Smart Tourism using Augmented Reality and Beacon Technology

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***Abstract*—Tourism is one of the world's largest economic sectors and is the third largest category of export after fuel and chemicals. As technology advances, smartphones and mobiles are growing faster and access to the internet and geolocation is easier. Tourists have to access information about destinations using online websites, booklets, maps, etc., or they can hire tour guides by paying an additional charge which is not affordable for all tourists. However, this search for information is very time consuming and tedious. Also, the visitor's interests are not adequately met by the information provided. To overcome all these challenges, a mobile app based on augmented reality can be used to explore nearby places. The system will make use of smartphone cameras and geo-location of the person. In this AR-based system, navigation will be provided, and with the help of AR objects, the system will present different points of interests. This mobile app also allows users to explore the indoor spaces, such as museums, temples, and palaces. Using beacons, you can navigate indoor spaces by displaying information about a particular point as the person approaches the beacon. Indoor navigation is facilitated by beacons, which are used to explore and navigate indoor spaces. In essence, the system replaces the tourist guide with a virtual guide.**

***Keywords*—AR, Tourism, Beacons, Virtual tourist guide.**

I. Introduction

Tourism is vital for the success of many economies around the world. The purpose of this system is to increase the tourist experience by providing him real-time navigation with relevant information. This system targets enhancing tourist satisfaction with the use of innovative technologies towards travel and tourism. In the modern world, people have a very tight schedule in their day-to-day life and hence for a change in their regular routine, they plan to visit new places and explore new destinations. For this, they have to plan out their tour with some tourist agencies which is very time-consuming and expensive. Moreover, on reaching a particular destination tourists face many difficulties in navigating to different places, language barriers, difficulty selecting appropriate destinations to visit, etc. The system gives tourists the ability to decide their destination based on their interest by providing information about nearby places in AR popups. When a person reaches a particular destination, he is able to get information about that place just by pointing the camera at the destination. He is able to get the information in text form as well as audio format. The indoor navigator helps the tourist to explore the destination by providing the route in AR format and helps him to explore different points of the destination the same as the tourist guide. Outdoor navigation helps the tourist to navigate from one destination to another destination. The main purpose of implementing this system is to provide valuable information to the visitor of the destination

A. Overview

Tourism is one of the largest economic sectors of a country. Due to the increase in technology, it is easy for a person to access internet services at any time and from anywhere. In tourism, tourists are using the web for searching information about the place, look for the best place to visit, use maps for locations, etc. The person has to depend on tours and travel services for booking, visiting different destinations, etc. The terms and travel agency also arrange a tour guide for tourists and this may disturb the privacy of a person.

Moreover, the tour guide will make the tourist travel to destinations that are disliked by tourists. When the tourist lands in a new city, he always finds it difficult to find good places, hotels, lodging, etc or find the best short route to reach a particular destination. This happens due to language barriers or lack of hospitality. Also, the tourist has time constraints but he wants to explore the new city as much as he can without getting bored. Moreover, if the person wants to explore a particular destination (indoors), he has to depend on the travel guide or he has to read the information himself. To overcome all such issues, there should be a single solution that should be easy to interact with.

B. *Objective*

- To enhance and intensify the tourist experience by providing an AR view to the tourist.
- To Provide real-time navigation that allows the user to choose the best routes and nearby destinations.
- To deliver platform-independent software applications that are compatible with both Android and IOS

II. LITERATURE SURVEY

This research project showed how a smartphone application may be used to make grocery shopping and outdoor shopping smart and simple. Due to their dissatisfaction with the supermarkets' infrastructure and their poor understanding of the quality and specifics of the products, the majority of customers have trouble finding the products inside the supermarkets. If they can't find what they're looking for there, they usually go to another store to try to find it. Although the goods are kept in racks and other storage areas with labels, people still struggle to find the items they need within supermarkets because of the vast space and abundance of products and goods. The final goal of this research is to create a mobile application that will address all of the aforementioned problems encountered by customers and enhance the level of service provided by online retailers.[1]

This paper the development of an Android indoor navigation system using Bluetooth beacons. Radio frequency signals that are emitted by Bluetooth beacons can be utilised to calculate distance. The user's location is presumed based on their separation from the beacons. The shortest path algorithm of Dijkstra was used to route planning. There were two navigable interfaces created. The applicability of the offered Indoor Navigation Application is supported by experimental findings. There are five main steps in the positioning algorithm: The Received Signal Strength Indication (RSSI) for each beacon is measured and filtered in the initial stage. The Log-Distance Path Loss Model then calculates the separation between each beacon using the mean of the RSSI measurements. The technique calculates the user's actual coordinates in the third phase using the user-device distance. The user's position is estimated in the following phase. The application uses proportional division to determine the user's position if they are in between beacons. The position of the phone is anticipated to be on the other side of the beacon if the user only sees one transmitter or if the second one is too far away. The determined position is then allocated to the database's closest position in the last phase. To record information about positions, edges, rooms, beacons, and persons, a database was created.[2]

