MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Unit of MAHE, Manipal

Python Web Application for an Interactive Indoor Map of ICT Department

Academic Block-5 MIT, Manipal.

A Project Report Submitted

to

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Abstract

The primary objective of this project is to develop an interactive and user-friendly map for the ICT department's 1st floor at Manipal Institute of Technology (MIT), Manipal. The project addresses the challenge of navigating the complex layout of the ICT department by providing a digital solution with easy search functionality. The backend of the web application is built using Python with Flask and SQLite, ensuring efficiency and scalability. The frontend is designed with HTML, CSS, and JavaScript/AJAX to create an intuitive user interface.

The project involves the creation of tables in SQLite for faculty chambers, labs, department offices, and seminar halls, each with a primary key for data uniqueness. The backend, seamlessly connected to the frontend, handles user requests, dynamic content delivery, and search functionality. The result is an interactive indoor map that successfully meets its objectives, offering simplicity, functionality, and a user-centric design. Future plans include expanding the system to other floors and departments, implementing real-time updates, and integrating additional features such as cafeteria booking and user authentication for enhanced efficiency and productivity**.**

In conclusion, the development of an interactive indoor map for the ICT department's 1st floor at MIT aims to create a successful fusion of technology and practicality. The project's backend, utilizing Flask and SQLite, ensures a robust and scalable foundation, while the frontend's user-friendly design enhances the overall navigation experience. By addressing the specific needs of users through simplicity, functionality, and efficient data retrieval, the map significantly contributes to streamlined information management within the department. The project's success lies in its modular design, providing adaptability for future expansion and improvements. This endeavor showcases the potential of technology to simplify complex tasks, offering a promising solution for efficient space utilization and resource management within educational institutions.

Introduction

The aim of this project is to build an interactive, scalable and user friendly map of the ICT department, 1st floor, AB 5. By offering a digital map with easy search functionality, this project aims to enhance navigation and promotes the technological integration to make daily life easier for students, faculty and visitors alike. It consists of a web application which displays the floor map of the first floor of AB5 – ICT department, and displays the details of each room when clicked on it, along with a simple search function to find faculty rooms, HOD office and labs.

Motivation:

The Information and Communication Technology (ICT) Department at Manipal Institute of Technology (MIT), Manipal, is a hub of academic activities, housing various faculty chambers, labs, and essential offices on its first floor in Academic Block-5 (AB5). Navigating through this complex can be challenging, especially for newcomers and visitors. Traditional maps and physical signage may not adequately address the diverse needs of students, faculty, and visitors. Recognizing this challenge, our project aims to leverage technology to enhance the accessibility and navigation experience within the ICT Department.

The project envisions the creation of an interactive indoor map that goes beyond conventional paper maps. This digital solution is designed to provide users with a user-friendly interface,

allowing them to explore and locate specific areas within the department effortlessly. The project not only addresses the practical navigation needs but also aligns with the broader goals of integrating technology to improve daily life within the academic block.

Tools and Technologies Used:

Backend- Python: Flask, SQLite

Frontend- HTML, CSS, Javascript/AJAX

Background Information.

1. Interactive Maps in Educational Institutions:

Interactive maps have become integral in enhancing navigation and user experience within educational institutions. In similar environments, the implementation of interactive maps offers several benefits, including improved wayfinding for students and visitors, efficient location-based information retrieval, and enhanced campus exploration. Challenges may arise in maintaining real-time data accuracy and ensuring seamless integration with campus databases. Success stories highlight instances where interactive maps have significantly reduced navigation time, increased accessibility to facilities, and positively impacted the overall campus experience.

2. Web Application Development for Maps:

The development of web applications for interactive maps often involves leveraging frameworks like Flask for backend functionality and HTML/CSS for frontend design. The use of scalable and efficient databases, such as SQLite, facilitates seamless data retrieval and storage.. Major challenge is optimizing performance for a large user base. Considerations involve selecting appropriate mapping libraries and ensuring compatibility with various devices and browsers.

