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AR based Indoor Navigation System

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***Abstract*— Indoor navigation within college campuses poses unique challenges due to complex building layouts and varying levels of accessibility. This paper presents a student project aimed at developing an Augmented Reality based indoor navigation system (AR-INS) specifically tailored for college campuses. The system integrates computer vision, depth perception and Google's ARCore techniques to provide users with real-time navigation guidance using their smartphones or AR-enabled devices. We describe the system architecture, implementation details, and evaluation results from user testing conducted on our college campus. The project highlights the feasibility of utilizing AR technology for enhancing campus navigation experiences and provides valuable insights for future research and development in this domain. This project addresses the growing need for efficient indoor navigation, which can significantly improve the overall user experience and accessibility in indoor spaces. The AR-INS is not only user-friendly but also adaptable to various environments, making it a valuable addition to smart building infrastructure and enhancing the quality of life for users. The implementation of this system can have an impact on how people navigate complex indoor spaces, and give an solution for complex indoor spaces.**

Keywords—AR-INS, computer vision, depth perception Google's ARCore

1. INTRODUCTION

Augmented Reality (AR) technology has rapidly evolved and has the potential to revolutionize how we interact with and understand our physical surroundings. By seamlessly blending the digital world with the real world, AR offers an innovative solution to the challenges of indoor navigation. This project explores the development and implementation of an AR-INS, a cutting-edge system that combines the power of real-time data, spatial awareness, and digital mapping to provide users with an enhanced and intuitive means of navigating complex indoor spaces.

The primary objective of the AR-INS project is to address the limitations of traditional indoor navigation methods and to offer a more immersive and efficient way for users to find their way within intricate indoor environments. By capitalizing on the advanced capabilities of AR technology, we aim to bridge the gap between physical spaces and digital information, ultimately improving the quality of indoor navigation.

1.1 Goals

The main purpose of this application is to provide a mobile-based, controlled-to-visitor solution as they move around any buildings such as College, Supermarket, Hospital, etc., and, the purpose is to reduce time-consumption, split- group and gain efficiency, accuracy, application friendliness, as well as the speed, of the application for a small area of the building.

Objectives

Provide an easy-to-use, mobile-based solution system, which will contain all the necessary information, to ensure convenience, accurate navigation and identification of various buildings, doors and to help guests reach their desired location without difficulty.

1.2 Scope

The scope of the application is determined by the time allocation, resources and customer demand. The scope of the program is limited and can grow the way it is done. Users can navigate the building with the advice provided by the AR browser. They can view construction, locations etc. Orthey are searching for places.

1.3 Overview

In this modern era, successful navigation has become increasingly important as cities develop and are set to grow with skyscrapers and large buildings built continuously. Due to this need, for technologies such as the Global Positioning System, GPS was developed to help navigate. However, door-to-door is still a problem because there is no such accurate, efficient and risk-free technology to find the need. The project aims to use augmented reality to develop the type of advertising that facilitates circulation within the home. An augmented reality is the idea of a real world transmitted by some kind of sensory input to a production such as sound or graphic. This app is designed for smartphones as almost all smartphones today are equipped with the camera and the processing power of the graphics that provide access to other graphics. This program is developed using the Android SDK and the Unity Engine.

2. LITERATURE SURVEY

Augmented Reality in Indoor Navigation (2023) Jatin Adya B, Shantanu Yadav, Rahul Sharma, Yaswanth Varma

AR-based indoor navigation is a promising technology that enables users to quickly navigate through challenging indoor environments. Augmented reality (AR) enhances the user's perception of the physical world and makes for a more natural and enjoyable navigation experience by superimposing digital data on the actual surroundings. This research examines the state-of-the-art AR-based indoor navigation, the underlying technology, and the challenges that must be overcome to realize its maximum potential. We provide a summary of the plane detection, route marking, and path following problems.

