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Indoor Campus Navigation Using Augmented Reality

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***Abstract*—Augmented Reality can now be used for a variety of things including educational purposes, businesses, tourism, museum illustrations, manufacturing and marketing as well. One of the parts Augmented Reality is highly exercised and researched, is the Indoor Navigation, Indoor Navigation can be applied in campuses, malls, multiplexes, offices etc., basically where the area is huge, and we need to locate a particular place in that huge indoors. Because in these places what happens is a lot of new visitors enter who are not familiar with the place, and so they keep on searching for their desired location and waste a lot of time in it. So that is the problem that is solved through AR Navigation System. Indoor Campus Navigation Using Augmented reality, which provides people with essential AR direction and Drop-down buttons which consist of destination names. The aim for our project is to direct user to different areas of the campus and alert user about the areas they are passing through with a mini-map. For indoor navigation augmented reality uses inbuilt characteristics to determine a person's position and provide the necessary navigation directives. The project makes use of technology like UNITY, AR CORE, AR FOUNDATION, and NAVMESH etc.**

Keywords: Indoor campus Navigation system, Augmented Reality(AR),Navmesh, AR Foundation, Unity

I. INTRODUCTION

Augmented Reality's Indoor Navigation has started becoming a trend in industry nowadays. Tech Giants have already started investing in AR technology because of its interesting features and its compatibility with other devices. Augmented Reality can now be used for a variety of things including educational purposes, businesses, tourism, museum illustrations, manufacturing and marketing as well. One of the parts Augmented Reality is highly exercised and researched, is the Indoor Navigation, Indoor Navigation can be applied in campuses, malls, what happens is a lot of new visitors enter who are not familiar with the place, and so they keep on searching for their desired location and waste a lot of time in it. So that is the problem that is solved through AR Navigation system. Indoor Campus Navigation Using Augmented reality, which provides people with essential AR direction and Drop-down buttons which consist of destination names. The aim for our project is to direct user to different areas of the campus and alert user about the areas they are passing using a mini-map. For indoor navigation augmented reality uses inbuilt characteristics to determine a person's position and provide the necessary navigation directives.

The project makes use of technology like UNITY, AR CORE, AR FOUNDATION[1], PAINT and NAVMESH[2] etc. A Nav Mesh is a designated mesh in your Unity scene, which specifies navigable areas in your environment, including areas where characters can walk, as well as obstacles. This is useful for scenarios which incorporate pathfinding and AI-controlled navigation. AR Foundation is a cross-platform framework that lets you build an augmented reality experience once and build it for Android or iOS devices. AR Core Extensions for AR Foundation enables additional AR Core functionality and features that are not exposed through AR Foundation and the AR Core XR plugin on Android and the AR Kit XR plugin on iOS. AR FOUNDATION that helps to track the user's location and movement. AR Foundation use some AR algorithms such as SLAM[3] (Simultaneous Localization and Mapping) or marker-based tracking for tracking and localizing the user position. This allows the system to recognize and track the user's position and orientation relative to the NavMesh, and to provide real-time feedback to the user as they move.

Paint is use for make the floor plan of the campus and measurement of the plan should be accurate. So that system can understand the real-world size and responses correctly

II. RELATED WORK

A. Survey and limitations of the existing system

In [3]"AR Smart Navigation System": by Tina Sayapogu, Kevin Dsa, and Priya kaul, the system provides people with essential pop-ups to their desired places on the way. Which use the tools like Unity IDE, AR Core SDK, Nav mesh, Simultaneous Localization and mapping(SLAM) and Android SDK for making Android app. The Advantages of the this system are Cost-effective and minimal use of hardware and software, Use of Wifi and Bluetooth beacons are eliminated. The challenges of this system are Use of paid Softwares, need cloud support to access the area details in the database.

