A Bluetooth Based Efficient Indoor Positioning System Using a Mobile Phone

Contents

[Chapter 1 3](#_Toc499250259)

[Introduction 3](#_Toc499250260)

[1.1 What is Indoor Positioning System (IPS)? 4](#_Toc499250261)

[1.2 What are personal networks (PNs)? 5](#_Toc499250262)

[1.3 Global Positioning Module 6](#_Toc499250263)

[1.4 Scope and Benefits 6](#_Toc499250264)

[1.5 Overview of the project 7](#_Toc499250265)

[. 8](#_Toc499250266)

[1.6 Project aims and objectives 8](#_Toc499250267)

[1.7 Thesis Outline 8](#_Toc499250268)

[Chapter 6 concludes this paper and presents future work. 8](#_Toc499250269)

[Chapter 2 9](#_Toc499250270)

[2.1 Problem Identification and localization problem statement 9](#_Toc499250271)

[2.2 Existing advance technologies 9](#_Toc499250272)

[2.3 Several localization methods specified for signal 10](#_Toc499250273)

[2.3.1 Localization technique on the basis of Signal Strength 11](#_Toc499250274)

[2.3.2 Methods based on distance between node and target 11](#_Toc499250275)

[2.3.3 Fingerprinting 11](#_Toc499250276)

[2.4 Technologies 12](#_Toc499250277)

[2.4.1 Dedicated Localization Technologies 12](#_Toc499250278)

[Radar 12](#_Toc499250279)

[2.4.2 Localization enabling technologies 12](#_Toc499250280)

[GSM 12](#_Toc499250281)

[GPS 13](#_Toc499250282)

[Wi-Fi 13](#_Toc499250283)

[RFID 13](#_Toc499250284)

[Bluetooth 13](#_Toc499250285)

[Chapter 3 14](#_Toc499250286)

[Developing of the positioning system 14](#_Toc499250287)

[3.1 Bluetooth Technology 14](#_Toc499250288)

[3.1.1 Bluetooth 5 15](#_Toc499250289)

[3.1.2 Bluetooth Low Energy (BLE) 15](#_Toc499250290)

[Block Diagram 18](#_Toc499250291)

[References 19](#_Toc499250292)

# **Chapter 1**

## **Introduction**

Now-a-days, the smartphone is highly increasing user demand. Almost 60% people are dependent on a mobile phone for spending their daily work like communicate to others people via emails and social media, buy something from the online shop. So, smart phones make important to our daily life. (Hu, 2013).

Smartphones are highly increased due to their more functionalities and various types of sensors such as Global Positioning System (GPS) receiver, Bluetooth, Wi-Fi, accelerometers, gyroscopes, digital compass, Temperature, fingerprints, and camera etc. In smartphones, these sensors are used for a communication system and also used for entertaining and location-based-services (LBS).

Real-time-indoor positioning, immediate response, accurate, reliable, position-based protocols, cost-effective, and service become more and more leading-edge in present and future generation communication networks.

Location-based-service (LBS) is highly sophisticated due to their service such as navigating, tracking, monitoring, tourism etc. which positioning system enables a mobile device. The LBS service for indoor positioning system which location information of device or users could extensively improve the performance of network system. The network system is a wireless system network whose performance is significantly improved for network planning, network adaption, load balancing, etc.

Some Indoor positioning system (IPS) has been used in hospitals because there have many expensive types of equipment whose need to be tracked to avoid stolen, and give the best performance to the patients. IPS system not only used in hospital but also used in shopping mall, office, ship manufacturing industry, shopper convenience, healthcare, shopper engagement, staff and store efficiency, data analytics, etc.

GPS (Global Positioning System) is widely used in location-based-service such as navigation system, tracking, and tourism etc. The satellite positioning system is used in GPS which is cover maximum area. Although GPS is significantly working on the outdoor system and give the best performance in the indoor positioning system, GPS cannot deploy because of the line of sight transmission. The line of sight transmission between receiver and satellite is not possible in indoor environments. The indoor environment is more complex form outdoor environment because of there are various things such as walls, humans, building structure, and home appliance objects, etc. and the propagation of electromagnetic wave lead to the multi-path propagation. So that IPS is used for improving the propagation system and raising the applications for the present and future communication systems. So the personal networks (PNs) need to be used for developing and integrating the networks.

