Journal of Theoretical and Applied Information Technology
15th May 2019. Vol.97. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

AN ALGORITHM TO DETECT AN OBJECT IN A CONFINED SPACE BY USING IMPROVED FINGERPRINTING APPROACH

[1]IMMANUAL, [2]SHONEY SEBASTIAN

[1]Department of Computer Science, Christ (Deemed to be University), Bengaluru - 560029, Karnataka, India.

[2]Department of Computer Science, Christ (Deemed to be University), Bengaluru - 560029, Karnataka, India.

E-mail: [1]immanual.a@mca.christuniversity.in, [2]shoney.sebastian@christuniversity.in

ABSTRACT

The rapid evolution of location-based services has made tremendous changes in the society. In this paper, Trilateration method is implemented in fingerprinting methodology to obtain very precise and low error position details of the client portable device. Trilateration is a method in which the portable device is determined by the received signal strength intersecting at one position from the three reference points. Fingerprinting method involves several steps like training stage and positioning stage in which the training stage consists of the creation of the database of the signal strengths along with its associated location measurements. In the positioning step where effective and efficient received signal strength collected from the portable device is matched with the data saved into the database to get the position information of the client. The position of the user is estimated by collecting the received signal strengths from three reference points by using the concepts of trilateration approach in fingerprinting methodology to obtain more precise and accurate information.

Keywords: *Fingerprinting, Trilateration, Received Signal Strength, Wi-Fi, Indoor Positioning System.*

1. INTRODUCTION

The Wireless technologies have gained popularity and its importance throughout the world. It is considered as one of the inexpensive modes of internet access and also a location-based system. Global Positioning System (GPS) is the currently undertaken by Wireless technologies for Indoor Positioning Systems. Indoor positioning Systems involves the usage of Real-Time Location Systems (RTLS) technologies like Radio-Frequency Identification (RFID), Bluetooth, Wi-Fi, Wireless Local Area Network (WLAN) and so on. The usage of a portable device to act as a Wi-Fi tag for computing the Received Signal Strength Indication (RSSI) signal. Even it sends the RSSI to the system for applying the location algorithm to fetch the position of the portable device. The real-time location system methodologies are the telecommunication technologies used to determine the position of the user. The global positioning system is widely used for an outdoor positioning system. Google maps is an instance for global positioning system. Wi-Fi positioning system in a portable device is deployed by using Wi-Fi signals from any of the private or public Wi-Fi. By using Wi-Fi signals and its signal strengths, location-based services are provided. The Wireless Positioning System (WPS) provides errors in GPS measurements for some location but Wi-Fi signals provides better accuracy on the tracking of positions. The wireless Positioning system is the primary pillar of the consistency for high and portable interactive media applications and other uses. The most accurate position is difficult to acquire in both outdoor and indoor conditions. It is easy to implement by using a wireless positioning system with minimal efforts. There are many types of research and studies being done in Wi-Fi Positioning system for calculating the position by using the signal strength of the Wi-Fi or other WLAN technologies.

Global localization framework is one of the very outstanding commitments of deciding the location of the client and also directing the user to their

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

destination. This method utilises satellites to triangulate the position of the global positioning system gadget. Global localization framework establishes a decent connection with the server for finding the position of the user. It provides exact position details in the targeted outdoor area, but it is ineffective for indoor conditions. The explanation behind its Ineffectiveness is the goal for a global positioning system to execute a Triangulation with the portable device. The portable device should be in the pathway from the geo-satellites. The global positioning system framework has the less exactness that makes it inappropriate for indoor environments. There are several real-time location system technologies like Wi-Fi, Bluetooth, and radio-frequency identification for an absolute indoor position determination system. In few papers fingerprinting algorithms are used like deterministic and probabilistic approaches to find the positioning of the user. The Deterministic approach consists of the signal strength and it is converted to distance values. The calculation of the distance is done with the help of Euclidean distance formula. In probabilistic approach, it consists of conditional probability and Bayes rule in estimating the position of the client.

Positioning systems are the main component needed by location-based Services. It provides the information about the design, execution, and examination of the function called compass. It is almost dependent on Wi-Fi network services. In the portable device, the compasses values consist of received signal strength data values of several reference points within its broadcasting range. It utilizes the direction of the client by firstly selecting a set of data values from the training step. The remaining training data values are utilised by the probabilistic location algorithm to determine the position of the client. We employ the digital compasses to identify the direction of the client or user so that we manage with obstructing effects. The system represents less accuracy because of blocking effects affected by the client physic.

Wi-Fi-based RTLS solutions often use fingerprinting methodologies. It utilizes both deterministic and probabilistic calculations for raw and smoothened information. The execution of these calculations for the outdoor locations is assessed. The ideal estimation is produced by the integration of a few calculations. This incorporates the development of a portable gadget (a Wi-Fi tag) for measuring the RSSI flags and sending them to a system and applies the positioning algorithms to get the location of the gadget. All trilateration and fingerprinting approaches are used in obtaining the position of user in indoor surrounding. Each of these methodologies have its own limitations. Consider in trilateration there is no offline database to check the position of the user. Aim of this paper is to obtain an improved algorithm with no such limitations. The improved fingerprinting algorithm is our proposed approach.

2. RELATED WORK

This section discusses the various types of methodologies and approaches followed in the indoor positioning system.

The low signal strength faced inside closed rooms and buildings. As many researchers are involved in increases the signal strength, this paper utilises an approach based on RSS (Received Signal Strength) [1]. Fingerprinting method identifies the region or the place. As the user inputs the impression, using the received signal strength algorithm the exact position of the user is determined precisely. Initially, the signal strength are stored in the backend as the data. Signal strength is fetched to classify data into strong and weak based on its obtained value. By using the Wi-Fi network, it is easy to not only organize signals and it reduces the unwanted signal from the obtained value. Eventually the signal values captures the place of the person from its current process of evaluation. Along with it, it also works for both online and offline times. But here it also includes another criterion called Euclidean Distance measurement which obtains a value which is the average of both online and offline RSS. When android based online and offline applications consist of data being stored at the backend, which is the vital source of information. In both sources, the process of obtaining the fingerprint impression is obtained when it is in online the involvement of the server is more comfortable comparatively. In this new approach of obtaining the location from GPS is recommended for an increase in accuracy and involves enhanced research [2].

