Indoor Navigation Using Augmented Reality

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Abstract

Whenever People visit places like hospitals, museums, and colleges, they find it difficult to navigate to a particular location. Using GPS for indoor navigation is impossible because GPS-enabled smartphones are typically accurate within a 4.9 m (16 ft.) radius in an outdoor environment. Their accuracy reduces near buildings, bridges, and trees. Sometimes these places provide a 2D static map for navigation, but it is difficult to interpret. Augmented reality is a technology that superimposes a computer-generated image on user view in the real-world. The basic idea is to improve indoor navigation using Augmented Reality. The proposed application used to locate a particular room in an indoor location. The application shows directions using a 3D model and 2D map, and it also provides instructions to reach the particular room on the website. The product provides a more accurate result than paper-based but less accurate than Wi-Fi-based. It is a stable and more convenient way for indoor navigation.

1. INTRODUCTION

We introduce Indoor Navigation System for navigation in university, offices and other indoor location. This app doesn't need any external hardware like WIFI or Bluetooth beacons for navigation. But it requires the target image for navigation. User needs to select the room where the user wants to go and then scan the nearest target image. We can use the room's exiting features as a target image or create a unique target image for each room. The indoor navigation requires accuracy of up to 1 or 2 meters so we cannot use GPS for indoor navigation. User can click on the virtual button to open the webpage, which contains step by step information to reach the destination. When the user scans the target image, the system considers it as the user's current location and shows path accordingly.

1.1. Need and Motivation

Navigation systems have been widely used in outdoor environments, but indoor navigation systems are still in the early development stages.[2] Static maps do not help to navigate a particular location from its current location.

1.2. Existing System

Most of the systems use WIFI and Bluetooth Beacons for navigation. WIFI signals are used as a fingerprint to collect data about the path to the destination. It also uses a magnetometer, barometer, and Gyroscope to identify the guide's motion during the trip, such as turns, going upstairs/downstairs, steps, walking/stop status, etc.[1] In Bluetooth beacons, devices are used to detect signals coming from the Bluetooth Beacons and mark devices' locations. All these methods require external Infrastructure and maintenance of external devices for navigation. Malls also provide 2D maps at some locations for navigation inside the mall. User first needs to find the 2D map for navigation and interpretation in the real world. Users need to remember a complete path for navigation or use the 2D map again for navigation. But the maps provided in malls are general maps, not for a specific location so they are hard to interpret.

Disadvantages of Existing System:

- The bluetooth-based system requires an external device for all real-time processing which makes it expensive and inconvenient.
- 2D maps are not suitable for navigation to a specific location, and they are hard to interpret in the real world.
- GPS is not accurate in the indoor location for navigation.
- WIFI-based systems are inaccurate for navigation in an indoor environment.

1.3. Proposed System

The proposed application will help the user to navigate inside a closed premise or any building. For easy navigation, we have used augmented reality to show the user's direction. The application will contain buttons named with the room names. The user needs to select the desired location where he wants to go. After selecting the destination, user must scan the nearby target image using their phone camera inside the application to get their current location. Each room has a unique target image associated with it. Target

images can be anything a picture, a barcode, a QR code, or a string alphabet and/or digit. A target image must have distinct feature points that can be used to differentiate between two target images. In the proposed application, we have given each room a unique name and a different font style, which make them distinct from each other. After scanning the target image, the camera will capture the image's feature points and process them to determine which image was scanned and the current position of the user.

After scanning, the target image user will see 3D arrows on its phone screen indicating left or right direction and descriptive texts. User must follow the 3D arrow to reach the destination room. To manage the scanned target images and augment 3D objects into the real world, we have used Unity Application to build and augment AR. Unity provides a web application where we have to upload the target images, and based on the number of feature points, the image is rated out of five. More the number of features will be several ratings, which shows a better possibility of image for getting recognized by unity application.