In [4]"Augmented Reality Indoor Navigation System": by Mantripragada Sai Pavan Aditya, K. Anvesh, Kolluri Sai Madhav, here the system use AR Core to show the navigation path to the user on his mobile phone along with a 2D minimap for guidance and QR Code is used to track the initial position of the user. The tools used for this system are AR Core, QR code, Unity Engine, Androrid SDK, 2D minimap and Navmesh. The limitation of this system are it is not platform independent and for AR Core an external data base support is need to store the data.

In “Indoor Navigation System Using Augmented Reality"[5] by: Aaimoı between the mobile device and the web server. As the new institutes enroll into our website, the same institutes are reflected in the android application for navigation purpose. Software used Unity, MapBox SDK, Wikitude SDK, Andriod Studio, Bootstrap, [5]A* Algorithm. The limitation of this systems are Continues upload of infrastructural details is required when we visit a new place, It requires many different map view for finding the exact shortest path.

In “Indoor Navigation using Augmented Reality” [6]by Ashly Martin, John Cheriyan, JJ Ganesh, Joel Sebastian, Jayakrishna V. Here the system inspired by augmented reality and 2-D Visual markers are the fundamental elements used in this system. Several visual markers are placed within the complex building structure. When using an application to scan these visual markers, the user is guided to their destination using arrows that appear on the screen. The application allows users to select their desired destination and change destinations along the way. Tools used for this system are Unity, Vuforia SDK Firebase. The limitation of this system are requires visual markers to be placed correctly, navigation will stop if visual markers is not present in the area.Based on the visual marker the area to be navigated is detected and the user guided using the AR path.

III. PROPOSED ARCHITECTURE

The approach implemented will be easy to make cost effective and will give us a better result as it won’t be dependent on external factors like Wifi, Bluetooth beacons, Internet etc. Our Proposed system is mainly going to consist of Unity game engine, AR Foundation, Navmesh[3], paint and AR Core[6] plugin for android app to build. We can also use AR Kit plugin for Ios app to build. The AR Foundation is the framework used to build the augmented experience in this System which is a cross-platform framework. Which enables the system to built in both Android and Ios.

AR Foundation[1] supports a wide range of features, including world tracking, plane detection, object recognition, and image tracking. It also supports multiple platforms, including mobile devices, AR glasses, and virtual reality headsets. It use certain Algorithm like SLAM to localize the initial position of the user.

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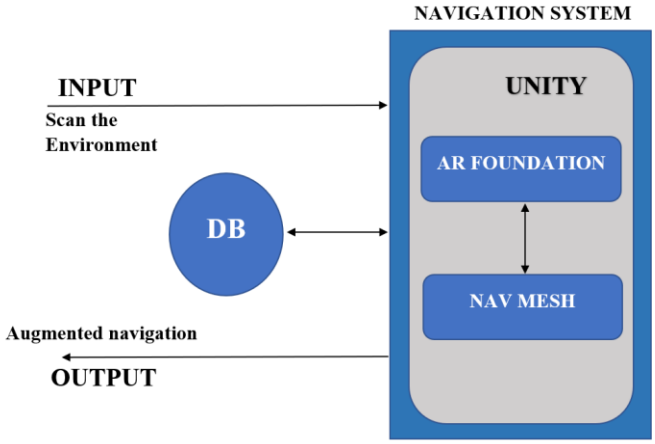

Fig. 1. System Architecture

AR core is going to enable us to design the Augmented reality aspect of the project that is adding animation to seemingly real-life objects. will also play an integral part in camera movement understanding as it is simultaneously determining the person's location as well as understanding the movement of the user and updating the user on the map for that AR Core XR plugin in added.

NavMesh is a standard category that can be used for the purpose of spatial queries.Baking Navmesh for a scene can be done along with the usage of spatial queries. Navmesh enables us to do a variety of things Mainly define the map and add information to it. i.e., determine if a defined area on the map is either or not or if an area is restricted for certain users. Another important aspect of Navmesh is that it enables us to do i.e., it allows us to define the shortest path between the initial location to the final destination which is the most important part of navigation.