This paper aims to develop the kind of advertising that facilitates circulation inside the home using augmented reality. The concept of augmented reality is the transmission of the real world to a production through some form of sensory input, like as sound or graphics. Since practically all modern smartphones come with a camera and the processing power to turn photos into other graphics, this software is made just for them. The Android SDK and the Vuforia Augmented Reality SDK were both used in the creation of this programme. [3]

This study introduces an indoor navigation system with BLE beacons. An Android application was created to gather the signal in order to measure system accuracy. Wireless and smartphone-integrated indoor positioning technology is being developed. Additionally, a compact, static Kalman filter was created to enhance the model's location accuracy. The size and location of the geo-fence have an impact on the precision that can be achieved, according to testing data. In the investigated context, the addition of a static Kalman filter can increase location accuracy by up to 78.9%. Signal noise is more noticeable the closer the beacons are to one another. Therefore, a larger indoor area is where this technology works best. [4]

This paper deals with the chance to use BLE beacons within indoor navigation in conjunction with a changed version of the Kalman filter as an associate degree economical means for noise elimination. The localization is predicated on the activity of the supposed received signal strength, which ends within the position calculation of a BLE signal receiver. The projected navigation system is finalized by making a navigation map victimization BLE beacons and a depth detector and. during this paper, it had been used for navigation of a mobile mechanism. A series of experiments was done and also the most important results square measured delineate and summarized.[5]

III. METHODOLOGY

A. *System Architecture*

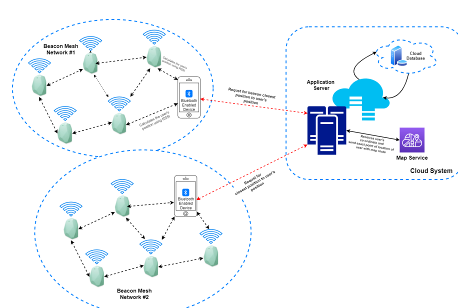


Fig. 1: Beacon's Mesh Network

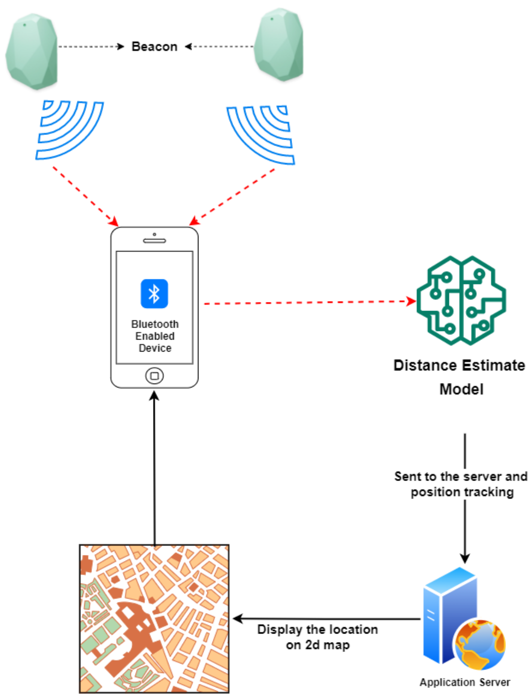


Fig. 2: Distance Estimate Model

B. *Working:*

The indoor navigation system's flow is depicted in the diagrams above. In Fig. No.1, a mesh network of beacons will be used to determine the tourist's precise location. The actual distance between beacons will be estimated when the device is in range of them using the RSSI value, and the tourist's position will be derived using that information, for this Distance Estimate Model will be used. As shown in Fig. No 2. The Distance Estimate Model technique will be used here for location tracking. The position of the visitor will be sent to the application server after position tracking. The location of the tourist will be located on the organization's map based on that. A produced map and an AR-derived navigation path to the visitor's destination will then be sent to their smartphone.

