

# Localization in IoT- A Review

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**Abstract**— We are witnessing the dawn of a new era of Internet of Things. With the development in various technologies, the internet of things has been widely used in building smart cities and homes. There are various challenging issues in IoT like routing, addressing, localization and so on. Localization is one of the key issues which needs to be taken into account. Many localization algorithms and systems have been developed by means of wireless sensor networks for both indoor and outdoor environments. This paper reviews various localization algorithms designed for IoT systems. With the increasing demand of smart objects in our everyday life promotes an advance generation of communications under the umbrella of the Internet of Things (IoT). For IoT, location-based service is one of the main services, while localization accuracy is a primary problem.

**Keywords**— Internet of things, localization, outdoor localization, indoor localization.

## I. INTRODUCTION

With the advancement of technology in this 21st century, everyone is using smart phones and other smart electronic objects. With this, the use of Internet of Things is in the trend. So basically the Internet of things (IoT) is the interconnection between these smart objects on Internet which helps to send and receive data. Here are some more definitions: IoT can be described as the interlinking of everyday objects on a network in which intelligence is used for global connection [1]. It is Internet of Things which makes it possible to access remote areas only because of connection with physical things on internet [2]. It is the internet of things which can connect anything with anything else in the world and is important to business and other enterprises [4]. It facilitates exchange of data on global level with security of data. It acts as a bridge between real life time objects and their external environment or we can say physical world on the internet. The IoT will act as a medium to increase the efficiency of networks in the global world. It will also be the medium to keep everything open as every single real life object will be connected to the network. The purpose of IoT is to make every single daily life object network enabled and also describe a technique how internet can be applied to everyday objects. [3] The Internet of Things (IoT), also known as the Internet of objects or Cyber-Physical Systems (CPS), can be described as relation between daily life objects on a network. It is a platform which connects various technologies with wired or wireless technologies. Thus, IoT helps to create an environment to share different things on the network in efficient manner.

IoT allows access of objects which are at far off places and can also be controlled from other places and these two places are connected on the network and in this way connection between the physical and virtual world is increasing. This has advantage that it increases efficiency and reduces human intervention. This technology of IoT which contains sensors

and actuators creates more cyber physical systems. This is the reason behind the concept of smart cities and smart homes. Thus IoT is the infrastructure of the information society

## II. LOCALIZATION

### A. Meaning & Definition

Localization, as the word suggests its own meaning, is the process of making something local in an area. It restricts an object to a particular area. It makes a product adaptable to a specific locale or market. The purpose of localization is to create a product or an object for a particular market called target, without taking into linguistic, cultural or religion differences. Just as the software industry looks forward to create and develop the next big technological capability, so must the localization and language industry. If the inanimate objects that we use in our everyday lives are one day going to be smart, what impact will this have on the localization and translation industry? The cloud, social and mobile technologies are key growth areas and they are all areas that further enable global markets. Future software and technologies must increasingly speak to global markets in a local language to enhance user experience. Localization or tracking is considered a major problem in today's technology and has been under study in various fields including Global positioning system and other wireless networks [5].

### B. Elements of Localization Process

Translation which means converting data from one form to another is a part of localization process. Other elements area as follows:

- Making your product available to target market
- Making your product accessible to other markets by modifying content
- Modify design and layout according to translated text
- Making it more efficient for local requirements such as currency
- Displaying dates, addresses and phone numbers in proper local formats
- Taking into account rules and regulations of local areas

One of essential components in the IoT is wireless sensor network, in which environmental data (e.g. temperature, humidity, and object movements) is collected and processed using hundreds of sensor nodes. To respond and react to this environmental data, location information which is collected by sensor nodes should be made available at the base station (a.k.a., data center, sensor fusion, access point). There are various actions in IoT like fire alarm, energy transfer and emergency request are established on the data center, a way to identify the location information of all the nodes at the data center is of importance. In this approach, i.e. localization at

datacenter, location information is sent to the data center after it has been collected by data sensor node. Using the obtained distance information, data center constructs a map of sensor nodes.

For performing localization process at the data center, pair wise distance information between each sensor pair should be provided. It has been shown that if exact location of sensor nodes (also called anchor nodes) is provided, information regarding location can be found accurately.