3. Relevant Technologies and Tools:

For the backend development of our project, we opted for Flask, a user-friendly Python framework, and employed SQLite databases due to their lightweight and scalable nature, ideal for our application's scope. HTML and CSS were fundamental in structuring the web content, with the potential inclusion of JavaScript for added interactivity, providing a solid foundation for our user-friendly interactive map web application.

Our project design took inspiration from prominent indoor mapping projects like those found in the San Francisco Airport[1] and Dubai Mall[2]. Additionally, insights from gaming maps influenced our initial design for the ICT department's indoor map. We adopted this mix and match of technology and inspiration from various sources to deliver seamless navigation in an educational environment.

4. User Experience in Navigation Systems:

User experience considerations play a crucial role in the success of navigation systems within educational or campus environments. The intuitive design of interactive maps, coupled with clear labeling and visual cues, contributes to a positive user experience. Integrating feedback mechanisms and regularly updating map data enhance user trust. The interactive map in our project aims to elevate user experience by offering an intuitive interface, quick search functionality, and detailed information retrieval, ultimately simplifying navigation within the ICT department.

Python Concepts Used

Flask:

Flask is a lightweight and efficient web framework for Python. It provides a simple and straightforward way to develop web applications, making it a popular choice for backend development[1].

Flask handles HTTP requests and responses using a routing system. Each route is mapped to a Python function, which is responsible for generating the response. Flask also provides a templating system, which allows developers to create dynamic HTML templates.

A Flask application is typically structured as follows:

- app.py: This file contains the main Flask application object. It also defines the routes and other configuration for the application.
- templates: This directory contains the HTML templates that are used to generate the dynamic content of the application.
- static: This directory contains static files, such as images, CSS, and JavaScript files.

Flask is a great fit for our project because it's a lightweight and efficient web framework for Python. It simplifies the process of handling web requests and responses, making it easier to create dynamic web applications. In our project, Flask neatly organizes routes and seamlessly connects them to Python functions, allowing us to handle user interactions smoothly.

SQLite:

SQLite is a lightweight and self-contained database engine. It is often used as the embedded database for web applications and mobile apps[2]. SQLite is very efficient at performing common database operations, such as inserting, updating, and querying data. It also supports ACID transactions, ensuring that data integrity is maintained even in the event of a failure. SQLite is very easy to use. It does not require any installation or configuration. To create a SQLite database, we simply create a new file with a .db extension.

In our project, it is suitable to use SQLite because:

1. SQLite is a serverless database. This means that it does not require a separate database server process.
2. SQLite is a file-based database. This means that the database is stored in a single file.
3. SQLite is a transactional database. This means that it supports ACID transactions.
4. SQLite is a portable database. This means that it can be used on a variety of platforms, including Windows, Linux, macOS, and Android.

Methodology

Design Approach:

Since the users need not have access to all the data there is, we decided on the architecture that would make it simpler to get the needed information only as per the user using the search or clck functions. Thus the required data is only accessed from the SQLite database as and when the need arises.

