Smart Campus Navigation Assistant

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Introduction

- College campuses are growing larger and more complex.
- Visitors, new students, and staff struggle to locate rooms and departments.
- Indoor GPS tracking is unreliable; static signboards are limited.
- The system provides **QR-based, voice-enabled path guidance** with visual route display.
- Supports the vision of a **digital and accessible smart campus**.

Problem Statement

Aim: To build a QR-initiated voice guidance system using shortest-path computation and map visualization.

Literature Survey (Part 1)

Sl. No.	Paper Title	Source	Overview	Advantages	Limitations
1	Web-based Campus Navigation Using QR Codes	*Int. Journal of Research and Analytical Reviews, 2023*	Uses QR codes at key locations; users scan with smartphone to get directions.	Simple and cost-effective; no special hardware required.	Manual QR scanning; no real-time updates.
2	Smartphone-based Real-time Indoor Positioning using BLE Beacons	*IEEE CASE, 2022*	Uses BLE beacons for indoor navigation; smartphones detect signals to determine position.	Works where GPS fails; real-time tracking possible.	High deployment cost; signal interference.
3	Smart Campus Navigation: An IoT-based Approach for Intelligent Administration	*IJSRT, 2025*	Uses IoT devices for navigation and campus management.	Multi-purpose; improves efficiency.	Expensive; complex integration.
4	Shortest Path Algorithms for Pedestrian Navigation Systems	*Design Automation & Comp. Eng., 2021*	Compares Dijkstra, A*, and heuristic algorithms for pedestrian navigation.	Comprehensive comparison.	Theoretical; lacks real-time data.
5	Navigation Network Derivation for QR Code Based Indoor Path Planning	*Transactions in GIS, 2022*	Converts QR codes and floor plans into navigation graphs.	Low-cost; accurate; easy to update.	Lighting affects scanning; QR maintenance.
6	Campus Navigation System Using QR Code and Web	*Int. Journal of Creative Research Thoughts, 2025*	A two-dimensional web application linking QR codes to a live database and floor plan for shortest path generation.	Continuous, real-time web-based guidance; low-cost deployment.	Scanning required at multiple locations; dependency on internet and QR condition.

Literature Survey (Part 2)

Sl. No.	Paper Title	Source	Overview	Advantages	Limitations
7	Using a Smart Chatbot System as a Communication Tool for Campus Navigation	*The Asian Conference on Communication, 2022*	SoshaMapBot: hybrid chatbot using text and image inputs to infer location and provide instructions.	Multimodal interaction; NLP-based natural communication.	Accuracy around 75%; requires photo uploads (privacy concerns).
8	Smart Campus Navigation: Leveraging Augmented Reality (AR)	*Int. Research Journal of Engineering and Technology, 2025*	AR-based indoor navigation showing digital directional overlays on smartphone camera view.	Visual, intuitive guidance; enhances accessibility and user experience.	Needs reliable positioning; high phone resource usage.
9	Campus Navigator	*Int. Journal of Advance Research, Ideas and Innovations in Technology, 2024*	Web-based navigation (Python, Django, Map APIs) with real-time multi-modal pathfinding.	Supports walking, cycling, shuttle modes; real-time adaptability.	Internet required; depends on external APIs.
10	Theories and Methods for Indoor Positioning Systems: Comparative Analysis	*Journal of Positioning and Sensing Technologies for Ubiquitous Mobile Intelligence, 2024*	Compares Wi-Fi, BLE, UWB IPS technologies and algorithms like Fingerprinting, SLAM.	Comprehensive evaluation; highlights hybrid systems.	No universal standard; setup cost high.
11	Advanced Service Search Model for Higher Network Navigation Using Small World Networks	*IEEE Access, 2021*	Applies Small World Network strategies to improve navigation efficiency in large networks.	Scalable and low computational cost.	Requires precise network modeling.
12	The Making of Smart Campus: A Review and Conceptual Framework	*Journal of Advances in Sustainable and Smart Cities, 2023*	Reviews smart campus concepts and proposes a sustainability-focused framework integrating users, services, and technology.	Holistic approach; sustainability and user-centric design.	Conceptual only; lacks technical validation.

Objectives

- Create a QR-based indoor navigation system for campus environments.
- Generate shortest path using graph algorithms.
- Provide voice-based step-by-step guidance for destinations.
- Visualize routes with floor-wise labeled maps.
- Enable QR code sharing for quick access to the route map.

Methodology

1. **Campus Representation:**
    - Rooms, labs, and offices are treated as graph nodes.
    - Hallways and stairs are represented as edges .
2. **Route Calculation:**
    - Dijkstra's algorithm determines the shortest path to the destination.
3. **Voice Guidance:**
    - gTTS converts text instructions into speech.
    - Instructions are played sequentially.

Methodology (contd.)

4. QR Code Generation:

- A single QR code links to the route map stored on Google Drive.

