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AR-Based Virtual Campus Tour and Information System for Smart Educational Navigation

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Abstract— Augmented Reality (AR) is rapidly transforming the way users interact with real-world environments by integrating digital information with physical surroundings. In large educational campuses, navigation and access to essential information remain significant challenges for new students, visitors, and parents due to the limitations of traditional methods such as printed maps, signboards, and guided tours. These approaches often lack interactivity, accuracy, and real-time updates. This paper proposes an AR-Based Virtual Campus Tour and Information System designed to enhance campus navigation and user experience through immersive technologies. The system leverages AR to provide real-time navigation by overlaying contextual digital information, including building details, directions, facilities, and announcements, directly onto the user's view. Additionally, Virtual Reality (VR) is integrated to enable remote exploration of the campus through interactive 3D environments, offering users a comprehensive understanding of the campus layout before physical visits. The proposed system incorporates advanced image recognition, AR visualization techniques, and 360-degree imaging to ensure accurate and engaging interaction. Furthermore, compatibility with modern VR devices enhances immersion and usability. By combining AR navigation, VR-based virtual tours, and real-time information delivery, the system aims to improve navigation efficiency, accessibility, and overall user satisfaction within educational institutions.

Keywords— Augmented Reality, Virtual Reality, Smart Campus, Navigation System, Unity 3D, Image Recognition, 360-Degree Imaging.

I. INTRODUCTION

The AR-Based Virtual Campus Tour and Information System is designed to enhance the way users explore and interact with large educational campuses. With the increasing size and complexity of institutions, traditional navigation methods such as printed maps, signboards, and manual guidance are no longer sufficient. This system introduces an innovative solution by utilizing Augmented Reality (AR) to provide real- time navigation and information directly overlaid onto the user's physical environment, making campus exploration more intuitive and efficient. In addition to AR, the system incorporates Virtual Reality (VR) to offer a fully immersive virtual tour experience. Users can explore the campus remotely through a 3D environment, which is especially useful for prospective students, parents, and visitors who are unable to visit the campus physically. The integration of 360-degree imaging further enhances the realism of the system by capturing real-world environments and converting them into interactive visual content, enabling a more engaging and comprehensive understanding of the campus layout. Furthermore, the system is supported by a centralized database that stores and manages all campus-related information, including building details, departments, facilities, and announcements. This ensures that users receive accurate and up-to-date information at all times. By combining AR, VR, and advanced imaging technologies, the proposed system provides a smart, user-friendly, and efficient platform that improves 9 navigations, enhances user experience, and supports the digital transformation of educational institutions.

II. MATERIALS AND METHODS

This study focuses on developing and evaluating an AR-based campus navigation system using modern software tools and hardware components.

The system consists of two main modules:

- AR Navigation System
- VR Virtual Tour System

The implementation was carried out using Unity 3D with C# programming. The hardware setup includes a system with Intel i5 processor, 8GB RAM, and VR headset support.

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A. AR Navigation Module

The AR Navigation Module provides real-time guidance using a mobile device camera. It overlays digital elements such as:

- Direction arrows
- Building names
- Distance indicators

The working process includes:

- Capture real-time camera input
- Detect environment using image recognition
- Overlay AR objects on real-world view
- Update navigation dynamically

B. VR Tour Module

The VR module provides an immersive virtual campus experience. Users can explore the campus remotely using VR headsets.
Steps involved:

- Capture 360-degree campus images
- Convert images into 3D environment
- Integrate into Unity VR environment
- Enable user interaction and navigation

C. System Architecture

The system consists of:

- User Interface Module
- AR Navigation Module
- VR Tour Module
- Image Recognition Module
- Database Management System

The database stores campus details such as buildings, departments, and announcements.

D. Statistical Analysis

The system performance was evaluated based on:

- Navigation accuracy
- Time taken to locate destinations
- User satisfaction

Multiple test iterations (N=10) were conducted to compare performance with traditional navigation methods.

III. RESULTS

The proposed system demonstrated improved performance compared to traditional navigation systems.

Traditional Method (Time in sec)	
Test	AR System (Time in sec)
Test 120	65
Test 110	60
Test 130	70
Test 125	68
Test 115	62
Test 140	75
Test 135	72
Test 128	69

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Test 118	64
Test 122	66

TABLE I: COMPARISON OF NAVIGATION TIME USING TRADITIONAL METHOD AND AR SYSTEM

Average Time:

- Traditional: 124.3 sec
- AR System: 67.1 sec

The AR system reduced navigation time by approximately 45%.

IV. DISCUSSION

The results clearly indicate that the AR-Based Virtual Campus System significantly improves navigation efficiency and user experience.