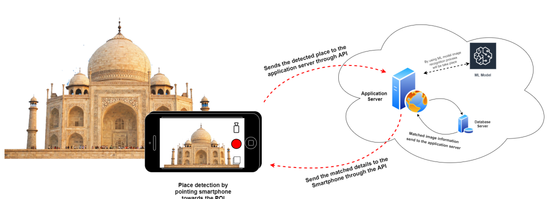


Fig. 3: Place Recognition System

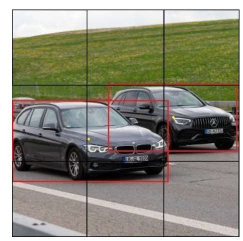
Our system also has a Place Recognition Module that allows visitors to just point their smartphone camera at a location or landmark, and the system will send a request to the application server on their behalf. The YOLO model will be used by the application server to identify the location, and based on that, the database will be queried for relevant information about the location. Using the AR Core Engine, the retrieved data will be delivered to a tourist device in an AR object.

IV. Algorithm

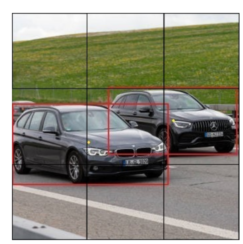
A. *YOLO v5 Algorithm : You Only Look Once*

Step 1: First, YOLO accepts an image as input.

Step 2: The framework then creates grids from the input image (say a 3 X 3 grid).



Step 3: The image has been divided into a grid of 3 x 3 squares, and there are three classes in all into which we want the objects to be categorised. Let's say the classes are, respectively, Pedestrian, Car, and Motorcycle. Consequently, the label y for each grid cell will be an eight-dimensional vector:

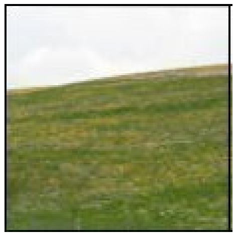


Here,

- pc (which is the probability) determines if an object is present in the grid or not.
- bx, by, bh, and bw provide the bounding box if an object is there;
- c1, c2, and c3 represent the classes. As a result, c2 = 1 and c1, c3 will be 0, if the item is a car.

$$y = \begin{bmatrix} pc \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

Step 4: Suppose we choose the first grid from the image:



pc will be zero and the y label for this grid will be since there is nothing in this grid.

y =	0
	?
	?
	?
	?
	?
	?
	?

'?' indicates that since there is no object in the grid, it is irrelevant what bx, by, bh, bw, c1, c2, and c3 contain.

Step 5: Let's take another grid in which we have a car (c2 = 1):

Step 6: In this grid, pc will be equal to 1, and the values of bx, by, bh, and bw will be determined in relation to the specific grid cell in question. Car being the second class, c1 and c3 are equal to 0, and c2 is equal to 1. We will therefore obtain an eight-dimensional output vector for each of the nine grids. The final product will be 3 X 3 X 8.

y =	1
	b_x
	b_y
	b_h
	b_w
	c_1
	c_2
	c_3

Step 7: Determine bx, by, bh, and bw with relation to the grid cells. Think about the grid on the center-right, which has a car in it. Therefore, just this grid will be used to calculate bx, by, bh, and bw. This grid's y label will read:

Since there is object in this grid, pc will be 1

y =	1
	b_x
	b_y
	b_h
	b_w
	c_1
	c_2
	c_3

pc = 1 Given that there is a car in this grid and that there is an object there, c2 = 1.

Step 8: Let's now examine how to choose bx, by, bh, and bw. The coordinates given to each grid in YOLO are:

Step 9: The midpoint of the item with relation to this grid is indicated by the coordinates bx, by, which are in x and y. It will be (approximately) bx = 0.1 and by = 0.3 in this instance.:

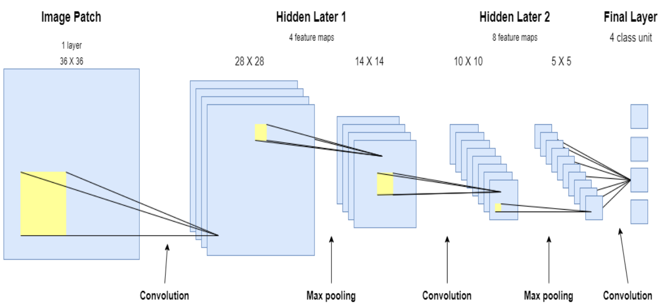
Step 10: The height of the bounding box (the red box in the example above) divided by the height of the corresponding grid cell, or bh, is approximately 0.9 in our case. So, bh = 0.8. The width of the bounding box to the width of the grid cell is expressed as a ratio, or bw. So, bw = 0.7 (roughly). This grid's y label will read:

Here,
Since the midpoint is always inside the grid, bx and by will always fall between 0 and 1.
- If the bounding box's dimensions are greater than the grid's dimensions, bh and bw may both be greater than 1.

