INDOOR POSITIONING USING WCL BASED ON RSSI

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Abstract--- This paper presents the use of RSSI (Received Signal Strength Indicator) in terms of Wi-Fi Signals for calculating the current position of the user. For Outdoor Navigation satellite signals are the best option but those are not sufficient for Indoor Positioning. There has been associate degree upward trend within the demand of indoor positioning systems victimization Bluetooth low energy (BLE), Wi-Fi and visual light weight communication. There are numerous centroid algorithms used to calculate the current position but the one which we are using over here is Weighted Centroid Localization (WCL) algorithm using RSSI values. This WCL is simulated and the results are calculated in terms of error rate.

Keywords--- Indoor Positioning (IP), Outdoor Navigation, Weighted Centroid Localization (WCL), Received Signal Strength Indicator (RSSI).

I. INTRODUCTION

The system mistreatment location is principally enthusiastic about the technology named Global Positioning system (GPS). GPS is absolutely appropriate for Outside Navigation however but it's not sensible for Indoor Positioning as a result of it desires undisturbed reception of signals from a minimum of four satellites with line of sight [4]. If someone visits any building or website for the primary time it desires navigation steerage to ease them to find their destination area during a building. However this physical navigation signs area unit usually confusing and even misguide within the building [2]. So as to handle this drawback a selected system is required [1].

Augmented reality (AR) may be a variation of virtual reality (VR) [8], however the link between real space, virtual space and every one the intermediate kinds of mixed space are formalized by Milgram & Kishino in 1994 [9] [10]. Augmented Reality (AR) is a neighborhood of analysis that aims to reinforce the important world by overlaying computer-generated information on high of it [11]. Author identifies 3 key characteristics of AR systems: (i) mixture virtual pictures with the important world, (ii) three-dimensional registration of digital information and (iii) interactivity in real time [11][12]. The primary AR expertise with these characteristics was analyzed over forty years ago [13], however the most adoption to AR has been restricted by the offered technologies [11]. Applications of augmented Reality area unit as follows: Amusement likes Games, Robotics, producing and Alternatives industries, training, Engineering design etc. varied devices area unit used for implementing AR in it. They're sensible Phones, Tablets, sensible Glasses, and AR Headsets [13].

II. RELATED WORK

Hanas Subakti et al. [2], projected an iterative guidance device that become interface between guidance device, building setting, and therefore the contemporary user. Maps and pictures of the building, directions, and elaborate of specific places or rooms or facilities for serving to new students or users to get way to their department. This method consists of 3 subsystems. They're the marker-based Cyber-Physical Interaction (CPI) system, the indoor positioning (IP) system, and therefore the augmented-reality (AR) system. The CPI system that's Cyber-Physical System (CPS) that collects device information from the important world and links them to varied data sources for analysis of current state of affairs in cyber setting [14]. The author proposed an android application referred to as Engfi Gate System that's a guidance device. Hanas Subakti et al. [3], projected a guidance device to guide new students to navigate totally different places. Author has designed and enforced a marker-based cyber-physical augmented-reality indoor guidance device, referred to as Engfi Gate, for serving to new students to navigate buildings among field. Author has not nevertheless concerned a game server within the Engfi Gate system to supply a virtual setting for cyber users to navigate and act with physical users. Author is about to improve the information processing system to supply a lot of correct user position data. Santosh Subedi et al. [4] proposed a weighted centroid Localization (WCL) derived from a centroid determination methodology wherever weights are accustomed estimate position [15]. Demonstration of WCL methodology that may be utilized in indoor positioning system with the assistance of wireless technology called Bluetooth Low Energy (BLE) is projected. Author measured the performance of WCL methodology beneath the varied degrees of weight and obtained that degree of 0.5 is most reliable at the testing setting. This WCL may be joined with fingerprinting to boost the estimation of this location.

Nizetic Kosovic et al. [5], projected localization methodology that counts the distinction among numerous anchor nodes and also the consumer device or receiver. Then it calculates the common signal strength from multiple repetitive mensuration, to create the external interference best. It are often used with a spread of various inexpensive, Wi-Fi access point devices, doesn't need any further or specialized hardware, and uses the options that area unit wide accessible on virtually each mobile device nowadays. This localization method is completely administrated by software package on the user's device solely therefore the location and movement history is simply familiar to user that creates user's detail secure. Author describes that further the development in accuracy and quality of locality are often improved. Quande Dong et al. [6], projected a weight-compensated weighted centroid localization algorithm (WCL) supported RSSI for an outside surroundings. By in theory analyzing, the projected algorithm has the advantage of lower complexness, very little prior info and lower power consumption. Author analyzed the performance of WCWCL-RSSI algorithm through the amount of anchor nodes, the standard deviation and