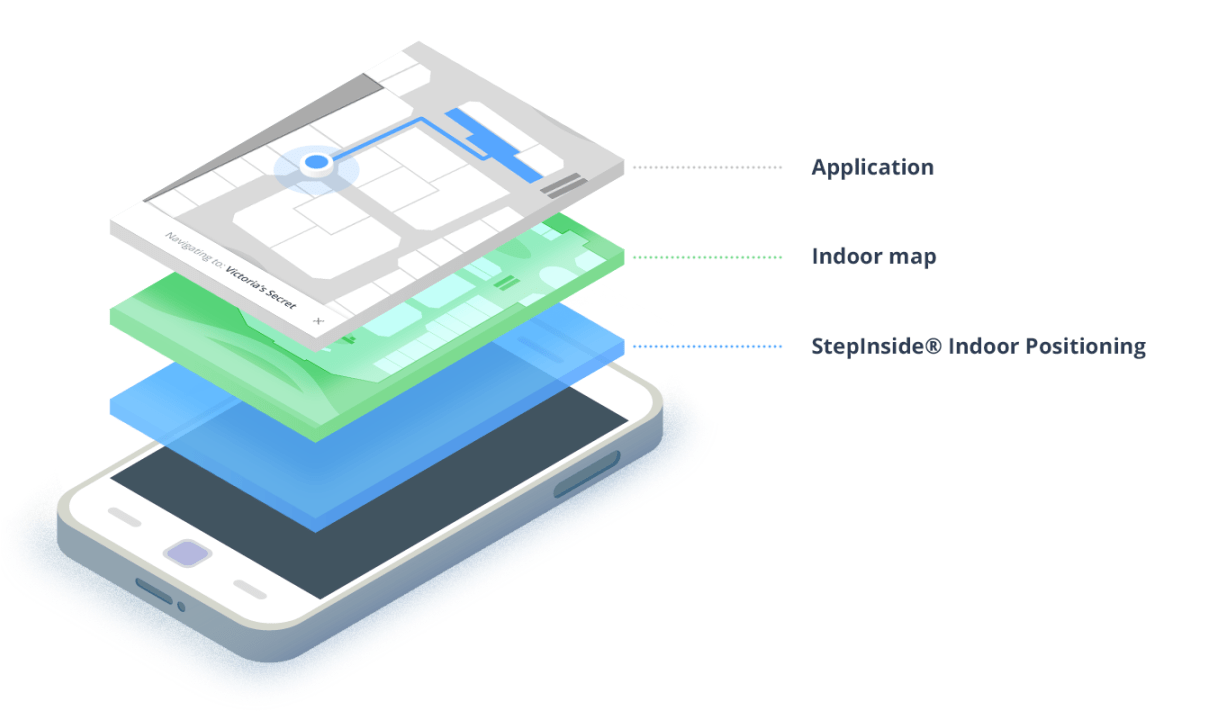
### What is Indoor Positioning System (IPS)?

Indoor Positioning System (IPS) is like as Global Positioning System (GPS) just for work indoor environment system. This system is navigated or locate human, objects, paths location or any other things inside the building using some existing signal or field such as radio waves, magnetic fields, acoustic signals, and sensory data which is collected by the mobile device. A mobile device which is Smartphone has some sensors these are a gyroscope, accelerometer, magnetometer, GPS, Wi-Fi, Bluetooth, NFC, Infrared, Proximity, Barometer, Light sensor, etc. and use some sensors like Bluetooth, Wi-Fi, gyroscope, etc. for collecting data in IPS system.

Using different technologies like Wi-Fi access point also called router, Bluetooth Low Energy (BLE) tag, magnetic positioning, etc. to measure or locate the different node distance which is known position. In IPS technology, use the internal sensors which exist in smartphones to calculate the position which is the device’s indoor position using complex mathematical algorithms. There are three distinct elements which are used for best user experience, collecting accurate data and working fast, these elements are the underlying dynamic positioning system platform, the beacons or BLE tag, and the apps. The beacons or BLE tag used to transmit or broadcast signals and the signals picked up the smartphone then provide to the positioning system. And the apps built for the positioning system at the top which can add value and make the system crucial to users.



***Figure 1: Indoor Positioning System (IPS)***



**Figure 2: There layer of location based service**

### What are personal networks (PNs)?

In personal networks, users interconnect to the various users to use their personal devices at different places like home, office, hospital, shopping mall, vehicles, etc. using a single network system, which is connected to the users, as shown in figure 3.

In the personal networks use the different technologies like personal area network, vehicle network, home network, company network, etc. and these technologies are used personal devices to connect the users.