The Wi-Fi reference points, Wi-Fi packets and received signal strength which is the parameter to estimate the location. In the beginning, two radio maps are built and larger map with proper grid spacing. At each grid, we take care of fifty samples of each for each Wi-Fi RSSI data per access point. Then the measurements are taken at each test points within the grid so apply algorithms and determine the accuracy. Then apply the data algorithms we

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

calculate the averages and the standard deviation of the data at each GridPoint [3]. Then we implement several algorithms as follows:

- Minimum Euclidean distance algorithm
- Standard deviation-based algorithm
- Probabilistic methods

And then we identify the impact of grid spacing size on the accuracy of the result. During the product development, we develop a portable device with existing references points and calculates the Wi-Fi received signal strength indicator from each reference point of every grid points. Then the transmitting signal strength data measured to the central server via either transmission control protocol (TCP) or user datagram protocol (UDP) at last then the system gets the required location information. The development of a portable device for a Wi-Fi tag for measuring the received signal strength indication signal and sending them to a system in applies the positioning algorithm to get the location of the device [4]. The real-time location systems technology used in this paper is Wi-Fi for positioning the client and receive the signal strength from the reference point to the source system.

Received signal strength data values from the reference routers that is calculated three times and the average of the received signal strength values is computed. And we calculate the distinction between those mean, and if in case the values not providing more different than the data value is dropped, and the average of precise data values is computed again, then the average data value which is matched with a data value is saved in the server and an accurate position is detected [5]. The implementation in a room environment in which four Wi-Fi reference point which is installed later the methodology is applied. And the set of data values has been gathered, and their average is computed, and then the difference of each data value is obtained then it is compared with the data saved in the server [6].

To calculate the place of the person located in an open environment is not a challenging task. But when the same person is found to be in a place which is surrounded by Building and trees the signal is practically not reachable. In Layman terms, we used to call it the Weak signal. This paper has given the ideas of as to how to obtain the position with some position obtaining techniques and more importantly, how to obtain the necessary information even under immense noise in signal with two primary approaches consisting of both Infrastructure and mobile [7]. In this paper primarily focuses on the physical equipment required like necessary terminals, the element required to grasp frames passing, servers to obtain and to compute from the obtained data and Many more. It is out of port or points the device is intended to send the request at the beginning stage, once the request is reached, it is then forwarded to the respective server, Again another server is in charge computes the maintained data and gets the accurate result of position and so this computed the result is forwarded to a particular person [8]. Even as complications involved in this process is increasing day by day so as the demand to obtain the successful manner of keeping track of user is in Demand in the current trend of technology.

The global positioning system is utilized to estimate the position of the client and guide them to the destination. But now we can access the indoor location system like Bluetooth, Wi-Fi, RFID, and more preferable technologies. To access the indoor positioning by two steps like offline and online phases. In offline phase, we develop radio map using that we store the received signal strength values from every detected reference points and its known as marking position. The marking positions along with machine authentication code address and corresponding received signal strength value will be saved in the server to build a map. In the online phase, the client tries to gather the received signal strength value from every detected reference points later the data which is collected is compared with the map. The map of all the values of a particular location on the map is called fingerprints [9]. It consists of a location name in the measurement vectors like access points and the signal strengths which is given in the equation 1.

$$p = \{a\_1, a\_2, \ldots ai, ap\} \quad (1)$$

- p is place name
- ap is count of reference points of the place
- ai is received signal strength of reference points

The filtering technique is applied while collecting the data like the signal strength of the current location and the time required to compute also reduced and also the size required to store the data is also reduced. By using Euclidean distance and with their existing fingerprint stored in the server we Compute the optimal distance between two sets of fingerprints. By looking at the future

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

scope, we can use backtracking method by which the user can look at his previous location and Current with the next location to get the clarity about the positionings [10], [11].

Indoor positioning system has several methodologies based on ultrasonic sensors and global positioning system [12]. Both methodologies have the high price of maintenance and costly to install. The ultrasonic sensor systems have to install a lot of sensors at the ceiling and connect the sensors to the server. This methodology which utilizes a global positioning system has to be installed to the pseudo lite satellite. Wireless indoor positioning system utilizes the received signal strength data value between the portable device and router to determine the position of the portable device user. The portable device also computes the received signal strength of neighbouring portable device terminals. Wireless indoor location system utilizes the wireless local area network components which provide the position information to portable client devices. When a signal strength of mobile users increases then the precision of position information becomes high. For instance, if the signal strength of position access points is high then clearer and more accurate the location details can be produced that the normal system. The received signal strengths of wireless local area topology are utilized for determining the position. However, the received signal strength value does not change the space or gap between portable device, because the received signal strengths are decreased not only space or gap but also in multi-pathway and other reasons.

In the Wireless indoor location system, the database gathers the received signal strengths from every portable device and reference router point. The database server computes the position and notifies to each portable device. Every reference router point defines its position and alerts the position to the server database with the received signal strengths. The method of position computation on a database is mentioned below. So the steepest descent approach is utilized.

- Collect the data values of received signal strengths of each pair of the portable device and reference router points.
- Estimate the beginning location of the portable device.
- Repeat the alteration of the location of the portable device, till the signal range.
- Notify the position to each portable device terminal.

Then the simulation is performed based on two assumptions for every reference router points. The initial assumption is computed by the space or gap between hosts which consists of an error. The next supposition is computed distance which has no error. The next supposition is computed distance space or gap which has no faults. So, this assumption won't suit for the real-time scenario. If space or gap is computed by the received signal strength value. This supposition is utilized to represent the opportunity on which the signal strength values of reference points is very low. The wireless indoor location system can accomplish clear precision where many portable devices exist and also in the indoor surroundings of additional reference router points [13].

