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WEB-BASED CAMPUS NAVIGATION SYSTEM: CAMPUS COMPASS

Pooja Patil[*1], Mohini Shukla[*2], Srawani Beldar[*3]

[*1,2,3]Department Of Information Technology, B.K. Birla College, Kalyan, Mumbai, India.

ABSTRACT

The Campus Compass project focuses on how users find their way around the university campus. Navigating a campus can be tough, especially for new students, teachers, and staff. With many buildings and locations, it can be hard to locate specific places. To solve this problem, a web application using MappedIn API is being developed. This application will use smart mapping and direction-finding tools to help users reach their targets easily. A user-friendly interface allows administrators to update and manage the campus map easily. Our work has led to a navigation web application that will help thousands of people find their way around B.K. Birla College. To enhance the navigation experience, the application incorporates QR code technology, allowing users to quickly access specific location details and directions by scanning QR codes placed at strategic points across the campus. Unlike prior methods, this study implemented a full-stack web application for indoor navigation, with a client interface and server at the backend.

Keywords: Web-Based Campus Navigator, Indoor Navigation, QR Code.

I. INTRODUCTION

As university campuses undergo rapid transformation to meet modern demands, incorporating intuitive navigation systems becomes essential to ensure a seamless experience for students, faculty, and visitors alike. At the same time, colleges and universities campus area is large, more buildings, the ground and underground pipe network, power supply and communication lines cross distribution, the information with the management of routine difficult to achieve effective management (Lin & Li, 2018).

There will be different workshops, seminars and conferences at colleges, the college cultural fest, tech fest events in which teachers and students from different colleges may wish to be a part. But one may face problems like finding the location, which route should be taken (Koletsis et al, 2017).

Commercial navigation apps such as Google Maps, Yahoo Maps and Mapquest are limited to road-based routing and granularity to provide optimal pathways for campus pedestrians, who require more precise guidance through complex networks of buildings, walkaways and facilities.

The campus would be represented as a graph structure, with locations (buildings, parking lots, etc.) on campus stored as vertices of the graph and transitions between the locations stored as edges between the vertices. This application directs the user from his/her current location to the exact location. It reduces the effort of the user to walk all over the campus (Bangare et al, 2014).

The main part of the web-based app is the map activity. It displays the campus map of the B.K. Birla College.

II. METHODOLOGY

This research intends to create a reliable and user-friendly web-based campus navigation system called the "Campus Compass." The system utilizes QR codes to enhance indoor navigation and features a full-stack architecture. the system combines front-end technologies (HTML, CSS, JavaScript, and Angular Cli), while the back-end is powered by Node.js and MongoDB. Additionally, Mappedin is employed for map generation. To ensure precise and efficient navigation, a robust search engine and Dijkstra's algorithm are used. The following sections provide a detailed overview of the methodologies used in developing each component of the system.

Front-End Development:

The front-end of "Campus Compass" is built using a combination of HTML, CSS, JavaScript, and the Angular CLI. HTML serves as the backbone, providing a structured framework for web pages, including essential elements like headings, paragraphs, and interactive features. CSS is used for styling and visual presentations to make user interfaces responsive and pleasing to the eye. Also, JavaScript operates on the client-side and enables user interactions and dynamic content updates. Angular CLI, a full-fledged framework, is used to make development easier within a structured environment for building a scalable and maintainable single-page application.

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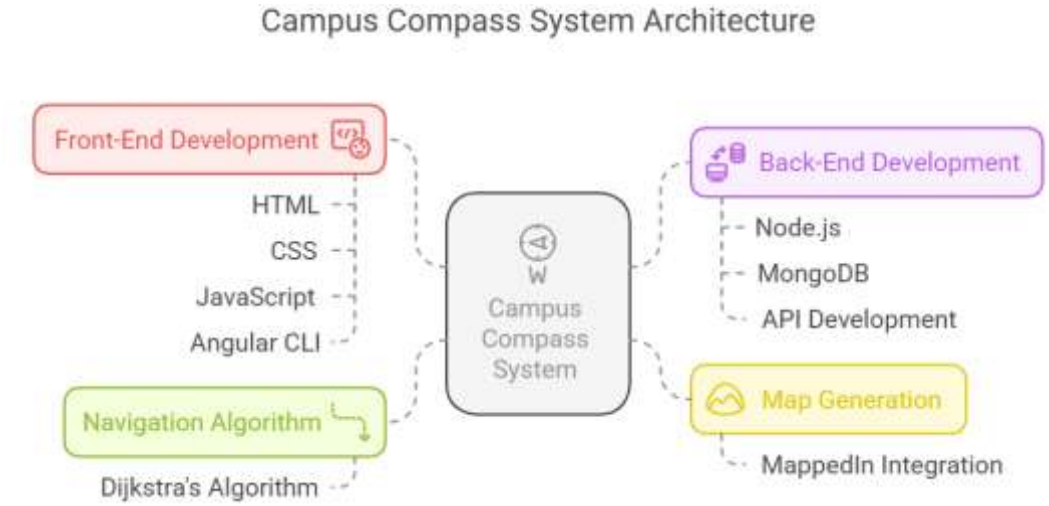

