A Literature Review On Indoor Localization using NodeJS & BLE

Manjula M. Devar
Computer Science & Engineering
Ballarpur Institute Of Technology
Chandrapur, India
manjudevar1997@gmail.com

Vandana D. Vishvakarma
Computer Science & Engineering
Ballarpur Institute Of Technology
Chandrapur, India
vishwakarmavandana021@gmail.com

Prof. Priyanka Kale
Ballarpur Institute Of Technology
Chandrapur, India
priyanka7.kale@gmail.com

Abstract— This paper provides a comprehensive review of indoor localization techniques and stimulate new research effort in this feild Implementations of tracking systems have become detection of objects. Objects are usually tracked using trackers based on GPS, GSM, RFID and Bluetooth signal strength implementation. These mechanisms usually require line of-sight operations, limited coverage and low-level programming language for accessing Bluetooth signal strength. This paper presents an alternative technique for tracking the movement of indoor objects based on Bluetooth communication technology and trilateration. Algorithms are designed and implemented using python.

Keywords-Beacons, ESP32, Python software

I. NTRODUCTION

Tracking systems, systems designed to monitor devices or persons, have become prevalent issues in modern technology. There are many advantages of locating and tracking a person or object, in a variety of contexts such as following the movements of a child around an amusement park, locating colleagues in an office or tracking the movement of luggage through an airport. The predominant mechanisms for tracking humans involve the use of video surveillance systems. These systems require human operator to monitor the CCTV images at a central location. Loss of concentration usually occurs when fatigue sets. Vehicles and other objects are usually tracked using trackers whose implementation is based on Global Positioning System (GPS). These systems display the location of a vehicle within a specified time frame. GPS, however, supports outdoor navigation since it requires lines
/of-sight operation with at least three satellites. Another technique for implementing tracking system is by using Radio Frequency Identification (RFID). RFID uses either passive
or active tags to track objects. Passive RFID tracking is very common in shops and libraries
where tags are attached to products and are checked as they leave the shop by passing through
receivers near the doors. Active RFID is popularly used in warehouses and locations like
airports where a larger range is needed. RFID tracking uses ultra-low power and there is no need for line-of-sight operation. While RFID tags are very cheap, small and suitable for tracking objects, the sensors are considerably more expensive and require extensive configuration and software installations. RFID signals are easily blocked by Objects and other radio waves. One more method for tracking objects is based on GSM communication technology. The GSM equipment communicates with the GSM network through relay stations. The times at which signal arrive together with the angle of arrival from at least three stations allow location detection through triangulation. The main problem with GSM is inaccuracy in location determination due to its limited coverage in densely populated area. With the range of personal devices using Bluetooth, the possibility arises to locate and track the movements of objects.

Bluetooth has become an emerging technology for determining indoor and sometimes outdoor position of a communicating device. Although there is no specific support for positioning service in Bluetooth technology yet the predominant technology used are signal strength measurement, link quality and bit error rate which rely on the services of the Host Controller Interface. Thus the Received Signal Strength Indicator (RSSI) value of the Bluetooth protocol is used to get a correlation to the distance between sender and receiver in a network. The RSSI value in providing the distance between the received signal strength and an optimal received power rank is called the Golden Receiver Power Rank (GRPR).

i. Trilateration

Trilateration method is used to determine the relative location of use by measuring distances using geometry. Trilateration method does not have an offline phase unlike like fingerprinting method . However, it needs coordinates location of Access Point (AP) as well as AP's Mac Address stored in a centralized database .

Trilateration based positioning technologies uses three fixed noncollinear reference nodes to calculate the physical position of the target node n 2D . Figure 31shows the trilateration based positioning.

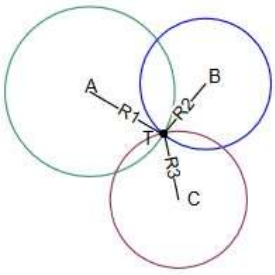

Fig. : Trilateration based positioning

ii. Python Software

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales.[26]

Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including objectoriented, imperative, functional and procedural, and has a large and comprehensive standard library.[27]

Python interpreters are available for many operating systems. C Python, the reference implementation of Python, is open source software[28] and has a community-based development model, as do nearly all of its variant implementations. C Python is managed by the nonprofit Python Software Foundation.

iii. Beacons

I Beacon is a protocol developed by Apple and introduced at the Apple Worldwide Developers Conference in

2013. Various vendors have since made iBeacon-compatible hardware transmitters – typically called beacons – a class of Bluetooth low energy (BLE) devices that broadcast their identifier to nearby portable electronic devices.

