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A Survey Paper On Staff Location Tracking System

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Abstract: The Teacher Tracking System using ESP32, Wi-Fi, and RSSI is a wireless monitoring system designed to track the location of teachers in educational institutions. The system uses ESP32 microcontrollers, Wi-Fi access points, and RSSI beacons to collect and transmit data from the Wi-Fi-enabled devices carried by teachers, such as smartphones or tablets, to a cloud-based server. The system provides real-time updates on the location of teachers, enabling administrators to monitor teacher performance and improve educational outcomes.

The Teacher Tracking System uses Wi-Fi and RSSI technologies to identify and track teachers as they move around the school premises. The ESP32 microcontrollers communicate with the Wi-Fi access points and RSSI beacons to collect data on the strength and location of the Wi-Fi signals transmitted by the teachers' devices. The system's cloud-based server processes the data and provides real-time updates to administrators through a web-based dashboard.

I. INTRODUCTION

A teacher tracking system using ESP32 is an innovative solution that utilizes the power of Internet of Things (IoT) technology to track the attendance and movements of teachers within a school or educational institution. The ESP32 is a low-cost, low-power microcontroller with integrated Wi-Fi and Bluetooth capabilities, making it an ideal choice for building such a system. The teacher tracking system using ESP32 can be implemented by installing small beacons or sensors around the school campus that are connected to the ESP32 microcontroller. The beacons emit a unique signal that is detected by the ESP32, which then uses its Wi-Fi capabilities to send the data to a central server for processing and analysis.

This system can help school administrators to monitor the attendance and movements of teachers in real-time, ensuring that they are present in their assigned classrooms and performing their duties effectively. The system can also provide valuable insights into the utilization of school resources and help identify areas where improvements can be made. In this project, we will be using the ESP32 microcontroller, along with various sensors and beacons, to develop a robust teacher tracking system that can help improve the efficiency and effectiveness of school operations.

1.1 HARDWARE ARCHITECTURE

The hardware architecture of our teacher location tracker consists of an ESP32 module and a battery. The ESP32 module is responsible for detecting the Wi-Fi signals emitted by teachers' devices, and the battery powers the ESP32 module.

1.2 SOFTWARE ARCHITECTURE

The software architecture of our teacher location tracker consists of three main components: the Wi-Fi module driver, the location tracking algorithm, and the Wi-Fi data transmission module. The Wi-Fi module driver enables the ESP32 module to detect the Wi-Fi signals emitted by teachers' devices, and the location tracking algorithm determines the location of the teacher based on the signal strength and signal quality of the detected Wi-Fi signals. The Wi-Fi data transmission module is responsible for transmitting the teacher location data to a central server over Wi-Fi.

1.3 LOCATION TRACKING ALGORITHM

Our location tracking algorithm is based on the received signal strength indicator (RSSI) and signal quality (SQ) of the Wi-Fi signals emitted by teachers' devices. The algorithm first scans the Wi-Fi channels to detect the available access points, and then it measures the RSSI and SQ of the signals emitted by these access points. The algorithm uses a triangulation method to determine the location of the teacher based on the RSSI and SQ data.

1.3.1 WI-FI DATA TRANSMISSION

The teacher location data is transmitted to a central server over Wi-Fi using the MQTT protocol. The ESP32 module connects to the Wi-Fi network and publishes the teacher location data to a specific topic on the MQTT broker. The central server subscribes to this topic and receives the teacher location data.

II. KEY TERMINOLOGIES

2.1 RSSI

RSSI stands for Received Signal Strength Indicator. It is a measure of the signal strength of a wireless communication signal, such as Wi-Fi or Bluetooth. RSSI is usually expressed in decibels (dBm) and can range from -100 dBm to 0 dBm, with higher values indicating a stronger signal. RSSI is typically used by devices to determine the strength of the signal they are receiving from a nearby wireless access point or device.

2.2 ESP32

ESP32 is a low-cost, low-power system-on-a-chip (SoC) microcontroller designed by Espressif Systems. It is a successor to the popular ESP8266 microcontroller and offers more features and capabilities, making it an attractive choice for a wide range of Internet of Things (IoT) applications. ESP32 includes a dual-core 32-bit processor, Wi-Fi and Bluetooth connectivity, various interfaces for peripherals such as sensors and displays, and a range of onboard sensors such as temperature, humidity, and touch.

