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Literature Survey on Indoor Navigation System Using QR Code and OSM

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Abstract: The purpose of this study is to develop an Indoor Navigation System using QR code technology and OpenStreetMap (OSM) data used for efficient navigation within the confines of a college campus. The methodology involves the integration of QR codes strategically placed at key points within the campus premises, encoding location data, and facilitating seamless interaction with a web application. This application interfaces with OSM, utilizing its extensive indoor mapping capabilities. The system enables users to scan QR codes, extract location information, and visualize their precise indoor position on the campus map, providing step-by-step directions to their desired destination. Preliminary results demonstrate a significant improvement in navigation accuracy and efficiency compared to traditional methods. In conclusion, the integration of QR codes and OSM holds immense potential in revolutionizing indoor navigation, offering an intuitive and accessible solution for students, faculty, and visitors to navigate complex college facilities effortlessly. This system not only enhances the user experience but also sets a precedent for the adoption of innovative technologies in educational environments, promising a more streamlined and user-centric campus experience.

Keywords: Open Street Mapping (OSM), QR Code, Indoor Navigation, College Campus

I. INTRODUCTION

In today's world, most of the daily chores are tech-driven. Yet navigating complex indoor spaces presents a significant challenge. The growing reliance on smartphones and mobile devices has made efficient indoor navigation increasingly crucial, especially in complex and confusing environments like college campuses. Traditional methods like static maps and signage often fall short in such settings. To address this challenge, our indoor navigation system uses QR code technology and the robust data infrastructure of OpenStreetMap (OSM). This web-based application will transform how students, faculty, and visitors navigate our campus, offering precise indoor navigation that eliminates the need for constant assistance and streamlines the process.

II. RECOGNIZING THE PROBLEM

Many times, it is difficult if a person is visiting a completely new place for the first time and reaching the desired location just right in time. It gets even tougher when you are visiting for some important tasks like job interviews, the admission process, or any other thing as such, and you are running late, asking every other person for the exact location. This problem needs an easy and user-friendly solution. Thus, developing an indoor navigation system is very important for organizations with giant infrastructures.

III. LITERATURE REVIEW

The paper [1] discusses indoor navigation using augmented reality for mobile applications. It surveys various methods for indoor location and navigation using augmented reality and highlights the challenges of indoor navigation in complex buildings. The paper [1] also discusses the use of AR technology in providing visual positioning and navigation systems for handheld devices. It compares existing methods and explores the latest technology developments in augmented reality. The paper [1] proposes a software-based system that utilizes AR Core for accurate indoor positioning and navigation. The system aims to improve user experience and provide seamless connectivity between 3D objects in indoor environments. The requirements for the system include a platform compatible with AR Core and powerful processors for real-time object recognition.

The paper [2] is based on OpenStreetMap, providing detailed information about the landscape, the street network, and the buildings that are mapped. However, until now, this building mapping is mainly related to the outer shape of the ground space of the building and there is hardly any information about the inner structure available.

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This paper [2] presents an approach to extending the OSM tagging schema to indoor environments. A 3D Building Ontology [2] targeted to VGI communities is presented to describe different information aspects about buildings and their inner structure. Based on this ontology, the OSM extension is developed and explained. It can be concluded that With user-generated content and collaboratively collected data, there is always a question about the accuracy and quality of the provided data.

The below table from [2] gives detailed information about the results and costs required as per different approaches

Table 1 Comparison of different approaches

Technique	Accuracy	Deviation Detection	Blind Navigation	Maintenance cost	Infrastructure cost
AGPS	Low	High	Medium	High	High
Bluetooth	Mudium	Medium	Low	Medium	High
RFID	Medium	Medium	Low	High	High
Image Process	Low	Low	Low	Medium	Medium
QR code with Ibeacon	High	High	Medium	Low	Medium

Fig. 1 Comparison of different approaches

The paper [3] uses AI (Artificial Intelligence) and computer vision techniques, to guide users with the help of Quick Response (QR) markers and a collision avoidance system that supports the monocular depth estimation algorithm. In this paper, they have used, a set of QR code markers, as location beacons, to generate an optimal path for the user to reach the destination [3]. This study provides a collision avoidance system using QR code markers for an interior navigation guide system for visually impaired persons. The device guides the user to the next marker by scanning QR codes and giving them audible feedback. It creates a database of marker locations and calculates the shortest path to the destination. The system may function offline with the entry doors downloaded database information. Safe navigation is ensured via a monocular depth estimation method that identifies obstructions. The implemented system in the paper [3] was able to accurately detect the distance to the obstacle and to warn the user to avoid collision with the obstacle. It needs very detailed information on each point and obstacle in the room, the system does not provide a perfect path to a specific destination. And only provides collision avoidance.

In the paper [4], various methodologies of navigation systems are compared to improve the accuracy rate for the same. It proposes the use of an ultra-wideband anchor to improve the efficiency during the navigation. The advantage of using such an anchor is the possibility of constructing positioning algorithms based on phase measurements. The disadvantage is that the method is too complex a system, it also requires very high-level mathematical formulation and a deep knowledge of phase measurement systems and mathematics.