Indoor positioning systems are utilized to provides access to a map of a targeted area. The fingerprint algorithms execute way differently and consists of two phases are the offline and online phases. In the offline phase, fingerprints of the signal strengths of the client are gathered at predefined locations. The database of positions and their fingerprints are known as the radio map. In the online phase, the present Wi-Fi fingerprint probability values are matched with the values of the radio map [14]. The client position is determined by computing a mean of the three offline positions that perfect comparison with the online values. The motive of the offline stage is to gather data about the Wi-Fi reference points received signal strength in several locations. In the online stage, the computed received signal strengths are matched to the offline data values to discover the client position.

The methodology used is

- Determine of received signal strength probability data values: In offline and online stages, the received signal strength probability data values of each installed references point(RP) is determined from a set of data values Gathered at the positions of targeted place. A data value is a set of immediate received signal strengths measured in dBm [15].
- Offline stage: The motive of the offline stage, the received signal strength probability data values are Determined at N mainly situated locations, with data values at every position. Those data values saved to build the offline map, which provides as a reference from the database for the positioning system.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

- Online step: The motive of the online step is to detect the position of the client by Measuring the received signal strengths of the identified references points. Likewise, to the offline stage, a set of data values is gathered at the client position and utilized to determine the received signal density probability data values of the identified reference points. These probability data values are matched to the values of the offline map to detect the similar offline positions.

The results of the framework on performance are:

- Number of strongest reference points which increases the accuracy of the location.
- Time taken Measurement which estimates the simulation rate of the determination.
- Count of Nearest neighbors [16].
- Utilization to real-time positioning.

The indoor location finding system is mainly based on received signal strengths data values by which were determined by the received signal strength indication in a smartphone device. Triangulation approach associated with least square determination is utilized to discover the position of the portable device. The functional reliance is between the received signal strength indication and space or gap value fetched by an appropriate polynomial approximation. This method is generally prevented by a positive sign of the received signal strength indication [17]. It is needed that the precision of the determination could be improved by merging the approach with the results of data with other types of position determination. The location determination happens in the portable device terminal without any alteration in the installed network components. The Bluetooth devices cannot fetch a connection to collect the received signal strength data values, then positioning system used in this paper is using the received signal strength indicator values are provided to fetch a coverage determination between a reference point and an end user using the portable device terminal.

The location determination approach is established on received signal strength values using least square determination is implemented. The result of the equation solution results in the intersections of the adjacent circles of the signal range. To fetch a unique and different result, it is essentially required to compute the location of a portable device by establishing the space or gap between the portable device and more than two other radio base stations. Space or gap can be estimated by the functional correlation to the received signal strengths [18]. If the space or gap between a count of radio base stations more than two and a portable device client are already identifying the location can be feasibly computed by utilizing the least square determination approach. The received signal strength indication value is providing the space or gap information between the received signal strength value of the reference point and a recipient power rank so its known as golden recipient power rank.

Positioning based applications are smartphone applications which depend on a client's position to transfer information implementation. Three reference points with predefined coordinates are needed. If the space or gap from the reference point to a portable device can be computed, a circle with the radius which is drawn and the circles which intersect at a point which is the location of portable device user [19]. The received signal strength must be changed to a distance computation initially. The trilateration method is of two stages in which the first stage, by utilizing a signal propagation method to change received signal strength to reference point portable device user separated distance; the second stage, where the method is like the geometric method which can be utilized to calculate the position. The first phase is the main phase for this method. Since the surroundings vary to a huge range from one place to another place, the easiest method to identify the association between received signal strength value and space or gap is gathered at some signal strength data values with the predefined coordinates. This makes a new extra procedure added which is called as learning methodology which has to be placed to the trilateration method [20]. Position fingerprinting contains two stages which are training stage and positioning stage. The motive of the training step is meant to create a fingerprint database in the server. To build the database, the access router should be chosen. Positioning a portable device user from one access point position is fetched as the received signal strengths from all the reference routers points. From that data values, the feature advantage of particular reference points and also its received signal strength is estimated, and then it is saved in the database. This procedure is repeated at other reference points, and until every reference points are connected, and data values are taken. In the positioning stage where the portable

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

device user computes the received signal strength at a position where the location positions are required [21]. The computation is matched with the values stored in the server using a feasible matching algorithm.

The standard approach of building the database in the server does not use the correlation of data values at adjacent reference points. When data values at several numbers of reference points are installed, they not only produce information and data values at the reference points and also produces data about the targeted location. If a huge database in the server can be built efficiently and effectively by utilizing interpolation method based on several numbers of the reference point, manpower and time can be preserved in the time of training stage. The data values gathered in the implementation for the fingerprinting method was used to compute with the proposed approach. The deterministic approach provides reasonable positioning precision; it discards the data value present in the training database. Every fingerprint data value outlines the data as the mean of the received signal strengths to reference points, based on the order of received signal strength data stored at that particular position. Both average received signal strength and variance are not equal at each reference point. The received signal strength distribution is also not mandatorily Gaussian. Then the data information is matched between the input parameters and the signal strength map to increase the precision.