The advantage of this system is that it is easy to use and is not dependent on external resources such as internet or Bluetooth, Wifi[3] since most mobile phones are advanced and already have gyroscopes and accelerometers hence it is easily accessible to people and is not as expensive to make unlike the other a.

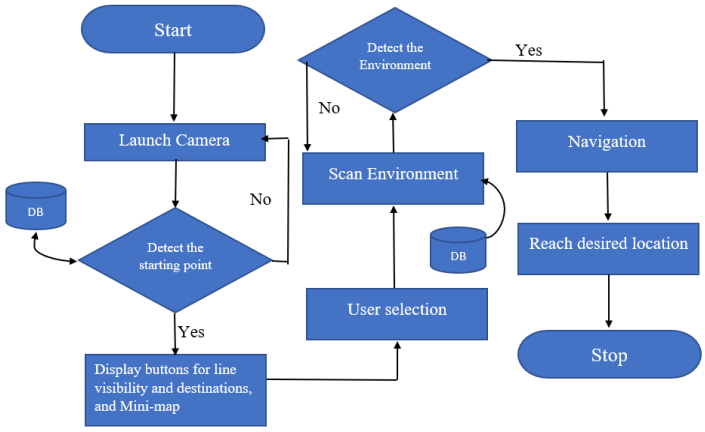

Fig. 2. Flowchart of the application

System architecture is going to consist of unity as the main platform using which we will be developing the app. Initially we will input the user's starting location using the device's camera sensor and localization techniques as well as the user's desired destination once we receive the input. AR Foundation[7] and Navmesh will work simultaneously to localize the users as wellas provide directions on the device until the user reaches its final destination.

The objective of this project is mentioned below:

1. The primary objective of the application is to eliminate all the dependencies like Wi-Fi Access points, Bluetooth beacons, Internet and other devices which are traditionally used for indoor navigation.
2. To direct user to different areas of the campus.
3. To give users predefined suggestions of the destinations
4. To give user a virtual interaction in the real world.
5. When a user launches the AR navigation app it detects the user's relevant location and the user selects the desired location he/she wants to go.
6. This system will show the navigation from point A to Point B (both being part of the desired mapped structure)

A. Details of Software and Hardware

1) Hardware: In Hardware components we only require contents listed in Table 1 of smartphone devices and Table 2of the Computer System.

TABLE I. SMARTPHONE DEVICE

Operating System	Android 7.0 Nogut or higher
Android version	Android API 29 or Higher
System requirements	Google play service for AR Enabledor AR integration Enabled

TABLE II. COMPUTER SYSTEM

Operating System	Windows 10
GenuineCPU	Intel Core i5
RAM & GPU	8 GB , 2GB

2) Software: Unity IDE: Unity Integrated Development Environment is used to make softwares for smart gadgets like mobile phones, smart tv etc

Android SDK: The Android Software Development Kit (SDK) is used to develop the systems which includes a global set of advancing tools. These include a mobile phone emulatorbased on libraries, help to build apks for android.

AR Foundation[1]: It is a frame work that helps, to track the This allows the system to recognize and track the user's position and orientation relative to the NavMesh, and to provide real-time feedback to the user as they move through the indoor space.

IV. METHODOLOGY

The approach to solve the problem will be using SLAM i.e., Simultaneous Localization and mapping this method provides an accurate and faster navigation system as well as allows us to add are components using AR Foundation will be divided into 4 modules:

A. Module 1: Taking real world scale and floor plan design

The measurements of the area of campus where the navigation is to be prepared is measured accurately as per meter scale. As the accurate scaling is an important factor for navigation to desired position in that particular area.

