RESEARCH ARTICLE OPEN ACCESS

A Mobile Application for Campus Navigation and Lecturer Availability System (CNLAS)

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Abstract

Background and Motivation: University campuses are characterized by expansive layouts and complex infrastructures that present significant navigation challenges to students, staff, and visitors. Additionally, inefficiencies in locating academic staff and determining their real-time availability compound these difficulties, reducing academic productivity and increasing time wastage. Methods: This study presents the design and development of a mobile-based Campus Navigation and Lecturer Availability System (CNLAS) using Flutter for the frontend, Node.js with Express for the backend, and PostgreSQL for database management. An Agile software development methodology was adopted to ensure flexibility, adaptability, and user-centered design throughout the development lifecycle. The system integrates interactive navigation with real-time lecturer availability tracking into a unified mobile platform. Results: The system was evaluated based on functionality, performance, and usability. All features operated as expected, maintaining acceptable response times and enabling users to complete tasks without difficulty. User feedback indicated that the system significantly reduced the time required to locate buildings and lecturers, thereby improving overall efficiency and reducing time wastage associated with campus navigation. Conclusion: The CNLAS system successfully demonstrates the effectiveness of integrating spatial navigation with real-time availability systems to provide a comprehensive solution that improves user experience and operational efficiency in academic environments. This work highlights the potential of mobile technology in enhancing campus-based academic operations.

Keywords: academic environments; campus navigation; lecturer availability; mobile application; real-time tracking; user experience

I. INTRODUCTION

University campuses are complex and dynamic environments consisting of multiple interconnected facilities such as lecture halls, administrative buildings, student hostels, libraries, and recreational centers [1], [2]. For many students, particularly newly admitted ones, navigating these environments can be both confusing and time-consuming. Visitors and staff members also face similar challenges when attempting to locate specific buildings or offices. Traditional navigation methods, including printed maps and directional signage, have long been used to assist individuals in finding their way around campuses. However, these methods are inherently limited due to their static nature and inability to provide real-time updates [3]. Additionally, students frequently encounter difficulties when attempting to locate lecturers, with no centralized system providing real-time availability information. This lack of integration between spatial and informational resources creates a fragmented user experience and reduces academic productivity.

The rapid advancement of mobile technologies and widespread adoption of smartphones present an opportunity to address these challenges through innovative solutions [1], [4]. This study proposes the Campus Navigation and Lecturer Availability System (CNLAS), a unified mobile application that integrates navigation and real-time lecturer availability tracking. Our contributions are:

A comprehensive mobile solution that integrates campus navigation with real-time lecturer availability tracking into a single user-friendly platform.

An implementation using modern technologies (Flutter, Node.js, PostgreSQL) demonstrating cross-platform capability and scalability.

Empirical evidence showing significant reduction in time required to locate campus facilities and academic staff, improving overall user experience and operational efficiency.

The remainder of this paper is organized as follows. Section II reviews related work on campus navigation and availability systems. Section III describes the proposed methodology and system architecture. Section IV presents experimental results and evaluation findings. Section V concludes with future research directions.

II. RELATED WORK

A. Campus Navigation Systems

Existing research on campus navigation systems reveals that most solutions focus on spatial guidance using GPS and mapping technologies. Several studies have explored the use of augmented reality (AR) and mobile applications for campus navigation, with approaches including interactive maps and visual guidance [2], [4]. These systems are effective in providing directions but often lack integration with real-time information about individuals and their availability within locations.

B. Academic Information and Availability Systems

Academic information systems provide data related to lecturer schedules, courses, and institutional activities, supporting management and communication [3]. However, these systems typically operate independently of spatial navigation, requiring users to navigate separately to locate specific individuals or resources. This separation creates inefficiencies in user workflows.

C. Integrated Solutions and Research Gap

The key gap identified in existing literature is the lack of integration between campus navigation systems and real-time lecturer availability systems. While individual components have been extensively studied, no comprehensive solution addresses both spatial guidance and real-time availability information within a unified platform. This study addresses this gap by proposing CNLAS, which combines both functionalities through a single, cohesive mobile application that leverages modern technologies and user-centered design principles.

III. METHODOLOGY

A. System Architecture

The CNLAS system adopts a four-tier architecture to enhance scalability and maintainability. As shown in Fig. 1, the layers are organized as follows:

Presentation Layer: Developed using Flutter, this layer provides the user interface and handles user interactions, supporting both Android and iOS platforms through cross-platform development.

Application Layer: Implemented using Node.js and Express, this layer processes user requests, manages business logic, and handles authentication through RESTful APIs.

Data Layer: PostgreSQL is used to store and manage structured data, including user profiles, lecturer information, schedules, and campus location data.

External Services Layer: Integration with Google Maps API enables real-time navigation, route visualization, and geolocation services.

B. Development Tools and Technologies

The system was developed using modern technologies selected for their efficiency, scalability, and community support. Flutter was chosen for frontend development due to its cross-platform capabilities and high-performance rendering. Node.js and Express were used for backend development because of their asynchronous processing capabilities and flexibility in handling concurrent requests. PostgreSQL was selected for database management due to its reliability, support for complex queries, and robust transaction handling.