Personal area network or other network is a computer network which is used for data transmission and receives amongst devices such as phone, tablet, laptop, vehicles, etc. Personal area network is also known as Wireless Personal Area Network (WPAN) which is carried a low-powered PAN in a short-distance wireless network. Personal area network uses different technologies such as Bluetooth, Z-Wave, ZigBee, IrDA, INSTEON, and Wireless USB, etc. In this project, use of BLE tag using Bluetooth technology.



***Figure 3: Personal Networks***

### Global Positioning Module

In this project, use of Bluetooth technology to develop an efficient indoor positioning system. The Global Positioning Module is developed in the project as software which is not a Bluetooth provider but also receives the signals from BLE tag using Bluetooth sensor in the Smartphone and calculates the distance because the Smartphone is responsible for detecting the Bluetooth signals and point out the location. This module is developed in Android platform, which is placed on mobile devices and the system architecture.

### Scope and Benefits

#### Hospital

In the hospitals or healthcare industry, applications of IPS technology have been more demandable in some areas. First, to track the patients, make sure their safety or track their important things. Secondly to track or monitor the movable equipment location so that it can be found easily and quickly when these are needed. The third one is tracking all the staffs in the hospitals so that when they need to be assigned an emergency work or which work is suitable for their and can be assigned them. And also track or monitor the important equipment because more of the times these things are damaged, lost, or stolen by any other.

#### Shopping mall

IPS technology helps the people in a shopping mall to find what they look for or find what’s going on around them.

#### Shopper convenience

We can make sure a shopper’s journey is more enjoyable and efficient from the past experience to the shopping to use the IPS system. And also give them some features like way or path finding, “show me the store location” or “show me where I am”, shopping route or location, “please, help me”

#### Offices

Workplaces, seating policies, activity-based work, different department floors, etc. are completely different for every company so that here the problem is occurred to find a place to work, meeting, meet the employees. IPS technology solves this problem and collaboration with each other.

#### Real Time Positioning

#### Immediate Response

#### Cost Effective

### Overview of the project

Now-a-days, an indoor positioning system (**IPS**) also increases high demand in many areas. Which have been broadly applied in different areas such as find missing object, search patient position, navigation, and monitoring, etc. (Kalbandhe and Patil, 2016)

Some existing technology is used for IPS which is GPS, GSM, Wi-Fi, etc. These systems are highly used in location based service. But these systems are not correctly detecting the indoor position. So, we use Bluetooth to find correct position in indoor. (Fard, Chen and Son, 2015).

Now-a-days, Google maps have worked an important role in multiple business models who are they successful in their business like Uber, Amazon, etc. We use it for some causes like navigation, traffic information, or to share our location. Without a doubt, it is the best app we use it. But when we go too indoors to home, office, market this app doesn’t accurately detect an object or human location. Then the problem is occurred because of the signals from satellites which are blocked by concrete and iron structure.

In indoors, the direction becomes less and then people can ask for the direction or depend on sign-board. Thanks to the technologies like Bluetooth Low Energy (BLE), GEO-Magnetic Fields, Wi-Fi and other Sensors which comes in as a problem solver.

First, implement system server for collecting and storing information from mobile or web service. This server also integrates with the mobile app and the device status.

Secondly, develop an android mobile app which is work to find the correct position and give the efficient output. Because efficiency is most important in this project.

### Mobile app filters data in two ways. First, data filter on the average way than this average data through into the majority filter for filtering these data. Second, these filtering data through into the server and server stores all data.

### Project aims and objectives

This mobile app is used for searching indoor position. This mobile app made by the android system. With the android app, the user can connect to the system.

1. Design and build an efficient indoor positioning system via Bluetooth
2. Develop user friendly android mobile application for indoor positioning system
3. In all indoor environments, GPM must be used for working.
4. Provide simple, cost effective, and low energy system

### Thesis Outline

This paper consists of six chapters which are organized as follows:

**Chapter 1** introduces indoor positioning system, personal network, Global Positioning Module, scope and benefits of the implemented system.

**Chapter 2** presents an overview of the existing indoor Bluetooth positioning systems and the various positioning techniques they propose.

**Chapter 3** describes the Bluetooth technology, implemented system, BLE tag, Bluetooth signal parameter and the positioning technique

**Chapter 4** presents the system architecture and implementation of the system using Bluetooth low energy (BLE) tag.

**Chapter 5** presents and discusses the results of the system and find out the difference to other indoor positioning systems.

### Chapter 6 concludes this paper and presents future work.

# **Chapter 2**

## **2.1 Problem Identification and localization problem statement**

Localization refers to find the placement or position of a material or a human being. Complex system includes multiple localization of mater or person which makes two parts. In the 1st stage, localization of an object estimates the position of that specific material. Secondly, more than one target materials.