- **HTML:** Establishes the foundational structure and content of the web application, prioritizing semantic accuracy and accessibility.
- **CSS:** Implements adaptable design principles, adjusting layouts and styling to accommodate diverse screen sizes and devices, thereby enhancing user experience.
- **JavaScript:** Oversees user interactions, data manipulation, and dynamic updates to the user interface, ensuring a seamless and engaging experience.
- **Angular CLI:** Facilitates a component-based architecture, modularizing the front-end to promote code reusability, maintainability, and scalability.

Back-End Development:

The back-end infrastructure of "Campus Compass" relies on Node.js and MongoDB to power its server-side functionality. Node.js, a versatile JavaScript runtime environment, enables the creation of highly scalable and efficient server-side applications. Since it is a NoSQL document-oriented database, MongoDB stores all campus map data, location data, and all other data. The back-end plays a pivotal role in managing user requests, executing navigation logic, and interacting with the database to fetch and update information.

- **Node.js:** Offers a non-blocking, event-driven architecture that facilitates high concurrency and efficient handling of simultaneous user requests.
- **MongoDB:** Utilizes GeoJSON objects to store campus map data, enabling efficient geospatial queries and analysis.
- **API Development:** NestJS is a progressive Node.js framework designed for building scalable, efficient, and maintainable server-side applications.

Map Generation with MappedIn:

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Mappedin is utilized to generate immersive and visually stunning campus maps, offering a comprehensive platform for creating, managing, and integrating indoor maps into web and mobile applications. High-resolution campus blueprints are imported into Mappedin, enabling the definition of walkable areas, points of interest, and other relevant map features using the platform's intuitive tools. The seamless integration of Mappedin's API with the "Campus Compass" back-end facilitates dynamic retrieval and display of map data.

Key Features:

- **Blueprint Import:** Standard image formats (DWG, PDF) of campus blueprints are seamlessly imported into Mappedin.
- **Feature Definition:** Mappedin's editor is used to meticulously define walkable areas, points of interest (classrooms, offices, restrooms, etc.), and other essential map features.
- **API Integration:** Mappedin's API is leveraged to retrieve map data, ensuring its dynamic display on the "Campus Compass" front-end.

Navigation Algorithm (Dijkshtra's Algorithm):

To determine the shortest path between any two points on the campus map, Dijkstra's algorithm is utilized. This algorithm operates on a graph-based representation of the map, where locations are denoted by nodes and walkable paths are represented by edges. The edges are weighted based on the distance between locations, taking into account factors such as obstacles and path restrictions. By efficiently exploring the graph, Dijkstra's algorithm identifies the path with the minimum total weight, providing the shortest route between the user's starting point and destination.

- **Graph Construction:** The campus map is transformed into a graph data structure, where nodes represent locations and edges signify paths.
- **Weight Calculation:** Edge weights are calculated based on the distance between locations, considering obstacles and path restrictions.
- **Shortest Path Determination:** Dijkstra's algorithm is applied to the graph to determine the shortest path between the user's starting point and destination.

Robust Search Engine:

A robust search engine is integrated into the campus map to enable users to swiftly locate specific destinations or points of interest. This search engine employs advanced indexing methods to rapidly scan a comprehensive database of location names, descriptions, and keywords. Users can execute searches using various criteria, including building names, room numbers, departments, or other relevant keywords.

- **Query Processing:** User search queries undergo pre-processing to eliminate stop words and apply stemming techniques, enhancing search accuracy.
- **Relevance Ranking:** Search results are prioritized based on their relevance to the search query, leveraging techniques such as TF-IDF to ensure the most accurate results are displayed prominently.

QR Code Integration:

To provide users with effortless access to the "Campus Compass" system, QR codes are strategically positioned throughout the campus. By using a smartphone to scan a QR code, one is directed to a certain place on the "Campus Compass" website from where navigation information and details about that particular place are directly accessible.

