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A Review of IoT-Enabled Indoor Positioning, Integrating MERN Stack and RFID

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***Abstract*— In recent years, the usefulness of indoor positioning systems (IPS) to give positioning and routing services in extensive indoor spaces, which are mistaken use of traditional GPS-based management systems, has increased. On college campuses, finding faculty members, administrative personnel, or looking for specific departments becomes a daunting task that leads to delay — especially when students are in the middle of an exam or approaching the deadline for an assignment. IoT (Internet of Things) applications, such as RFId Radio-Frequency Identification integrated with a web application based on the MERN stack (MongoDB, Express. js, React. js, Node. bg) and geolocation for seamless real-time indoor positioning system. The Creative Project Proposal is to create a web interactive page, and have people's or students find their way to the faculty members in the college building using the web navigation through their handheld smart devices. We have different data points (locations) that faculty members register on the system, allowing for real-time location sharing that takes place through the web application. The system provides users with this dynamic and interactive 2D building layout to transition between floor levels with high visual smoothness and intuitiveness. This paper will elaborate on the core technological building blocks that come into play—such as real-time geolocation tracking, data synchronization, and front-end viz—while also addressing major challenges including signal interference, data privacy and scalability. This review highlights the feasibility and advantages of IoT-based indoor positioning in educational institutions, providing valuable guidance and potential research opportunities for enhancing campus navigation systems..**

Keywords: — Web application, MERN Stack, RFID, Internet of Things (IoT), Geo location, Indoor Positioning, Real time interaction.

I. INTRODUCTION

Indoor positioning System (IPS) has attracted significant attention in recent years due to the ability to increase navigation within large buildings and complex environment where GPS signals are ineffective. Educational institutions, especially universities with vast complexes, often face challenges in helping students find faculty members, employees and specific departments in a timely manner. Traditional methods, such as asking manually for directions or using a printed map, are disabled and taking time, especially during significant times such as examination or assignment submission.

To address this issue, integration of Radio Frequency Identification (RFID) technology with web-based applications can provide a viable solution. RFID is a well -established technology used in various industries for trekking and identification purposes, including logistics, healthcare and safety. By taking advantage of RFID for indoor positioning, the proposed system can enable the real -time tracking of faculty members within a college building, allowing students to efficiently find and navigate their desired places.

In this system, each faculty member will carry an RFID tag, which will be established by RFID readers in various places within the building. The collected location data will be processed and displayed on an interactive web application, which will provide students with an easy-to-use interface to search for faculty members and look at their real-time positions on the digital map of the campus. The application will also support floor-based navigation, when a faculty member runs between different levels of the building, automatically updates the displayed map.

Unlike other condition technologies such as Wi-Fi or Bluetooth-based systems, RFID provides benefits such as low power consumption, cost-effectiveness and reliable trekking capabilities. However, it also presents challenges such as signal intervention and limited detection limit from surrounding materials. Despite these challenges, the recent progress in RFID technology has improved accuracy and efficiency, making it a suitable option for indoor positioning application.

II. ARCHITECTURE

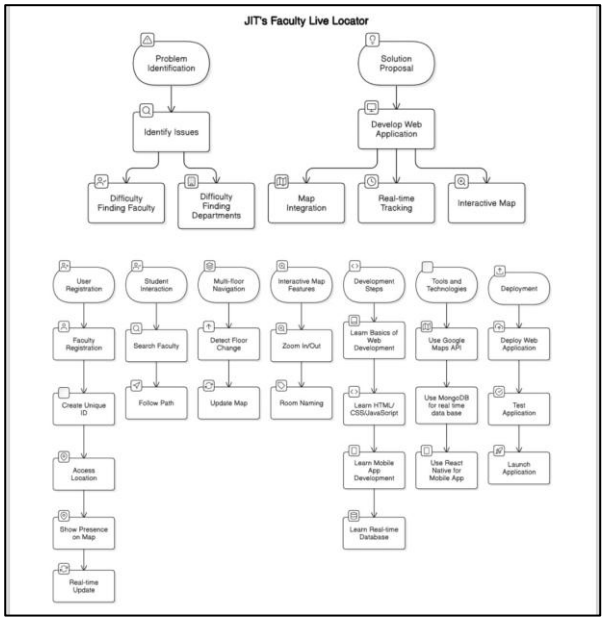

Fig no. 1

III. LITERATURE SURVEY

The advancement of indoor positioning systems has led to various technical approaches, with RFID emerging as a reliable solution due to low cost and efficiency. Several studies have discovered the integration of RFID for indoor positioning in various environment, including educational institutions, health facilities, and industrial settings.

