IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-8, Aug 2019 E-ISSN: 2347-2693

Smart Approach for Finding Indoor Navigation Using BLE for Visually Impaired Person

Kalyani Mule[1*], J. V. Shinde[2]

[1,2]Department of Computer Engineering, Late G. N. Sapkal College of Engineering, Nashik, India

DOI: https://doi.org/10.26438/ijcse/v7i8.8893 | Available online at: www.ijcseonline.org

Accepted: 14/Aug/2019, Published: 31/Aug/2019

Abstract — In todays' life, the problems faced by the visually impaired persons are increases due to the huge growth in urbanization in cities. Even a normal person also gets confused, if they come across to the new locations. To handle this problem, in this paper, we have proposed a new robust system, which provide help to user while navigating in big industrial buildings. This system uses BLE (bluetooth low energy) devices to communicate with the hardware present at user and then it will direct the route to the user. The process includes user interaction through voice for the input location after that system will find desired location of user by connecting the hardware to various BLE devices and depending upon the signal strengths from each BLE user will be get navigated. If the range of BLE devices get less than that means, that user is going away from that BLE device and similarly if the range of particular device is getting increase then it means that user going towards the BLE device. Now to get accurate result we are implementing Three Dimensional Triangulation Technique where the hardware present at user will simultaneously connect with multiple BLE devices and then find the required route for navigation. Along with this we are providing IR(infra-red) SONAR sensors through which we can find any obstacle that comes between the user and its navigation. We have added buzzer and LED lights to notify the obstacle to others.

Keywords — Indoor navigation, BLE beacons technology for triangulation. Blind navigation, wayfinding, robotic navigation aid, pose estimation.

I. INTRODUCTION

Indoor navigation technology is becoming practically available in different forms and quality. We cannot use GPS satellite technology to for indoor navigation and to reduce this problem we are using bluetooth low energy devices [1]. The global positioning system becomes major part of human life and every other person is dependent on the map for navigation. The first model of GPS has introduced in late 90's. In current days almost every device is having GPS functionality in built which will provide the easy way to understand how to use route navigation. The GPS has shown significant improvement in outdoor positioning. Currently after 15 years later, the positioning system goes indoor and it creates new possibilities generated for indoor use. Satellite-based positioning will not be going to work indoor navigation, but other technological specification of GPS has created the way to make indoor positioning possible. Indoor navigation is more complicated than outdoor navigation using GPS because a certain infrastructure should have to be in place indoor. GPS signals does not work for indoor navigation or though the narrow streets as they tend to reduce the effect of GPS signal and scatter by roofs and walls. The main concern about the proposed system is that we need an indoor navigation system. The question is why we need so? The answer for this is that in big buildings where someone may spend good amount of time for finding what they are looking for. Shopping centers, airports and museums are just some good examples where indoor navigation would make great experience to users.[7] Let's imagine that everybody would have a map of the structure marked with their current location on a raspberry device? This would definitely make great improvement while indoor navigation. [3] Then, it will also helpful for organization to serve better to their users. With indoor positioning systems, it is possible for organizations that they can deliver location-triggered content, location-based advertising and much more to the user. Bluetooth Low Energy (BLE) signals from battery driven beacons are at the basic core of the indoor location technology. It's one of the most recent advancements that has risen and turned into an industry standard accessible on most gadgets today. It utilizes purported BLE reference points (or iBeacons) that are modest, little, have a long battery life and don't require an outside vitality source. The gadget distinguishes the flag from the signal and can compute generally the separation to the guide and consequently gauge the area. Geolocalization innovations have turned into a fundamental piece of our day by day lives because of the omnipresence of cell phones and GPS inclusion. We use