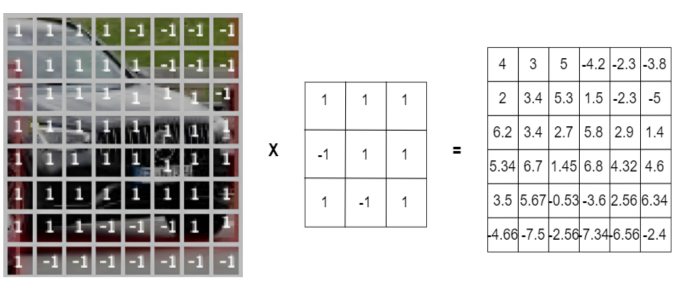
$$y = \begin{bmatrix} 1 \\ 0.1 \\ 0.3 \\ 0.8 \\ 0.7 \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

Step 11: Thus, we currently have a goal vector and an input image. Our model will be trained as follows using the example above (input image - 344 X 344 X 3, output - 3 X 3 X 8):

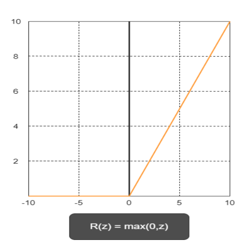
Neural Network Model Training:



1. Convolutional layers perform a convolution operation on the input before sending the results to the layer below. This is where the removal of useful components from an image starts. The convolution operation in a convolution layer is carried out by several filters working together. Each image can be considered as a matrix of pixel values.



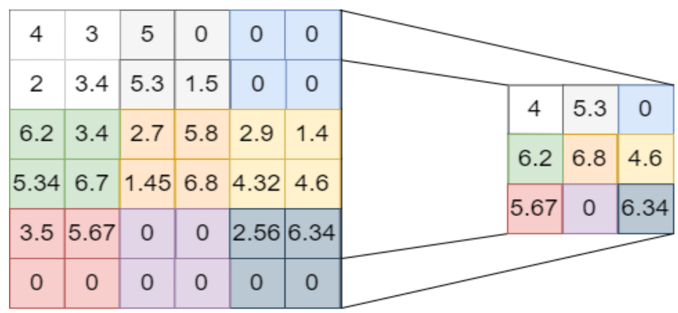
2. ReLU Layer abbreviates for rectified linear unit.The feature maps must then be transferred to a ReLU layer after being retrieved. ReLU carries out a task, converting each negative pixel to 0 one at a time. The final result, a rectified feature map, gives the network non-linearity.



4	3	5	0	0	0
2	3.4	5.3	1.5	0	0
6.2	3.4	2.7	5.8	2.9	1.4
5.34	6.7	1.45	6.8	4.32	4.6
3.5	5.67	0	0	2.56	6.34
0	0	0	0	0	0

Fig. 4: Replacing negative values with 0

3. After each individual convolutional layer, **Max Pooling** is a type of operation that is often applied to CNNs. Max pooling decreases the dimensionality of pictures when it is added to a model by lowering the amount of pixels in the output from the previous convolutional layer.



B. *Algorithm to calculate user's position using Beacon:*

Step 1: Start
Step 2: Get RSSI from device
Step 3: Filter out the inconsistencies RSSI-s
Step 4: Calculate the known distance based on the average RSSI, with Log-Loss distance model
Step 5: Calculate the real distance from the beacon
Step 6: If use in between beacons then calculate proportional division
Step 7: Else current user's position
Step 8: Determine the closest beacon position to the user's position
Step 9: Stop

Acknowledgment

We would like to thank the entire Computer Department faculty of our college for their generous support and encouragement. We are indeed delighted for their time, valuable and skillful guidance and assessment from time to time. We would also like extend our heartfelt gratitude to our guide
Asst. Prof., P. R. Pachorkar for her constant support and for her timely guidance, inspiration and administrative support without which our work would not have been completed. We express our deep sense of gratitude towards all the staff of the Computer Department.

CONCLUSION

Tourists constitute the third largest export category after fuels and chemicals, making tourism one of the most important economic sectors. Using this application, tourists can enjoy tourism more comfortably. Tourists can use this application to choose a destination based on their interests. With the assistance of AR, the app will guide the tourist through an AR interface by showing him directions with AR objects. Using the app's object recognition, the user will be able to obtain information about the location where the user's camera is pointing. In addition to multimedia, the application will also offer audio information about the location. Tourists can explore places in a particular destination using the app, which acts as a tourist guide. Moreover, if the destination is a palace or a museum then for navigating the indoor spaces BLE beacons are used. A BLE beacon finds out the user's position and displays information depending on the position depending on where you are in the world. The beacons find out the user's coordinates and assist the app in identifying the location. This application provides tourists with accurate information about the destination and assists them in exploring it.

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