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Optimizing university path navigation : A statistical and decision sciences approach using augmented reality

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Abstract

This study focuses on the interaction of AR for the navigation of paths in the university setting. Statistical analysis and decision sciences are used in assessing the performance of such a system. The innovative AR framework offers users real-time personalized route assistance, thereby improving user experience in navigating these complex environments in universities. The system uses GPS along with advanced camera technologies, providing real-time information to the user on smart devices, merging physical and digital into the same spatial context. 150 sample participants tested the application, with 92% having succeeded in reaching their destination. Key metrics analyzed include navigation accuracy, time efficiency, and user satisfaction. This study applies statistical methods to assess the performance of the system by highlighting its potential for making optimization decisions in educational environments, thereby transforming the potential of AR in enhancing the management of spatial environments and user interactions.

Subject Classification: *86A30, 68U35.*

Keywords: *University way, AR, GPS tracking, Camera tracking, Navigation.*

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I. Introduction

From ancient maps and compasses to modern tools like Google Maps, navigation has long been a focus of improvement. Today, satellite route drives most frameworks, offering turn-by-turn directions [1]. However, these frameworks, commonly on cell phones or PCs, request client consideration, prompting disappointment and mishaps. Increased reality (AR) mixes virtual and genuine data flawlessly [2]. These structures have advanced after some time, moving from out-of-date way-finding techniques to current automated arrangements that work with simple routes and development. Proposes a route application specifically designed for college campuses, geared toward assisting novices in investigating the frequently perplexing design of these environments [3].

By engaging users to download the application on their phones, it intends to chip away at the most widely recognized approach to finding their course to various blocks and workplaces inside the university walls [4]. These frameworks give users improved spatial mindfulness by overlaying route data onto the College climate. Moreover, the versatility of AR innovation considers consistent routes across different conditions, from Office locales to indoor spaces, guaranteeing reliable directions any place users head [5]. This process is experienced by the newbies by guiding them throughout the university walls. Even this is to show the user the information of the particular block and explain the required information regarding the place in the form of a button to be clicked and explain the block directions and what it contains on every floor [6].

Problem Statement:

As the world progresses in internet technology, systems like Google Maps give a 360-degree view of scanned areas. However, navigating within certain locations, like college campuses, is difficult for most newcomers. Students, parents, visitors, and event attendees find themselves confused even with verbal directions that may be vague.

They introduce a navigation app on campuses to aid with navigating. Using this application would mean installation and the ability to enable the device's GPS together with using its camera to access routes leading to various blocks of a building [7]. That is a simplistic means of moving people around while guaranteeing to reduce stress significantly.

II. Related work

A study contrasts digital maps, handheld augmented reality browsers, and AR + map combinations for navigation. Overall task completion time differences were not observed. However, in some settings, AR browsers are less useful. When it comes to navigating, users favour the AR + Map condition over AR alone [8]. Comparing methods for affordable indoor navigation is the focus of research. The suggested solution makes use of AR technologies and integrated mobile sensors. The development incorporates ARCore for navigation and IndoorAtlas for placement. Survey-derived efficiency and feedback that illustrates the architecture and use of the method [9].

The system selects destinations in buildings using QR codes. The live camera feed is integrated with Google AR Core for mapping and localization. The shortest route to the selected location is determined using the A* algorithm. Real-time animated directions are displayed on the user's camera screen using a Unity-based application that utilizes the ARCore plugin [10]. The study gives tourists and students an introduction to augmented reality technology. The app shows campus structures and rooms in two and three dimensions on smartphones with ARCore compatibility. On the smartphone screen, text pop-ups with more information are displayed. The project intends to familiarize users with augmented reality technology and streamline access to educational information [11].

For immersive navigation, the Augmented Reality Navigation Interface combines virtual and physical environment data. For indoor navigation, it makes use of vision, geographic data, and sensor fusion to provide step-by-step instructions and adjust to changing situations [12].

Versatile AR applications frequently need ceaseless spatial data, expecting clients to switch between AR and 2D perspectives for course direction. This paper proposes a situation-based answer for flawlessly coordinating direct spatial information and improving routes in portable AR applications [13][14].