The reliable indoor location system is a main platform and methodology for indoor location-based applications [22]. Many indoor location detection proposals depend on a one wireless network technology. A hybrid location finding system integrates methodologies technologies and fetches the best location finding precision by presenting the wide features of the several technologies. In the hybrid network technology like wireless fidelity and Bluetooth, the previous research contribution is the important framework to allow fingerprint based location identification, while the Wi-Fi hotspot portable devices split the indoor space surroundings as a wide Wi-Fi radio map. Then Wi-Fi oriented online location determination has increased the improvements in a split and rule procedure. There are three features of a hybrid indoor location identification system. Initially to prevent wide location identification errors affected by familiar locations that are tough to differentiate, then build an implementation algorithm that notices and splits the locations into several tiny maps by installing Bluetooth at certain positions [16]. Secondly, design representations which increase the separation exchanging that happening when an end user provides the identification traces signal coverage of the Bluetooth. Thirdly there are three architectural features proposal for calculation workload. It is decided that all suggestions using simulation and also implementation methods in two dissimilar indoor space of dissimilar room dimensions. The solution results represent the suggestions are efficient and feasible in achieving very precise indoor location finding performance. Since the very proper space signal range, Wi-Fi orientation indoor location finding systems usually involves an analysis technique known as Fingerprinting. In fingerprinting utilizes, the Wi-Fi received signal density and contained an offline and online step. In the online stage always occurs after the offline phase. The received signal density from every number of installed Wi-Fi references points are gathered at installed, predefined access point positions. For every access point position, some dimensional received signal strength vector is fetched as the fingerprint. The fingerprints from all the access point locations build a database in the server that is known to be a radio map for the confined space environment.

When developing a hybrid indoor location finding system, the main focus must be given to the power charge usage of portable appliances. The parallel utilization of many wireless network technologies and Wi-Fi location determination in online can be higher power usage, which can drain battery charge very quickly. So effective and efficient power management is given high priority in its usage. Mainly, the rate of accepting position determines or examine data values which is important while constructing a clear and precise network. The results represent that the Bluetooth implementation algorithm is feasible and provides better location finding precisions when matched with the implementation. The solution results also represent that the newly split switch approaches perform more efficiently than the straightforward approach for identifying the right indoor split-up. The solution data value provides the three planning concerning device power usage and location finding efficiency [23]. The final results are verified that hybrid indoor location finding is power efficient and powerful in providing accurately determined positions.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Indoor location finding systems provides position based information details of a portable device anywhere in the network signal range area by utilizing the signaling system to compute the position of the user on various criteria. Received Signal strength is called the value fetched from the reference point to the portable device through a received signal strength indication which is saved as the squared magnitude of the network. By using wi-fi based technology for positioning the object in a wide of reference points by collecting the received signal strength indicator values in the signals by estimating the distance of portable client device from each reference points and apply trilateration method to fetch the accurate information which provides the position of the user portable device in the confined space [24].

For every Wi-Fi access point in the confined space, the RSSI readings at some distance from the user device are taken. Like this ten RSSI readings are taken at a time slot of 10 seconds. Huge datasets readings maintain the consistent data. Then the dataset is sorted in descending order then the best three access points for further computations. After calculation distance samples from each point for every access point then calculate standard deviation using the athematic mean of distance samples for that access point [25]. The perfect distance estimation is the square of the actual distance from each access points. In spite of utilizing trilateration methodology, it utilizes the coordinates of every reference point in the approach where the minimum results which represent the best approximation of the sensor devices position.

Wi-Fi signals are used to calculate the location of transmitting medium and user. The location was utilizing to generating a circle around every transmitting medium than by fetching the intersection of three circles by which the user location is identified [26]. It provided information is perfect then it provides a unique output. On the other side if the circles generated is getting intersected at a point or if it does not meet at the same point then the data is wrong.

Wi-Fi based trilateration utilizes the received signal strength data values to locate the client from each of three reference points. The approach which is used to implement the globular trilateration algorithm which utilizes the framework with known Wi-Fi networks, received signal strength, the machine authentication code address and their coordinates of Wi-Fi reference points [27]. The received signal strength of three access points installed in three room space within the floor in which computed with an application developed in a smartphone by utilizing the Wi-Fi by estimating the signal level. Then the data measured to estimate distance using the trilateration method. The system is designed for client-server architecture which contains three equipment's Wi-Fi Access points, client portable device, and server. The information received in client device will consist of a reference points service set identifier, received signal strength indicator values and Machine Authentication Code Address of each router. The server which estimates and calculates the position coordinates of the client by using positioning algorithms. The server performs two types of algorithms in which by determining the distance of the client from each reference points and trilateration algorithm to discover the exact position of the user. The Wi-Fi trilateration method provides low accurate positioning and also used for the indoor location finding system [28].

Bluetooth Positioning System is of low cost and has less power consumption. Positioning using Bluetooth can be done using RSSI values[29]. Least Square algorithm can be used in evaluating the position. Positioning using Bluetooth can also be done by using a Bluetooth enabled device and by using signal based parameters. The accuracy mainly depends upon the parameters chosen and measurements obtained. The measurements obtained can be corrupted by using various environmental factors. Fingerprinting is one of the most commonly used approaches, and it provides the accurate result. It is mainly performed in two stages, which are the online and offline stage. But the disadvantage of the fingerprinting method is that it takes a lot of time in the process. The accuracy of trilateration method which relies on the received signal strength and the environmental conditions. So, to improve the accuracy Extended Kalman Filter Algorithm is used [30].

3. FINGERPRINTING AND TRILATERATION APPROACH

The fingerprinting approach has two steps: training step and positioning step. The training step is to create a database consisting of data like room dimensions, access points installed in the room environment and their distance measurement according to the respective signal strength. Thus the offline database is so called as fingerprinting

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

database [31]. To generate the database, initially a portable device terminal connected to the access points at the room environment. And then the received signal strengths is fetched from all the reference router points. Fig 1 exhibits the block diagram of the fingerprinting approach.

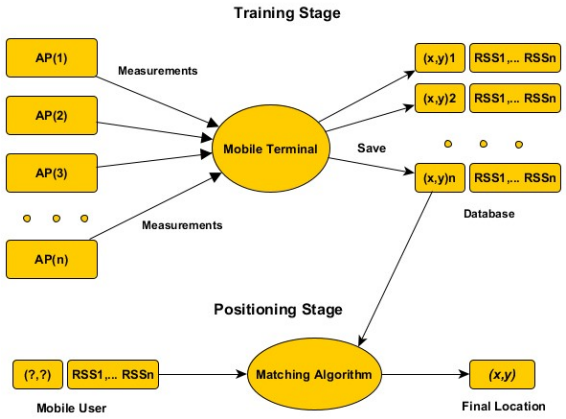

Figure 1: Phases of Fingerprinting Approach

All the above measurements and the features of those reference router points along with its received signal strength data values are estimated and entered into the database or server. This step is repeated to all other reference points. In the positioning stage, the portable device computes the received signal strength data values from all the reference router point. Then the measurements of received signal strength value are matched with the data values in the database server using the comparison algorithm.