also the path loss exponent. The compared results show that projected algorithmic program achieves a reduced localization error than WCL and Anchor optimized changed weighted centroid localization supported RSSI (AMWCL-RSSI). If there are unit fewer anchor nodes, author decide to work on improvement of the localization accuracy as a future work. Jijum Zhao et al. [7], projected associate algorithmic program referred to as weighted centroid localization distinction of estimated Distances (WCL-DED). This algorithmic program is as associate improvement of changed weighted centroid localization (MWCL). The algorithmic program utilizes the distinction of e3stimated distances to enhance the MWCL algorithm. It describes the influence precisely to the anchors nodes, because it has another more information to observe the unknown node. Thus by creating many experiments the algorithmic program given up here is better than the MWCL algorithm without introducing any new variable.

III. WCL ALGORITHM

Centroid Localization algorithmic program is extremely necessary for node localization. The received signal strength (RSS) are often accustomed reduce positioning time [16]. Weighted centroid localization (WCL) is first of all proposed in [6]. Weighted centroid localization has already caused a lot of attention because of their simplicity and strength to changes in wireless transmission [15]. These varied blessings makes this rule appropriate for each node within the network. the essential plan of weighted center of mass localization algorithmic program supported RSSI is that the unknown node to beacon node RSSI info gathering around them, to receive the information and so one by one to every anchor node because the center of the circle, Communication distance for the radius of a circle, then unknown sensor anchor nodes on the intersection a part of all spherical, on the idea of ancient centroid algorithmic program, for every of the anchor node coordinates, increase the distance, that reflects every anchor node's contribution to the localization method [1] [17].

Steps for RSSI Weighted centroid Algorithm:

If there are square measure n anchor nodes in wireless sensing element network, unknown sensing element node coordinates is ready to (a,b), then the centroid localization algorithmic program supported RSSI specific estimation steps square measure as follows:

1) The anchor node send their related data, including their own ID info and current position coordinates info to the neighboring nodes in the form of flooding (broadcast).
2) Unknown node receives the flooding data issued by the anchor nodes, to the identical anchor Unknown node have to record data broadcast by the anchor node for several times and calculate the common received signal strength of anchor nodes.
3) once the node beneath take a look at receive anchor node data variety over setting the edge value of n, we will establish formulas concerning anchor node coordinates and signal strength Positionset ={(a_1, b_1) , (a_2, b_2) ,…(a_n, b_n) } and RSSIset={$RSSI_1$,$RSSI_2$,_$RSSI_n$}.
4) Consistent with the formula, we are able to calculate the coordinates of the node beneath take a look at (a, b).

$$\begin{cases} a = \dfrac{w_1 * a_1 + w_2 * a_2 + w_3 * a_3 + \cdots + w_n * a_n}{w_{*1} + w_2 + w_3 + \cdots + w_n} \\ b = \dfrac{w_1 * b_1 + w_2 * b_2 + w_3 * b_3 + \cdots + w_n * b_n}{w_1 + w_2 + w_3 + \cdots + w_n} \end{cases} \quad (1)$$

$$w_i = \frac{RSSI_i}{RSSI_1 + RSSI_2 + RSSI_3 + \cdots + RSSI_n}$$

$$(where\ i = 1,2,3, \ldots n)$$

5) Activity error analysis, the calculating formula is as follows: ERROR _ (a _ a*) 2 _ (b_ b*) 2 the (a, b) is obtained by improved algorithmic program of unknown node coordinates, the (a, b) is obtained by improved algorithmic program of unknown node coordinates, (a*, b*) could be true coordinates of the unknown node.

The author in [4] describes that WCL could be location estimation technique assignment weight (w_i) to every beacon, supported distance to beacon and degree (g). This algorithmic rule range location estimation within the region enclosed by beacons. Since any beacon with reference to tag device will have highest weight, the ultimate position estimation is force towards this beacon. The position estimation algorithmic program is given as follows:

$$a_w = \sum_{i=1}^{m} a_i w_i \,/\, \sum_{i=1}^{m} w_i \quad \ldots\ldots (2)$$

$$b_w = \sum_{i=1}^{m} b_i w_i \,/\, \sum_{i=1}^{m} w_i \quad \ldots\ldots (3)$$

$$w_i = \frac{1}{d_i^g} \quad \ldots\ldots (4)$$

Where, (a_w, b_w) is the estimated position, (a_i, b_i) is the position coordinate of i^{th} beacon, d_i is distance between tag and beacon i, and g is that the degree of weight. Total range of beacons thought of at any time for position estimation is denoted by m. The WCL positioning system is shown in Figure 1.