An Indoor Navigation Support for the Student Halls of Residence using Augmented Reality: A Design Perspective (2021) Dinna Mohd Nizam, Nooralisa Mohd Tuah, Zaidatol Haslinda Abdullah Sani, Lim Wei Shin

This project aims to investigate the requirements needed for an AR-based indoor navigation application to be applied within the student halls of residence and to identify technical issues through a small-scale prototype development within a small navigational area. Seventy-one students participated in the feasibility study by responding to a set of questionnaires related to the Student Residence AR indoor navigation application. At the same time, four users with and without previous experience with AR applications evaluated the prototype application. The results identified that the more the students have difficulty searching, the more they require additional time to reach their destination and seek help from others, a promising reason to implement the Student Residence AR indoor navigation.

A game-based augmented reality navigation system to support makerspace user education in a university library(2023) Chih-Ming Chen, Ya-Chu Yang

Purpose A makerspace has recently been identified as an essential learning field for cultivating students' creative and thinking abilities. Creating a makerspace service within a

university library is vital, as it fosters innovation, interdisciplinary learning, practical skills, entrepreneurship and career readiness while transforming the library into a dynamic centre for hands-on education and collaboration. Nevertheless, the wide-ranging functions and uses of makerspace equipment can potentially lead to a situation where librarians are overwhelmed by their duties due to manpower constraints. Therefore, this study aims to develop a novel game-based augmented reality navigation system (GARNS) based on the Octalysis gamification framework and scaffolding theory to support makerspace user education, hoping to promote learners' learning motivation and their immersive experience and to enhance the learning performance of makerspace user education.

Augmented reality technology in the libraries of universities of medical sciences: identifying the application, advantages and challenges and presenting a model (2021) Malihe Dalili, Maryam Salami, Faramarz Soheili

Purpose This study aimed to present a model for the use of augmented reality (AR) in the libraries of universities of medical sciences. The goal was to introduce the applications, advantages, opportunities and challenges of AR. Design/methodology/approach This study adopted a qualitative approach, had an applied goal and was based on data theory. The statistical population comprised 20 experts in the field of AR, and the data were collected based on in-depth semi-structured interviews until achieving theoretical saturation. A model was proposed after open coding and the formation of the main categories, and the use of AR in the development of libraries of medical universities was discussed. Findings The category of application consisted of strengthening education, promoting users' information literacy, finding resources, user guidance, gamification, educational justice, helping management, enriching resources, providing new services and economic savings. The advantages were library services, sociocultural excellence, educational level, software potential and helping the librarian.

The challenges were technical, economic and cultural barriers. Libraries can attract many users by enacting effective policies, using technology and enriching the content of resources.

The effect of immersive experience, user engagement and perceived authenticity on place satisfaction in the context of augmented reality (2023) Kazım Dağ, Sinan Çavuşoğlu, Yakup Durmaz

Purpose This study aims to measure the effect of augmented reality (AR) on immersive experiences, place satisfaction, user engagement and perceived authenticity. Design/methodology/approach The population of the research consists of museum visitors visiting the Sakip Sabanci Museum in Turkey, which provides an interactive experience to the audience using AR technology via iPads. The data were collected both online and offline. The research was carried out with 397 questionnaire forms. The hypotheses were tested through smart partial least squares (PLS) 3. Findings Immersive experience positively affects place satisfaction, user engagement and perceived authenticity. It was also concluded that user engagement and perceived authenticity mediated the relationship between immersive experience and place satisfaction. Research limitations/implications The entire universe could not be reached, as the study had limitations in terms of time, cost, accessibility and control difficulties.

3. PROBLEM STATEMENT

In today's increasingly complex and expansive indoor environments, the need for efficient and user-friendly navigation systems has grown substantially. Traditional navigation methods, such as static maps and signage, often fall short when guiding individuals through intricate indoor

spaces, including shopping malls, airports, hospitals, corporate campuses, and cultural institutions. To address these challenges, there is a critical need for the development and implementation of Augmented Reality (AR)-based indoor navigation systems. These systems can significantly improve the user experience, accessibility, and efficiency of indoor navigation.