2.3 BLUETOOTH BEACONS

Bluetooth beacons are small wireless devices that use Bluetooth Low Energy (BLE) technology to transmit signals to nearby devices. They are typically powered by a small battery and can be placed in various locations, such as retail stores, museums, airports, or other public spaces.
The primary function of a Bluetooth beacon is to broadcast a signal that can be detected by other Bluetooth-enabled devices, such as smartphones or tablets. The signal typically contains a unique identifier that can be used by nearby devices to determine the proximity of the beacon and trigger various actions or notifications.

2.4 MQTT BROKER

MQTT (Message Queuing Telemetry Transport) broker is a server that acts as a messaging middleware for IoT devices to communicate with each other over the internet. MQTT is a lightweight publish-subscribe messaging protocol designed for efficient communication between IoT devices with low bandwidth, high latency, and unreliable network connections.

2.5 WI-FI TRANSMISSION MODULE

It is a type of wireless communication device that allows devices to communicate with each other over a WiFi network. It consists of a radio transceiver, an antenna, and firmware that implements the Wi-Fi communication protocol. WiFi transmission modules typically use the IEEE 802.11 standard for wireless communication, which is a widely used standard for local area networks (LANs). This standard specifies various parameters, such as frequency band, modulation scheme, data rate, and security mechanisms, to ensure reliable and efficient wireless communication.

2.6 LMS

A learning management system (LMS) is a software application designed to facilitate the delivery, management, and tracking of educational and training programs. It is a platform that provides instructors and learners with a centralized system to create, organize, manage, and deliver courses, as well as track and report on learners' progress and performance. An LMS typically includes features such as course creation tools, course management, learner management, tracking and reporting, and assessment tools. With an LMS, instructors can create and deliver content in a variety of formats, such as videos, presentations, and quizzes, and learners can access this content from anywhere at any time.

III. IMPLEMENTATION METHODOLOGIES

This section briefly discusses the methodologies utilized for the implementation of the Staff Location Tracking System proposed in the previous research.
Sayali A. Kumbhar et.al [1] The primary object of the system is to provide a system for tracking the teachers in the college campus. This system will be able to track the teachers using computer-based systems. This can be easily done by having an active RFID at the transmitter side, which helps in sending its unique id to the receiver side. At the receiver side we use various devices such as Micro controller AT89S52, USB to TTL, Zigbee (CC2500) circuit, IR sensor, Personal computer which mainly help the performance and productivity. It is the performance indicator or benchmark of all listed companies of KSE. So it can be regarded user in tracking the location.IR sensors which are set in the classroom helps in tracking the teacher.

Pranita Kadam et.al [2] This paper aims for providing Real Time Location Services (RTLS) using IoT enabled devices. In this student tracking system, we focus on two main things. The first aim will be to build reliable system to access student data and the second is to monitor students' attendance percentages in each class. RFID reader having antenna producing radio waves the tag responds by sending back its data. The main thing here is the distance at which we the tag can read.

R. Al-Ali et.al [3] This paper describes the design of an RFID Kids Tracking System. It is designed to track a moving child in a wide area, such as a park or mall, using RFID technology. Here we have RFID active tag, RFID tag reader, web server and database server. The tags readers are distributed around an open area e.g., playground. The tags are worn by kids, and the communication between the tag reader and web is done via wireless LANs. The software architecture consists of a communication driver that handles all communication functions done at the master station, an Application Programming Interface (API) that handles and analyses the data, a friendly GUI and a database that saves all readings and client information.

Rajashree H S et.al [4] This paper describes an algorithm proposed for indoor positioning using Bluetooth communication technology and trilateration. In this system BLE nodes will be stationery and beacons will be movable. When the beacon is detected by three or more nodes, the system can triangulate beacon's location. Python script is used to calculate the distance between beacon and mobile devices. The BLE nodes get client information and upload data to the server. Through RSSI we get the signal strength to determine the location more accurately.

Garla Ramesh et.al [5] In this paper, an IoT-based GPS Location tracker using NEO-6M GPS Module and NodemCU ESP8266 is built. The components used for making this project are NodeMCU, OLED Display Module, NEO-6M GPS Module, and 3.7 to 6V booster circuit. To display the location detail, a simple local web server is created. This web server is directly connected to google maps through google maps API to display the current location.

