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INDOOR NAVIGATION USING AR TECHNOLOGY

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Abstract— **Navigation systems have been widely used in outdoor environments, but indoor navigation systems are still in early development stages. The current available systems make use of GPS, Bluetooth, Wi-Fi, RFID and Sensor Chip technologies. The Bluetooth technology is cheap but has limited range and accuracy. For an effective location tracking and navigation using this technology, we need to setup Bluetooth hotspots across the building. The same is applicable for other technologies like Wi- Fi, RFID and Sensor chips. The implementation and maintenance cost is exorbitant for all these methods and a change in weather condition may affect the signal strength downing the hotspot if any one device fails. In all such existing systems, additional infrastructural facilities are inevitable for the perfect working of it. In this work, we put forward a low cost, simple, reliable and efficient method to accomplish the same goal by introducing an augmented reality-based indoor navigation application to assist people navigate in indoor environments.**

Keywords— **indoor tracking; navigation; augmented reality; ARCore SDK; indoor positioning and navigation.**

I. INTRODUCTION

Mobile outdoor GPS navigation apps have proven to be lifesavers to countless people. With smartphone in hand it's easier to find your destination even in unfamiliar city. However, it is still easy to get lost indoors, where GPS satellite signals are not accurately traceable for navigation applications. Guiding people to specific locations in indoor environments is a challenging task. Especially in complex buildings like airports, hospitals or other public buildings operators are struggling with the problem of guiding visitors through their building in an optimized way.

Augmented reality is a technology, which integrates the virtual information generated by computer into the real world to create a better immersive experience for users. At present, AR technology has been mainly applied for many fields, such as digital publishing, digital marketing, design simulation, science research, etc. Mobile navigation application based on augmented reality has also become a new research hotspot. The motivation force behind the technology is the enhancement of the visual effect that could assist users in presuming certain object more easily. Therefore the interactive 3D image being superimposed on the real scene may improve the efficiency in training based application such as assisting doctors in surgery demonstration, robotic design and others.

An augmented reality navigation would typically work in the following way:

1. Acquire the real world view from the user's perspective.
2. Acquire the location information for tracking the user. This information is typically the GPS coordinates.
3. Generate the virtual world information based on the real world view and the location information.
4. Register the virtual information generated with the real world view and display the information to the user, thereby creating an augmented reality.

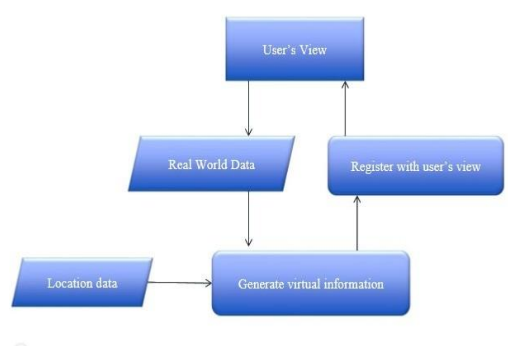

Fig.1 Augmented Reality Navigation

II. BACKGROUND OF TECHNOLOGY

Wi-Fi routers and Bluetooth beacons, to be deployed and installed in the indoor environment. Some technology solutions such as Bluetooth and infrared methods also have high latency during the detection phase. Although these Technologies used for indoor positioning can be generally categorized into two groups, wireless transmission methods and computer vision methods. Wireless transmission methods use technologies such as Ultra-wide Band (UWB), Wireless Local Area Networks (WLAN), and Radio Frequency Identification (RFID) to localize a device. These technologies often require physical infrastructures, such as technologies are popular localization solutions, they have difficulties in estimating the user's orientation, and therefore are not ideal for AR applications.

In contrast, computer vision techniques are more suitable for AR-based applications, and previous studies have found computer vision technologies to be more accurate in comparison to Wi-Fi based fingerprinting. A commonly studied vision-based indoor positioning approach involves image recognition of the real environment through live camera feed.

The pre-collected images are annotated with their locations, and the inertial sensors of the device can help deliver orientation. This technique can therefore be used to deliver successful AR-based directional instructions as well as user localization. An issue with this technique, however, is that it requires extensive computational power because a large database of images is being utilized, which may cause delays during navigation.

A. ARCore

Google's ARCore platform was released on March 1, 2018. ARCore includes features such as motion tracking, environment understanding, and light estimation providing developers information that can be used for numerous automation tasks. Motion tracking allows the phone to track its position relative to its environment, environment understanding includes features that allow the phone to detect the size and location of surrounding surfaces, and light estimation allows the phone to estimate the current lighting conditions.

B. Unity

Unity is a cross-platform game engine developed by Unity Technologies, first announced and released in June 2005 at Apple Inc.'s Worldwide Developers Conference as a Mac OS X-exclusive game engine. As of 2018, the engine had been extended to support more than 25 platforms. The engine can be used to create three-dimensional, two-dimensional, virtual reality, and augmented reality games, as well as simulations and other experiences. The Google ARCore SDK preview for Unity enables you to develop android applications with captivating AR experiences. Create realistic looking virtual objects rendered over the real world that react as if physically there.

III. LITERATURE SURVEY

Indoor navigation is a subject that has been studied over the years using variety of techniques and technologies posit that an indoor navigation system consists of a network of devices used in locating objects or people inside a building. In effect, there has been a steady and exponential growth in the research and use of positioning (also known as localization) and navigation technology outdoors in recent years. As a result, attempts to implement these technologies indoors have led to numerous studies in this field, spurring researchers into discovering ways to make life easier for people while navigating indoor spaces.