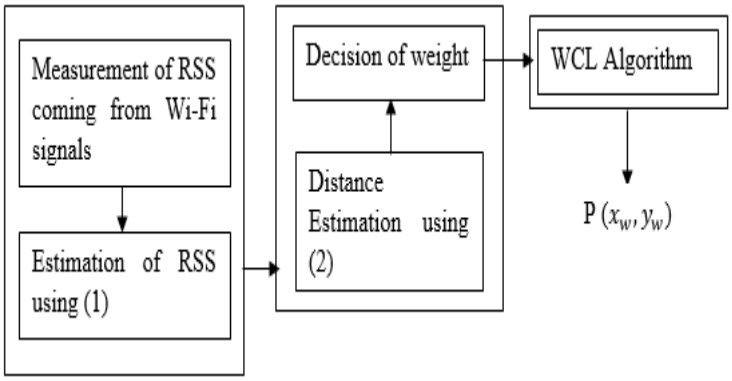

Figure 1: Block diagram for WCL Algorithm using RSSI value

Since RSSI fluctuates over time because of attenuation and a number of other noise factors, Kalman filter [17], is employed on the highest of moving average filter. The calculable RSSI is then born again to distance using the subsequent formula:

$$P_r(d)[dBm] = A - 10n * log_{10}(d) \quad \ldots\ldots(5)$$

Finally, the chosen beacons' locations and their individual calculated distances are utilized in WCL for position estimation. Here, beacons are chosen on basis of their current RSSI values.

IV. PROPOSED WORK

From the on top of literature discussion, the matter of achieving higher error rates that result the accuracy of whole system and additionally will increase response time was highlighted among all [1]. Thus currently our task is to form the localization algorithmic program efficient which will cut back the error rate and reduce the response time. This section presents a proposal to beat the constraints of the on top of issues and to form the algorithmic program efficient.

After observing varied centroid localization algorithms, here we've designed a weighted centroid localization algorithmic program that's a basic to get the present position of the device using RSSI signals. This algorithmic program is deployed and extended for several outside and indoor implementations however here we tend to are simply moving to optimize the error rate and acquire accurate current position for indoor positioning using Wi-Fi signals. This can be the basic steps that explains the particular flow of algorithmic program with the use of application build with Augmented Reality.

Step 1: User Enter input (destination)
Step 2: System display navigation directories
Step 3: User selects route and starts the camera
Step 4: System receives the signals from neighbouring nodes
Step 5: System Processing WCL Algorithm using RSSI values and calculate the current position of device (user)
Step 6: System displays the current position to user and draw the next step to the path
Step 7: User view and moves towards path

V. SIMULATION AND EXPERIMENTAL RESULTS

The proposed solution have been designed using MATLAB. Here it creates an environment of n-nodes that works as an AP's and calculate the current position of the receiving node by demonstrating the WCL algorithm. The receiving node measure the RSSI values generated by Wi-Fi signals. The minimum requirement of this scenario is three Access Points. The area of the environment measured over here is 100*100 meters. The error rate is measured at the end on the basis of position P'(x, y). After calculating the RSSI values for different nodes (figure 2 and 3), these values will be considered as an input to WCL algorithm and final P'(x, y) is generated. This position is generated by having different degree value but better values are consider at 0 degree.

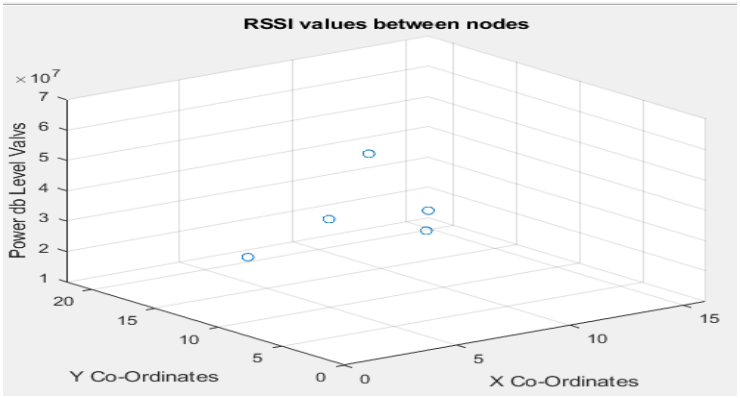

Figure 2: RSSI Deployment

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RSSI values in db b/w (6,3) and (5,7) is 4.164033e+01
RSSI values in db b/w (6,3) and (12,15) is 2.984161e+01
RSSI values in db b/w (6,3) and (3,13) is 3.234966e+01
RSSI values in db b/w (6,3) and (1,3) is 3.971202e+01
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Figure 3: RSSI values

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P1(6,3) is (1.543114e+01,1.243114e+01)
P2(6,3) is (1.370050e+01,1.070050e+01)
P3(6,3) is (1.144507e+01,8.445073e+00)
P4(6,3) is (6,3)
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Figure 4: Calculating P'(x, y) with degree

However, the proposed method have better results in the form of accuracy but is more expensive in terms of setting the infrastructure.