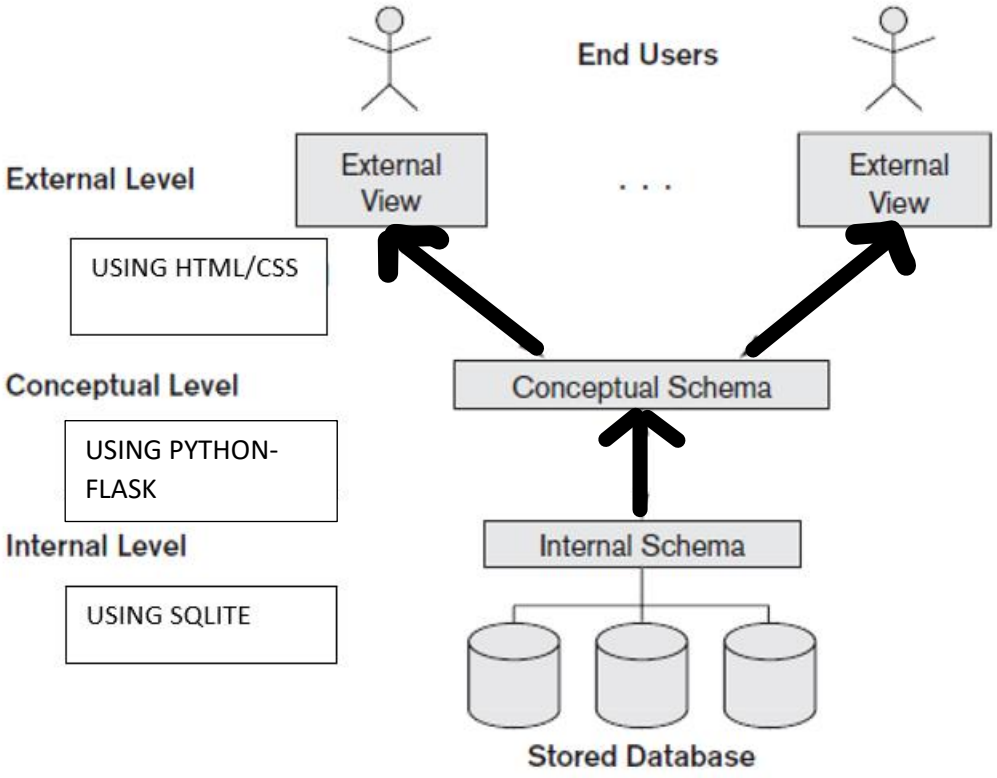


Figure 1.1: Web App Architechture

Architectural Decisions:

To ensure scalability and maintainability, we keep the program/code for the database, frontend, flask and loading json objects separately. This helps in the ease of integration incase we add more floors and departments in the same building.

Basic Approach:

The user interface (UI) of the map was crafted using HTML and designed in Figma, where each distinct section on the map corresponds to a specific region. These regions are seamlessly linked to the database through unique room numbers, establishing a systematic connection between the UI and the backend. The database contains comprehensive information about labs and faculty members, enabling dynamic retrieval of relevant details as required. The incorporation of unique room numbers ensures efficient data association and retrieval. Moreover, a search functionality empowers users to effortlessly access and utilize the stored data for personalized purposes. The entire system is hosted on a web application through Flask, providing a user-friendly and interactive platform for seamless navigation and information retrieval. This integration of front-end design with a robust back-end infrastructure enhances the overall user experience, contributing to the project's success.

Implementation

Database:

In the project, four tables were created to organize and store key information. The ***faculty_chambers*** table captures details about faculty members, such as their names, designations, and profile links. The ***labs*** table records information about various labs, specifying unique lab numbers and names. The ***department_office*** table provides details about different department offices, utilizing unique office names as identifiers. Lastly, the ***seminar_hall*** table manages data related to seminar halls, using unique hall numbers and names. Each table incorporates a primary key for data uniqueness, ensuring efficient data retrieval and maintaining data integrity. This design facilitates organized storage of information crucial for the interactive indoor map application.

Back-End design:

The back-end of the interactive indoor map application is built using Flask, a lightweight web framework for Python. It serves as the bridge between the frontend interface and the SQLite database, handling user requests and ensuring dynamic content delivery. Here's an overview of the back-end design:

Database Connection:

The Flask application establishes a connection to the SQLite database, which stores essential information about faculty chambers, labs, department offices, and seminar halls.

This connection is managed using Flask's g (context global) object, ensuring efficient and thread-safe handling of database connections.

API Endpoints:

Flask defines various API endpoints to cater to specific functionalities, such as retrieving details, searching, and fetching information based on user requests.