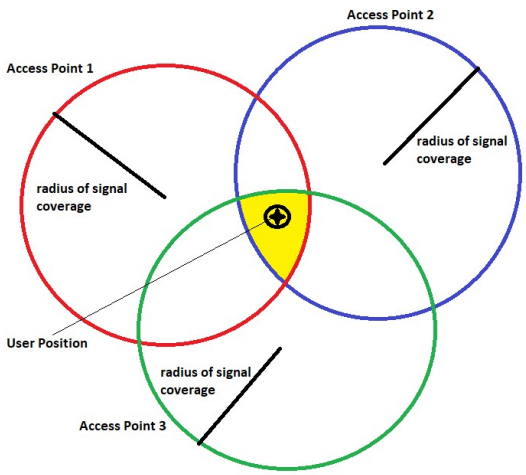

Figure 2: Indoor Positioning System Using Trilateration Approach

As shown in the Fig 2, the trilateration method which utilizes the received signal strengths to determine the distance of the user using a portable device, identifies the distance of the client from the three reference router points. This approach consists of circular trilateration algorithm and its parameters are follow are as follows Wi-Fi signals frequency, machine authentication code address, Wi-Fi signal strength and its position coordinates of reference router points. The received signal strength from the portable device to the reference router points is computed to identify the distance determination. In this method, there are three or more reference router points installed in the indoor surroundings. The signal strength of the reference router points increases as the portable device is nearer to the reference router points. Since there are the chances of error or noise in the detection of distance, so we have the need of more than three reference router points.

All reference router point has a particular range for its own signals. Based on its type of configuration each signal coverage is formed. The received signal strength is measured from the portable device and reference point. When the portable device is placed in the room surrounding, it computes the received signal strength from the three-reference router point. This process is repeated for all the three reference router points. As a result, the portable device is intersected at one point of the room. And based on the received signal strength values the distance is calculated. Thus, the portable device is identified in the confined space.

4. IMPROVED FINGERPRINTING ALGORITHM

In this indoor positioning system, initially, a local database is created where access points installed in the room. The received signal strength is measured across all the room and their respective distance measurements which are shown in Fig 3. The server collects the received signal strength data value from the reference router point to portable device terminal from all reference points in the room as shown in Fig 4. The portable device terminal measures from every access points of the room the signal strength which depicts the nearest point to the access point forms an arc range where the mobile is situated. But for more precision, the adjacent received signal strength of the reference points is being recorded as the coordinates to make the position more accurate. This procedure where the range arc and other two coordinates received

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

signal strength data value is measured to get the position estimation of the client. This type of methodology is known as the trilateration approach.

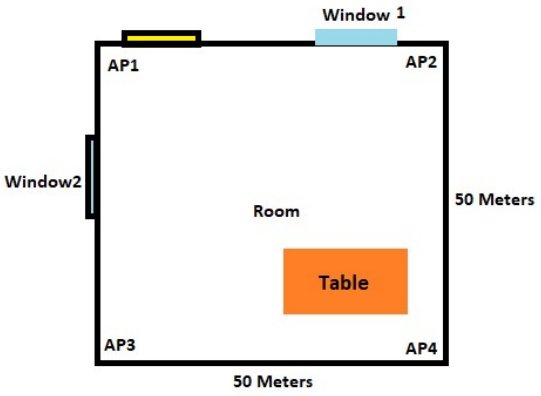

Figure 3: Blue Print of the Room Environment

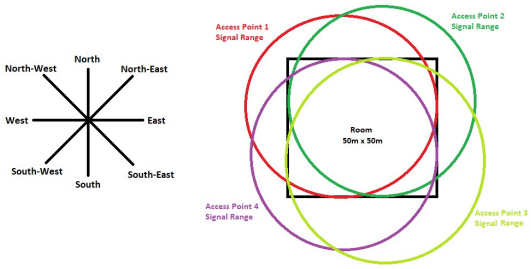

Figure 4: Access Point installed in the room environment

Consider a room environment with four access points and a portable device terminal. There are two approaches which are an offline stage and online stage. Offline phase involves the database and signal strength from several access points across the room. In the online phase the data is fetched by the mobile terminal from all access points and undergone some operations and methods then later compared with offline data in the database.

The algorithm steps are as follows

1. Identify the four different reference points along with its distance from each reference points. Determine a local database of received signal strength data and its distance measurements.
2. Connect the portable device to all the four reference points and obtain its received signal strength.
3. Obtain the received signal strengths from all the four reference router points. Check if the received signal strength data is greater than or equal to -100 dBm and less than or equal to 0 dBm, then the algorithm states that the portable device is available within the confined space. Otherwise the algorithm ends with the result that the portable device is not available within the confined space.
4. Calculate average or mean of received signal strength value fetched from all four reference points.
5. Compute the difference between each received signal strengths and mean received signal strengths which is known as equated received signal strength.
6. Obtain all the four equated received signal strength values from all the four received signal strength.
7. Identify and select the greatest equated received signal strength among the equated received signal strength.
8. Select the reference router points which gives the greatest equated received signal strength value.
9. Compare Received Signal strength value of selected Access points with fingerprint database to determine the distance of the range arc.
10. Based on the comparison of the previous step, we determine the radius or the range arc where the portable user device is located.
11. We take the received signal strengths value of the adjacent reference router points. Compare it with the local database and find the distance of the object by considering it as x and y coordinates. Thus, we determine the location of the portable space by using this algorithm.