Rakshith A et.al [6] The primary aim of this paper is to come up with an indoor navigation system using BLE and ESP32. It describes a method where a mobile application that helps the users to navigate inside a building without any use of maps is built. This indoor navigation system uses the following concepts and technologies – RSSI to distance calculation, Trilateration, MQTT Protocol for communication between ESP32 stations and PC, TCP protocol for communication between user (mobile device) and PC and Dijkstra's algorithm for path planning. This proposed system has enough accuracy to navigate in an indoor facility.

Leverage [7], This paper tells about .Real Time Location Systems (RTLS) have become more accessible through smartphones and mobile applications, but indoor RTLS is still facing technical hurdles and infrastructure costs. Leverege R&D team is building a high-resolution indoor tracking system that fuses data from multiple sources using Bluetooth Low Energy (BLE) tracking tags and programmable location "hub" devices. Hub placement and density, hardware selection, and signal obstructions are important considerations when designing an indoor RTLS system. The team developed Leverege's Location Engine through a series of prototypes, and after testing geolocation techniques, discovered that a particle filter delivered the most accurate and stable location results in dynamic indoor environments.

Srinivash Raula et.al [8] This article is about location tracking without using a GPS module, which is a widely used method for location tracking but has some issues such as weak signal, power consumption, and cost. The authors propose using the geolocation API and Node MCU ESP 12E board to find the location without GPS module. The article describes the process of geolocation and how it works through a pre-built GPS in a device that propagates the devices longitudinal and latitudinal coordinates. The proposed method involves obtaining SSI, RSSI, and MAC addresses characteristics of nearby Wi-Fi access points and cellular sub-systems, consolidating the obtained information into a data block, transmitting the data block to google' s geolocation service with the help of geolocation API, estimating the latitude and longitude in degrees as well as the estimated location in meters, and returning the JSON-formatted output response back to the device. The article also includes a literature survey and an explanation of the existing method.

V. Thirupathi et.al [9], This paper explains the design and development of a cloud-based home automation system using the MQTT protocol. The system enables users to control and monitor home appliances using a mobile app or a web page. The paper discusses different wireless technologies that have been used to develop smart home systems, such as infrared, Bluetooth, ZigBee, Wi-Fi, RFID, and GSM. The paper also discusses related work, such as home automation systems based on Bluetooth and ZigBee. The authors implemented a home automation system using MQTT protocol and ESP32, which is a combination of Wi-Fi, cloudMQTT, relays, and a power supply unit. The system is cost-effective, secure, and reliable, as many cloud vendors are offering their services free of cost. The authors suggest that cloud-based home automation systems are becoming more popular due to the availability of free cloud services, and the MQTT protocol's built-in security features provide security at Secure Socket Layer (SSL) level.

Parth Jindal et.al [10] The research paper is about a progress tracking application developed using Flutter and Firebase. The paper explores the issues faced by users of task management applications and how these issues can be addressed through the development of an application that provides users with a descriptive, pictorial view of their daily timeline and how to improve it. The application aims to improve productivity by mapping daily tasks and providing analysis of how time was spent, helping users better understand where they must improve. The paper also discusses the technology used in developing the application, including Flutter, a cross-platform UI framework developed by Google, and Firebase, a backend platform for mobile and web applications.

Pasumarthi Amala et.al[11]This paper presents a new antenna design for on-body communications in biomedical applications. The proposed antenna model is an elliptical shape patch (ESP) antenna with inverted U-shaped slots, which covers ultra-wideband (UWB) characteristics in free space and is observed at 3 to 10.7 GHz. When implanted on a flat tissue model of the human body, the bandwidth is 2.2 to 10.8 GHz. The antenna is fed with a coplanar waveguide (CPW) ground to produce impedance matching. The inverted U-shaped slots are used to produce the UWB. The specific absorption rate (SAR) values of 1.26 W/kg and 1.58 W/kg are observed on-body at 4.9 GHz and 7.3 GHz operating frequencies, respectively. The paper presents the results with respect to the radiation pattern, gain, reflection coefficient, and surface current distribution. The proposed antenna design overcomes the limitations of MICS and ISM band antennas used for on-body applications and provides a lightweight,

bio-compatible, and conformable antenna for implantable medical devices with wireless networks. The paper also compares the proposed antenna model with other existing antenna models designed for UWB applications in biomedical communications.