Compared to traditional systems:

- Provides real-time guidance
- Reduces confusion
- Improves accuracy
- Enhances engagement

The integration of VR allows remote users to explore campus environments, which is beneficial for admissions and virtual visits.

However, the system has some limitations:

- Requires high processing power
- Depends on device compatibility
- Indoor tracking accuracy may vary

Future improvements include:

- AI-based route optimization
- Indoor positioning system integration
- Cloud-based real-time updates

V. CONCLUSION

This study presents an innovative AR-Based Virtual Campus Tour and Information System that enhances navigation and information accessibility in educational institutions.

The system successfully integrates AR, VR, and 360-degree imaging to provide:

- Real-time navigation
- Immersive virtual tours
- Accurate information access

Experimental results confirm that the system improves efficiency, reduces navigation time, and enhances user experience.

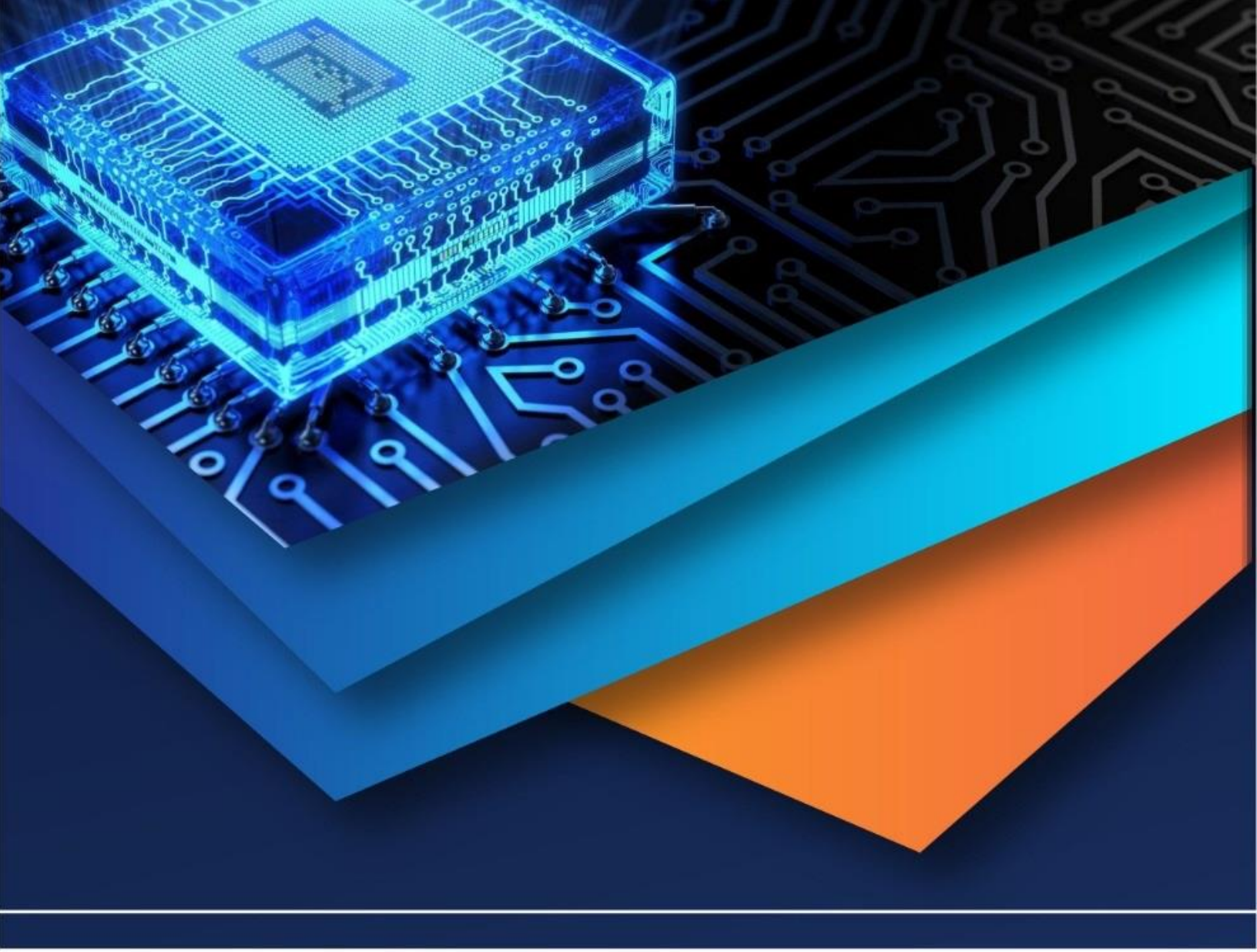
This research highlights the potential of AR and VR technologies in building smart and interactive campus environments.

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