GPS controlled administrations for asking for headings, offering our area to loved ones, for offering setting to photographs and recordings, and to trigger activities dependent on area. Solid open air route is anyway a standout amongst the most valuable uses of geolocalization advancements and giving a comparable answer for indoor situations has been so far a long haul hardware.[3] GPS is anything but a decent decision for indoor restriction in light of the fact that the dividers and roofs totally hinder the flag of the satellites utilized by GPS. In addition, the estimation mistake of GPS is unreasonably huge for its use in indoor situations where meters are huge and can put a client in the wrong room. Numerous advancements, for example, BLE (Bluetooth Low Energy), Wi-Fi and Electromagnetic Field have been endeavored to deal with the indoor constraint issue. [8] Wi-Fi fingerprinting is known to give precision of a couple of meters. Be that as it may, it is an eager for power convention and passages are seldom sent with the required geometry and thickness. Conversely, BLE has been intended to be a machine-to-machine vitality productive convention, permitting gadgets with long battery lives, bring down expenses and upkeep.

II. REVIEW OF LITERATURE

In the current frameworks, we are having the route utilizing the Depth Camera Sensor, utilizing that profundity camera ceaseless pictures are get caught and gets prepared for the discovering the separations among client and impediments or to explore the client to wanted area. In any case, it has some genuine disadvantage as the information gathered from the camera has enormous size and it needs to process just as that necessities to contrast with past pictures with foresee the yield, this isn't most ideal arrangement accessible due equipment in abilities in genuine world. Likewise, the precision of camera pictures diminishes amid night or in foggy seasons, to defeat this significant downside in proposed framework we have present BLE based route framework. The current frameworks utilize 6-DOF present estimation (PE) framework. [5][6] The Pose Estimation framework has two diagram SLAM procedures to limit the steady posture mistake of the gadget. In these two stages at first, the floor plane is removed from the 3D camera's point cloud and henceforth making a milestone hub into the graphical portrayal of for 6-DOF SLAM [4] to lessen move, pitch and Z mistakes. X. Qian and C. Ye has propose another 3D object acknowledgment technique. The strategy sections a 3D point set into various planar fixes and concentrates the Inter-Plane Relationships (IPRs) for all patches. In light of the IPRs, the strategy decides the High Level Feature (HLF) for each fix. W. Burgard present a way to deal with concurrent limitation and mapping (SLAM) [9] for RGB-D cameras like the Microsoft Kinect. Our framework simultaneously gauges the direction of a hand-held Kinect and creates a thick 3D model of the earth. G. Osborne present a robot-helped wayfinding framework for the outwardly weakened in organized indoor conditions. The framework comprises of a portable automated guide and little inactive RFID sensors installed.

Existing system uses 3D-Camera's for continuous location and depth finding which is not feasible solution as the output may vary depending upon the lightning condition of indoor architecture and also it has the to calculate the location from processing the images which can errors due to the camera direction. [2]

III. SYSTEM ANALYSIS

Road route frameworks that depend on Global Positioning System (GPS) satellites are utilized by numerous individuals consistently. Lamentably, this sort of innovations must be utilized to explore in open spaces and are not accessible inside. It is a result of this that indoor route procedures utilizing Wi-Fi and Bluetooth signals, alongside successful situating calculations, have been an object of concentrate as of late.

Ideally, conveying an indoor route framework must be simple and practical. More often than not, signals got from Wi-Fi gadgets present in a building are utilized as reference, be that as it may, these are not intended to be utilized for this reason. It is a result of this that different advancements more qualified for indoor route, for example, Bluetooth Low Energy (BLE), might be a decent option.

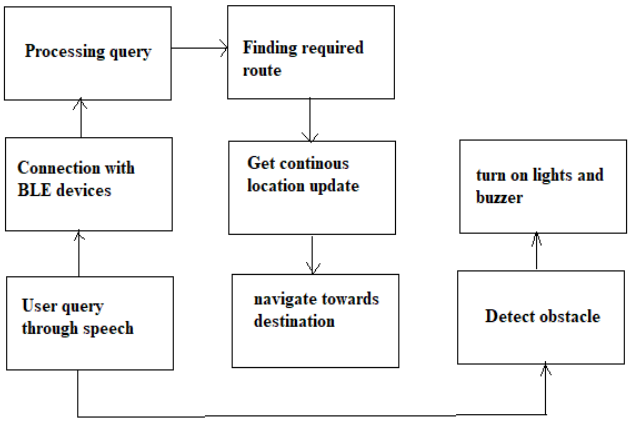

Fig. 1. System Architecture with basic modules

BLE is a subsystem of the conventional Bluetooth innovation fit for broadcasting information utilizing a negligible measure of intensity. This makes it perfect for gadgets working on little batteries which need to work continuous for significant lots of time. With the end goal of indoor route, [3] BLE gadgets known as guides appear to be the best decision. Signals are little gadgets that communicated bundles of information in brief time interims. These bundles contain data about the reference point, just as

telemetry readings ordinarily utilized in separation estimations.

