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Campus Compass Android App

Prof Y. D. Choudhari[1], Arnav H Choudhari[2], Rajesh P Raut[3], Janhavi C Raut[4], Samyak D Ramteke[5]
Department of Information Technology K.D.K College of Engineering, Nagpur

Abstract: The paper talks about using augmented reality and navigation tech to help people find their way inside big buildings like hospitals and university campuses. It's all about making it easier for folks to navigate through complex places, especially if they're new there. By using AR on a mobile app, users can see details of rooms and departments in real-time. This combo of navigation and AR tech makes finding your way around campus more accurate, realistic, and user-friendly.

I. INTRODUCTION

Navigating a large campus with multiple buildings can be challenging, particularly for new students and first-time visitors. Despite the presence of signs and static maps, many individuals still struggle to find their way around, especially when moving between classes or different departments. Our campus includes several buildings, with some being interconnected and others within walking distance, along with separate canteens and departments on various floors. Students often face the challenge of switching classrooms after each period, which can be time-consuming, particularly for those unfamiliar with the campus layout. Although signboards offer guidance, continuous assistance is lacking once users start moving toward their destination. They may ask for directions or consult maps, but these methods fail to provide ongoing help as they navigate. This app aims to guide users to their destinations efficiently and on time.

Assist freshmen and other newcomers in navigating the campus and help them locate places efficiently using modern technology. Our BIT Campus AR Navigation System offers users routes that are far more detailed than what most commercial applications provide. The complexity of our navigation app goes beyond the basic version of similar applications. Essentially, creating a simple navigation app wouldn't be overly challenging. The campus could be modelled as a graph structure, with campus locations such as buildings and parking lots represented as nodes, and the pathways between these locations (roads, sidewalks) as edges connecting the nodes. This application guides users from their current position to the exact destination they are looking for on campus, minimizing the time and effort spent wandering the campus.

II. LITERATURE REVIEW

"Campus navigation" involves exploring various technological and non-technological solutions developed to help students, staff, and visitors navigate large, complex university campuses. Below is a review of key themes in research and development around this topic, incorporating insights from various academic and technical domains.

Li Zhigang et al. [1] In the application of a visitor visiting the campus with a smartphone, the location and pose of the smartphone is retrieved by its GPS and IMU data and then the registration in 3D is realized by tracking the viewpoint of the phone or the visitor accurately based on result data. Then, the multi-sensor fusion approaches are used for the spatial registration, and a combination of the real and virtual world appears in the eyes of the visitor, which helps the visitor not only understand the campus style, but also deeply understands the history, tradition and culture of the campus.

Eman Yaser Daraghmi [2] In this paper, CAMA, a context-aware mobile application for a university campus is presented which provides users the most rewarding environments for users seeking personalized context-aware information and navigation service in a university campus. Here, the system allows users to locate classrooms, teachers and friends. The user profile retrieved from the university database is used to notify both students and teachers of their next classroom. The app provides all the information that the user needs to know what inside a closed classroom without interrupting he teacher while giving the lecture. And also, the mobile application includes additional features, such as providing the shortest path via the navigation service, detecting more than one object simultaneously, location sharing, personal context-aware, recommendation, and voicecommanded search.

h. Joseph T. Chao et al. [3] developed a Campus Event App which is based on the client-server model. The mobile Figure 1. Interaction between User and System phone app acts as the client, and an App acts as the Server, which is both a server and the server-side software that retrieves event data from the university calendar, stores it in a database, and later the user can retrieve when the client device requests it.

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The LLA coordinates are generated by the app server obtaining all of the event information, such as addresses, event name, event description, event time, and event links, from the university calendar which sends the physical addresses of all the events to Google Geocoding. Finally, the Campus Event App on the client device sends a request for data and the App Server processes the request, fetches the desired event data from the database, and sends that data in JavaScript Object Notation (JSON) format to the mobile phone.

Benjamin Lautenschläger et al. [4] This paper recognizes planar images and also complex 3D objects regardless of their size and geometry. This paper aims to create a mobile application which helps people on the campus of the University of Calgary to orientate themselves and find their destination. Here, server acts as a central point which is implemented so that clients based on different platforms can access information in an easy way via restful web services and a prototype for the Android platform was developed which connects to these data sources and supports users on the campus with routing features and other information.

Vaibhav Anpat et al. [5], presents a campus spatial information service system application which provides guidance and navigation service with a custom map simple and converts public map onto custom map in graphic format. The custom map may be in Kmz format, this kmz files loaded onto the application to show navigation on custom maps. When the visitor is interested in the POI (Point of Interest), then he/she may activate the guiding service and mainly implemented a map navigation system for travelling salesman problem on android using Google map and Google Geo-Coder API. The System is mainly the combination of Google Maps and MySQL database and provides facility of interactive information such as the picture, description, link and zoom out, zoom in, pan, eagle.