There are several localization methods available. Among them Signal based methods are dependent on signal spreading in a wide range of several mediums like liquid, air or earth. Accelerometer and gyroscopic localization are the exceptions then other methods and they can be seen in controllers for game and vehicle tracking system. In Vehicle tracking system these are used when Global Positioning System fails or get lost. Another localization systems are there such as localization via optical cameras where videography is used.

The information which has been achieved from signals from the receiver is used in Signal spreading based localization. In that case signal strength plays the major rule as the key information is gathered from signal strength. In this chapter various localization techniques are elaborately discussed.

In terms of mathematical or formal representation localization can be described as per following way:

Let ***P*** represents the placement of space where various components or materials are placed. These locations can be countable or uncountable i.e. infinite number of various spaces. There can be a set of inspections ***I*** within a period of time (**ti, tf)**and finally s set of aim A (A is determined from I)

The localization is defined as below:

*Ȓ*= *f*(*A, I*) (2.1)

Where (*Ȓ= ȓ1, ȓ1***,** *ȓ3…………. ȓn) (2.2)*

## **2.2 Existing advance technologies**

Use of Bluetooth technology for the purpose of localization is not a recent topic rather it has been established and used in modern life to make things easier. Bluetooth has been adopted in mobile devices for several years from now and people are getting used to it as the data transfer from one device to another is easier and convenient than other technologies available. This results in the technology more reliable. Starting from low cost mobile devices to high end smart laptops all have one technology common and it is Bluetooth. It has become an attractive experience in self-effacing localization.

This part of the paper demonstrates some earlier techniques in localization established by Bluetooth. Discussion of relating the thesis to earlier work has also been described in this section. Among the earlier works on Bluetooth based localization is done by Hallberg and Nilsson where the described a system for localization on the basis of Log-Normal Shadowing model. To roughly calculate aiming locations, which is dissimilar from the appearance is considered in this work where location approximation is found out by determining the placement in which the distinction among several Received Signal Strength (RSS) is reduced. Active Connection of Bluetooth is used to determine the Received Signal Strength values which are another distinction.

Feldman did make an attempt to demonstrate indoor propagation of signal by utilizing several models. He has deployed three models which include the LNS model. He also described the length of space between two points of RSS through two different functions that relate quadrature and cube. These two equations are 2.3 and 2.4 for quadratic and cubic respectively.

*y* = *c*0 + *c*1*x* + *c*2*x*2 (2.3)

*y* = *c*0 + *c*1*x* + *c*2*x*2 + *c*3*x*3 (2.4)

By using the least square sum of deviation one of these models is selected. This system of estimation results 2.06mm of mean error. Another research has elaborated that, there might be some effect on signal propagation due to changes in calibration data for environmental effect. Their proposal on localization system detects and updates new values in calibration using referred devices.

Localization based on Bluetooth is done by using another hot topic which is machine learning. Neural Network and Evolutionary Systems Structure Identification are used by Mayrhofer to describe the link among several techniques such as RSS and distance. Neural network approximation has come up with more perfection in localization based on Bluetooth technology. This time a mean error of 0.1 has been found by utilizing more than 3 base stations.

Some other researcher had given their own demonstration by using neural network dependent localization. If a differentiation between these two researchers is made then the basic difference is on the placement of product.

## **2.3 Several localization methods specified for signal**

Signal strength, Fingerprinting, Ranging are some of the system design considerations or methods used in localization techniques.

### 2.3.1 Localization technique on the basis of Signal Strength

Among several sensors node a relative order is described which are used to estimate RSS values in proximity techniques. The distance from the target to nodes are estimated by signal strength by the following estimation that, the more is the distance from the target to the node, the signal strength becomes less and vice versa. These acquired data are utilized to demonstrate and estimate a comparative placement of the nodes depending on proximity. In this type of system, the approximation is not very close to real data defining the relative displacement of target and node. It’s the easiest and convenient way to estimate the relative distance between node and target by estimating the highest signal strength. Other existing techniques may be accurate but has more complexity in data acquisition more specifically to determine the relative distance it becomes complex if other system algorithms are utilized rather than using signal strength.

There are several tradeoffs in proximity based techniques and one is, another system may find it more accurate utilizing fewer nodes.

### 2.3.2 Methods based on distance between node and target

This type of technique which is range based makes an estimation of the distance between the sensor node and object. RSS values are converted to distances using a special model. The LNS model describes the dependency between RSS and distance.