With internet access, the Android operating system enables the rapid expansion of smartphones.AR allows users to interact with virtual items and films. Augmented Reality improves navigation by offering up-to-date, user-focused information. The application of smartphone cameras and GPS for user guidance in augmented reality is covered in this study. With internet access, the Android operating system enables the rapid expansion of smartphones.AR allows users to interact with virtual items and films [15].

This study investigates how GPS and augmented reality (AR) could enhance pedestrian navigation in urban areas. It finds through user testing with a hybrid navigation application that AR navigation works best in intricate urban settings where 2D maps find it difficult to accurately depict street directions.

III. Methodology

The methodology started by doing a critical requirement analysis based on the general navigation problems most visitors to the university face, comprising students, parents, and even event attendees. Observations

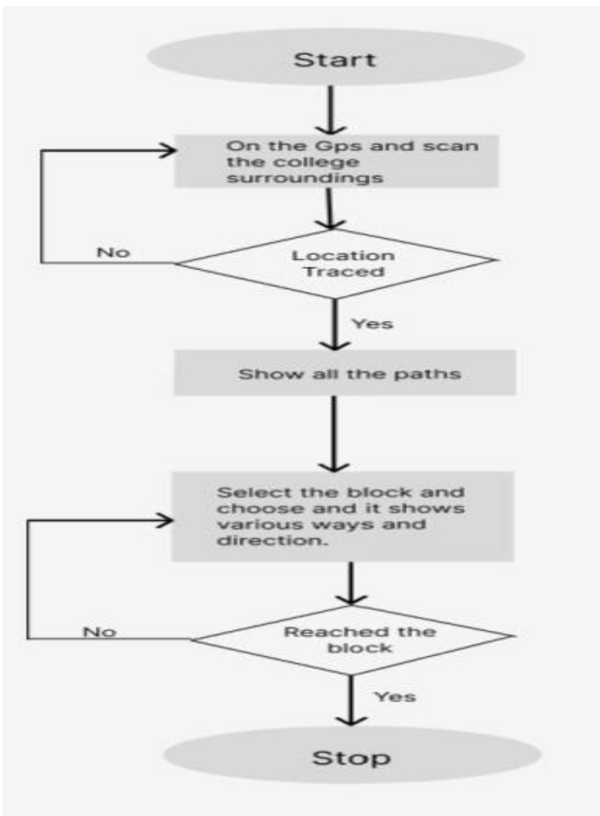

Figure 1

Flow diagram of the working process

and feedback highlighted how people could easily get lost on campus while searching for classrooms, blocks, or other facilities. These insights have been used in defining the goals and scope of the application. It focused on design and development, creating an intuitive mobile application, where AR technology is integrated with GPS for navigation. Designing the UI proved simple yet appeared to be user-friendly even for a first-time app user. The core features included a real-time camera overlay, GPS location tracking, and AR-based directional markers as aids to guide the user effectively. Figure 1 shows the flow diagram of the working process.

Destination Selection:

- User Action: The user selects a block from a list of available options or searches for a specific building.
- Application Response: The app confirms the selection and prepares to generate routes.

Route Calculation:

- Application Action: The app calculates the most efficient routes to the selected block, using the user's current location and predefined pathways within the university.
- User Notification: The app displays a visual route in augmented reality, highlighting paths and directions.

Navigation:

- User Action: The user follows the AR-guided route to the destination.

Application Feedback: As the user navigates, the app provides real-time updates and encouragement, such as "Continue straight for 100 meters" or "Turn right at the next intersection."

To represent the effectiveness of the "University Way Planning" application statistically, an equation can quantify its efficiency improvement and user satisfaction. The equation below combines the navigation success rate (S), time efficiency improvement (T), and user satisfaction (U) into a single effectiveness score (E):

$$E = \frac{(w_1 \cdot S) + (w_2 \cdot T) + (w_3 \cdot U)}{\sum_{i=1}^{3} w_i} \quad (1)$$

Where:

S = Navigation Success Rate

T = Time Efficiency Improvement

U = User Satisfaction

$w1$, $w2$, $w3$ = Weights assigned to each factor based on importance.