In the step 1, initially, the database is created with the room dimensions, the number of access points installed with their machine authentication code and also the signal strength across the room from each reference points. In the step 2, connect the mobile terminal to the access points and fetch the received signal strengths value of the portable device to all the respective reference points. In the step 3, check whether the value of all the reference points signal strength is collected, if yes then check if the received signal strength data is less than -100 dBm and greater than 0 dBm then the mobile terminal is not in the targeted place. If all the values fetched is less than or equal to -100 dBm and less than or equal to 0 dBm, then the mobile terminal in the targeted area. In the step 4, fetch the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

average of the received signal strengths value from all the reference router point in the targeted location. In the step 5, compute the difference between each received signal strength data and the average received signal strength data which is called as equated received signal strength.

In the step 6 and 7 verifying from all the access points, the equated received signal strength value is obtained. The maximum equated received signal strength value obtained from the particular reference points' signal strength is compared with fingerprint database. By comparing with the fingerprint database, the distance between the object or portable device and reference point is obtained. The distance from the reference point forms a range arc where the portable device would be situated in the room. To make it clearer in estimating the location of the user, the distance value obtained from the reference point forms a range arc where the mobile terminal is situated in the room. The better solution is to obtain the x and y coordinates by the range arc and coordinates values intersect at one place of the room which estimates the location with better accuracy. The adjacent reference points signal strengths are compared with fingerprint database. By comparing we obtain the distance of the portable device from the respective reference points. With the range arc which determines the portable device presence in the particular area and the adjacent reference points distance values as x and y coordinates, these three values intersect at one point of the room so that determines the position of the portable device in the confined space. By this way the portable user device is located through the implementation of trilateration method in fingerprinting approach.

5. THE SIMULATION METHOD

Initially, in offline stage the database is built which consists of the room measurements, the count of reference points installed, machine authentication code address of the reference points and the distance measurement. The distance measurements is done according to the network range from each access points along with the directions. Considering a room of 50 meters at all the sides where there are four access points installed. The Wi-Fi router is installed at four sides of the room. The signal strength is measured across the room from each router to generate offline data along with its distance measurement. The offline data is generated and stored in the server database. The mobile terminal is placed in the room is connected to all the access points of the room and then collected their respective received signal strength. Compute the average of all the four access point signal strength then obtained the difference from each received signal strength. Check that none of the different access points should be greater than 0 dBm and less than -100 dBm. Select the maximum equated received signal strength by computing the difference between each received signal strength of the reference router points and average received signal strengths value data. The minimum received signal strengths value among all the reference points forms an arc range where the mobile terminal could be located in the room. To make this more precise and accurate, the nearest reference point received signal strength acts as the a and b coordinates to situate the location of the portable device. The nearest signal strength value which is considered as the x and y coordinates which expressed as directions like north, east, west, and south. The final maximum signal strength value and other two nearest signal strength are compared to offline data in the server database from that certain reference point which depicts the position of the mobile user.

As represented in the Table 1, in this simulation the signals are interpreted in terms of dBm (Decibels below 1 Milliwatt) which ranges between 0 dBm to -100 dBm whereas if the strength of the signals is very near to 0 dBm then it said to be strong signal and if the strength of the signals is very near to -100 dBm then it said to be weak signal. There are chances of fluctuations in the strength of the signals if the mobile terminal varies in the distance with the access points. Computing the mean of all the access points increases the reliability and stability of the system. By using the trilateration and fingerprinting method, this simulation is performed using the room environment by which the fingerprinting method involving the offline databases which have been compared from the data fetched from the mobile terminal as the received signal strength. The range arc is the arc area where the portable device can be located concerning the strong signal strengthened access point. To make this process more accurate the trilateration method is being used where the mobile is placed in which all the signals from several access points intersect at one location where the other access point signal strength adjacent with the strong signal strengthened reference point is considered as x and y coordinates with this information, and the mobile terminal is situated.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 1: Simulation Results Measured From The Room

AP1 (RSS) *indBm*	AP2 (RSS) *indBm*	AP3 (RSS) *indBm*	AP4 (RSS) *indBm*	Mean RSS *indBm*	Selected AP	Range Arc	Location (x)	Location(y)
-76	-46	-26	-47	-49	AP3	38m	27.5m (SW)	28m (NE)
-26	-46	-76	-47	-49	AP1	38m	28m (NE)	27.5m (SW)
-37	-12	-37	-90	-44	AP2	45m	32.5m (NW)	32.5m (SE)
-36	-47	-66	-47	-49	AP1	33m	27.5m (NE)	27.5m (SW)
-81	-39	-21	-45	-45	AP3	40.5m	33m (SW)	31.5m (NE)
-91	-66	-11	-69	-60	AP3	45.5m	15.5m (SW)	18m (NE)
-59	-56	-57	-46	-55	AP4	28m	21.5m (NW)	21.5m (SE)
-39	-36	-66	-66	-52	AP2	33m	31.5m (NW)	18m (SE)
-52	-86	-54	-16	-52	AP4	43m	25m (NW)	24m (SE)
-59	-48	-53	-54	-54	AP2	27m	21.5m (NW)	24.5m (SE)

6. RESULTS AND DISCUSSION

The received signal strength is computed from all the four reference points installed in the environment of the room in the improved fingerprinting approach. Since the signal strength values are less than zero, so the values are converted to positive values by using modulo operation.

