlighted from the localization algorithms. The tabular study is also presented that helps in evaluating these protocols in comparison with each other. The related study of these papers is given below and in table 2.

2.1 Related Work

He et al. [18] presented a scheme based on area-based range-free localization which has been called APIT (PIT stands for Point-in- Triangulation), which perform best with the low communication overhead is required, random node placements and irregular radio patterns. Routing and tracking performance effects by location error has been studied. PIT tests with various different audible anchor combinations until the exhausting or the achievement of the required accuracy is gained, all combinations repeated in APIT.

Liu et al. [19] has proposed the ring overlapping has been used for estimation of the node's location. The RORCRSSI doesn't requires the sending of control messages, cost is light of the communication and on anchor only. As of the triangle-overlapping, the ring overlapping demonstrated best for the randomly deployed sensors. The generation of small intersections exhibits to the more accurate location estimation. Under irregular radio propagation the overlapping method is robust. With addition to the triangle three algorithms has been studied ROCRSSI, APIT and APIT+.

Tian et al. [20] presented the unknown nodes are made to choose the three anchor which are most precise to execute the trilateration. For the selective anchor node localization (SANLA), DV-hop algorithm will be implemented for attainment of the average hop and anchor list. Later the process of choosing anchor will begin with reference to the node and later reference node will be considered as the unknown node.

Zanca et al. [21] presented indoor comparison on RSSI based localization algorithms in wireless sensor networks. Min-Max, Multilateration, Maximum Likelihood, ROCRSSI are tested for two scenarios, one for 48 eyesIFX nodes and other for dozens of eyesIFX nodes. ML yields better performance when no of anchor nodes are high. Multilateration simple the ML.

Kumar et al. [22] reported for the proposing application of H-Best Particle Swarm Optimization and Biogeography Based Optimization for the distributed optimal localization of the randomly distributed sensors. The H-Best Particle Swarm Optimization is on the less side of the maturity but has a high convergence rate, were as to the BBO has a robustness build on science of biogeography and employs migration operator to share information between habitants. The comparison has been with the genetic algorithms and the simulated annealing algorithms. Error to noise has been taken into consideration.

Kumar et al. [23] two computationally efficient schemes using the HPSO and BBO has been proposed 3D node localization for range free. To overcome the edge weights between each targets node, non-linearity between received signal strength and distance and neighbouring anchor nodes have been considered for computation of localization of the target node. The edge weights modelled by FLS which being further more optimized by HPSO and BBO for the individually minimization of the location error. Schemes proposed has been in comparison to the centroid and weighted centroid methods.

Sabale and Mini [24] a novel path planning scheme localization has proposed the D-connect, with the minimum trajectory length of all the sensor nodes. The shortest path with minimization localization error for diagonal tracing out of the whole area. The outperformance of D-connect is seen in comparison to LMAT, Spiral, Scan, Double Scan, Hilbert, and Z-curve. The three beacon node non-collinear positions is given by the Diagonal-connect for the location estimation by maintaining the shortest trajectory.

Singh et al. [25] for moving target nodes novel 3D localization algorithm using the application of computational intelligence in reference to single anchor nodes the localization has been carried out. The top layer is being deployed with single anchor node whereas at beneath and middle layers where the target nodes are. For 3D positioning, four anchor nodes are required. The virtual nodes has been proposed with the umbrella projection for the 3D positioning's in an anisotropic network. As to the projection of virtual anchor nodes has brought down the reduction in the problem of LoS.

Singh et al [9] for non-collaborative, isotropic and range-based WSNs, the Virtual anchor nodes using the applications inspired from the nature has been implemented. The single anchor node utilization has been done for calibrating the 2D positioning of the unknown nodes, the number of nodes localizes, and localization accuracy and scalability are the scales of the comparisons to which efficacy of the proposed algorithms has been virtue. The problem of Line of Sight taken into account and has been reduced.

Tuba et al. [26] RSSI describes the connection between transmitted and received power of the radio signal and the distance between nodes when RSSI is used for the node localization has used the radio signal strength indicator. The flipping ambiguity problem has been dealt with the fitness function and with use more anchor nodes. For solving of the hard optimization the swarm intelligence and firefly based algorithms has been used. To biogeography based optimization and swarm optimization the outperformance have been achieved.