If exact and accurate calibration is done the Ranging method performs more accurately and better then proximity.

### 2.3.3 Fingerprinting

The above two localization techniques define an inversely proportional relation between RSS values and distance between the sensor node and the target object. These two methods may give accurate data if the system is ideal or has less noise factor. But in reality, there are noise factors which become a blockade for signal and shadowing effect causes the approximation to fail partially. If the signal is blocked by some factor then signal strength will never give a wanted approximation.

In one case the RSS distribution is dependent on location is used where in a location the RSS values are considered to be fixed. Hence it is assumed that, the signal propagation has no affect whether the environment is changed or not.

A fingerprint is specified for every place in a localization area. The signal acquired by nodes is demonstrated by this fingerprinting based technique. The mean of RSS estimated value or the values described by a frequency distribution of rectangles where widths present interval area is proportional to frequency, to be more specific a histogram of the values are the characteristics of Signal.

Other alternative techniques like Time dependent techniques are deployed where RSS values are not considered to be the priority of determining localization. The Time of Arrival of the propagated signals is considered where the signal velocity is dependent on the property of signal and propagating medium.

## **2.4 Technologies**

Localization structures hold been formed the usage of a range of technologies. These technologies do stand broken between joining classes, those up to expectation bear been designed because of localization and applied sciences as had been designed because every other motive but execute stay aged for localization. Technologies within the first class are referred to as ‘dedicated localization technologies’ or those within the second category are referred to as ‘localization enabling technologies’. In this section, an overview concerning quite a few unique applied science beside each class’s pleasure keeps giving.

### 2.4.1 Dedicated Localization Technologies

### Radar

Radar is an acronym because of “Radio Detection and Ranging”. As the renown implies, Radar is a localization regulation so usage radio waves in imitation of determining the vicinity concerning objects, such as like ships, aircrafts, yet clouds. A Radar installation is able to detect objects by using emitting radio pulses, which are mirrored by means of objects concerning the course of pulses. Reflected pulses are obtained via the radar installation. The signal monitoring on the received pulses does below stand transformed in conformity with a score concerning the distance between the Radar set up and the object. Radar installations use directed use antennas, so the place regarding a destination is determined by means of its reach out of the set up yet the modern perspective over the antenna. Hence a Radar regulation executes localize objects the usage of an odd transmitter yet recipient only.

### 2.4.2 Localization enabling technologies

### GSM

GSM is the acronym for Global System for Mobile Communications, which technology is used for mobile networks also called cellular networks and the technology is enabled for mobile, tablet devices. GSM is used for mobile devices in many areas here one of the most usable areas is location-based service which is used to estimate the location-based service of a mobile phone or tablet, etc. In this technology trilateration, propagation model is used to estimate the location, distance to the phone/mobile. RSS signals or values measured for location service using the propagation model with the base station signals.

### GPS

GPS is the acronym for Global Positioning System which is a community of orbiting satellites that send precise info on their role in the area which means space returned to earth. The signals are obtained by GPS receivers, such as navigation devices and are used to calculate the precise position, velocity, speed, and time at the vicinity of the car.

GPS is well known for its navy, military uses and becomes first evolved via the US to a useful resource in its global intelligence efforts at the peak of the bloodless warfare which is called Cold War.

Ever since the early 1980s, but, the GPS has been freely available to all people with a GPS receiver. Airlines, shipping agencies, trucking corporations, and drivers everywhere use the GPS system to track cars, observe the exceptional route to get them from A to B in the shortest feasible time.

### Wi-Fi

Wi-Fi is the present day widespread for small scale speedy wireless networks. The name is a hallmark of merchandise which uses the IEEE 802.11 standards own family. Now-a-day, the era or technology is generally discovered in laptops and smart telephones or cells. One of the earliest proposals to use Wi-Fi for localization is the RADAR device. Localization using Wi-Fi is viable because Wi-Fi makes use of radio alerts/signals in the 2.4 GHz range and the same old permits software to query the signal electricity of devices in variety. This allows the usage of RSS (received signal strength) primarily based localization strategies to estimate the location of target objects or gadgets or devices.

### RFID

Radio Frequency Identification is an abbreviation of RFID. The generation/technology uses radio signals to switch the identification code of a digital tag to a receiver. RFID tags typically use the strength from a transmitted radio signal to ship a response message and hence do not need a battery. The range wherein these tags may be scanned is restricted. Active tags, those with a battery, can be examined from more distances. Localization the usage of RFID tags is feasible with the aid of the use of the signed power of reaction messages from the tags. Whilst such data is available, the RSS primarily based localization strategies, can be used to estimate the vicinity of RFID tag.