For instance, there are endpoints like /get_details and /search that handle requests related to detailed information retrieval and search functionalities.

Search Functionality:

The /search endpoint is responsible for processing search queries initiated by users. It executes SQL queries on the database to find relevant information based on the provided search criteria.

Search results are then formatted and sent back to the frontend for display.

Dynamic Content Rendering:

The back-end supports dynamic content rendering, ensuring that information is fetched from the database in response to user interactions.

For example, when a user clicks on an interactive element on the map, the back-end fetches the corresponding details from the database and sends them to the frontend for display.

Error Handling:

Error handling mechanisms are implemented to manage exceptions that may occur during the application's operation.

For instance, an @app.errorhandler is defined to handle general exceptions, providing a structured response or logging the error for future analysis.

The Flask back-end acts as a middleware, seamlessly integrating the frontend with the database. It efficiently handles user interactions, processes database queries, and ensures the timely delivery of dynamic content to the frontend, contributing to a responsive and user-friendly interactive indoor map experience.

Frontend Map Design:

The frontend map design focuses on simplicity and user-friendliness, providing an intuitive interface for users to interact with the indoor map. We have used HTML and Javascript to implement these parts.

Key features of the frontend design include:

Search Function:

The search function allows users to input queries and quickly locate specific areas within the indoor space. Search results are fetched from the database.

Hover/Interactive Function:

Interactive elements, such as buttons and clickable areas, respond to user interactions, enhancing the overall user experience.

Hover effects provide instant visual feedback, indicating clickable elements and guiding users on potential actions.

Clicking on interactive elements triggers the display of concise information about faculty chambers, labs, department offices, and seminar halls.

Users experience seamless interactions, and the map stays up-to-date with the latest data from the database.

Results

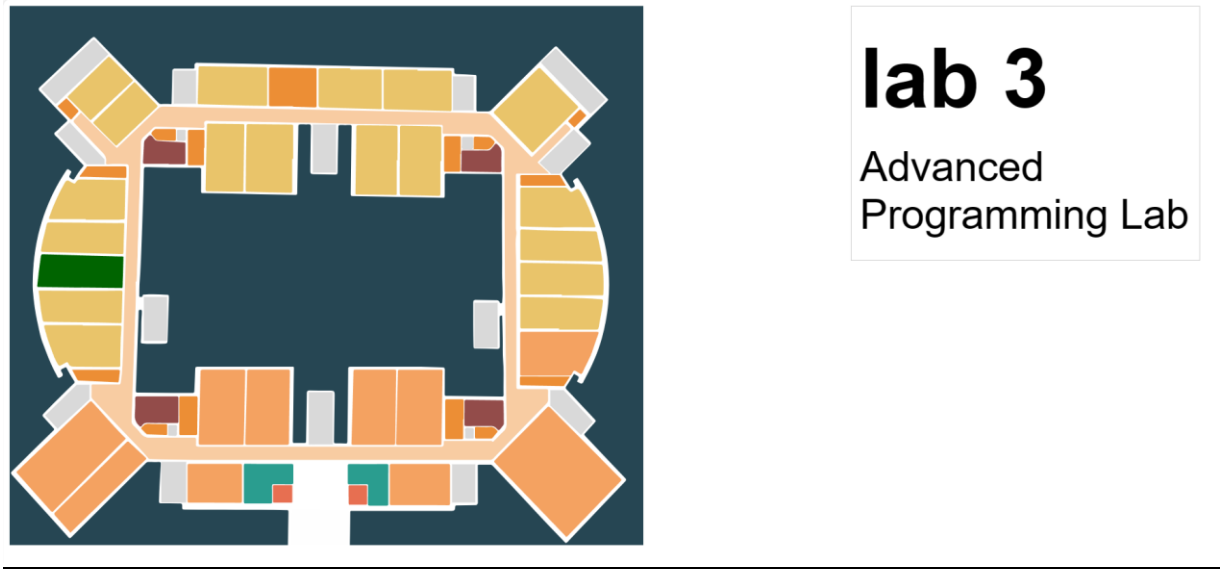
Interactive Map Showcase with Features:

Pictures of the map interface demonstrate the Display, click and search functions along with interactive map elements.