Phoemphon et al. [27] by the technique of fine-tuning with F-based centroid localization method the location inaccuracies by FLS has been improved. The utilization of the virtual anchor has been proposed for the coverage of unknown nodes. All the unknown nodes are in the reach of anchor node and virtual anchor node that as of creation of virtual anchor nodes. Approximation of unknown nodes has been proposed through fuzzy weighted centroid algorithm.

Shit et al. [28] stated the comparison in the research work having the framework applicability to IoT infrastructure in relation to the localization and classify them. In depth to the study of localization techniques into self-determination and training dependent method. Self-determination further due into geometric approach, statistical approximation, path planning and mobility model. The training dependent into fingerprinting, stochastic model and machine learning. Various path planning approaches have been with in consideration of sufficient no of anchor nodes and the shortest trajectory length with least energy consumption. The conflicting noise distribution and effect of them on localization has been exposed in the study.

Kim et al. [13] averaging of the test node locations that exactly matching the number of anchor nodes in the distributing map has been proposed in a test node based weighted centroid localization. Variability in RSS leading to the not matching of the exactly matched anchor node and localization accuracy, an intersection threshold has been proposed to compensate the localization accuracy. Improvement has been seen through the conventional WCL algorithm. A consideration as of the real channel conditions, a path-loss channel model with log-normal shadowing has been taken.

Liu et al. [19] proposed a virtual anchor node based localization, which figures out the highly precise location of the unknown nodes and then upgrades them as a virtual node for the purpose of localization of other. The evaluation of Euclidian and DV hop with VANLA for the precision of the localization. The precision and the cost of localization are important criterion, as of which effectiveness is determined.

Singh et al. [30] proposed an algorithm that used mobile anchor nodes by deploying three virtual anchor nodes with an angle of 60 degree as it helps to locate the target node. PSO and HPSO is used for the localization and anchor node is moved through the Hilbert curve path. Though this algorithm proposed a novel way of locating the nodes but it suffered from the following drawbacks. (a)The nodes are randomly deployed in the network, so there may be sub-square shaped regions with no nodes. However, the anchor nodes are made to move in the whole network which is in efficient approach. (b) The use of six virtual anchor nodes create complexity, so the use of only two anchor nodes at an angle of 180 degrees will reduce the complexity of the algorithm by the significant amount.

III. Inferences and Discussions.

After studying the various techniques proposed in the literature for the localization, the following inferences can be drawn.

a) It is essential to associate the sensed data from the target area with its geographical location. So that the actual position can be targeted for further operation.

b) It is very expensive to employ nodes which are having GPS device embedded on it. It not only increases the cost of the network, but also makes the network non-reliable as these GPS devices have their own hardware constraints.

c) Anchor node deployment which as a source node helps in the determination of actual position of the deployed sensor nodes which are also termed as target nodes.

d) The various techniques discussed in the literature cover range based and range free techniques. However, the range-based techniques are more useful for the real time implementation.

e) As of the physical disturbing elements presence in the environment the problem of line of sight with anchor nodes placement or other sensor nodes can be difficult to give optimum results for localization.

f) The study to the different optimization technique has to be seen for choosing in accordance to the application the area of concern.

g) As of coverage being a concern in the localization, proper path planning should be done.

h) The use of virtual anchor nodes has indeed helped to overcome the line of sight problem and

IV. Conclusion:

The study of various localization techniques has been done in the review. Wireless sensor network experiences the random deployment of nodes in the network. It becomes imperative to know the geographical location of deployed nodes along with the information sensed by that node. The node whose location is to be determined is termed as target node. When the nodes are thought to be deployed with the GPS systems installed on their devices, the cost of the network goes very high. It is checked for the RSSI signal, if it is received then the distance calculation is done between the target node and anchor node. The use of centroid algorithm to obtain the coordinates of the target node has been seen to be most efficient than others. To avoid and to minimize the localization error, the optimization algorithm are being seen using of PSO and HPSO proving better as of others. The nodes are randomly deployed in the network, so there may be sub-square shaped regions with no nodes. However, the anchor nodes are made to move in the whole network which is in efficient approach which has brought the different path planning in consideration. In future localization with mobile sink having two virtual anchor node at an angle of 600 following a circular path using HPSO with better reduction in the localization error and reducing the convergence time for various anchor positions can be seen.

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