The technology enables smartphones, tablets and other devices to perform actions when in close proximity to an iBeacon. The identifier and several bytes sent with it can be used to determine the device's physical location, track customers, or trigger a location-based action on the device such as a check-in on social media or a push notification. IBeacon can also be used with an application as an indoor positioning system.

iv. Trackers

Tracking objects with BLE receivers are referred as BLE nodes, are placed at a known location throughout a venue. BLE beacons are movable whereas the trackers are fixed. BLE beacons can be tagged with objects and can be carried by the people. Each beacon is configured such that, it had to identify an object or a person. When three or more BLE nodes detect the same beacon, the system can triangulate beacon's location. Bluetooth beacon tracker provides a dashboard for system administration and management. BLE nodes are placed in each floor in grid pattern. While ibeacons move around advertising their identifiers, BLE nodes collect the client advertisements and upload that data to the server. Then server estimates the clients' location relative to BLE nodes. ESP32 is the combination of BLE and Wi-Fi device which are used to receive RSSI signals from ibeacon.

II. RELATED WORK

An Indoor Positioning Algorithm Using Bluetooth Low Energy RSSI

As the Bluetooth technology evolves to its 4.0 version, great applicational opportunities emerge based on the inquiry of Received Signal Strength Index (RSSI). In this paper, a positioning algorithm using Bluetooth Low Energy RSSI is proposed for indoor application. First in our algorithm, RSSI value is pre-processed: outliers of RSSI are removed, and moving average of RSSI is calculated. Finally, a triangulation algorithm is used to calculate the current location of the mobile device.

An Indoor Tracking System Based on Bluetooth Technology

The mechanisms used in this paper require line of-sight operations, limited coverage and low-level programming language for accessing Bluetooth signal strength. It presents an alternative technique for tracking the movement of indoor objects based on Bluetooth communication technology, principles of motion and least square statistical method. Algorithms are designed and implemented using Java.

Location Detection Techniques and Location Algorithms

Several different methods are used for location techniques and algorithms in wireless based localization. Location detection techniques can be divided into three general categories: proximity, triangulation and scene analysis as shown in Figure

Proximity Detection (Connectivity Based Positioning). Proximity detection or connectivity based is one of the simplest positioning methods to implement. It provides symbolic relative location information. The position of mobile client is determined by cell of origin (CoO) method with known position and limited range [7]. When more than one beacon detects the mobile target, it simply forwards the position nearest where the strongest signal is received. The accuracy of CoO relates to the density of beacon point deployment and signal range. This method is implemented with several wireless positioning technologies, in particular, the system running infrared radiation (IR), radio frequency identification (RFID) GSM (Cell-ID), bluetooth, and custom radio devices .

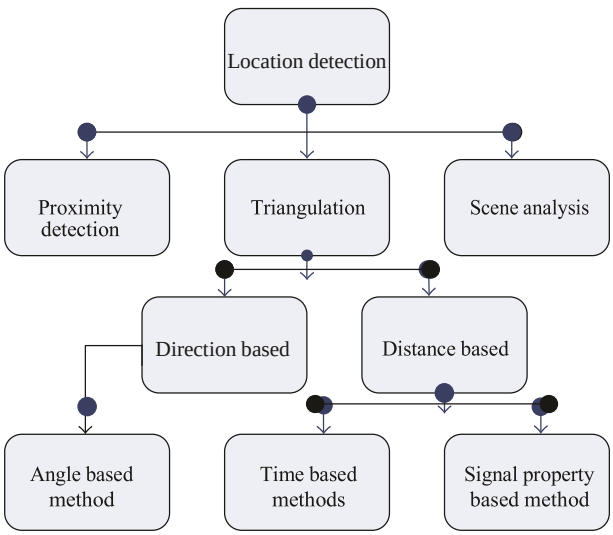

Figure : Location detection based classification.

