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Indoor Mapping Based on Augmented Reality Using Unity Engine

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Abstract:- Every people, at some point in their life, may get lost inside a large auditorium, struggled to find their exit point at the airport, or may get late to a lecture because they couldn't find the right lecture hall at the university. But this way of getting lost inside complex and large venues could soon be a thing of the past. Nowadays, applications for indoor navigation for mobile devices are being common and they are needed for the people to find destinations inside large buildings. Different technologies like Wi-Fi Fingerprinting and Bluetooth Beacons are being utilized by most of the indoor navigation applications. These applications use pre-calculated paths and fixed background maps to lead the user to their destinations. Users of these systems need to have an understanding of how specifically indoor maps work and general map reading signals. Also, complex and accurate calculations are needed to be implemented by these systems to determine the routing paths before the navigation starts which could be affected by the unstable Wi-Fi signals. Meet Indoor Maps the next generation of indoor navigation. In this paper, we put forward an indoor mapping which is extended to 3D feature with Augmented Reality, with a growing concern on commerce and general wayfinding.

I. INTRODUCTION

Indoor Navigation or Mapping is a revolutionary concept that visualizes indoor venue and spatial data on a digital 2-Dimensional or 3-Dimensional map. It allows us to navigate through colleges, large malls, hospitals, auditoriums, etc.

In terms of complexity, Indoor Navigation is quite different compared to Outdoor Navigation. In the case of outdoor navigation, millions of people use the currently available technology like GPS as it does require much performance. Nowadays, built-in GPS and maps are found in modern smartwatches and smartphones. On the other hand, AR indoor navigation technology is quite complex as it consists of 3 modules that have to be categorized into the mapping of premises, populating the database, and user interface design. Augmented Reality (AR) depends on a dynamic, accurate 3D map that will enable experiences in the real-world. Showing people, assets, and places on a digital map enable solutions such as indoor navigation and indoor positioning.

AR Indoor navigation can be implemented using handheld devices like Google Glass [1] which are costly whereas the application discussed in this project is cost-efficient. The scope of this application lies in developing map databases for environments such as colleges, shopping malls, auditoriums, etc. Augmented Reality can be experienced when an image generated from the computer is being projected in the user's environment. It can be seen as a way of blurring the lines between the digital and the real world by superimposing virtual images within the contents of the real world.

II. EXISTING SYSTEMS

There are two existing systems for indoor mapping which are Indoor mapping based on Bluetooth Beacons and Indoor Mapping based on Wi-Fi Fingerprinting using RSSI.

Bluetooth Beacons [2] are hardware transmitters. They are Bluetooth low energy devices that broadcast their identifier to the portable electronic devices nearby. The technology in these beacons enable tablets, smartphones, and other devices to perform actions when they are near to the beacons. To transmit a universally unique identifier, Bluetooth Beacons use Bluetooth low energy proximity sensing. These identifiers are then picked up by a compatible application or an operating system. Several bytes are also been sent together with the identifiers that can be used to determine the device's physical location, track the customers, or can also trigger a location-based action on the device such as a check-in on the social media or a path notification.

Wi-Fi Fingerprinting using RSSI is another existing system. RSSI is the acronym for the Received Signal Strength Indicator [3]. To the naked eyes, they are usually invisible. The power present inside the received radio signal can be measured using RSSI. Traditional finger printing is also RSSI-based, but there is a slight difference. There are several access points in traditional fingerprinting and it has relied simply on the recording of the signal strength from these access points that are in range. This information is then stored in a database along with the client device's known coordinates in an offline phase. This stored information can be probabilistic or deterministic.

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III. PROPOSED METHODOLOGY

The main objective of this Augmented Reality based indoor navigation is to develop an application that can be used to map indoor spaces more accurately for indoor navigation. The project focuses to build a flexible as well as a robust smartphone-based indoor navigation system that has the following features:

- High Accuracy: The application should be able to guide the user to their destinations within a reasonable distance consistently.
- Low-cost: The installation cost should be less. To obtain accurate data positioning, the application should not require any expensive changes to the infrastructure.
- Pre-loaded indoor maps: There should be a pre-loaded map in the application which helps the user to navigate easily.
- Intuitive user interface (UI): There should be an easy-to-use User Interface for the user in the application that hints navigation details correctly based on the current state of the user.

For this indoor navigation, different technologies like Placenote SDK [4], Unity Game Engine [5], and XCode IDE are used. Placenote SDK(Software Development Kit) allows us to build and deploy spatial apps easily on the mobile. This SDK includes several open-source sample projects. Placenote provides a path to a huge area of AR applications such as indoor navigation, digital information overlays, and multiplayer gaming. Unity Game Engine is another technology used which is a cross-platform game engine that helps to create games in 2D, 3D, and virtual and augmented reality as well as simulations and other experiences. The XCode IDE is also used in this navigation which provides declarative syntax, design tools, and live mode.