On recognizing the target image, the unity framework will load the load based on the user's current location and the destination he had selected. Whenever the user feels like he is going in the wrong direction, he can ensure the correct direction by scanning the target image again. The application will show the path based on the current location to the user-selected destination. The proposed application provides an interactive way to read maps and understand the direction that can be quite challenging for a kid or old people to interpret the 2D static maps and remember the directions. The block diagram below shows the functioning of the AR navigator.

2. RELATED WORK

2.1. Peer-to-Peer Indoor Navigation using Smartphones

Peer-to-Peer Indoor Navigation system collects user data every time users walk through the same path to generate hints to navigate the user next time on the same path. Any user traveled through a path collects trace information and shares it with other users [1]. A person may collect trace data for other user's or use data provided by another user to navigate on a path it depends on whether previous data is available for that path or not. It uses Wi-Fi signals as a fingerprint to collect data about the path to the destination. It also uses a magnetometer, barometer, and Gyroscope to identify the current user position, orientation, speed of walking, whether a person is in motion or stationary, etc.[1]

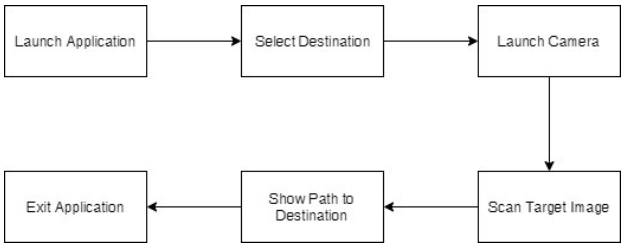

Figure 1: Proposed System Block Diagram

2.2. Bluetooth-based Indoor Navigation Mobile System

Bluetooth-based indoor navigation uses Bluetooth beacons for navigation. Bluetooth beacons emit radio frequency signals used to calculate the user's distance from the Bluetooth Beacon [4]. Based on the distance, the user location is calculated. Dijkstra's algorithm is used to find the shortest path from source to destination.[4]

3. WORKFLOW OF SYSTEM

The sequence diagram has depicted our system working. The user in this system is the one using the application, the system is of the android application consisting buttons used by the user and the camera used to scan the target images, while the backend is the Unity Engine which will augment the 3D objects and provide a visual representation for directions with descriptive texts.

4. METHODOLOGY

The methodology used in this Indoor Navigation system use image processing and computer vision. In this approach, the user selects the destination and scan the nearby target image. Scanning the target image features gives the user's source location that would be used to show the path from source to destination.

The simple target image detection consist of the following steps:

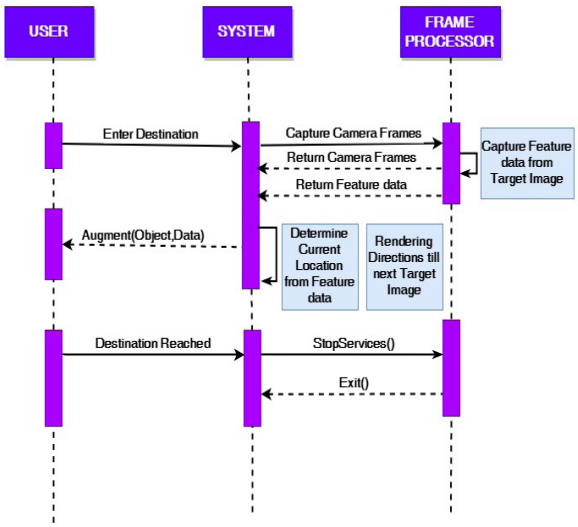

Figure 2: System workflow

1. Image acquisition.
2. Pre-processing of the image.
3. Feature detection.
4. Comparing the detected feature with existing features present in the system database.
5. Showing the result, i.e., a path from source to destination.

5. IMPLEMENTATION

5.1. Home Screen

On Home Screen, there are buttons for all classrooms/labs present in the college. Firstly, the user needs to select a classroom/lab where the user wants to reach.