III. METHODOLOGY

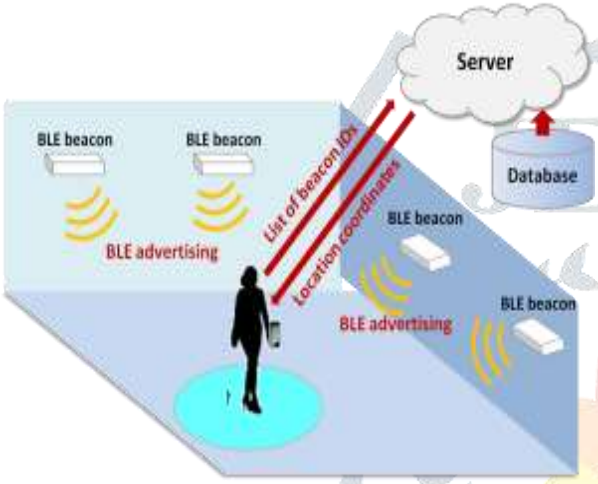

Figure. Sketch of Indoor Localization

In certain scenarios, tracking technology provides significant benefits over traditional such as RFID and has fuelled the development of BLE receivers. These devices are mounted to Permanent Fixtures and continuously monitor the environment for beacons or other BLE signals. When a tagged asset is nearby, the BLE receiver broadcasts this information back to cloud service via Wi-Fi or cellular data. Implement a tracking system based on BLE beacons has included the components are ibeacons,BLE nodes,and a cloud-based server.
IBeacons are placed throughout a venue.By first scanning the ibeacons signals, user built a database of ibeacons identifiers detected throughout the space.BLE beacons are movable while the BLE nodes are fixed. In this case BLE receivers referred to as BLE nodes, are placed at known locations throughout a venue. This time, the BLE beacons are moving, attached to the object or carried by people. Each beacon is configured to identify an object or person.

Ibeacons move around advertising their identifiers. BLE nodes collect the ibeacons advertisements and upload that data to the server. When three or more BLE nodes detect the same beacon, the system can triangulate that beacon's location. The Server estimates the clients' locations relative to the BLE node's known location.

$$(X-X_1)^2 + (Y-Y_1)^2 = r_1^2 \quad \ldots\ldots\ldots (1)$$

$$(X-X_2)^2 + (Y-Y_2)^2 = r_2^2 \quad \ldots\ldots\ldots (2)$$

$$(X-X_3)^2 + (Y-Y_3)^2 = r_3^2 \quad \ldots\ldots\ldots (3)$$

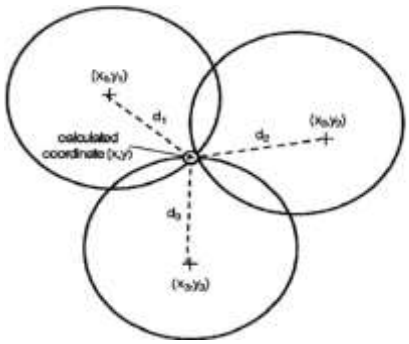

Figure2: Trilateration technique

ESP32 is a series of low cost, low power system on a chip microcontrollers with integrated Wi-Fi and dualmode Bluetooth. The ESP32 series employs a Ten silica Xtensa LX6 microprocessor in both dual-core and single-core variations and includes in-built antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. ESP32 is created and developed by Espress if Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

Figure:ESP32

Figure 5: Radius network beacon

RadBeacon USB is a fully standalone Bluetooth Smart proximity beacon using iBeacon, AltBeacon and Eddystone technology, implemented in a tiny USB package.

As the industry's first multi-beacon, with concurrent support for all major industry-standard proximity technologies, the RadBeacon USB enables simultaneous proximity services across iOS, Android, and other emerging mobile environments. Supported beacon proximity
technologies include

- iBeacon
- AltBeacon
- Eddystone UID
- Eddystone URL

No batteries means no *dead* batteries. RadBeacon USB is powered from any standard USB port. You can use any USB AC adaptor, car adaptor, or computer with a spare

USB port. However, we recommend using our official RadBeacon USB Power Supply. Its UL listed and certified.

The most flexible coin cell battery beacon.

1. Officially the first beacon compatible with iBeacon and Eddystone (UID, URL, TLM, EID) at the same time.
2. iBKS 105 is cost efficient and reliable, the main keys for your beacon deployments.
3. From 30 to 40 months of battery lifetime (CR2477) advertising once per second.

All the parameters of this product can be modified. Please check out our 'iBKS Config Tool' app, available for iOS and Android.

iBKS 105 is a Bluetooth Low Energy (BLE) beacon based on **Nordic Semiconductors nrf51822** chipset that uses a CR2477 coin cell battery

IV. CONCLUSION

In this paper, an algorithm is proposed for indoor positioning. The proposed algorithm first pre-processes RSSI by single direction outlier removal and moving average. Then distance between mobile devices and beacon is calculated using python. Finally, beacons location is determined by trilateration. The system serves as a basis for implementing tracking system that has the following characteristics to enhance its performance and functionalities. It does not require line-of-sight operation. The tracker system and the Access Point system implementations require low memory and computational overload.

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