### Bluetooth

In deep ways, Bluetooth is a technological know-how that is comparable to Wi-Fi. It is additionally a wireless networking technology but at the smaller. Bluetooth transmits radio signals at the equal frequencies as Wi-Fi does, consequently dense regarding the localization principles because of Wi-Fi are also relevant because of Bluetooth. An elaborate discussion on how much Bluetooth may stay ancient because of localization is given within section 3.1.

# **Chapter 3**

## **Developing of the positioning system**

This chapter illustrates the Bluetooth technology, Bluetooth 5, Bluetooth Low Energy (BLE) beacon technology in more detail and also discuss how it can be used in IPS system. It then goes to describe BLE beacon technique and the positioning algorithms which has been implemented in the project.

## **Bluetooth Technology**

Bluetooth technology is a wireless system which allows communicating between electronic devices without wires. This technology is designed for low power utilization and low cost transceiver. Bluetooth is used radio waves to communicate with the frequencies which range is between 2.402 GHz and 2.480 GHz. 2.4 GHz is the (ISM) frequency band, which is the international frequency band agreement for industrial, scientific and medical devices. IEEE 802.15.1 is standard for Bluetooth according to the **IEEE** standard but Bluetooth no longer maintains this standard. In 1994, Bluetooth Interest Group (SIG) is conceived the specification of Bluetooth and manages the qualification program.

Bluetooth technology is divided into three classes, every class has a different range, as shown in table 1.

|  |  |
| --- | --- |
| **Class** | **Range** |
| **Class 1** | **100 m** |
| **Class 2** | **10 m** |
| **Class 3** | **5 m** |

***Table 1: Bluetooth range***

These three classes also have different power management which is shown in table 2.

|  |  |  |  |
| --- | --- | --- | --- |
| **Power Class** | **Max power output** | **Min power output** | **Power level control** |
| **1** | **100 mW (20dBm)** | **1mW (0dBm)** | **Mandatory** |
| **2** | **2.5 mW (4 dBm)** | **0.25 mW (-6 dBm)** | **Optional** |
| **3** | **1 mW (0 dBm)** | **-** | **optional** |

***Table 2: Bluetooth power classes***

In Bluetooth power classes, one of the most important features is power control because this technology is designed to support low power wireless communication where the feature allows to transmit the signal strength according to the RSSI (see section 3.1.3) received from another device. For this feature transmission signal strength can be increased or decreased and it’s more important to ensure that the received signal strength is within the most favorable range for the receiver. Reduce the power is a significant feature for many Bluetooth devices, which devices lead to the significant feature, for this reason, Bluetooth devices don’t always need to transmit maximum power output.

### Bluetooth 5

Bluetooth 5 is released on 6 December 2016 with more important and highly demandable feature which is “connectionless” IoT, advancing beacon and location-based service, which are capable for home, an enterprise like office, shopping mall, and industrial applications. It has 4x range, 2x speed, and 8x broadcasting message capacity. In future, Bluetooth 5 is highly adopted and developed into a beacon and location-based services in the smart office, smart shopping mall, home automation, enterprise, and industrial applications. Bluetooth is a unique system because of its ubiquity. Because Bluetooth technology exists almost over 10 billion devices, where there is no other wireless technology can match with this technology. And Bluetooth 5 provides low energy functionality, flexibility for maintaining a complex environment which is global IoT environment and give to desire needs for developers of their device or application.

### Bluetooth Low Energy (BLE)

#### History and technical overview of BLE

The Bluetooth SIG (Special Interest Group) introduced Bluetooth low energy capabilities with model 4.0 of the Bluetooth specification in 2009. It turned into later re-branded as Bluetooth smart, and has just been rebranded once more in 2016, therefore the terms Bluetooth clever or smart; Bluetooth Low Energy, BLE, and now Bluetooth low strength technology are regularly used interchangeably.

Bluetooth low strength/energy technology is an intensive departure from what’s called Bluetooth fundamental rate/ superior facts rate (Bluetooth BR/EDR) or classic Bluetooth, added inside the overdue 1990s and used this day in handsets, speakers, earphones, car kits, etc. The SIG’s purpose with Bluetooth low strength generation war to outline a brand new model of Bluetooth that may perform for years on a coin cellular battery and changed into higher appropriate for sending small bits of records on a rare foundation.