Raspberry Pi gadgets, for example, tablets and cell phones can utilized to get BLE flags and read the communicated information, which thusly can utilized on indoor route applications. The frame of reference points, just as indoor situating frameworks that depend on them, has expanded eminently amid the most recent few years. Signals are modest when purchased in vast amounts and simple to set up. Moreover, Apple and Google have created committed guide conventions, which make overseeing and speaking with these a simple undertaking. For this undertaking, a raspbian application that enables clients to explore inside a building and get logical data produced. This application depends on data assembled from reference points and sensors incorporated into the Raspberry Pi gadget to work.

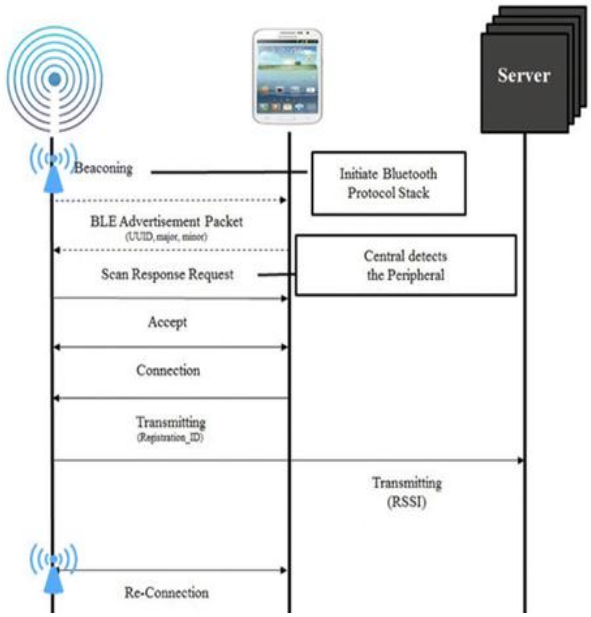

Figure. 2. Data Flow with beacon, user device, and server

The fundamental explanation behind building up this application is to more readily comprehend indoor route and show how cell phones can be utilized for this reason. To assess the execution of the proposed 3-D situating framework, we play out the explore different avenues regarding BLE signals, advanced cell, and server PCs as appeared in Figure. 2. It demonstrates the flagging procedure among reference points, a client (advanced mobile phone), and a server to play out the proposed situating framework. In the investigation, the server draws and communicates a circle, which depends on the deliberate reference points and demonstrates the area of a moving client. RSSI is utilized to quantify separates between a client gadget and a guide. The server is actualized with content based Node.js to give availability and light-weight the executives for the signals and raspbian information. The server has two capacities. The principal work is to express the deliberate signal on the web screen, and the other is to demonstrate the genuine area of a moving client in the communicated screen. The client gadget application is actualized with a PDA utilizing the raspbian OS. Since lower form of raspbian OS does not bolster BLE, we utilize an advanced cell that underpins the most recent raspbian adaptation. The client gadget can speak with guides through this application. Promoting bundles, which are occasionally transmitted by reference points, are examined by the client's Raspberry Pi gadget. At the point when the filtering procedure is finished, the gadget gets the demand of a reaction and makes an association with a guide. In association with this, the proposed strategy in application estimates the separation relying upon the flag quality of the publicizing bundle. In the actual implementation of the application, the user must be present in the range of at access point i.e. in it connected with BLE devices. Only then, his location can be determined. The actual implementation takes place in the following steps.