Table 1: WCL positioning accuracy error rates

Real Nodes				
X_1	Y_1	X_1'	Y_1'	Accuracy Error (meters)
8	12	1.5	1.9	7.1
6	7	1.8	1.9	1.2
2	3	1.5	1.6	1.3
3	3	1.8	1.8	1.5
0	5	1.6	2.1	1.6

In above table, Accuracy in terms of error rate are calculated. Similarly to make a comparison accuracy is calculated by having error nodes. Comparing table 1 and 2, it is clear that the proposed WCL using RSSI based on Wi-Fi signals gives accurate results.

Table 2: WCL positioning for error nodes, accuracy error rates

Error Generated Nodes				
X_2	Y_2	X_2'	Y_2'	Accuracy Error (meters)
8.5	1.25	1.6	1.6	5.1
6.5	7.5	1.8	1.8	1.1
2.5	3.5	1.5	1.5	1.2
3.5	3.5	1.9	1.9	1.5
5.5	5.5	1.6	1.6	1.3

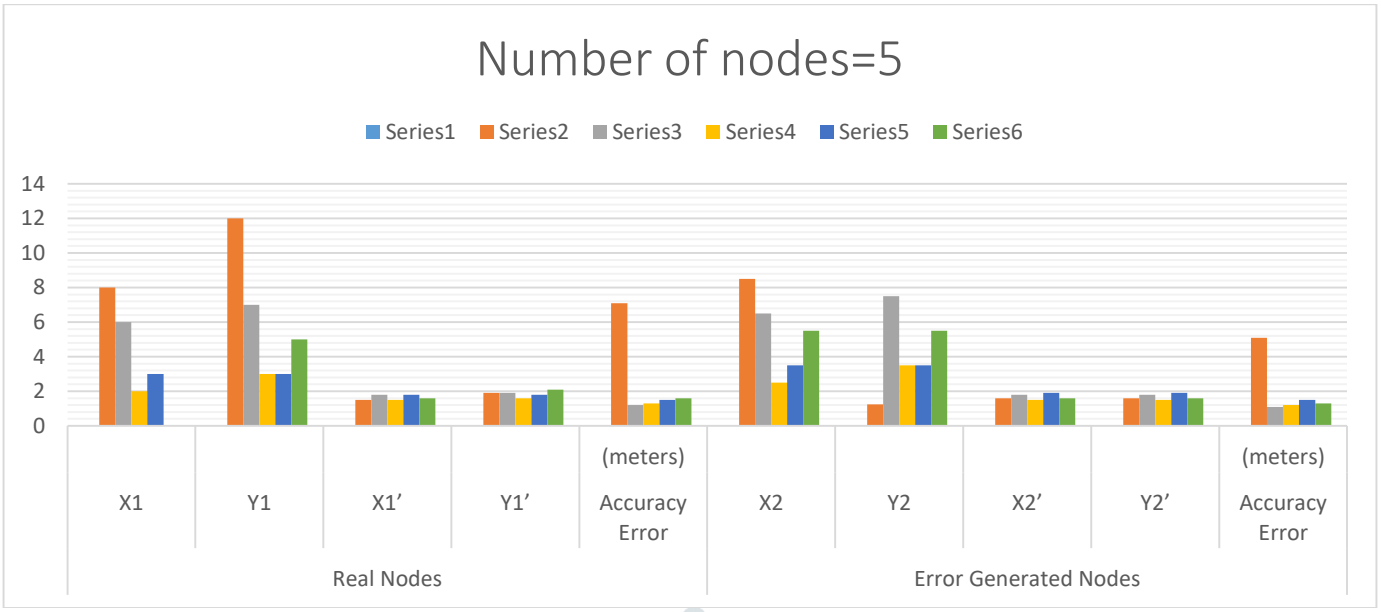

Figure 5: Result Analysis

VI. CONCLUSION

The problem we concluded was the increase in error rates and response time beyond the limits. So we have simulated the environment using a WCL algorithm with RSSI values. This can optimize the error rates by using variation of values with the inputs. In this manner we can also maintain the accuracy of the whole system. As far to make a complete Indoor Positioning System is our future work.

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