One of the initial implementation of RFID-based tracking in universities focuses on automatic the appearance systems. Researchers developed systems where students and faculty members tagged RFID, and strategically placed RFID readers discovered their presence. Effective for attendance monitoring, these systems lacked trekking and interactive map-based navigation in real-time location, which are essential for dynamic indoor positioning

In healthcare, RFID technology has been widely applied to asset tracking and monitoring the patient. Research studies indicate that RFID-based systems help to reduce the devices incorrectly, ensure employees accountability and increase patient safety. Hospitals have deployed RFID-based tracking to monitor medical personnel and optimize workflows, but these applications are limited to predetermined areas rather than providing continuous real-time tracking during most convenience.

Many studies in industrial settings have demonstrated the use of RFID for workforce tracking and safety monitoring. RFID tag organizations linked to workers allow workers to ensure compliance of safety rules in a dangerous environment. Manufacturing plants and godowns have successfully deployed RFID-based systems to track inventory and personnel movement, improving operational efficiency. However, most of the existing implementation is designed for logistics and asset tracking rather than human-focused indoor positions.

Recent research has compared RFID with other indoor positioning techniques such as Wi-Fi, Ultra-Wide band(UWB), and Bluetooth-based systems. While UWB provides high accuracy, it is expensive and requires more infrastructure. The Wi-Fi-based condition is more accessible but is often affected by intervention. RFID provides a balance between cost, power efficiency and accuracy, making it a viable option for mass deployment in college premises.

The proposed study creates these research findings to develop RFID-based web app for real-time faculty trekking within the college campus. By taking advantage of the Mern Stack, the system aims to provide a user -friendly interface, where students can detect faculty members in real time on an interactive campus map. Unlike traditional RFID applications, which mainly focus on access control and appearance, the system integrates dynamic indoor positioning with web-based accessibility, enhancing user experience and functionality.

IV. EXISTING WORK

Many research studies and implementation have detected the RFID-based indoor positioning system for various applications including education, healthcare and industrial settings. RFID technology is used widely for asset tracking, identification of personnel and tracking in real time, which is its cost-effectiveness and trekking due to ease of deployment.

In educational institutions, RFID-based tracking is mainly applied to presence monitoring and access control. Some universities have used RFID cards to record students and faculty movement within the campus campus. However, such systems typically have a lack of trekking and interactive map-based visualization in real-time location.

In healthcare, RFID system has been deployed to track medical staff, patients and equipment in hospitals. These systems improve workflow efficiency and increase security. Studies have shown that RFID-based space in hospitals can reduce tracking waiting time and adapt the resource allocation. However, most of the implementation is limited to specific rooms or departments instead of providing comprehensive indoor navigation.

The industrial environment has taken advantage of RFID to monitor the workers' movement in dangerous areas. Warehouses and manufacturing units appoint RFID tags to track inventory and personnel, ensuring safety compliance and efficiency. These applications display the reliability of RFID for indoor positioning, but mainly focus on logical tracking rather than real -time human interaction.

Comparison between RFID and other positioning techniques, such as Wi-Fi, Ultra-Wide band (UWB), and Bluetooth-based solutions indicate that RFID provides balance between accuracy, cost and power efficiency. Unlike Ble-based systems, RFID does not require continuous transmission of

signals, making it more energy-skilled. However, RFID systems usually depend on fixed readers placements, which can limit flexibility in dynamic environment.

The proposed system aims to enhance existing RFID-based tracking solutions, which is integrated with them with a corn stack web application. Unlike traditional RFID tracking systems, this approach provides real -time updates, interactive campus maps and user friendly search functionality. Taking advantage of web technologies, the system ensures access from several devices, making it a practical solution for improvement in faculty of faculty in large college complexes.