C. Development Methodology and Implementation

The development of CNLAS followed the Agile Software Development Life Cycle (SDLC). Agile methodology was chosen due to its flexibility and emphasis on iterative development, enabling

incorporation of user feedback throughout the development process. The implementation was divided into several sprints, each focusing on specific features:

Sprint 1: User authentication and profile management with secure credential handling.

Sprint 2: Campus navigation features using Google Maps integration and route optimization.

Sprint 3: Lecturer availability tracking with real-time status updates and scheduling.

Sprint 4: Testing, optimization, and user interface refinement based on feedback.

Regular testing and evaluation were conducted at the end of each sprint to ensure system functionality, performance, and adherence to user requirements.

IV. RESULTS AND DISCUSSION

A. System Evaluation

The CNLAS system was evaluated based on three key performance criteria: functionality, performance, and usability.

Functionality: All system features were comprehensively tested and found to operate as expected. Navigation features correctly display campus maps and provide accurate route guidance. The lecturer availability system successfully tracks and displays real-time status information for all registered academic staff members.

Performance: The system maintained acceptable response times across all operations, with average API response time of 250–350 milliseconds. Users experienced smooth interaction with the application, with minimal latency during map loading and real-time data synchronization.

Usability: User testing revealed that the system interface is intuitive and user-friendly. Participants successfully completed navigation and availability lookup tasks without difficulty, with an average task completion time of 45 seconds for location searches and 30 seconds for lecturer availability queries.

B. User Feedback and Impact

User feedback indicated substantial improvements in campus navigation experience and academic coordination. Participants reported an average 60% reduction in time required to locate campus facilities compared to traditional methods. The real-time lecturer availability feature eliminated unnecessary visits to offices, with users reporting 75% reduction in fruitless office visits. Overall user satisfaction scored 4.3/5.0 on the system's ease of use and utility.

C. Discussion

The integration of campus navigation and lecturer availability into a single application represents a significant advancement over existing fragmented systems. By addressing both spatial and informational challenges simultaneously, CNLAS provides a comprehensive solution that enhances user experience and operational efficiency. The successful implementation demonstrates the potential of mobile technology in improving academic environments.

However, certain limitations were identified during evaluation. First, the system currently relies on GPS for outdoor navigation, which limits its effectiveness indoors where GPS signals are weak or unavailable. Second, the deployment scope was limited to Babcock University campus, with expansion to larger or multiple campuses requiring architectural modifications. Third, real-time status updates depend on active lecturer participation in updating their availability, which may be inconsistent. These limitations should be addressed in future iterations.

V. CONCLUSION AND FUTURE WORK

This study demonstrates the effectiveness of a mobile-based solution in addressing campus navigation and lecturer availability challenges. The CNLAS system successfully integrates navigation and real-time availability tracking into a single platform, providing users with a convenient and efficient tool that reduces time wastage and improves academic productivity. The findings highlight the importance of integrating multiple functionalities into a unified system to comprehensively address complex problems within academic environments.

Future research should focus on the following directions:

Indoor Navigation Integration: Incorporating advanced indoor positioning systems (IPS) such as Bluetooth Low Energy (BLE) or WiFi-based trilateration to provide accurate navigation within buildings where GPS is unreliable.

Multi-Campus Expansion: Extending the system to cover multiple university campuses and institutions, requiring scalable architecture and centralized data management.

Machine Learning Enhancement: Implementing machine learning models to predict optimal routes based on campus traffic patterns and user preferences, and to predict lecturer availability based on historical patterns.

Augmented Reality Features: Integrating AR technology to provide immersive navigation guidance and virtual campus tours for prospective students and visitors.

VI. DECLARATIONS

A. Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The development was conducted as part of the authors' academic coursework at Babcock University.

B. Conflict of Interest

The authors declare no conflict of interest. No author has any financial or non-financial competing interests in relation to this work.

C. Data Availability

The datasets and code supporting this study are available from the corresponding author upon reasonable request. The source code is maintained in a private repository at Babcock University and can be made available for academic purposes with appropriate agreements.

D. Ethics Statement

This study did not involve human subject testing beyond voluntary user feedback during system evaluation. User feedback was collected on a voluntary and anonymous basis. No sensitive personal data was collected or retained beyond what was necessary for system functionality. The study complies with Babcock University's research ethics guidelines.

E. Author Contributions

Conceptualization, F.O.B. and O.O.T.; Methodology, F.O.B.; Software, O.O.A. and U.A.; Validation, F.O.B. and O.O.T.; Investigation, O.O.A.; Writing — original draft, F.O.B.; Writing — review and editing, O.O.T.; Supervision, F.O.B. All authors have read and agreed to the published version of the manuscript.

VII. ACKNOWLEDGMENTS

The authors acknowledge the Department of Computer Science at Babcock University for providing the necessary resources and infrastructure for this research. We thank the student participants who provided valuable feedback during user testing and evaluation phases. Special thanks to the university administration for granting access to campus facilities and data required for system implementation.

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