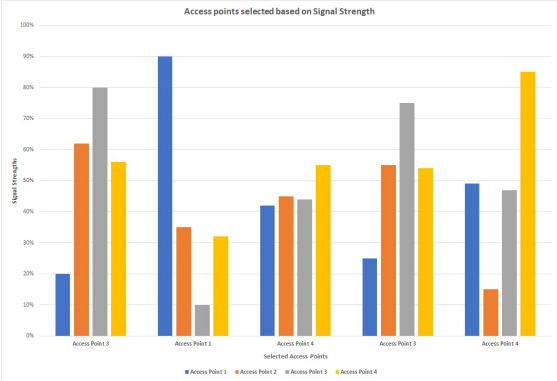

Figure 5: Signal Strength Value Based Selection For Location Estimation

Once the signal strengths are collected from the reference points. From Fig 5, we can say that received signal strength is one of the important aspects of an indoor location determination system. The highest signal strength from the reference point is selected. The highest signal strength reference point is said to have a strong signal from the portable device to the reference points. Based on that highest signal strength is selected and forms a range arc across the room. It interprets that the portable device is located within that area, to make it more precise in estimating the position of the portable device. We consider the adjacent reference points as the coordinates for indoor location determination. There are five scenarios are represented in the graph which tells about the selected reference points. In the first scenario the all the reference points at the different quantity of values out of those the third reference point has the better signal strength, so it is selected. But in the third scenario most of the reference points are almost of the same range but since the signal strength from the reference point four is high so it is being considered as the range arc for the next step of improved fingerprinting location determination.

The data values collected from the experiments for the fingerprinting method, and it was used to determine the deviation in values or error in distance measurements generated is compared with other methodologies. There are three sets of data values being fetching from individual experiments from trilateration, fingerprinting method and improved fingerprinting approach for the distance error representation in the Fig 6.

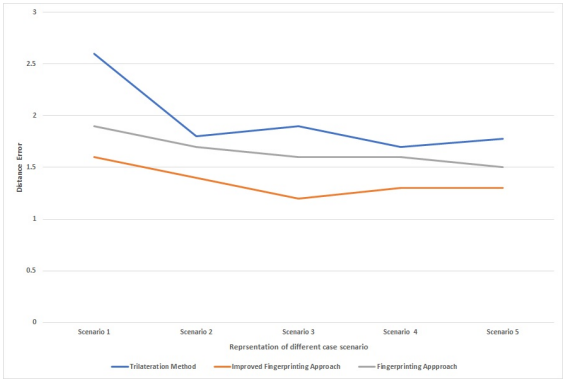

Figure 6: Distance Error By Using Several Positioning Approaches

There are several indoor positioning approaches to estimate the location of the portable device in the room environment. There are three set values of values is fetched to obtain the results to interpret the better and error-free positioning system. Initially, the location is estimated by using the trilateration method, fingerprinting method and

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

improved fingerprinting approach. In the trilateration method, all the reference points intersect at one point where the portable device is situated with the three reference points installed in the room. In fingerprinting method, with the help of online stage and offline stage the location of the portable user device is determined, but in improved fingerprinting approach with the four reference points installed in the room, fingerprinting database is built which consists of location distance information. With the data fetched from the operation performed by measuring the received signal strength from reference points which are implementing trilateration in fingerprinting method. From the Fig 6, the distance error is calculated for the set of data which is obtained by using trilateration, fingerprinting method, and improved fingerprinting method. There are several scenarios considered with the portable device at the same position. By analyzing the graph, the trilateration method produces a certain error in distance estimation but in improved fingerprinting fetches a better accuracy by combining the concepts of trilateration along with the fingerprinting method by using certain conditions to check whether the portable device is within a room or outside the room.

In this paper, the improved fingerprinting approach creates the local database of fingerprints. Data collected through the routers in the room are subjected to several operations. Then the final data obtained in computation is compared with the data from local database, to estimate the location of the user. Hence by combining both the aspects of fingerprinting approach and trilateration approach, we have obtained advanced approach called as Improved Fingerprinting approach. This combination has provided the proven advantage of less error in estimating the location of the user.

7. CONCLUSION

Deployment of improved fingerprinting algorithm for confined space is to increase the accuracy and efficiency. These results of methodologies provide better precision and effective results. Identifying the position of the client using Wi-Fi signals consists of low investments. There are several new algorithms to reduce the error rate and to find the positions. In the future, Dynamic methodology of this process includes increased signal strength data with increased precision in positioning. Hybrid technologies and other algorithm techniques will enhance the stability and reliability to examine the results of position determination in a confined space.

REFRENCES:

[1] S. R. Doiphode, J. W. Bakal, and M. Gedam, “A hybrid indoor positioning system based on Wi-Fi hotspot and Wi-Fi fixed nodes,” *Proc. 2nd IEEE Int. Conf. Eng. Technol. ICETECH 2016*, no. March, pp. 56–60, 2016.

[2] M. Caceres, F. Sottile, and M. A. Spiriteo, “WLAN-based real time vehicle locating system,” *IEEE Veh. Technol. Conf.*, pp. 1–5, 2009.

[3] L. Liyanagedara and B. Madarasinghe, “Wi-Fi based Positioning system,” pp. 3–4, 2013.

[4] W. M. Yeung and J. K. Ng, “An enhanced wireless LAN positioning algorithm based on the fingerprint approach,” *IEEE Reg. 10 Annu. Int. Conf. Proceedings/TENCON*, vol. 2, no. 1, pp. 2–5, 2007.

[5] B. J. Shin, K. W. Lee, S. H. Choi, J. Y. Kim, W. J. Lee, and H. S. Kim, “Indoor WiFi positioning system for Android-based smartphone,” *2010 Int. Conf. Inf. Commun. Technol. Converg. ICTC 2010*, pp. 319–320, 2010.

[6] B. D. S. Lakmali, W. H. M. P. Wijesinghe, K. U. M. De Silva, K. G. Liyanagama, and S. A. D. Dias, “Design, implementation & testing of positioning techniques in mobile networks,” *Proc. 2007 3rd Int. Conf. Inf. Autom. Sustain. ICIAFS*, pp. 94–99, 2007.

[7] H. Liu, H. Darabi, P. Banerjee, and J. Liu, “Survey of wireless indoor positioning techniques and systems,” *IEEE Trans. Syst. Man Cybern. Part C Appl. Rev.*, vol. 37, no. 6, pp. 1067–1080, 2007.

[8] M. Cypriani, F. Lassabe, P. Canalda, and F. Spies, “Open wireless positioning system: A Wi-Fi-based indoor positioning system,” *IEEE Veh. Technol. Conf.*, pp. 0–4, 2009.