The map interface, designed for simplicity and functionality, effectively demonstrates essential features:

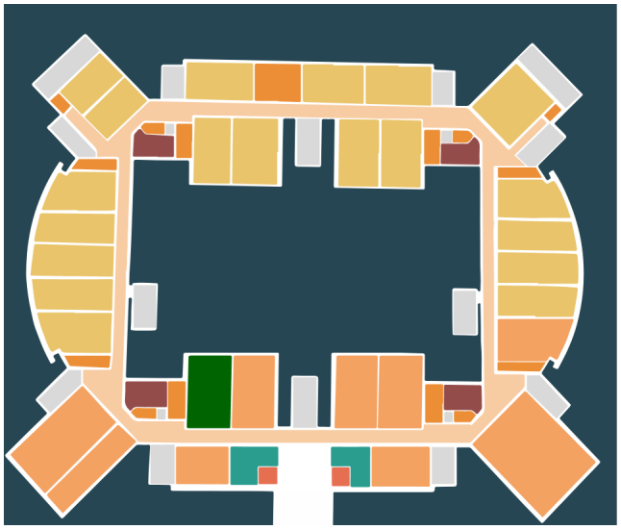
Display Function:

The map layout is cleanly presented, offering an uncomplicated representation of the indoor space.



Click Function:

Clicking on interactive elements reveals concise information about faculty chambers, labs, department offices, and seminar halls.



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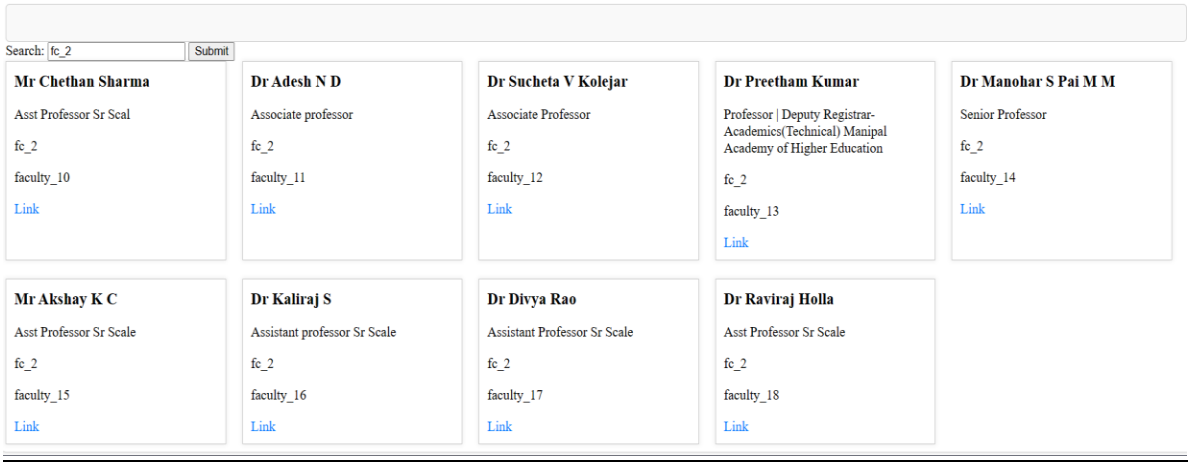
Search Function:

The search function facilitates quick navigation, allowing users to find specific areas efficiently.



Interactive Elements:

Simple yet effective interactive elements contribute to a user-friendly experience

Dynamic Content Rendering:

Dynamic content rendering optimizes load times by fetching and displaying content dynamically. This approach contributes to a smoother user experience, reducing waiting times for information to load and improving overall responsiveness.