1. User is the location with BLE integrated complex.
2. Automatic voice input for the desired location after connecting with the BLE devices.
3. Once user input validated then system will process the path to navigate.
4. System will calculate the distance between each BLE device and user.
5. After user movement it will relocate the user current point using three-dimensional triangulation technique.
6. System will follow the step 4 and step 5 till user gets its desired location.
7. Meanwhile system is continuously recognizing the obstacle that comes in while navigating with the user.

IV. ALGORITHM

Algorithms 1: Fast SLAM Algorithm
Input: Current location from BLE.
Step 1: Extract from the environmental sensors characteristic points.
Step 2: Spike (Distances Measure Set from the beacon to the user location)
Step 3: RANSAC (Random Sampling Consensus- using k-NN verify distances)
Step 4: Scan-Matching (match with stored details)
Step 5: Geometric polygon extraction (Path / route mapping for specific location or point of interest POI)

Output;
Location distances of POIs from user current location.

Algorithms 2: k-NN Algorithm

In pattern recognition, the k-Nearest Neighbors algorithm (or k-NN for short) is a non-parametric method used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for classification or regression:

Step 1: In k-NN classification, the output is a class membership. An object is classified by a majority vote of its neighbors, with the object being assigned to the class most common among its k nearest neighbors (k is a positive integer, typically small). If k = 1, then the object is simply assigned to the class of that single nearest neighbor.

Step 2: In k-NN regression, the output is the property value for the object. This value is the average of the values of its k nearest neighbors.

Step 3: k-NN is a type of instance-based learning where the function is only approximated locally and all computation is deferred until classification. It can be used to assign weight to the contributions of the neighbors, so that the nearer neighbors contribute more to the average than the more distant ones.

Step 4: The neighbors are taken from a set of objects for which the class (for k-NN classification) or the object property value (for k-NN regression) is known. This can be thought of as the training set for the algorithm, though no external training step is required.\\ Step 5: The k-NN algorithm is used to determine the nearest artifact from the user's location. The user's current RSSI values are queried and the current values are compared with the training set database. The k- nearest neighbor algorithm will be implemented on the training dataset to find the artifact having RSSI values nearest to the user's parameter.

V. MATHEMATICAL MODEL

Our problem statement comes under the polynomial class according to definition of polynomial class; the problem is solved in P-time. So above two deterministic algorithms called P-class algorithms.
Set: S=I, P, O
Where, I= Set of Inputs for our system
P= Set of Processes
O= Set of Outputs
Input (I):

I= {I1, I2, I3,}
Where,
I1: userid,
I2: Input Location
I3: point of interest
Process (P):
P= {P1, P2, P3, P4}

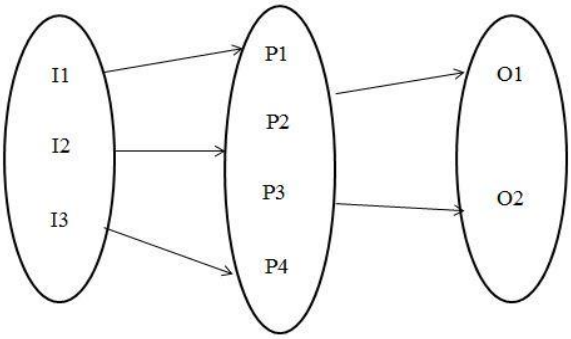

Figure. 3. Venn Diagram

Where,
P1: obstacle detection
P2: Voice input processing
P3: find key route navigation
P4: Process the location data to find the distances
Output (O):
O= {O1,O2}
Where,
O1: Obstacle detection
O2: User navigation
Figure 3 shows two side by side images for obstacle detection. Figure 3(a) show led light, buzzer and UNO sonar sensor devices without any obstacle in the picture, and Figure 3(b). shows the same setup with obstacle detection.

VI. RESULT AND DISCUSSION

3(a). Without obstacle 3(b). With obstacle

Figure 3. Obstacle Detection

When obstacle is detected then then light gets blow and buzzer plays sounds.