- Major problem with the localization process is that may be the data center not have the enough information of the sensor nodes
- Moreover, it is difficult to recover the original Euclidean distance matrix  $D$  from a subset of its entries because for the unknown entries there are many completion options. [6]

### C. Performance Metrics [7]

The performance in the area of localization is evaluated on the basis of following factors:

- a) **Accuracy:** Accuracy or location error is one of the significant factors in positioning of localization system. It is defined as an error in distance between the calculated distance and exact device location.
- b) **Responsiveness:** In general, responsiveness refers how quickly something reacts to a situation. In localization, responsiveness can be defined a show fast the device location can be updated.
- c) **Coverage:** It is important in positioning system to determine the problem of network coverage area in a designated area. It is closely related to accuracy.
- d) **Adaptiveness:** Adaptiveness as the name suggests is the ability to cope up with the environmental changes. Localization accuracy and performance can be affected with the environment. Thus an adaptive system is one which increases efficiency by making it adaptable to the environment. Need for repeated adjustments can be removed from adaptiveness.
- e) **Scalability:** When system has to be operated in larger areas, its performance is measured in terms of Scalability. Lesser the scalability, lesser will be the performance.
- f) **Cost and complexity:** The parameters that contribute to the cost of localization system are additional bandwidth, energy weight, lifetime, money etc. In addition to this it may include the charges of the installation and survey time during the period technology has been deployed.

### III. RELATED WORK

Localization in Wireless sensor networks (WSN) or other places where connection between the objects is needed is an popular area of research. Many literatures have been suggested on this topic. In these literatures the authors have discussed most important localization techniques and how those techniques can be applied to the practical world. Nirupama Bulusu, et al., 2000 described techniques in localization and suggested which simple technique can be used for positioning in outdoor environment which makes use of RF communication capabilities of the devices. The regions with

the overlapping coverage that contains fixed number of reference points are used to transmit beacon signals. He then described that the distance between the adjacent nodes and the coverage area of their transmission is used to measure efficiency inaccuracy of localization. His future work includes how the proposed localization method can be adopted even to noisy environments. Dr. S. S. RiazAhamed, et al., 2009 in his literature described the ZigBee technology as the low-cost, low-power wireless technology which employs a plenty of technologies are in which the networks are self organizing that can handle data patterns in various manners. This technology can be deployed in various areas like wireless sensor networks and monitoring in which batteries with longer lives are used with high reliability and larger range. This has been possible only because of low cost, low power usage and mesh networking. ZigBee technology can be used widely in IoT applications because the technology is quickly adopting market and the cost is also less. Paweł Kułakowski, et al., 2010, In his literature described a weighting function which has been discovered to decrease the location errors. In the model proposed the accuracy of localization has been validated through Monte- Carlo simulations in which physical conditions like noise and propagation conditions of WSN are also taken into account. Finally, a balance between the incompatible types that is number of anchors and localization time is achieved. XiaolinJia, et al., 2012, describes in his literature how radio waves can be used to record metadata, identify objects or control individual target through radio waves and technology is called Radio frequency identification system (RFID). RFID is often considered before setting up of localization system in any IoT application. His paper introduces the technology of RFID and how it is used in various areas with its upcoming demerits. Joe-Air Jiang, et al., 2013, his paper focuses on smart service localization. It is the localization in IoT that offers discoverable services. When position of an object is taken into consideration, then information which is obtained from the combination of information gathered from sensors and other smart objects, creates very opportunities for developing systems that adapt to changes in environment quickly. The trilateration technique based on the strength of coming signal is considered good for localization because it requires low hardware and is simple in design. However, its performance depends on the factors such as number of people in room, other environmental factors and the location of objects. Hence to enhance accuracy in method of trilateration, a more accurate method has been developed which is dynamic-circle-expanding mechanism that establishes the geometric relationship between an unknown node and reference nodes. This proves that this algorithm is better than other algorithm methods. Yan Huang, et al., 2015, In his paper, he proposed a vigorous localization algorithm based on the RSSI ranging scope by which the RSSI ranging error has been eliminated using a constant parameter. He has numerous contributions in this paper. He discussed that the positioning accuracy is influenced by RSSI ranging error. Second, he developed a robust localization algorithm which creates a one-to-one mapping between the RSSI value and the distance scope based on the value scope of path loss exponent

in the signal propagation model. Results based on experiments of simulations prove that the proposed localization algorithm

based on the RSSI ranging scope can be adaptable to different environments.

TABLE I. Comparison of various localization technologies.

