UNIVERSITY OF LEICESTER

School of Computing and Mathematical Sciences

CO7201 Individual Project

Preliminary Report

A Mobile App for Campus Navigation

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1. Aims and Objectives

This project proposes the development of a mobile-based campus navigation tool which will assist students, staff, and visitors in navigating complex university environments. Keeping in mind the recent research in location-based services, usability, and Human-Computer Interaction (HCI), the app aims to address usability limitations in current navigation systems and deliver an intuitive and context-aware user experience.

The main motivation for developing this app is the challenges faced by new students and visitors in locating buildings, departments, and facilities within large campuses. This application will integrate real-time location tracking and accessible pathfinding options to improve wayfinding and reduce navigation-related problems.

Beyond daily navigation, the app is expected to have the potential to support campus-wide events, emergency routing, and accessibility guidance for individuals with mobility challenges. Challenges anticipated in the development phase include ensuring high-accuracy indoor positioning where GPS is unreliable, accommodating frequent changes in campus layouts, and designing an interface that remains usable across different devices and user groups.

2. Requirements

The following is a provisional list. The list is not exhaustive and may change as the project progresses.

2.1 Essential

- Research of existing campus navigation tools, focussing on university environments.
- Design and development of a mobile application (preferably using Flutter) specifically for the University of Leicester campus.
- Real-time GPS-based outdoor navigation, guiding users from their current location to campus buildings.
- Interactive campus map integration, showing building names and entry points.
- Search functionality to locate specific rooms or departments.
- Accessibility support, including route options that avoid stairs or steep slopes to assist individuals with mobility issues.
- User testing to assess navigation accuracy and overall usability of the application.

2.2 Recommended

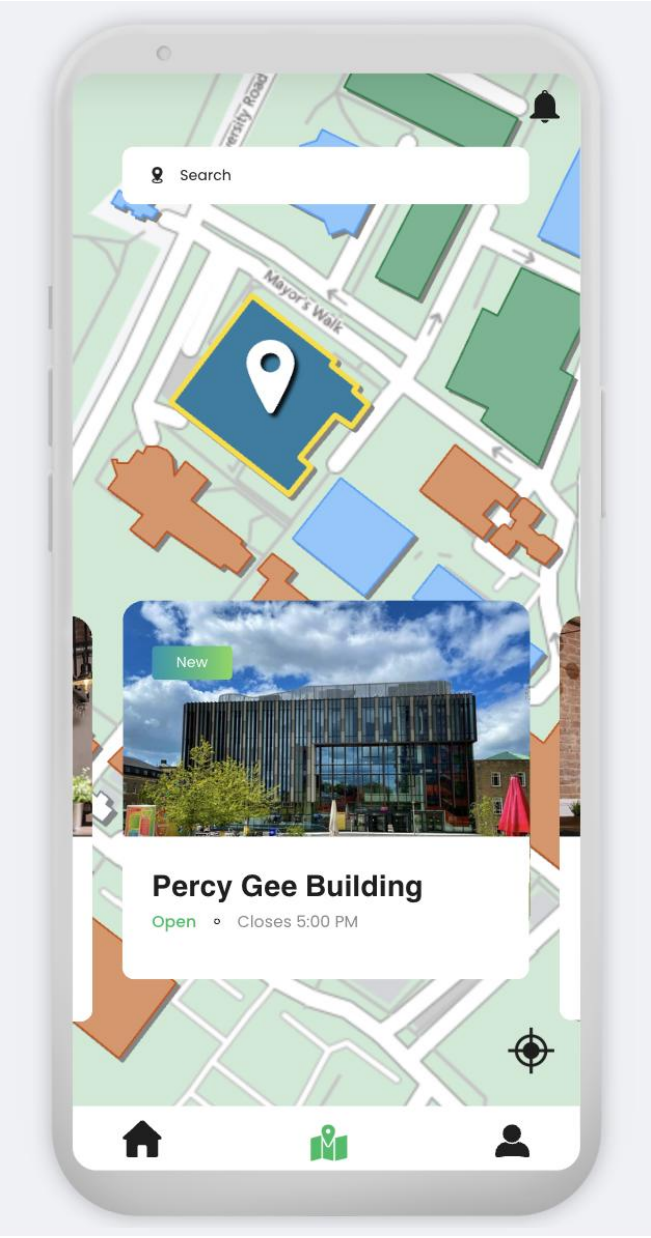
- Indoor navigation for complex buildings like the David Wilson Library and Attenborough Tower, using QR codes or Wi-Fi fingerprinting to guide users to specific rooms.
- Timetable integration via university systems to provide guided navigation to the user's next scheduled class or event.
- Integration with University of Leicester Centre bus schedules, allowing users to view real-time arrivals, plan routes that involve bus segments (from village accommodation).
- Offline mode, with cached campus maps and preloaded route data.