III. METHODOLODY

A. Introduction to Campus Navigation Challenges

University campuses are often large, complex environments with numerous buildings, roads, and pathways. Navigating them can be challenging, especially for new students, visitors, or individuals with disabilities. The need for effective campus navigation systems has increased as campuses expand and become more intricate. The literature identifies several core challenges:

1) Lack of signage or inadequate campus maps.
2) Complexity of routes between buildings or facilities.
3) The presence of multi-floor buildings.
4) Dynamic environments (e.g., construction sites, events).
5) Accessibility issues for people with disabilities.

B. Technological Solutions for Campus Navigation

Technological advancements have significantly improved campus navigation by leveraging tools like mobile apps, GPS, indoor navigation systems, and augmented reality (AR). Below are the primary technological solutions identified in the literature:

1) Mobile Apps with GPS

Mobile applications have become one of the most common solutions for campus navigation. Many universities now offer official apps with features such as:

- GPS-based navigation that provides turn-by-turn directions across campus.
- Interactive maps that show important landmarks, such as lecture halls, libraries, and cafeterias.
- Integration with academic schedules to guide students to their next class.
- While GPS technology works well for outdoor navigation, its accuracy diminishes in indoor environments where signals are blocked or weak.

2) Indoor Positioning Systems (IPS)

To address the limitations of GPS indoors, campuses have begun using indoor positioning systems (IPS) based on various technologies:

- Wi-Fi triangulation, where a device's location is determined based on its proximity to Wi-Fi access points.
- Bluetooth beacons, which provide micro-location information that helps users navigate complex buildings.
- Infrared, RFID, or ultrasound technologies for highly precise indoor navigation.

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3) Augmented Reality (AR)

Augmented reality is gaining traction as a tool for campus navigation. AR overlays digital information onto the physical world, typically through a smartphone or smart glasses. Some universities have developed AR-based navigation systems that provide users with visual cues (arrows, routes) overlaid onto real-world images.

Enhanced user experience: Users can see real-time directions in their environment.

Interactive and educational: AR can also display historical or academic information about campus landmarks.

4) Wayfinding and Accessibility Technologies

There is an increasing focus on navigation solutions designed specifically for students and visitors with disabilities. Literature highlights the development of:

Voice-guided navigation apps for visually impaired individuals.

Accessible campus maps that highlight wheelchair-accessible routes, ramps, elevators, and more.

Haptic feedback systems (vibration or tactile-based navigation) for users with limited visual capacity.

C. Non-Technological Solutions

While technology plays a major role, non-technological solutions are still relevant, particularly in environments where digital tools might not be accessible. Examples include:

Improved signage across campus, designed with clear, consistent, and intuitive symbols.

Printed maps with updated information, often available at key entry points, information desks, and buildings.

Human guides and information booths, especially during the start of the academic year, to help new students and visitors navigate efficiently.

D. Integration of Campus Navigation with Other Systems

Research emphasizes the importance of integrating campus navigation tools with other university systems, such as:

- Class schedules and course management platforms, so students receive guidance based on their academic activities.
- Event management systems, which update navigation routes to accommodate one-off events like conferences or concerts.
- Public transportation systems, providing real-time information on buses, shuttles, or ride-sharing services around campus.

E. Case Studies and Implementations

Several studies document successful campus navigation projects:

- Stanford University developed a comprehensive campus map app with GPS-based navigation and additional services like shuttle tracking and parking availability.
- MIT introduced an indoor navigation system leveraging Wi-Fi signals to guide users through its complex multi-building campus.
- University of Michigan launched an AR-based app that offers interactive campus tours and real-time indoor and outdoor navigation.

F. User Experience and Evaluation

The literature often emphasizes the need for thorough user testing of campus navigation solutions. Factors influencing the success of a system include:

- Ease of use: Intuitive interfaces and easy-to-follow instructions are key.
- Reliability: GPS or indoor navigation must be accurate to prevent frustration.
- Adaptability: The ability to update navigation tools based on campus changes (e.g., construction or new buildings).
- Feedback mechanisms: Allowing users to report issues or suggest improvements in real time enhances the system's effectiveness.

G. Future Directions

The future of campus navigation will likely be shaped by advancements in:

- Artificial Intelligence (AI): AI could personalize navigation experiences based on a user's preferences or past behaviour.