IV. SOFTWARE IMPLEMENTATION

Placenote is an SDK used to build spatial apps for iOS. It helps in localizing indoor positions such as rooms by scanning the surroundings. Placenote also helps to add different 3D objects to the localized area and store these in Placenote server. The addition, storage, and retrieval of this data to the Placenote cloud is free and uses a unique API key. This SDK is compatible with Unity 3D application which is mainly used to develop games. Unity is not only limited to game development but also you can create mobile applications with the help of various SDKs. Unity uses C# language. We have designed different 3D objects using unity and the definition of these objects is designed using C#. In unity, we need to import Placenote package from assets. This package offers different functions such as scanning and localizing. We create different scenes in unity for different purposes such as saving the map, loading the map, etc. As we are doing it on the iOS platform, we have to export it to XCode. Unity has the option to export directly to XCode and from XCode, the application is deployed to the phone. There are two scenarios in this project.

- *Saving the Map*

The first scenario in our project was to populate the database, which is saving different paths to different locations inside a building, ex Restroom, hall, etc. The flowchart of this scenario is depicted in Figure 1. The paths are stored in Placenote's cloud storage as metadata which is shown in Figure 2. Placenote provides a unique API key for the user so that this stored data is reusable. In our project, we mapped a path by walking from a starting point to a destination point and saved it with a specific name. For mapping these paths, we have designed 3D nodes which can be seen in Figure 3 and a different destination node. These nodes are dropped while walking and with the help of Placenote, each node is saved with its location to the previous node.

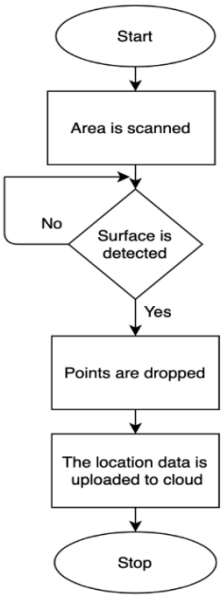

Fig 1:- Flowchart of Saving the Map

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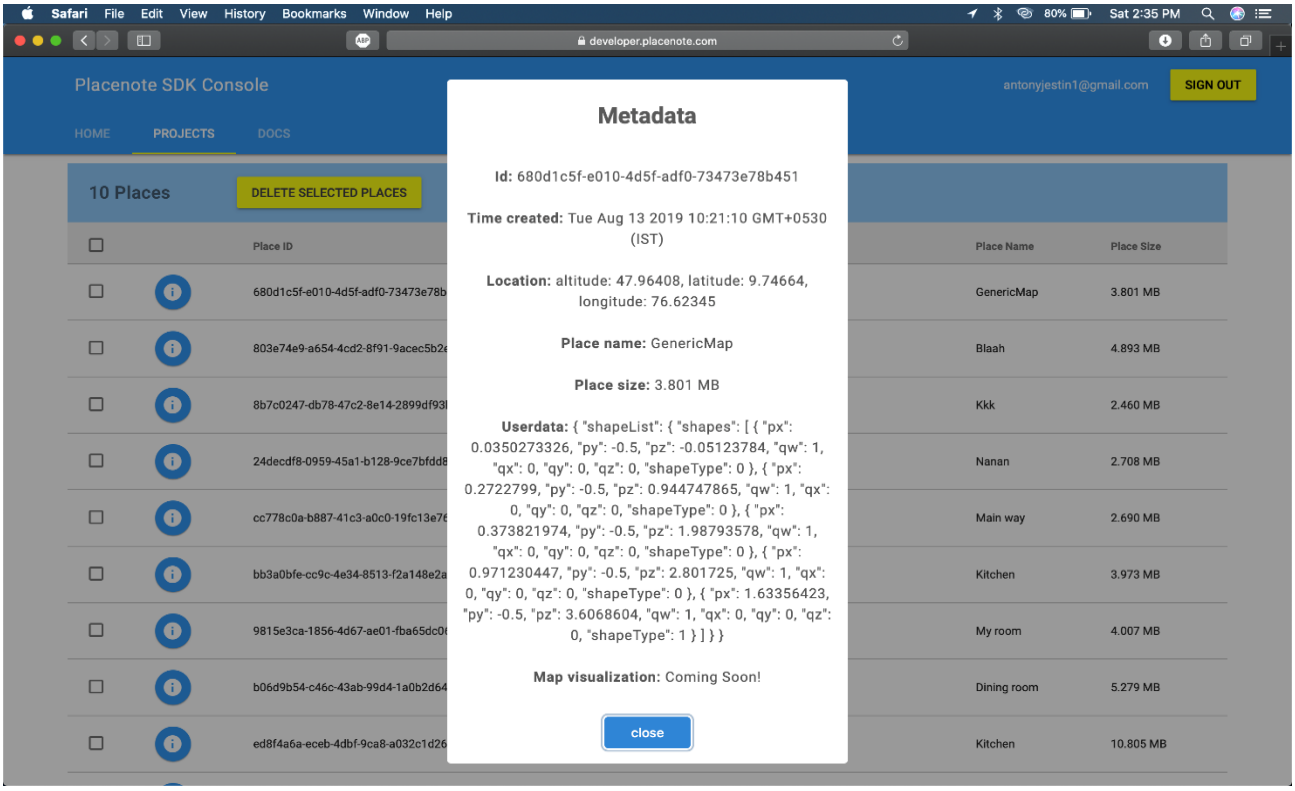