5. Visualization:

- Route maps are plotted floor-wise using NetworkX and Matplotlib.

System Architecture / Implementation

Modules Overview:

- **Voice Guidance / Speech Module:** Converts navigation text into audio using gTTS. Ensures each instruction is played clearly and sequentially.
- **Graph / Navigation Module:** Builds the campus graph (nodes = rooms, edges = corridors). Uses Dijkstra's Algorithm for shortest path computation.
- **QR Code / Sharing Module:** Generates a QR code linking to the saved map image on Google Drive. Enables users to scan and view the map on mobile.
- **Map Visualization / Display Module:** Displays the campus map with routes and room numbers using Matplotlib.

Implementation & Code

- The complete system is implemented in **Python** using **Google Colab**.
- **NetworkX** is used for campus graph creation and shortest path computation.
- **Dijkstra's Algorithm** determines the optimal route between locations.
- **Matplotlib** is used for floor-wise route visualization.
- **gTTS** provides voice-based navigation instructions.
- Generated route maps are shared using **QR codes**.

Google Colab – Complete Implementation:
`https://colab.research.google.com/drive/1dbbCBLySuNK_zGS5lJvrL4SLR2On_y0v?usp=sharing`

Results

- The system successfully generates:
  - Shortest path between source and destination.
  - Voice guidance for navigation steps.
  - QR code for sharing route maps.
  - Visual map output showing floor-wise paths.

Example Output:

- Text: "From Entrance, go to 3rd Floor to reach CSE Department."
- Voice: Same instruction played using gTTS.
- Visual: Route map image displayed and saved.

Output

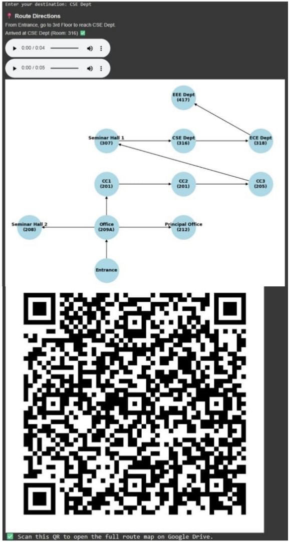

Figure: Example output showing route map and navigation guidance.

Analysis

Advantages:

- Simple and cost-effective (no GPS or IoT sensors).
- Voice and visual assistance improves accessibility.
- Scalable to multiple buildings or floors.
- QR-based access makes it user-friendly.

Limitations:

- Only static path generation (not real-time tracking).
- Manual QR scanning required.
- Depends on predefined campus graph accuracy.

Conclusion

- The proposed system provides a low-cost and efficient indoor navigation solution for academic campuses.
- Integrates QR scanning, voice assistance, and graph algorithms into one framework.
- Enhances visitor experience and accessibility.
- Can be easily expanded into a web or mobile app.

Future Scope

- Add IoT or BLE beacons for live tracking.
- Integrate mobile app UI for smoother navigation.
- Support for multi-language voice guidance.

References

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4. Wei Li, C. Xu, and F. Wang, "**QR Code-Based Indoor Path Planning Using Floor Maps**," *Transactions in Geographic Information Systems (GIS)*, Vol. 26, No. 4, pp. 512–522, 2022.
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6. A. Kumar, R. Gupta, and S. Lee, "**Voice-Assisted Smart Campus Applications for Accessibility**," *IEEE Access*, Vol. 8, pp. 125678–125686, 2020.
7. M. Sato, H. Takeda, and K. Nishida, "**QR-Integrated Mobile Navigation Framework**," *IEEE International Mobility Conference*, pp. 320–326, 2023.

Conference Paper Submission Proof

Hello,

The following submission has been created.

Track Name: IPRECON2026

Paper ID: 303

Paper Title: Smart Campus Navigation Assistant

Abstract:
This paper presents a software-based Smart Campus Navigation System designed to assist users in navigating large
academic environments through graph-based indoor routing. The system models campus pathways as a directed graph and applies Dijkstra's algorithm to compute the shortest path between the user's current location and the desired destination. The methodology integrates QR code, Google Text-to-Speech for voice guided instructions, and Matplotlib for visual route visualization, enabling a multimodal navigation experience. Extensive testing demonstrated high route accuracy, fast response time, and strong user satisfaction, confirming the system's effectiveness as a low-cost and accessible alternative to GPS-dependent or sensor-based indoor navigation systems. The results highlight the system's potential to enhance campus accessibility for students, visitors, and visually impaired users.

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Submission Files:
Smart Campus Navigation Assistant paper.pdf
(267 Kb, Wed, 31 Dec 2025 15:53:16 GMT)

Submission Questions Response: Not Entered

Thanks,
CMT team.

Paper Title: *Smart Campus Navigation Assistant*
Conference: IPRECON 2026

Project Repository

GitHub Repository:

https://github.com/MFathimaSudheer17800/Smart-Campus-Navigation-.git

Thank You!