V. METHODOLOGIES

The proposed system uses RFID technology with marry stacks to develop a real -time indoor positioning system for college complexes. The functioning includes several stages, including system design, data acquisition, processing and web app development

1. **System acting and architecture:** The system consists of RFID tags assigned to faculty members, RFID readers are strategically placed in various complex locations, and real-time data for visualization a corpse-based web application. RFID readers detect the presence of faculty members and send their location data to a backand system, which processes and updates it on the web application.

2. **RFID-based location tracking:** Each faculty member is assigned a unique RFID tag that emits signs that are detected by RFID readers placed in different areas of the campus. These readers transmit tag ID and location data on the backnd server. Readers are deployed in a way that ensures proper coverage of the entire campus, including several floors and prominent places such as department offices, staff rooms and classrooms.

3. **Data acquisition and processing:** When a RFID reader detects the tag of a faculty member, it records the tag ID, timestamp and reader location. This data is then transmitted to the backnd, where it is stored in a mongodb database. Backnd is created with Node.JS and Express. JS, processes the data obtained and updates the final known status of the faculty in real time.

4. **Web application development:** The web application developed using react.js offers an interactive 2D campus map to display faculty locations in real time. Students can search for faculty members by name or department and can see their current position within the campus. The map dynamically adjusts floor changes, allowing students to navigate efficiently at several levels.

5. **Real-time data synchronization:** Websockets or polling mechanisms are applied to ensure real -time updates in web applications. Whenever a RFID reader detects a faculty member in a new location, the system immediately updates the information displayed without the need for manual refresh.

6. **Confidential and security ideas:** The faculty location is limited to hours of the active complex, ensuring privacy. Additionally, access control mechanisms are applied so that only registered students can access only location data. RFID data transmission follows a safe communication protocol to prevent unauthorized access or data violations. Measurement and performance adaptation The system is designed to efficiently handle the increasing number of several concurrent users and faculty members. Load balanced technology and database indexing are applied to customize query performance. Additional RFID readers can be established to improve location accuracy and expand coverage area as required.

VI. WORKING

The proposed system takes advantage of RFID technology and MERN stack to create an IOT-enabled web application for real-time indoor positioning. The system includes RFID tags, RFID readers, a web application and a central database that dynamically manage and display location data.

Each faculty member will have an RFID tag, which transmits a unique identity signal. RFID readers placed at various places inside the campus will explore these tags and send the data to the backend system. Mern Stack-based web application will process this information and update the real-time location of the faculty on the interactive campus map.

1. **RFID tagging and scanning :** Each faculty member is entrusted with an RFID tag, which emits a unique ID in proximity to an RFID reader.
   RFID readers are strategically placed at various places such as entrances, corridors and departmental offices to capture the presence of faculty.

2. **Data transmission and processing :** RFID reader detects tag ID and sends information to the backend server through communication protocols such as HTTP or websockets. Backend, node.js and express.js are designed, receive data and update the location of the concerned faculty member in the mongodb database.

3. **Real-time location update :** Web app is designed using react.js, receives data from database and dynamically updates the position of the faculty member on the 2D interactive map of the college campus. The map reflects changes in the floor and allows users to zoom in or out for better visibility.

4. **User conversation:** Students can discover faculty members through web interfaces, which will show their final detected space based on RFID reader data. The system ensures that faculty locations are displayed only when they are within the premises of the campus, increasing privacy and security

5. **Scalability and maintenance:** The system can be expanded by adding more RFID readers for better tracking accuracy. The application supports real -time updates, ensuring efficient tracking without manual intervention.

VII. CONCLUSION

In this review, we discovered the capacity of IOT-enabled indoor positioning system RFID technology and Mern Stack for web-based implementation. The study states how real -time indoor tracking can improve navigation and resource management in a large environment such as college complexes. To explore the exact location by integrating RFIDS and to avail a Mern Stack-based web application , users can track dynamically faculty locations and reach interactive indoor maps.

Compared to traditional status methods, RFIDs provides a cost-effective and scalable solution for indoor tracking , ending the need for continuous GPS connectivity. Use of web technologies ensures that the system remains accessible and responsible, while IOT integration increases real -time interaction. Future research RFID-based tracking can focus on adaptation of accuracy , improve energy efficiency , and extend system scalability for large environment.

This approach presents a promising direction to indoor positioning system , which provides an innovative and user friendly solution to increase the real -time space in the complex indoor spaces..

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