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- 5G networks: Faster internet speeds and lower latency will improve real-time navigation experiences.
- Wearable technology: Smartwatches, AR glasses, or other wearables could offer seamless navigation without needing a handheld device.
- Sustainability: Eco-friendly solutions, such as encouraging walking or biking through optimized route planning, may become integrated into navigation systems

IV. SYSTEM FRAMEWORK

The process begins by the user initiating the system and selecting the navigation option. They then input the desired destination. If the entered location is not found, navigation to that spot cannot proceed, and the process moves to the termination state. If the location is available, it is captured. Should the captured location be invalid, the system will continue repeating the process until a valid location is found. Once validated, the location is scanned, identified, and the process concludes at the termination state.

V. IMPLEMENTATION

A. Location

The app determines the user's location on campus by utilizing latitude and longitude coordinates, which are captured through Unity. These coordinates are then stored within the system. The API facilitates digital map navigation, allowing users to obtain location data via satellite view. Alternatively, mapping between buildings or classrooms can be used. This mapping process collects coordinate points within a defined space and stores them in the database as unique reference points. Each point is named according to specific search requirements, providing detailed navigation options between different locations.

After marking all the destinations on the map, a virtual map is created within Unity, displaying directions with each viewpoint acting as the user's destination on the system interface. Based on the user's chosen destination, the system initiates localization. Once the camera scans the user's target area, holographic arrows guide them along the optimal route within the navigation interface.

B. Storing and Registration

To accurately guide users to their desired locations, we begin by identifying all the buildings on the campus and placing markers on a virtual system's map. A detailed floor map is created for each building floor, pinpointing the rooms and capturing the viewpoint of each room through mapping. The process involves the following steps:

Step 1: The camera records a video capturing various points within the room. This helps identify the room's unique edge points.

Step 2: After recording the points for each room, the rooms are labelled, corresponding to their positions on the pre-uploaded floor map. The recorded points are then matched with the room numbers on the map.

Step 3: With all the data stored, a virtual map is created for the user, marking each destination with a red symbol. Navigation from the current location to the destination is provided based on the map database. The phone's camera calculates the transformation from world coordinates to image plane coordinates. The marker in this coordinate system, along with the camera parameters, can be resolved using a homographic matrix (H) generated during the mapping process. Determining and computing these homographs requires at least four or more viewpoints in the recorded data. The more coordinates that are used, the greater the accuracy in estimating the distance to the destination. In this approach, we utilize four pairs of points corresponding to the vertices on the map to establish the homography.

Step 4: Once the user selects a destination, the scene surrounding the user is rendered using OpenGL for camera image processing. The destination symbol is drawn through the OpenGL API, utilizing the camera's external parameters. After the system loads the database, it tracks and registers the location using visual-based technology. In the next step, the system calculates the user's location, displaying key information on the screen, including the step count and estimated time to reach the destination.

C. Image and Display

The system stores images containing guide markers and data for each building on the campus. The map can store and display images of walls and other relevant markers to the user. The system requires an Android phone equipped with a built-in camera and display for full functionality. To make navigation easy, the user interface includes buttons and dropdown lists, allowing users to select specific buildings and floors they wish to visit and access detailed information for each location.

VI. SYSTEM ARCHITECTURE

The BIT AR Navigation system is structured into four key components: information input, information processing, device input, and information output. Initially, it receives input from markers, which are processed by the AR-based marker detection system.

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This system identifies continuous boundaries in the input image, unwraps it into a rectangular form, and compares it to the existing Marker model.

The information input includes building and maintenance details, such as floor numbers and positions, which help in route calculation, handled by the information processing block. After the route is calculated, the system aligns it with the user's current location and displays it via the information output.

Device input utilizes an IMU (Inertial Measurement Unit) to monitor user movements, including body force, angular velocity, and direction, by integrating multiple sensors. The step counter uses this movement data to determine the number of steps required to reach the destination. The output then displays three key pieces of information on the user's smartphone: navigation instructions, the path to follow, and the positions of maintenance objects.

VII. EXPERIMENTAL RESULTS

When a user scans the QR code using an Android device running version 8.5 or higher, the system initiates a localization process. This happens when the camera scans anywhere on the campus, displaying a list of locations that the user can choose to visit. This information is stored in a database. Each localization attempt is shown on the screen, along with distance and time estimates. The distance informs the user how far the destination is in meters, while the time estimate indicates how many seconds it will take to reach the destination.

A localization button is provided at the bottom of the screen, allowing users to change their destination without needing to scan the QR code again. Navigation is guided by augmented reality, where holographic arrows direct the user toward their selected destination.

VIII. APPLICATION

1) Campus: Augmented reality technology allows users to accurately locate and view detailed information about every block within the campus.
2) Hospital and Infrastructure: AR can be utilized for indoor navigation, guiding users through complex buildings like hospitals.
3) E-commerce and Retail: Augmented reality app development is transforming both online and offline shopping experiences.
4) Interior Design, Landscaping & Urban Planning: Apps like IKEA Place use AR to measure objects, walls, and spaces, aiding in design and planning.
5) Games, Leisure, and Entertainment: The popular game Pokémon GO remains one of the most recognized examples of AR technology in gaming.