4. REQUIREMENT ANALYSIS

The main requirement which leads this application to work involves the following,

1. Google Arcore:
2. Unity:
3. AR Foundation

Google Arcore:

ARCore is Google's platform for building augmented reality experiences. Google ARCore includes different APIs that are used to sense the environment using just a smartphone's RGB camera and understand the world and interact with it. Google ARCore considers key capabilities like Motion Tracking, Environmental Understanding, Depth Understanding, Light Estimation and User Interaction to provide a feature called Simultaneous Localization and Mapping (SLAM).

Unity:

Unity provides a workspace that combines artist-friendly tools with a component-driven design that makes game development pretty darn intuitive. Both 2D and 3D development is possible in Unity, with 2D physics handled by the popular Box2D engine. Unity uses a component-based approach to game dev revolving around prefabs. With prefabs, game designers can build objects and environments more efficiently and scale faster.

AR Foundation:

AR Foundation is a software framework developed by Unity Technologies that simplifies the creation of augmented reality (AR) applications. It is designed for use with the Unity game engine and provides a unified interface for building AR experiences that can run on various platforms, including iOS and Android devices. Key features of AR Foundation include support for motion tracking, plane detection, hit testing, light estimation, and interactions with the real world. It simplifies the implementation of features such as object tracking, image recognition, and face tracking. Additionally, AR Foundation integrates well with Unity's existing tools and workflows, making it accessible to a wide range of developers, from beginners to experienced professionals.

5. DESIGN DETAILS

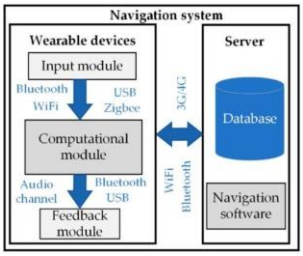


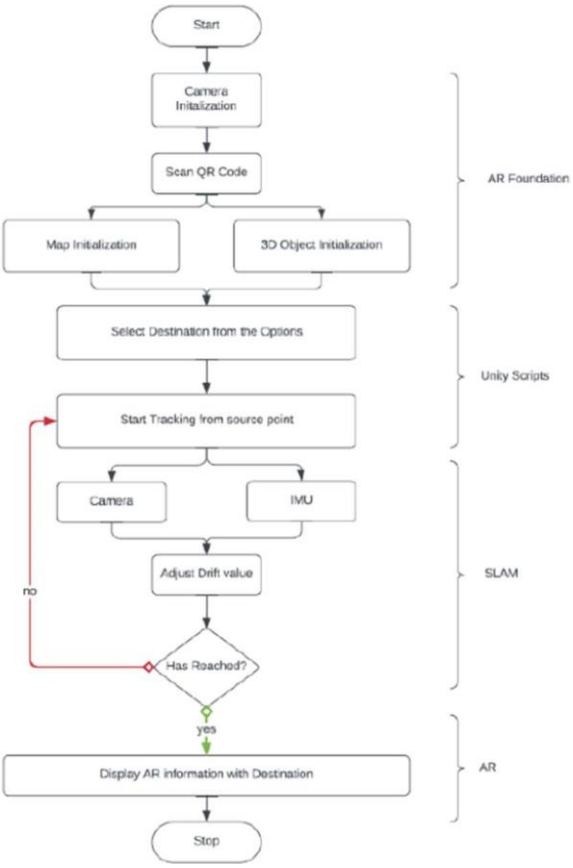
Figure: Design Details

The proposed AR-based indoor navigation system aims to revolutionize the way individuals navigate intricate indoor environments, such as shopping malls, airports, hospitals, and office buildings. This system leverages cutting-edge Augmented Reality (AR) technology to provide users with an enhanced and intuitive navigation experience. It offers features such as real-time indoor mapping, turn-by-turn directions, point-of-interest identification, and customizable user interfaces. Additionally, the system adapts to various user needs, including those with disabilities, and integrates with existing building infrastructure to ensure accurate positioning and guidance. By addressing the limitations of traditional indoor navigation methods and offering a user- friendly, adaptable, and inclusive solution, this proposed system has the potential to greatly enhance accessibility and the overall user

experience in indoor spaces, making it an invaluable addition to the modern urban environment.