Fig 2:- Storing of paths as Metadata

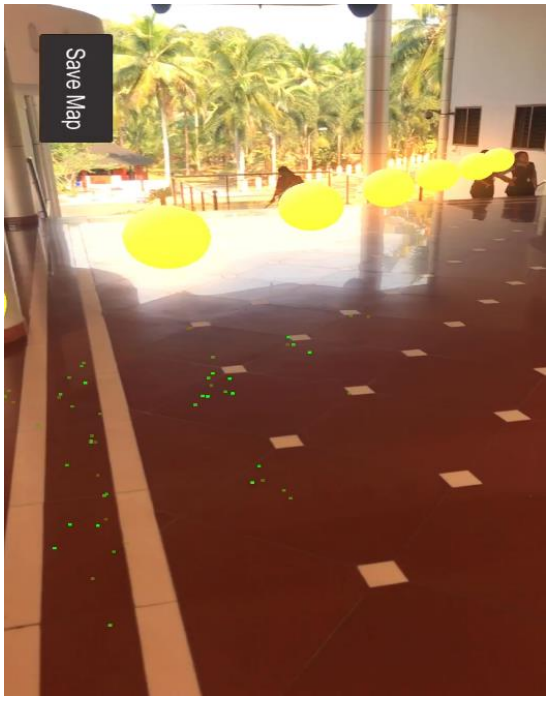

Fig 3:- Saving the Map

➢ *Loading the Map*

Loading of the map can be depicted using a flowchart which is shown in Figure 4. When we load the map, there will be a search option available, where we can enter the name of the destination. By entering the destination which is already stored in the Placenote server. The application will begin to scan the areas that we previously scanned and the device will localize. After localizing the nodes that we have dropped during the save map scenario will be transformed to Arrowheads as shown in Figure 5. These arrowheads will show the path to the destination. It does not show the whole path because we don't want to show everything through the walls so that we will just activate the next nodes in the path when we walk to our destination. As we reach the destination, it will show the destination node. Again, we can use the search option to find the path to another destination.

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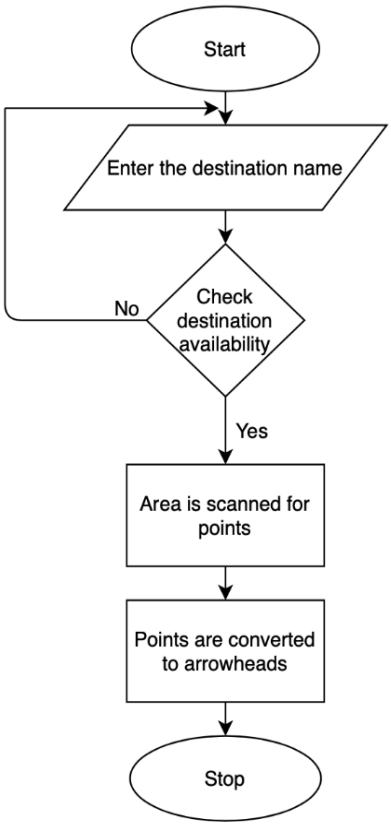

Fig 4:- Flowchart of Loading the Map

Fig 5:- Loading the Map

V. RESULTS

The person who searches for the destination to be reached will be provided with the correct path which will be directed using the arrowheads as shown in Figure 5.

VI. CONCLUSION

The suggested approach helps the people to reach the destination easily and accurately with less amount of time. In the future, we would like to add sticky notes or labels which will detect different objects while navigating through the paths.

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