Bluetooth BR/EDR is still the protocol of preference for voice or streaming track, however Bluetooth low strength generation is higher appropriate for wireless sensor and control programs. Bluetooth low strength generation also decreased records latency to only 10% that Bluetooth BR/EDR and delivered the ability for Bluetooth to broadcast information.

Like Bluetooth BR/EDR, Bluetooth low energy era makes use of the 2.4 GHz ISM band and a frequency hopping approach to spread its RF (Radio Frequency) energy between more than one channels. However in a departure from Bluetooth BR/EDR, it uses 402 MHz-wide channels as opposed to 791 MHz-extensive channels. Therefore, the two versions are essentially incompatible over the air. Devices that could help both Bluetooth BR/EDR and Bluetooth low energy generation were known as “Bluetooth smart prepared” up until March 2016. Most handsets, tablets, and so forth fall into this category.

* + - 1. **BLE-beacon**

A BLE beacon is a Wi-Fi device that periodically broadcast a Bluetooth Low power marketing packet, this is obtained via a smartphone and used to determine the position with recognizing to the beacon itself. This allows offering “context-conscious” information to the mobile consumer, opening up the possibility to attach the online (virtual) world with the offline (actual) physical global.

BlueUp beacons are licensed to assist the two most important BLE-beacon technologies available on the market: iBeacon, released via Apple in 2013, and Eddystone, launched by means of Google in 2015.

* 1. **Received Signal Strength Indicator (RSSI)**

Commonly, the RSSI is a measurement of the strength of an incoming radio signal. It is a relative indicator and its gadgets are arbitrary, however the higher value of the RSSI, the stronger is the sign. In Bluetooth, the RSSI is used to inform whether the obtained signal is in the Golden Receiver Power Range (GPRR), that’s the call used to explain the precise range of incoming signal strengths. The RSSI is measured in dB, and the signal strength in the GPRR effects in an RSSI of 0dB. A wonderful or negative RSSI shows that the signal power is above or beneath the GRPP, respectively. The Bluetooth specification does not specify the upper or lower restriction of the RSSI, however, actually states that it need to be feasible to inform whether the incoming signal is within, above or below the GPRR, subsequently this cost is device specific.

The RSSI of a Bluetooth tool is obtained by using beginning the inquiry procedure from a 2nd tool. The RSSI will then be covered within the first devices’ response to the inquiry that means it isn’t important for second devices to certainly be linked or be paired.

* 1. **Localization Measures**

The data input for localization is very important and it can easily be done using Bluetooth which has various expecting measures. So, for localization algorithms these input data can be utilized. The RSSI measure is placed in the top at the stage of the inquiry. This measure is utilized in the main area of the work.

**3.3.1 Localization depending on inquiry**

Passive or active devices which desire to data transfer using Bluetooth technology need to process a successful connection. There are several procedures which need to be performed to make a connection for Bluetooth communication. A master starts the steps and it wants to communicate with another slave or master device the first task comes in consideration and which is finding the slaves are in range to discover or not. In this stage of communication, the master device transmits inquiries. These inquiries are in the form of random frequencies which are pseudo random ones. Determining a single time slot, the master sends more than one frequency, more specifically two frequencies for a single slot. The master tries to listen to responses from the previous time slots.

**Discover**

**Connect**

**Pair**

**Search**

***Fig: Overall scenario of Bluetooth communication***

Slave devices are set to a state of inquiry and pseudo random frequencies are used here by the slave devices. Frequency Hopping Synchronization packet which keeps among others a MAC address of 48-bit. This bit is the absolute identifier of the slave devices. Meanwhile a master can locate and recognize Bluetooth devices in the area. For a successful connection a master device remains in standby mode up to it acquires an accurate MAC address with a Frequency Hopping Synchronization packet.

The Received Signal Strength Identification (RSSI value) value is determined by the master which is reliable on received signal power. The Host Command Interface (HCI) which is an application layer to the hardware controller for Bluetooth permitted for both RSSI values and MAC address.

There are several localization measures are there, hence the result Inquiry for RSSI is not the only technique to make a Localization system for Bluetooth. Link Quality, RSSI state in connection and transmit power level are included in the stage of the work. The quality of the connection is indicated by LQ which is an 8-bit integer which ranges from 0 to 255.

**Architecture of the System**

In this chapter most commonly, used system architectures are described following the prescribed system overview of the thesis is demonstrated. The system architecture is normally deployed by using less costly devices which can be comparatively easier to deploy. Detection of beacons is used by most of the authors accomplishing localization by demonstrating the devices reliable. Privacy is a bi matter of fact for mobile devices and the opportunity is that they do not need to be in ascertainable mode. Data storage to servers is also not necessary due to the devices itself done the mathematical calculations.