[9] A. H. Lashkari, B. Parhizkar, and M. N. A. Ngan, “WIFI-based indoor positioning system,” *2nd Int. Conf. Comput. Netw. Technol. ICCNT 2010*, no. January, pp. 76–78, 2010.

[10] Z. Xiang, S. Song, J. Chen, H. Wang, J. Huang, and X. Gao, “A wireless LAN-based indoor positioning technology,” *IBM J. Res. Dev.*, vol. 48, no. 5.6, pp. 617–626, 2004.

[11] S. Saha, K. Chaudhuri, D. Sanghi, and P.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Bhagwat, "Location determination of a mobile device using IEEE 802.11b access point signals," *IEEE Wirel. Commun. Netw. Conf. WCNC*, vol. 3, pp. 1987–1992, 2003.

[12] S. Feldmann, K. Kyamakya, A. Zapater, and Z. Lue, "An indoor Bluetooth-based positioning system : concept , Implementation and experimental evaluation," *Int. Conf. Wirel. Networks*, no. JANUARY 2003, pp. 109–113, 2003.

[13] M. Garcia, C. Martinez, J. Tomas, and J. Lloret, "Wireless sensors self-location in an indoor WLAN environment," *2007 Int. Conf. Sens. Technol. Appl. SENSORCOMM 2007, Proc.*, pp. 146–151, 2007.

[14] A. Baniukevic, D. Sabonis, C. S. Jensen, and H. Lu, "Improving Wi-Fi based indoor positioning using bluetooth add-ons," *Proc. - IEEE Int. Conf. Mob. Data Manag.*, vol. 1, pp. 246–255, 2011.

[15] B. Dawes and K. W. Chin, "A comparison of deterministic and probabilistic methods for indoor localization," *J. Syst. Softw.*, vol. 84, no. 3, pp. 442–451, 2011.

[16] G. Anastasi, R. Bandelloni, M. Conti, F. Delmastro, E. Gregori, and G. Mainetto, "Experimenting an indoor bluetooth-based positioning service," *Proc. - 23rd Int. Conf. Distrib. Comput. Syst. Work. ICDCSW 2003*, vol. 1, pp. 480–483, 2003.

[17] B. Li, J. Salter, A. G. Dempster, and C. Rizos, "Indoor positioning techniques based on wireless LAN," *October*, vol. CD-ROM pro, pp. 13–16, 2006.

[18] Jaimyoung Kwon, B. Dundar, and P. Varaiya, "Hybrid algorithm for indoor positioning using wireless LAN," *IEEE 60th Veh. Technol. Conf. 2004. VTC2004-Fall. 2004*, vol. 7, pp. 4625–4629.

[19] P. Le Dortz, N. and Gain, F. and Zetterberg, "Wifi Fingerprint Indoor Positioning System Using Probability Distribution Comparison," *Acoust. Speech Signal Process. (ICASSP), 2012 IEEE Int. Conf.*, pp. 2301–2304, 2012.

[20] N. S. Kodippili and D. Dias, "Integration of fingerprinting and trilateration techniques for improved indoor localization," *2010 7th Int. Conf. Wirel. Opt. Commun. Networks, WOCN2010*, pp. 1–6, 2010.

[21] A. Taheri, A. Singh, and E. Agu, "Location fingerprinting on infrastructure 802.11 Wireless Local Area Networks (WLANs) using locus," *Proc. - Conf. Local Comput. Networks, LCN*, no. 0303592, pp. 676–683, 2004.

[22] T. Kitasuka, T. Nakanishi, and A. Fukuda, "Wireless LAN based indoor positioning system WiPS and its simulation," *IEEE Pacific Rim Conf. Commun. Comput. signal Process.*, vol. 1, pp. 272–275, 2003.

[23] A. Agiwal, P. Khandpur, and H. Saran, "LOCATOR: location estimation system For wireless LANs," *Proc. 2nd ACM Int. Work. Wirel. Mob. Appl. Serv. WLAN hotspots*, pp. 102–109, 2004.

[24] V. Varshney, R. K. Goel, and M. A. Qadeer, "Indoor positioning system using Wi-Fi & Bluetooth Low Energy technology," *2016 Thirteen. Int. Conf. Wirel. Opt. Commun. Networks*, pp. 1–6, 2016.

[25] C. Papamanthou, F. P. Preparata, and R. Tamassia, "Algorithms for location estimation based on RSSI sampling," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 5389 LNCS, pp. 72–86, 2008.

[26] B. Bobescu and M. Alexandru, "Mobile Indoor Positioning Using Wi-Fi Localization," vol. 1, no. 1, pp. 1–4, 2015.

[27] M. Robinson and I. Psaromiligkos, "Received signal strength based location estimation of a wireless LAN client," *IEEE Wirel. Commun. Netw. Conf. WCNC*, vol. 4, pp. 2350–2354, 2005.

[28] A. Kashevnik and M. Shchekotov, "Comparative analysis of indoor positioning systems based on communications supported by smartphones," *Conf. Open Innov. Assoc. Fruct*, vol. 2012–Novem, pp. 43–48, 2017.

[29] S. Mazuelas *et al.*, "Robust indoor positioning provided by real-time rssi values in unmodified WLAN networks," *IEEE J. Sel. Top. Signal Process.*, vol. 3, no. 5, pp. 821–831, 2009.

[30] F. Subhan, H. Hasbullah, A. Rozyyev, and S. T. Bakhsh, "Indoor positioning in Bluetooth networks using fingerprinting and lateration approach," *2011 Int. Conf. Inf. Sci. Appl. ICISA 2011*, 2011.

[31] C. Pei, Y. Cai, and Z. Ma, "An indoor positioning algorithm based on received signal strength of WLAN," *Proc. 2009 Pacific-Asia Conf. Circuits, Commun. Syst. PACCS 2009*, pp. 516–519, 2009.