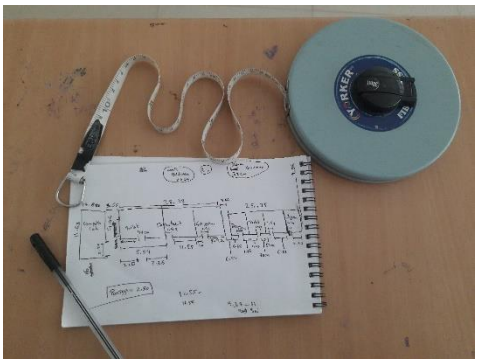

Fig. 3. Real world measurement and rough sketch of the area

After the rough sketch is prepared as shown fig 3 then a floor plan is drawn using paint for 3-D Modelling[7] the area.

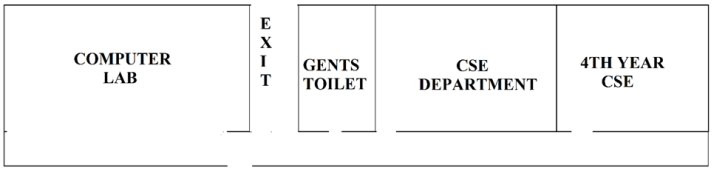

Fig 4 Floor plan

As we can see in the above fig 4 how the floor shows the areas to be navigated in the specified area.

user's location and movement, AR Foundation can use computer vision techniques such as SLAM[6].

B. Module 2: 3D Modelling and Setting navigation targets

Creating the 3D model of the area according to floor plan designed using the real world scale. Modelling important for setting the navigation targets for navigating the user to different areas accurately and precisely without any navigating errors.

After the model is design the various navigation target is set from the start position in model from where the navigation starts and user is navigated to different areas in the campus.

Fig. 5. Setting multiple targets

it will be deleted and a new one will appear in front of the user with the correct position angle. This is done using the AR Core[8] SDK which enables us to project AR objects on the camera[9] screen. Using this an AR[10] generated path to the destination is created.

C. Module 3: Localization and Mapping

This module uses Navmesh for creating the navigation path to different targets that is specified in the Module 2 path creation is done using Navmesh. NavMesh is a navigation mesh, or a pathfinding system, used in Artificial Intelligence (AI) applications such as video games. It is a set of data structures and algorithms that define a path for an AI character to follow through an environment. The mesh is made up of polygons, which define the boundaries of navigable and non-navigable areas in the environment. NavMesh[2] allows AI characters to traverse the environment by finding the most efficient path from one point to another. And afer creating the navigation targets then logic for determining the list of targets and showing path to different targets is written using the C#.C# is the language used in unity All the languages Unity works with are object-oriented scripting languages. C#[8] was created by Microsoft. It is object-oriented Language.

D. Module 4: Deployment

Building[11] the android app by specifying the application name platform of the android. After building the android app then it can be installed in the android for further confirmation of the working of the application.

E. Module 5: Testing

Testing the functionalities of the application for any errors checking the functionalities of each component of the app.

V. RESULT

A fully functional android app that can navigate through the different areas of the campus that are present in the floor plan that is given as input to the Indoor Campus Navigation System.

In the app there is dropdown that helps to select the areas that are available for navigation. After selecting the destination when click on toogle line visibility button we get the augmented path from the starting point to the destination.

Fig 6. Intializing the starting point & reaching destination using AR Path

VI. CONCLUSION

This application with the help of Unity 3D, Navmesh and AR foundation[1] provides an easy solution for the development of such indoor applications. As soon as this application is launched, it first detects the user's current position, then provides its user with few relevant destination points and once the user selects one of those points the augmented arrow is launched through the camera, which then helps the user navigate through the place and get to the desired location using the drop down and toogline visibility button in UI.

FUTURE WORK

This project can be implemented for any industry possible for site visit and the guides can be eliminated by this project. This project can be easily integerated metaverse when it becomes popular in the future. It can be also used for AR/VR[12] based navigation games like exciting Pokemon GO. It can also used in Indoor and Outdoor based navigation which will give a better experience. It can be also used by tourist department instead of allocating a tourist guide for everyone.

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