- Multilingual support, especially for new international students during Welcome Week.

2.3 Optional

- Gamified onboarding tours to help freshers explore key areas of the campus and earn virtual rewards.
- Admin portal for university staff to update building information and routes.

This is a mock-up designed using Canva to show the UI of the application I intend to develop.



3. Technical Specification

The mobile application will be developed using Flutter framework by Google using Dart language. I am using Flutter by Google for its ability to build high-performance mobile applications efficiently with a single codebase. Powered by the Dart language, Flutter offers fast hot-reload, a rich set of customizable widgets, and smooth UI experiences, making it ideal for creating responsive and visually appealing interfaces. For backend I'll be using Firebase by google for its seamless integration with Flutter and real-time database capabilities, which streamline backend development. It offers built-in authentication, cloud storage, and scalable hosting, reducing the need to manage complex server infrastructure.

Some of the key services I'll be using are,

- Google maps API for maps integration.
- Firebase Authentication.
- Firebase cloud Firestore for storing data.
- GetX for state management in the app.
- Shared preferences to cache necessary data within the app.
- Gitlab for version control.

4. Requirements Evaluation Plan

To evaluate the effectiveness of the system and the experimental results, I will use a mixed approach focusing on usability and technical correctness. A survey method will be used to collect qualitative and quantitative feedback from my fellow classmates, who will act as representative users [1]. This will help assess the app's overall usability, user satisfaction, and identify areas for improvement from the end-user perspective.

In parallel, I will conduct unit testing during the development phase to ensure each component of the software functions correctly. This helps detect and resolve any bugs or issues [2]. This systematic testing will help maintain code quality and stability as new features are integrated. Together, these methods will provide a comprehensive evaluation framework. User surveys will validate whether the app meets usability and functionality expectations, while unit testing will verify the technical accuracy and robustness of the software. This approach ensures that the project achieves its intended goals both functionally and from the user experience standpoint.

5. Background Research and Reading list

This section presents the background research conducted to support the development of a mobile application for campus navigation. The literature review is guided by the structured methodology proposed by Okoli and Schabram [3], which is well-suited for research in Information Systems, Human-Computer Interaction (HCI), and mobile application design. The methodology ensures a transparent and replicable process. It has eight stages,

Purpose, Protocol, Search, Practical screen, Quality appraisal, Analysis, Write-up, and Use.

I have not used the exact stages proposed by Okoli and Schabram. I have drawn some inspiration from the studies and conducted a literature review.

5.1 Purpose

The primary aim of this literature review is to investigate the current state of campus navigation applications, location-aware mobile systems, indoor/outdoor positioning technologies, and their usability challenges. This informs both the design and technical feasibility of the proposed mobile app.

5.2 Protocol

For the review I came up with the following research questions so that I have a base.

- What technologies are commonly used in indoor and outdoor campus navigation apps?
- What are the usability and design principles that influence the effectiveness of campus navigation apps?
- What are the key challenges faced in implementing location-based mobile services in university settings?
- How do campus navigation apps address accessibility needs for students with disabilities?
- What methods are used to evaluate the effectiveness and user satisfaction of campus navigation systems in real-world scenarios?

5.3 Search

A thorough online search was done mainly on websites like Google Scholar, IEEE Xplore, ACM Digital Library. The search was not limited to these websites.

Search strings included the following keywords "campus navigation", "university navigation", "mobile app", "location-aware systems", "indoor positioning systems", "GPS alternatives", "BLE beacons", "smart campus", "usability", "user experience", "navigation apps", "wayfinding", "accessibility in mobile apps" etc.

5.4 Selection

Articles were selected using the titles and abstracts from the top 3-4 pages of each search result. These were included based on relevance to the mobile navigation domain.

5.5 Selected Articles

Research question	Papers	Justification
What technologies are commonly used in indoor and outdoor campus navigation apps?	Mautz, R. (2012). Indoor Positioning Technologies. Habilitation Thesis, ETH Zurich	This article provides a good overview of indoor positioning systems such as Wi-Fi, Bluetooth Low Energy (BLE), RFID, and UWB, comparing their accuracy and applicability. It is foundational for understanding technical