Algorithm	Description	Working Principle	Applications	Merits	Demerits
RFID [8]	An automatic technology which helps computers to record data with the help of radio waves	<ul style="list-style-type: none"> <li>Consists of tags and readers</li> <li>A tag consists of a microchip, which identifies an object when attached to it because of the antenna connected to it.</li> <li>The communication between RFID reader and tag is done through radio waves.</li> </ul>	<ul style="list-style-type: none"> <li>Agriculture Industry</li> <li>Supplies and management</li> <li>Medication</li> <li>Military and Defense</li> <li>Marine Operations</li> <li>Financial Transactions</li> <li>Monitoring of Environment and pre warnings of disaster</li> </ul>	<ul style="list-style-type: none"> <li>information gathering for complete changes can be done automatically</li> <li>The cost of systems which are being in use, are decreased.</li> </ul>	<ul style="list-style-type: none"> <li>Collision Problems</li> <li>Security and Privacy Concern</li> <li>High Cost</li> </ul>
Robust Localization Algorithm Based on the RSSI Ranging Scope [9]	Distances from the beacons is estimated which is applied by RSSI measurements by using signal propagation model.	<ul style="list-style-type: none"> <li>First the distance from a node to the beacons is measured.</li> <li>Then to calculate the coordinates of the unknown nodes three algorithm i.e. trilateral algorithm, the least square algorithm, or the maximum likelihood estimation algorithm are applied.</li> </ul>	<ul style="list-style-type: none"> <li>Indoor applications</li> </ul>	<ul style="list-style-type: none"> <li>Greatly adaptable to a dynamic environment.</li> <li>an injective function is established between the RSSI value and the distance scope based on the value scope as described in the signal propagation model</li> </ul>	<ul style="list-style-type: none"> <li>RSSI ranging may have errors due to inaccurate exponential of path loss.</li> <li>Inefficiency in accuracy of the coordinate obtained from trilateral algorithm.</li> </ul>
A Distributed RSS-Based Localization Using a Dynamic Circle Expanding Mechanism [10]	An efficient localization algorithm to establish a relationship with a dynamic-circle-expanding mechanism between an unknown node and reference nodes based on its geometry.	<ul style="list-style-type: none"> <li>Expansion of the area covered by circles of localization is measured through the three nodes' confidence level.</li> </ul>	<ul style="list-style-type: none"> <li>Indoor applications</li> </ul>	<ul style="list-style-type: none"> <li>it establishes an accurate geometric relationship between an unknown node and reference nodes</li> <li>A possible location can be explored even if trilateration algorithm fails when the circles don't extend over.</li> </ul>	<ul style="list-style-type: none"> <li>Regression error comes in range where the distance is more than 1.5m.</li> </ul>
Angle of Arrival (AoA) [11]	In this localization method, the antennas are placed on sensor nodes in different directions and then the localization is evaluated.	<ul style="list-style-type: none"> <li>Anchors in the network are arranged on the vertices of a square whose working is achieved by four antennas equipped on it. The square formed has diagonal <math>k/2</math>.</li> <li>In this method, the direction of maximum radiation is changed to create rotating beacon.</li> </ul>	<ul style="list-style-type: none"> <li>Outdoor applications</li> </ul>	<ul style="list-style-type: none"> <li>a good precision of 0.5 m can be achieved only with three anchors.</li> </ul>	<ul style="list-style-type: none"> <li>High costs of hardware [12]</li> </ul>
ZigBee [13]	It is a set in which radio connections are established between electronic devices like computers.	<ul style="list-style-type: none"> <li>First the three typical traffic types are addressed.</li> <li>All these three types are accommodated by IEEE 802.15.4 MAC.</li> </ul>	<ul style="list-style-type: none"> <li>Automization of home</li> <li>Applications in Telecommunications</li> <li>Usage in personal home</li> </ul>	<ul style="list-style-type: none"> <li>Long battery life</li> <li>low cost</li> <li>consumes very low power</li> <li>The protocol used for data transfer can be relied on completely</li> </ul>	<ul style="list-style-type: none"> <li>limited only to rate of 250Kbps</li> </ul>
Global Positioning System (GPS) [14]	It is that positioning system which is used for localization process in outdoor environment.	<ul style="list-style-type: none"> <li>A unique code is transmitted by each satellite, a copy of which is created by the internal electronics.</li> <li>Then the receiver time shifts its internal clock until it corresponds to the received code, an event called <i>lock-on</i>.</li> </ul>	<ul style="list-style-type: none"> <li>Outdoor Applications</li> </ul>	<ul style="list-style-type: none"> <li>It does not require any coordination between two sensor nodes.</li> <li>Can be scaled to large distributed networks of devices.</li> </ul>	<ul style="list-style-type: none"> <li>Avoiding of collision</li> <li>Energy is conserved</li> <li>Reference Point Configuration</li> <li>Non uniform Reference Point Placement</li> </ul>

#### IV. CONCLUSION

In this paper, we have discussed various issues in Localization and how they can be solved using various techniques. Over the period of time, various Localization

algorithms have been developed but none is resolving or handling all the problems. With the comparison drawn in this paper, it is found that various techniques can be used for the purpose of indoor and outdoor Localization.

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