IX. FUTURE ENHANCEMENT

The proposed system holds significant potential for future applications. It has been developed by integrating both technical and user requirements, addressing future needs. The system's results offer an additional feature that allows users to visualize the path to their desired location. A key advantage of the project is its ability to track the user's current position and orientation using a step counter, enhancing the system's efficiency for future developments.

X. CONCLUSION

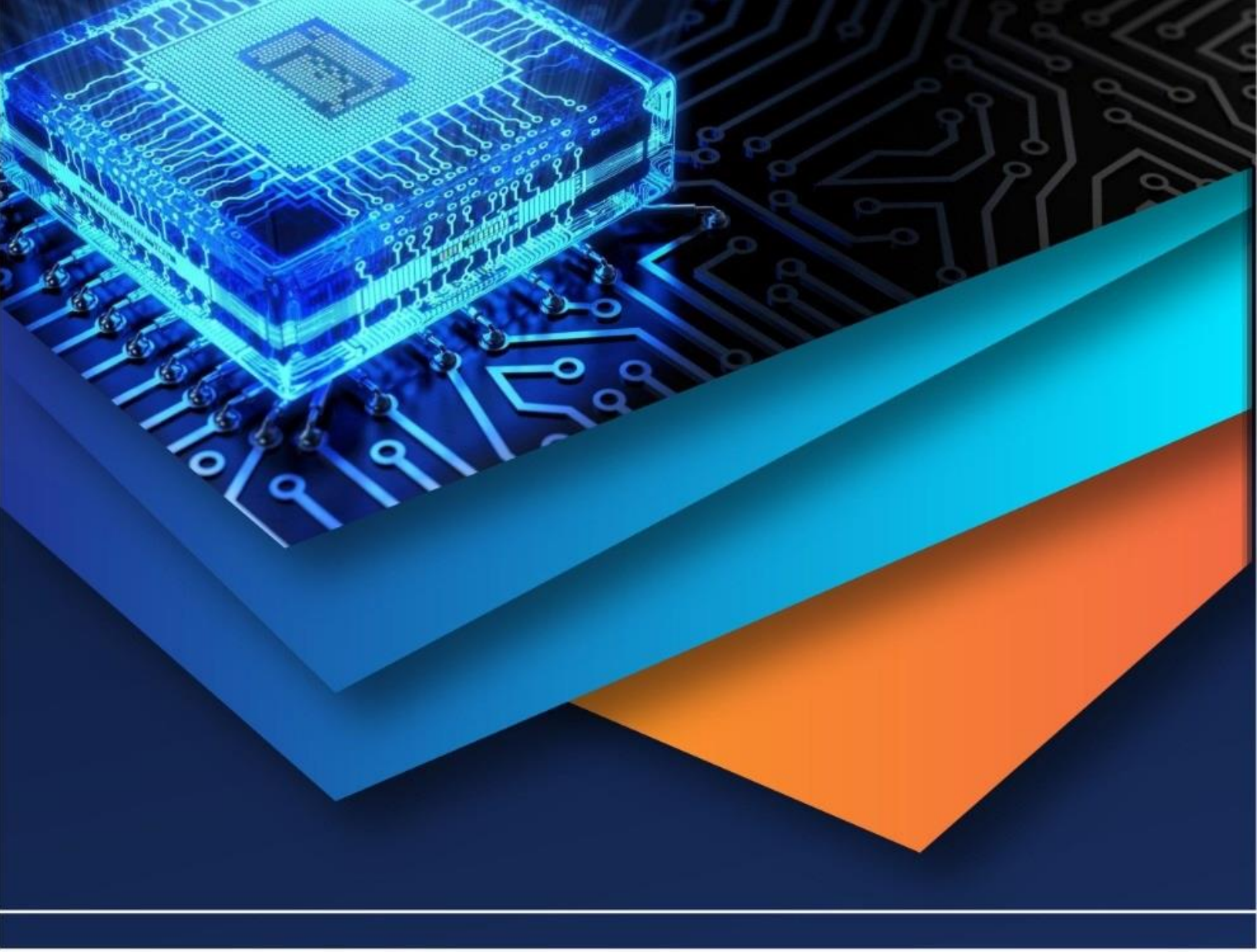
This paper explores various aspects of augmented reality, navigation, and image processing technologies, integrating them to create a campus navigation system. Based on experiments, the system assists users in navigating to different locations within the campus and provides detailed information about hospital facilities, aiding in a better understanding of the layout. The system has potential for broader applications, such as navigation in large factories, IT centres, and shopping malls.

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