Objective Achievement:

The primary objective of creating this map was to provide a user-friendly and efficient solution for navigating indoor spaces. The results indicate a successful achievement of this objective:

Simplicity and Functionality:

The map design reflects a commitment to simplicity, ensuring that users can navigate and understand the indoor space effortlessly. The combination of essential functions, such as display, click, and search, contributes to the overall functionality of the map.

User-Centric Approach:

The map's design and features are tailored to meet the needs of the users. The minimalist layout, interactive elements, and dynamic content rendering prioritize user experience, making the map accessible and intuitive.

Efficient Navigation:

The implementation of the search function and click functionality streamlines navigation, allowing users to find specific areas efficiently. Users can access detailed information without unnecessary complexity, contributing to an effective and goal-oriented user experience.

In summary, the project successfully meets its intended objectives by delivering a user-friendly, functional, and reliable interactive indoor map. The combination of essential features and a user-centric design ensures that the map serves its purpose effectively.

Conclusion and Future Work

In the course of this project, we successfully designed and implemented a comprehensive information system for the ICT department, encompassing faculty chambers, labs, department offices, and seminar halls. We utilized a SQLite database to store the relevant information and developed a Python script to create tables, populate them with data, and establish the necessary relationships.

We adopted a modular approach by creating separate tables for faculty chambers, labs, department offices, and seminar halls. This not only facilitated better organization of data but also allowed for easy scalability and maintenance.

The primary motivation behind this project was to streamline the information management system within the ICT department. By creating a centralized database, we aimed to enhance accessibility, organization, and retrieval of critical information such as faculty details, lab availability, and seminar hall schedules.

This project addresses the need for efficient management of resources and spaces within the department, contributing to better coordination and utilization of facilities. The integration of faculty details, lab information, and department office data is essential for creating a holistic view of the department's infrastructure.

The project was successful in achieving its primary objectives. We created tables for faculty chambers, labs, department offices, and seminar halls with appropriate attributes, ensuring the integrity and normalization of the database. The Python script effectively populated the tables

with sample data, showcasing the system's functionality.The modular design allows for easy expansion and modification as the department grows or undergoes changes

Future Work:

1. Expansion to Other Floors and Departments:

- Extend the system to accommodate multiple floors and departments within the institute. This involves creating additional tables and relationships to represent the diverse infrastructure.

2. Navigation:

- Implement a user-friendly interface or application for easy navigation through the system. This could include search functionalities, filters, and a graphical representation of the department's layout.

3. Real-time Updates:

- Integrate real-time updates to reflect changes in faculty schedules, lab availability, and seminar hall bookings. This ensures that the information is always current and accurate.

4. Booking in Cafeteria:

- Expand the system to include features such as cafeteria food booking. This could involve creating a new table for cafeteria spaces, managing bookings, and integrating it with the overall infrastructure.

5. Integration with Timetable:

- Integrate the system with the institute's timetable management system. This would provide a comprehensive solution for students and faculty to plan and organize their activities seamlessly.

6. User Authentication and Permissions:

- Implement user authentication to control access levels and permissions. This ensures that only authorized personnel can modify certain information, maintaining data security.

7. Feedback Mechanism:

- Include a feedback mechanism for users to report issues, suggest improvements, or provide comments. This feedback loop helps in continuous refinement and enhancement of the system.

By addressing these aspects in future iterations, the system can evolve into a robust, user-friendly, and indispensable tool for the ICT department, contributing significantly to efficiency and productivity.

References

[1] https://www.flysfo.com/maps/interactive-maps (SF Airport indoor map)

[2] https://thedubaimall.com/en/map (Dubai mall indoor map)

[3] Flask Documentation: Official Flask documentation (https://flask.palletsprojects.com/)

[4] SQLite Documentation: For database-related queries and operations, the official SQLite documentation (https://www.sqlite.org/docs.html)