Table 1. Range Vs Accuracy

	Range1	Range2	Range3	Range4	Range5
Attempt1	5	10	20	21	26

Attempt2	6	12	16	24	28
Attempt3	8	11	18	25	29
Attempt4	7	15	19	23	30
Attempt5	6	13	17	22	27

As the table shows various attempt made by users' for analyzing output of the system in the following manner there are two axes taken viz. x-axis and y-axis for the attempt vs range accuracy. So as for the first attempt the input distances is compared with different distances and checked whether it shows correct output or not. As we have seen from the table that the hardware efficiency and code optimization will take the output up to 30cm long. And still it shows 100\% output, due to hardware limitation after 30cm or at the particular distance it won't shows the buzzer and LED indication as obstacle is far away from the user to get interact with system. To avoid collision system will calculate necessary actions shows alert to user.

Figure 3. shows the Practical Setup and Output of the first module of the proposed system which detection of obstacle, here we have analyzed the results between the distance of the obstacle and user and how accurately system will detect that obstacle and react to the user. As the practical result shows that system is more accurate and gives output in milli seconds.

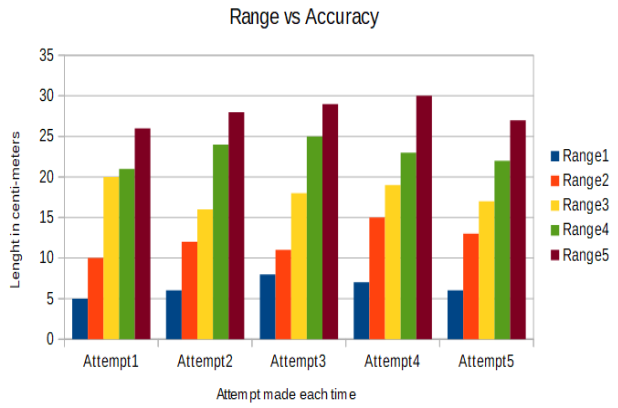

Figure 4. Graphical Result analysis

VII. CONCLUSION

An indoor location-based control system that provides services by estimating user's indoor locations has been implemented in this study (First scenario). The processing unit will estimate the location and navigation route by using BLE triangulation and COG (Center of Gravity) calculation for the hexagonal indoor spaces. The user application delivers the RSSI data to the server. Using this RSSI signals user is located to the exact location and due to its very easy to calibrate the data to form a navigation route between user query and user. Also system feature an obstacle detection module which must have functionality for visually impaired person. The key to a robust localization system is the accuracy so that we have proposed a method that selects the target of trilateration within the hexagonal basic unit space to increase the accuracy. Since proposed system uses Bluetooth Low Energy signals, therefore it consumes less battery power. In our project we have implemented more accurate cost efficient approach to indoor navigation.

ACKNOWLEDGMENT

I dedicate all my works to my esteemed guide, Prof. J. V. Shinde, whose interest and guidance helped me to complete the work successfully. This experience will always steer me to do my work perfectly and professionally. I also extend my gratitude to Dr. N. R. Wankhade (H.O.D. Computer Department) who has provided facilities to explore the subject with more enthusiasm. I express my immense pleasure and thankfulness to all the teachers and staff of the Department of Computer Engineering, for their co-operation and support. Last but not the least, I thank all others, and especially my friends who in one way or another helped me in the successful completion of this paper.

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Authors Profile

Miss. Kalyani P. Mule pursed Diploma in Information Technology from P.R.E.C. Loni of SSPU and Bachelor of Engineering in Information Technology from Sanjivani College of Engineering of SSPU .She is currently pursuing ME .

Prof. Jayashri V. Shinde Assistant Professor Computer Engineering Department ME(CSE) ,Ph. D (Pursuing) Recognized PG Teacher, Pune University, also had completed M. E. (CSE.) from SRTMU Nanded. Already having expertise in Object oriented modeling and Design Theory of Computation, Computer Networks Artificial Intelligence, Digital Electronics & Logic Design Computer Organization, Data Structures and Algorithm Data Structures, Microprocessor based system Microprocessor and Microcontroller.