		choices in navigation apps [4].
What are the usability and design principles that influence the effectiveness of campus navigation apps?	A. Shankar Majumder (Jan 2025). The Influence of UX Design on User Retention and Conversion Rates in Mobile Apps	This paper discusses interface design strategies, interaction models, and contextual usability for mobile navigation apps. It is key in understanding how design choices affect user experience [5].
What are the key challenges faced in implementing location-based mobile services in university settings?	Zandbergen, P. (2009). Journal of Spatial Science	This study measures GPS accuracy in urban settings, highlighting real-world limitations of mobile location services which directly impact app performance on campuses [6].
How do campus navigation apps address accessibility needs for students with disabilities?	R. N. Kandalan and K. Namuduri. (June 2019).A comprehensive survey of navigation systems for the visually impaired	This article examines how navigation apps integrate features for visually impaired users, such as voice guidance and haptic feedback. This is essential for inclusive design [7].
What methods are used to evaluate the effectiveness and user satisfaction of campus navigation systems in real-world scenarios?	Medvedev, A., et al. (2015). International Journal of Human-Computer Studies	Presents methodologies for field-testing navigation systems in campus environments, including usability testing, user feedback collection, and performance metrics [8].

5.6 Key Observations

The review revealed several important information:

- Technologies Used: BLE beacons, GPS, QR codes, Wi-Fi fingerprinting, and augmented reality (AR) are widely used for hybrid indoor/outdoor navigation.
- Design Principles: Simplicity, real-time feedback, minimal interaction effort, and visual clarity were emphasized in usability-focused studies.
- Challenges: Battery usage, signal instability indoors, privacy concerns, and infrastructure dependency are common hurdles.
- Accessibility: Very few studies focused directly on accessible navigation for students with impairments, highlighting an opportunity to innovate.
- Evaluation Methods: Most systems were evaluated through user studies, surveys, and observational trials.

6 Time-plan and Risk Plan

6.1 Time-plan

Week	Start Date	End Date	Tasks to be completed	Description
1-2	16th June	27th June	Explore similar Apps	Research the web for similar technologies and apps and note what is lacking in those
			Set-up app development environment	Install all necessary packages and set-up the environment for app development
			Report review	Take feedback from Dr Kehinde before submission
			Preliminary Report submission (27th June)	Submit Report
3-4	30th June	13th July	Design app wireframes and UI mock-ups	Create initial design sketches and screen flow diagrams for the app
			Begin frontend development	Start coding the user interface and basic navigation
5-6	14th July	25th July	Continue frontend development	Implement core UI features and interactive elements
			Develop backend architecture	Set up databases, APIs, and server-side logic
			Report review	Take feedback from Dr Kehinde before submission
			Interim Report submission (25th July)	Submit Report
7-8	28th July	10th August	Integrate frontend and backend	Connect UI to backend services

				and ensure smooth data flow
			Begin testing and debugging	Identify and fix bugs, improve performance
			Prepare demo prototype	Build a working prototype for demonstration
9-10	11th August	25th August	Conduct user testing sessions	Collect feedback from test users to improve usability
			Refine app features based on feedback	Enhance app functionalities and UI/UX
			Report review	Take feedback from Dr Kehinde before submission
			Final Report submission (15th August)	Submit Report
11-12	26th August	5th September	Final bug fixes and polishing	Finalize app features, fix any remaining issues
			Report review	Take feedback from Dr Kehinde before submission
			Final submission (6th September)	Submit the application

6.2 Risk Plan

Risk	Description	How to mitigate it
Learning Flutter/Dart	I am still in the learning phase of Flutter and Dart, which may delay development	Allocate extra time in the schedule, utilize tutorials and forums
Indoor Mapping Complexity	Obtaining, scaling, and customizing building floor plans can be time consuming and may face access restrictions	Start with a single building, request publicly accessible plans
Offline Mode Support	Enabling the app to function without internet access will need caching and technical complexity	Implement local storage for map and direction data
Privacy and Data Protection	Storing or tracking user location may have privacy issues	Avoid storing personal data and always request user consent

Device/OS Compatibility	Location and Bluetooth features may not work consistently on all devices	Conduct testing across multiple devices

7 References

[1] J. French, "*Designing and using surveys as research and evaluation tools," Journal of Medical Imaging and Radiation Sciences*, 2012. **https://www.sciencedirect.com/science/article/abs/pii/S1939865412001270**

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[4] R. Mautz, *Indoor Positioning Technologies*, Habilitation Thesis, ETH Zurich, 2012. eth-5659-01.pdf

[5] A. Shankar Majumder, "*The Influence of UX Design on User Retention and Conversion Rates in Mobile Apps*" Jan 2025 https://arxiv.org/pdf/2501.13407.pdf

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[7] R. N. Kandalan and K. Namuduri, "*A comprehensive survey of navigation systems for the visually impaired*", June 2019.https://arxiv.org/pdf/1906.05917.pdf

[8] A. Medvedev *et al*., "*Evaluation of wayfinding systems on campuses*," *International Journal of Human-Computer Studies*, vol. 83, pp. 1–17, May 2015.