Austin Corotan,Jianna Jian Zhang Irgen-Gioro,(2019) et al. in [4] have presented an AR-based navigation system, JAQL System, to provide users with a framework for autonomous indoor navigation. It's primary focuses were routing, localization, and object detection. Localization utilized a blueprint of the building and the camera's pose in the world space. In this paper authors have designed pseudocode for localization using the camera pose.

Daniel Andersen, Voicu Popescu,(March 2018) in [2] have presented a system that enables a novice user to acquire a large indoor scene in minutes as a collection of images that are sufficient for five degrees-of-freedom virtual navigation by image morphing.

Geory Gerstweiler. (March 2018) et.al in [1] has concentrated on three main topics. At first a tracking solution HyMoTrack is presented, based on a visual hybrid tracking approach for smart phones and tested in a real world airport scenario. The tracking and the guiding part of a reliable indoor navigation requests a 3D model of the environment. For that reason a 3D model generation algorithm was implemented, which automatically creates a 3D mesh out of a vectorized 2D floor plan. Finally the human aspect of an AR guiding system is researched and a novel AR path concept is presented for guiding people with AR devices.

IV. PROPOSED SYSTEM

A. System Design

The major function of the system is to assist people navigate in indoor environments using environment tracking technology and augmented reality instructions. The development of 3D point cloud localization requires a predeployment stage, where the indoor environment has to be 3D scanned. We developed our indoor navigation application using ARCore SDK that provides a multilayered environment to build AR applications on Android platform.

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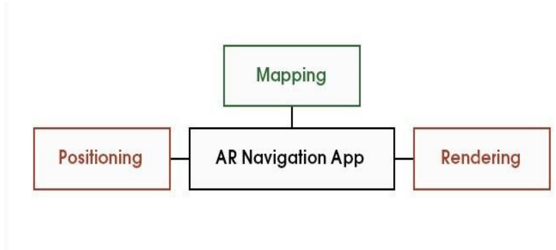

Fig.2 General System design

B. System overview

The pre-deployment data were collected and configured in ARCore SDK. The scanned environment that consists of visual features (3D point clouds) is stored as anchors. In a database, these anchors are associated with their corresponding locations and navigation related information, which can be superimposed on visual feed during the navigation aid process. The camera and inertial sensors of the device are used to track the 3D point clouds and device orientation. Based on the anchors identified from the camera feed, the current location and orientation of the user are determined. Then the route is calculated. The potential routes in this study, supplemented with directional instructions in a chronological order, are pre-stored in the application.

After the routes were fully scanned, the images were exported to ARCore SDK for AR information overlay. The 3D scans of all areas were placed in a sequential order to develop a movie- like timeline progressing from the start to the end of each route.

The next step is to add directional instructions on anchors. Various assistive information was overlaid on the scanned areas. Visual arrows (augmented object) were the first information added. The arrows were superimposed as augmented information on the camera feed, which was then shown to the user via the display devices.

For computing a shortest route, the system uses the A* algorithm. In the context of a weighted graph, A* is with the correct heuristic complete, optimal and admissible. This makes it suitable for the weighted graph of the system. A* has access to the POIs coordinates so that it can be used for A*'s heuristic.

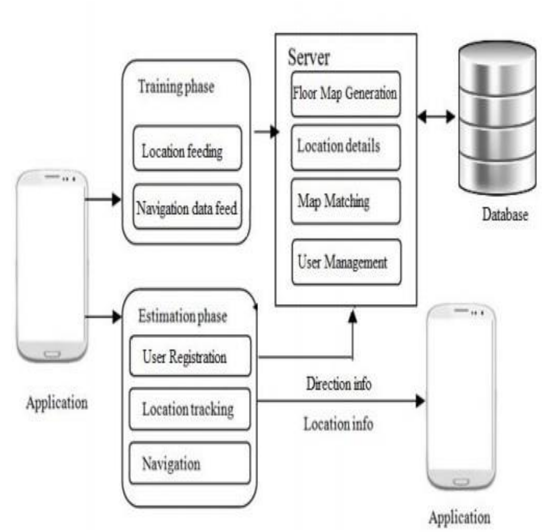

Fig.3 System Architecture

C. Mobile Application Design

1. Implementation: The application was designed for Android 7.0 and later devices using the Android Studio SDK, the ARCore SDK, and the Open Graphics Library (OpenGL) written in Kotlin. SQLite was used to store our routing information and Firebase was used to store our cloud anchors
.
2. User Interface: The interface contains 3 main views. The uppermost view is the ARCore scene view. This will show all of the ARCore features rendered over the phone's camera view using OpenGL. The middle view is the map view. The user can click on the drop- down menu at the top right of the screen to choose their desired location. They can then click on the "route" button to start the tracking and navigation toward their destination.

V. CONCLUSION

The technical solution developed in the current study is a design of indoor navigation systems that utilized advanced feature tracking and augmented reality approaches towards navigation. The application allows the user to track the exact location of another user and also to guide a user from a source end to destination end in an indoor environment. Our system requires no additional infrastructure or implementation cost.

The system used a pre-scanned 3D map to track environmental features. These features contained directional information so that instructions could be superimposed on the live visual feed at appropriate places. During navigation, directional information was presented to the user via both the visual channel (arrow and icons).

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