The proposed system consists of several software integrations which are developed for the android platform. The mobile app is the base of the whole system and Location map for mobile incorporate the localization which is an integral part of system server. Filtered data is processed in the mobile app. The overall system architecture has a scenario as given below. Several aspects will be taken care of in the system architecture in the next stages.

# **Block Diagram**

**System Server**

**aasa**

Mobile location map

MySQL Server

Web Service

**Bluetooth**

**Device Status**

**Mobile App**

Average Filter

Majority Filter

Mobile

PC

***Figure: System Architecture***

# **References**

Fard, H. K., Chen, Y. and Son, K. K. (2015) ‘Indoor positioning of mobile devices with agile iBeacon deployment’, *Canadian Conference on Electrical and Computer Engineering*, 2015–June(June), pp. 275–279. doi: 10.1109/CCECE.2015.7129199.

Hu, B. (2013) ‘Wi-Fi Based Indoor Positioning System Using Smartphones’, (November), pp. 1–76.

Kalbandhe, A. A. and Patil, S. C. (2016) ‘Indoor Positioning System using Bluetooth Low Energy’, *2016 International Conference on Computing, Analytics and Security Trends (CAST)*, 4(5), pp. 451–455. doi: 10.1109/CAST.2016.7915011.

Luoh, L. (March 01, 2014). ZigBee-based intelligent indoor positioning system soft computing. *Soft Computing: a Fusion of Foundations, Methodologies and Applications, 18,* 3, 443-456.

Xiong, Z., Song, Z., Scalera, A., Ferrera, E., Sottile, F., Brizzi, P., Tomasi, R., ... Spirito, M. A. (December 01, 2013). Hybrid WSN and RFID indoor positioning and tracking system. *Eurasip Journal on Embedded Systems, 2013,* 1, 1-15.

Tariq, Z. B., Cheema, D. M., Kamran, M. Z., & Naqvi, I. H. (November 08, 2017). Non-GPS Positioning Systems. *Acm Computing Surveys, 50,* 4, 1-34.

Kruijff, E., Marquardt, A., Trepkowski, C., Schild, J., & Hinkenjann, A. (April 01, 2017). Designed emotions: challenges and potential methodologies for improving multisensory cues to enhance user engagement in immersive systems. *The Visual Computer: International Journal of Computer Graphics, 33,* 4, 471-488.

Rapinski, J., & Cellmer, S. (June 01, 2016). Analysis of Range Based Indoor Positioning Techniques for Personal Communication Networks. *Mobile Networks and Applications: the Journal of Special Issues on Mobility of Systems, Users, Data and Computing, 21,* 3, 539-549.

Deak, G., Curran, K., & Condell, J. (September 15, 2012). A survey of active and passive indoor localisation systems. *Computer Communications, 35,* 16, 1939-1954.

Liu, H.-H., Lo, W.-H., Tseng, C.-C., & Shin, H.-Y. (November 01, 2014). A WiFi-Based Weighted Screening Method for Indoor Positioning Systems. *Wireless Personal Communications: an International Journal, 79,* 1, 611-627.

Do, T.-H., & Yoo, M. (April 01, 2014). TDOA-based indoor positioning using visible light. *Photonic Network Communications, 27,* 2, 80-88.

Jeon, S., Jeong, J.-P., Suh, Y.-J., Yu, C., & Han, D. (December 01, 2017). Selective AP probing for indoor positioning in a large and AP-dense environment. *Journal of Network and Computer Applications, 99,* 3, 47-57.

Rea, M., Fakhreddine, A., Giustiniano, D., & Lenders, V. (August 01, 2017). Filtering Noisy 802.11 Time-of-Flight Ranging Measurements From Commoditized WiFi Radios. *Ieee/acm Transactions on Networking, 25,* 4, 2514-2527.

Gil, S., Kumar, S., Mazumder, M., Katabi, D., & Rus, D. (August 01, 2017). Guaranteeing spoof-resilient multi-robot networks. *Autonomous Robots, 41,* 6, 1383-1400.

Liu, H.-H. (February 01, 2017). The Quick Radio Fingerprint Collection Method for a WiFi-Based Indoor Positioning System. *Mobile Networks and Applications: the Journal of Special Issues on Mobility of Systems, Users, Data and Computing, 22,* 1, 61-71.