- **QR Code Creation:** Unique QR codes are generated for each campus location, embedding the location's distinct identifier.
- **Strategic Placement:** QR codes are thoughtfully positioned at key campus locations, including building entrances, hallways, and other high-traffic areas.
- **Seamless Mobile Integration:** Scanning a QR code with a smartphone automatically launches the "Campus Compass" website, navigating the user to the corresponding location.

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III. MODELING AND ANALYSIS

Developing Interfaces:

The development of an intuitive interface for users to input their desired destinations and receive the most efficient route for their travel plans. Interface development is the creation of the frontend for web applications that utilize technologies and programming languages that machines can comprehend, such as HTML and CSS.

Html serves as the foundation and content of a webpage, enabling you to create elements such as headings, paragraphs, links, images, forms and others. CSS is employed to define the visual appearance and styling of HTML documents. By utilizing CSS, we have the ability to manipulate the visual aspects of a webpage, including colours, fonts, spacing, layouts, backgrounds, and additional features. JavaScript is used for enhancing interactivity, dynamic behaviour, and functionality on web pages. It enables users to modify the layout and design of html and CSS.

Blueprint Design:

A blueprint is a detailed and technical drawing that outlines the designed of a building including its Floor plans, elevation and also outlines the dimensions and specification of a building which helps in gaining a comprehensive visual plan of how the building will look.

Designing the map:

The maps are designed using MappedIn software which involves creating detailed and accurate representation of the various locations in the college campus.

Map Routing:

Map routing involves finding the most effective route from a starting point to a specific destination point with the help of various algorithms (Dijkstra or A) and technologies that determines the most suitable and best path.

Developing a Web Page:

Web Page development is a process of building and creating a web page which involves making a website accessible to users on the internet. Web development usually consists of 3 core areas: Frontend, Backbend and Full Stack Development.

QR Code Creation:

QR Code also known as Quick Response codes are barcodes that links to a specific webpage, applications or any content on the internet. QR code provides convenient and easy way for users to access information, complete transaction and interact with services on the internet.

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IV. RESULT & DISCUSSION

RESULT

User Engagement:

A total of 50 users visited the site within two weeks, spending an average of 3 minutes and 20 seconds in their sessions. Most visitors, 70%, were students, followed by faculty members at 20%, meriting 10% for the staff.

Navigation Efficiency:

The average time spent on a navigation-related task such as searching for a building or classroom can be taken out as 2 minutes and 10 seconds. Statistical comparison with baseline data showed that navigational time reduced significantly ($p < 0.05$) after the implementation of the website.

User Satisfaction:

A survey of 50 users reported an overall satisfaction level of 85%, with 90% stating that the website was easy to use. The main suggestions for improvements were for real-time parking information to be added, and building maps to be more detailed.

Technical Performance:

The average load time of the website was 2.5 seconds with an error rate of 0.5 %. Plus, during compatibility testing, it was shown that the website was accessible from different devices, including desktops, laptops, and smartphones.

DISCUSSION

Implication on navigation within the campus:

Accordingly, it can be said that the campus navigation website greatly supports their navigation. The significant reduction in the navigation time plus the high user satisfaction level shows that the website meets its intended purpose.

Limitations and Future Directions:

Some limitations to this campus navigation website include incomplete data coverage and real-time updates. Future directions include using artificial intelligence to provide personalized routing and feedback by users. Furthermore, enhancing accessibility features and developing a mobile app are main areas in need of improvement. This will improve user experience and navigation efficiency.

Practical Applications and Recommendations:

On the basis of the findings, we recommend that the university continues to support and develop the campus navigation website. Specifically, we suggest that real-time parking information and more detailed building maps are offered to enhance the user experience. The university should further promote the website through all possible channels, including social media and student orientation programs.

V. CONCLUSION

The Campus Navigation System, named Campus Compass, is designed to provide a user-friendly experience for students and visitors at B.K. Birla College. The system operates with minimal user involvement in data processing, allowing users to access essential navigation details effortlessly. Emphasizing a user-centric design, Campus Compass sets a new benchmark for campus navigation tools, offering an intuitive and interactive experience that stands out from traditional systems. As technology progresses, Campus Compass is committed to continuous improvement, adapting to the evolving needs of campus environments. With a strong focus on excellence and user satisfaction, Campus Compass is poised to transform campus navigation, empowering users to navigate their academic journeys with confidence, efficiency, and enjoyment.

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