Decision Trees are unsupervised machine learning algorithms that can be used for classification or regression. Logistic regression models the probability of a binary outcome and is commonly used in classification problems. Random Forest is a machine learning algorithm that combines the outputs of multiple decision trees to overcome overfittingand bias issues.

Figure: Workflow of the project



6. RESULTS

Figure: Application Working

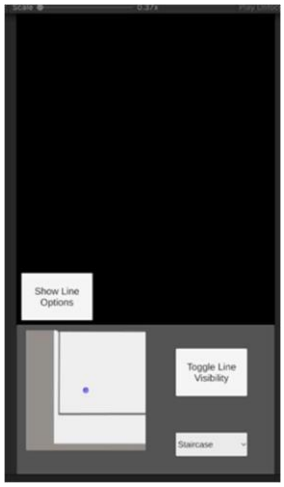


Figure: User Interface

7. CONCLUSION

The advent of AR-based indoor navigation systems heralds a transformative shift in how individuals traverse and engage with indoor environments. Offering an immersive and intuitive user experience, these systems hold the

promise of significantly enhancing accessibility, efficiency, and user satisfaction. By overlaying digital information onto the physical environment in real-time, AR navigation simplifies complex routes and provides tailored guidance, benefiting a wide range of users including those with disabilities and newcomers to unfamiliar spaces. Moreover, the integration of IoT technologies further augments the utility of AR navigation by delivering context-aware information and facilitating seamless interaction with the environment. Despite facing challenges such as technical limitations and privacy concerns, the commercial potential and ongoing advancements in AR technology underscore a promising trajectory for the future of indoor navigation. As innovation continues to evolve, AR-based navigation systems are poised to redefine how individuals navigate and interact with indoor spaces, offering unprecedented levels of convenience, efficiency, and user satisfaction.

Furthermore, as AR technology matures, future iterations of indoor navigation systems are expected to offer even greater precision, personalization, and seamless integration with other emerging technologies. With ongoing refinement and widespread adoption, AR-based indoor navigation has the potential to become a ubiquitous tool across various industries and contexts, revolutionizing the way people navigate and experience indoor environments. However, realizing this potential will require addressing technical challenges, ensuring privacy and security safeguards, and fostering collaboration among stakeholders to establish standards and best practices. Nonetheless, the promise of AR- based indoor navigation systems remains clear: to empower users with an intuitive and immersive navigation experience that transcends traditional limitations, unlocking new opportunities for accessibility, efficiency, and engagement in indoor spaces.

8. FUTURE WORK

Improved Accuracy and Reliability: Enhancing the accuracy and reliability of AR overlays and navigation instructions is essential for ensuring seamless navigation experiences. Future research could focus on refining algorithms for localization and mapping, integrating advanced sensor technologies, and leveraging machine learning techniques to adapt to changing environmental conditions.

Multi-modal Interaction: Exploring multi-modal interaction techniques, such as voice commands, gestures, and haptic feedback, can improve the accessibility and usability of AR navigation systems. Future work could investigate how different modalities can be combined to provide intuitive and efficient navigation experiences for users with diverse needs and preferences.

Real-time Collaboration and Social Interaction: Introducing features that enable real-time collaboration and social interaction within AR navigation systems can enhance user engagement and foster a sense of community. This could include functionalities such as shared annotations, collaborative route planning, and location-based messaging to facilitate communication and coordination among users navigating the same indoor space.

Integration with Smart Infrastructure: Integrating AR navigation systems with smart infrastructure technologies, such as indoor positioning systems (IPS), Bluetooth beacons, and smart sensors, can provide richer contextual information and enable more seamless navigation experiences. Future work could explore how AR overlays can leverage data from these sources to deliver personalized recommendations, real- time updates, and interactive experiences tailored to the user's context.

Augmented Reality Glasses and Wearable Devices: Advancements in augmented reality glasses and wearable devices present

opportunities to enhance the mobility and convenience of AR-based indoor navigation. Future research could focus on developing lightweight, ergonomic AR glasses with improved display quality, battery life, and connectivity, making them more practical for everyday use in indoor environments.

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