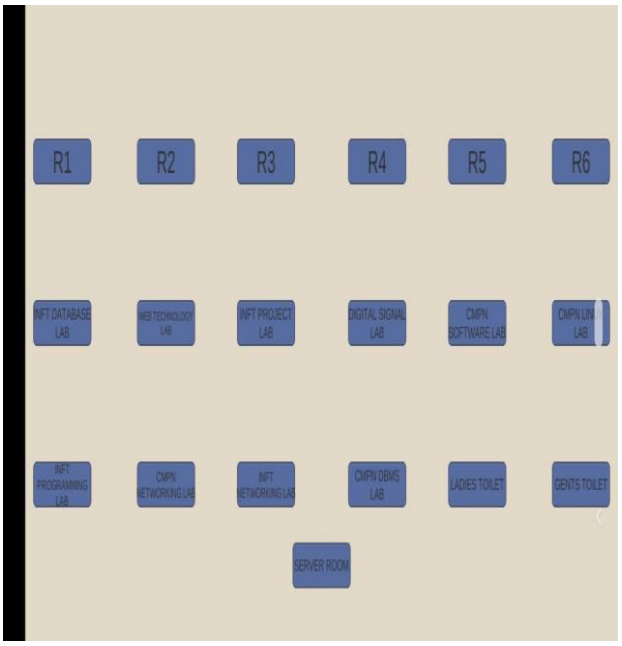

Figure 3: Home screen

Figure 4: Target image

5.2. Target Images

Target Images are unique images for each classroom/lab. It will present outside each classroom/lab The user needs to scan these target images, which acts as a source classroom/lab. There is a virtual button present on the target image that will take the user to the browser for monitoring the path.

5.3. Directions

When a user scans a nearby target image, then the path from source i.e., current classroom/lab, to the destination i.e., desire classroom/lab, will display on the screen.

5.4. Monitoring System

It is a website that is responsible for monitoring the path from the source, i.e., current classroom/lab, to the destination, i.e., desire classroom/lab. On the website, there are steps for reaching the destination. After completing each step, user need to click on that step. On clicking, that step will disappear. The user needs to follow all the steps to reach the desire destination.

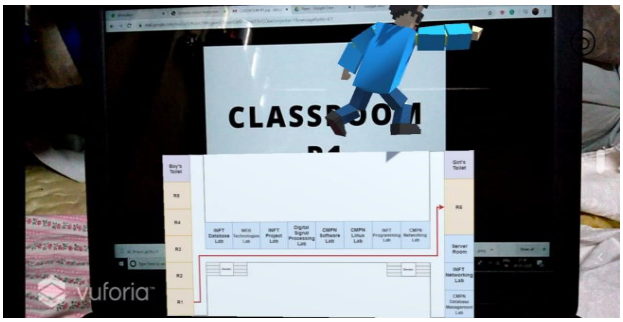

Figure 5: Directions

Figure 6: Monitoring system

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6. COMPARATIVE STUDY

Table 1: Comparative study between paper based, AR based and WIFI based techniques

	PAPER BASED	*AR BASED*	*WIFI BASED*
COST	Very Low as compared AR and Wi-Fi Based	Moderate cost as compared to Wi-Fi Based Navigation	Higher as required hardware installations.
ACCURACY	Low accuracy due to non-interactive design.	Better than paper but less accurate than Wi-Fi Based.	More accurate than AR Based by providing Real-time Tracking
CONVENIENCE	Least convenient as the user has to interpret itself	Better than paper and Wi-Fi-based by providing an interactive interface and is independent of any networking device.	Better than Paper-Based but require routers for navigation.

7. CONCLUSION

As we know, all available techniques are very inaccurate and expensive. They require external hardware and also require high processing power for navigation. They also use a GPS for navigation, but they are inaccurate indoor locations. 2D maps are hard to interpret in the real-world as they not for the specific location; they are for all locations. We avoid the use of external devices for navigation, so our system is cost-effective. Our system makes use of 2D maps for a specific location and proves to be a feasible approach. This will create a promising effect on the applications of navigation challenges faced by people.

8. REFERENCES

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