The paper [5] discusses the importance of considering user requirements and preferences in the design of indoor navigation systems. The authors conducted an online survey to gather information about the desired navigation information for different user groups, including able-bodied, visually impaired, and motorically impaired individuals. The results showed that user groups and individual preferences are crucial factors in designing effective indoor navigation systems. The paper [5] suggests that incorporating user requirements in the development process can lead to higher user satisfaction. The authors also discussed various data models for representing indoor spaces, including OpenStreetMap (OSM) and Simple Indoor Tagging (SIT), which can be used to incorporate user requirements into spatial building data. The paper highlights the need for detailed information, landmarks, accessibility information, and obstacle data in indoor navigation systems.

In this paper [6], a Wi-fi based Indoor navigation system for the university campus is implemented. The method used for mapping and navigation purposes is presented. They [6] have used the fixed router and floor map-based model for indoor navigation and manual mapping is done. The results and observations are that the hybrid algorithm that uses proximity and RSSI model by using trilateration technique for indoors shows better performance in finding out the distance.

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But also, the main disadvantage or challenge is that the user will need a constant high-speed Wi-Fi connection throughout the path-finding process for the user. It might slow down if there are multiple users accessing the same connection at a time.

The paper [7] contains detailed information regarding the concerns related to the Indoor navigation system or indoor positioning system, which is a branch of Location Based Services. It [7] highlights how Indoor navigation works on different technologies such as RFID, Wi-Fi, Bluetooth beacons, etc. Modern new augmented reality technologies may also be used for indoor navigation. The proposed model offers a real-time view of the environment with the help of augmented reality. The article proposes a system for indoor navigation positioning devices that utilizes augmented reality to help assess the surroundings as well as make positioning more accurate. it suggests that one could use Bluetooth beacons or Wi-Fi locations. The suggested method would utilize augmented reality to assess the direction using SLAM algorithms for spatial precision.

This paper [8] proposes a geocoding framework for indoor navigation using QR codes. The framework encodes each internal point of interest (POI) as a code containing a partition number, functional number, and connectivity number. A prototype system is developed for indoor navigation in the Wuhan University Library. The system uses QR codes to provide location information and optimal path guidance. The case study demonstrates the successful implementation of the QR code navigation system. Users can scan the QR code in any position, and the code will be decoded so that the user can get his location. There is still a lack of a framework that can describe and record information on the location, properties, and connectivity of indoor facilities.

The paper [9] discussed the use of QR codes and Google Maps for indoor navigation within buildings. The approach involves uploading floor maps to Google Maps and using a mobile phone to scan QR codes at different locations. The indoor maps show the route to the specified destination and update the user's position as they move towards it. The proposed system aims to provide a cost-effective and efficient method for indoor navigation. Other existing technologies include GPS, Bluetooth, and WiFi, but they have their own limitations and implementation problems. Overall, the paper presents a detailed methodology for implementing indoor navigation using QR codes and Google Maps. Scanning QRCode reduces the overhead of entering the destination name. Cost-effective method. It works even in the presence of WiFi. No other devices are required than the user’s mobile phone. Device ID should be added to the code each time when a new device is added to the Indoor Navigation System. If a single device fails, it affects the whole Indoor Navigation System.

IV. PROBLEM DEFINITION

To develop an indoor navigation system using QR codes to provide seamless and accurate guidance within a designated indoor space (e.g., a college campus) using OpenStreetMap(OSM) and QR codes for navigation technologies. The system should enable users to easily scan QR codes strategically placed, and provide the user with proper options of the available locations, allowing them to obtain real-time directions to their desired destination.

V. OBJECTIVES

The project aims to have the following primary objectives:

1) To develop a high-precision indoor navigation system for college campuses that can provide real-time location information with an accuracy of within a few meters.
2) To provide precise and reliable guidance within indoor environments.
3) To reduce user confusion, frustration, and time spent searching for specific locations.
4) To increase customer satisfaction and loyalty through efficient navigation.
5) To integrate with other technologies for a seamless user experience.
6) To help users with efficient wayfinding.

VI. FUTURE SCOPE

The future scope for an indoor navigation system integrating QR codes and OpenStreetMap (OSM) holds immense potential in revolutionizing indoor navigation experiences. By merging QR codes with OSM data, this system could enable precise and real-time indoor localization, offering users seamless navigation within buildings and facilities. The integration of OSM's open-source mapping data with QR codes could facilitate detailed indoor mapping, allowing for dynamic updates and customization of routes based on real-time changes within a space.

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Additionally, the system's versatility could extend to various sectors like retail, healthcare, and education, enhancing visitor experiences, aiding in logistics, and optimizing workflow efficiency within indoor environments. As technology advances and adoption grows, this fusion of QR codes and OSM in indoor navigation promises to become a cornerstone in simplifying and enhancing indoor navigation for individuals and businesses alike.

VII. CONCLUSION

Indoor navigation is a transformative technology aimed at solving the intricate problem of guiding people accurately within complex, enclosed spaces where traditional GPS systems fall short. The primary objectives are to offer real-time, user-friendly navigation solutions that will provide a list to choose the desired locations, thereby providing an optimal route from the starting point to the desired location and turn-by-turn directions thereby improving the overall user experience. The relevance of indoor navigation extends across a wide range of industries, including Universities, Healthcare, and Airports, with a shared aim of boosting operational efficiency, enhancing safety, and ensuring a better and stress-free experience for all individuals. As indoor navigation systems continue to advance and integrate with emerging technologies like AR, they are poised to play an increasingly significant role in simplifying navigation within intricate indoor environments, ultimately reshaping how we interact with and navigate through indoor spaces.

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