To support the functionality of the application, campus layout data, including building locations, pathways, and points of interest, were collected in detail. This information was then organized into a structured database, which was used as a basis for the generation of correct navigation paths. AR technology was implemented using open-source libraries combined with custom coding. The app uses the camera of the device to overlay directional arrows and labels onto live camera feeds, thereby providing clear visual guidance to users. Another important step is the integration of GPS functionality that enables the app to determine the user's real-time location. The system then combines GPS data with the mapped campus layout to dynamically generate the most efficient routes to the user's desired destination.

Testing at the university campus was conducted very intensively onsite. The testing simulated various user scenarios to validate the accuracy, responsiveness, and ease of navigation provided by the app. Testing feedback from both new students and visitors was obtained and used in the subsequent refinement of the application. Finally, the application was released and downloaded to smart devices. Installation and usage instructions were given to make the application accessible to all visitors to the university. This holistic approach ensures that the application effectively deals with the challenges of navigation on university campuses by providing a seamless and intuitive solution.

IV. Results & discussion

For evaluating the proposed application based on Augmented Reality, a statistical analysis was conducted using feedback from the users and their performance in navigation. As shown in Table 1, a total of 150 participants, consisting of students, parents, and visitors, tested the application on the university campus. The main metrics were accuracy in navigation, efficiency in time, and user satisfaction. The test results found 92% of users were able to reach their target destination, proving that the application was reliable. On average, it took less time to find a specific

Table 1

Performance of AR

Metric	Value
Total Participants	150
Navigation Success Rate	92%
Time Efficiency Improvement	35%
User Satisfaction	87%
Challenges Reported	12%
Resolution Success	90%

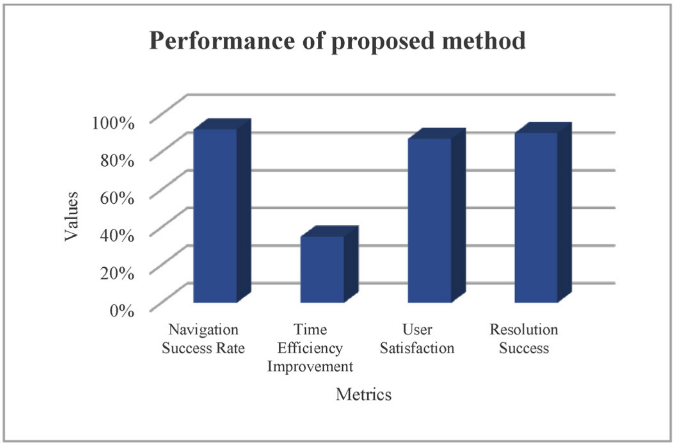

Figure 2

Performance of the proposed method

Figure 3

Result of this study

block as opposed to using other applications that did navigation: 35% less time was needed. Most participants rated the application "very helpful" or "extremely helpful": 87%. Common issues, including initial app setup and unfamiliarity with AR features, were reported by 12% of users but were addressed with on-screen tutorials and simplified instructions. Figure 2 shows the performance of the proposed method.

Figure 3, shows the sample outputs for the particular location where location marked for the central library in the university where the path takes us from the starting point where it started and takes us to the destination after reaching the location it asks the user to show extra information if the user needs the information he is asking for information then the details of the area is being given like no of floors what are there in each floor like classrooms in it, discussion rooms, etc. present in the library and after providing if the user decides to close the application he could close the application else he can continue using it.

V. Conclusion

This process is one of the best processes for the navigation system inside the University where the user who is new to the area has to suffer in searching the blocks in different locations of the university. This makes the user feel simple in finding different paths and the best path among them, to be chosen to go through to reach the destination. This not only allows users like students and Staff who are new also can be used the visitors of the campus where the visitors feel comfortable and can attract them with this method. This application can be downloaded by just scanning the QR code it takes to download the application and use it by allowing a camera in the handheld device.

Future Enhancement

This type of app can be generated for various purposes in different types of places from schools to hospitals. The application is to be generated using the AR. This can help to guide the user in unknown places and make them feel comfortable. They can add some of the attractive features to the projects in future which also entertain the user not only through direction but also through generating an AI that takes you through the path and helps to reach your destination. This attracts the user to learn and know about the place well and makes it pretty good for the user to be guided in a friendly way which is comfortable and entertaining for them to use the application. This methodology is to be developed in a more exciting way where every user is attracted from education, navigation, etc. in proper areas with proper application. This is the expected future outcome and more might also come through.

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