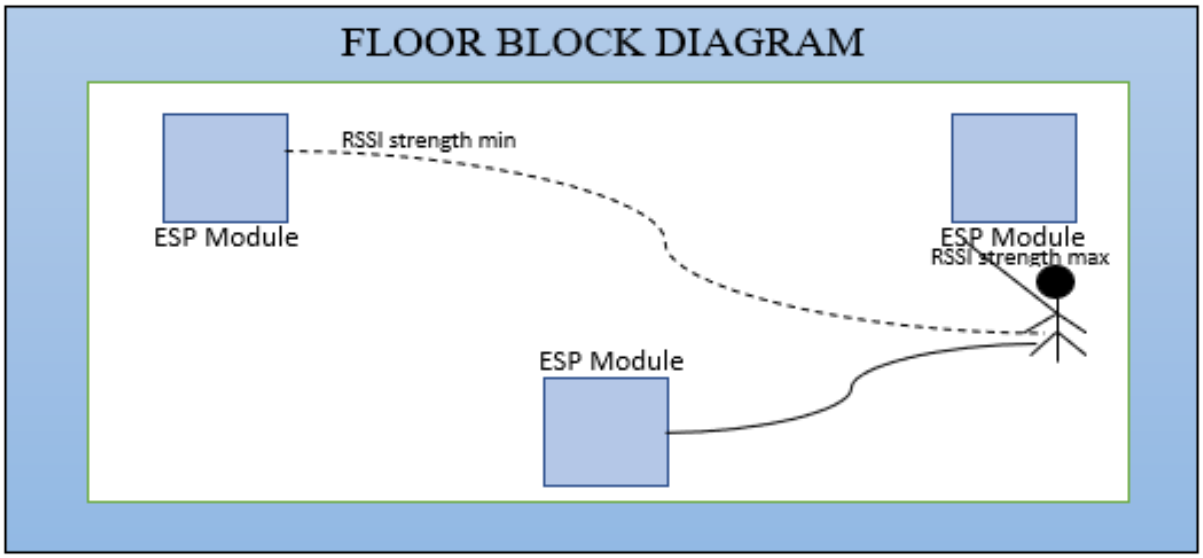
Sean J. Barbeau et.al[12]The main goal of this article is to emphasize the importance of having an API that provides access to real-time location information for mobile phones and to describe the Location API for Java 2 Micro Edition (J2ME). The article discusses the many benefits of having a standard cross-platform API for mobile phones, including the ability to shorten the development time of advanced Location-Based Services (LBS), and highlights the significant enhancements and new services included in the development of "JSR293-Location API v2.0." The article also provides coding examples to illustrate how software developers can use these new features to create next-generation location-aware J2ME applications.

Pratibha Sharma et.al [13] Android's Network Location Provider to obtain the user's location. The paper outlines the steps to create an Android app that identifies the user's location, including adding a Google Maps API key to access the Google Maps servers. The app's database allows users to save their name and address, which can be shared with others interested in traveling to the same location. The app is compatible with any Android device and occupies minimal space. Previous studies related to location tracking apps and Android-based applications are also discussed.

N.Rewanth Sai Simha et.al[14]This task involves the development of an Android application for GPS-based student location tracking. Any GPS-enabled handset can be located with the help of this application. The target user must have planned access and must be GPS-enabled. The application uses RFID to maintain the student attendance system. The application calculates school GPS mapping to determine the activity status of cell phone holders. The location of the cell phone holders can be identified as travelling or non-travelling based on which student violations during school times can be easily identified. The paper highlights the use of GPS, indoor location-based services, and Indoor Atlas Android SDK for indoor navigation. The paper discusses the challenges of urban travel studies and the feasibility of using a passive travel data collection approach in complex urban environments. The paper also describes the use of GPS data loggers to replace travel diaries for the collection of travel data, and the use of RFID-based positioning systems for hardware location in hospitals.

IV. PROPOSED SYSTEM

The proposed system consists of setting up multiple ESP's which will work as access point and stationary point across the campus to monitor the location of staff. Using the RSSI value that will be displayed by the ESP, we will use wifi fingerprinting to find out the mobile devices that are connected to each ESP and then have a main controller which receives that data from them and sends to it to the backend of the website for real time tracking. The backend will then filter out only the users that are mentioned in the database and display the live location of the staff members on the website/ kiosk.



V.CONCLUSION

Teacher location tracking in college campuses is an emerging technology that has the potential to provide numerous benefits to both teachers and students. In this technical paper, we have presented the development of a teacher location tracker using ESP32 without a GPS module. Our system is designed to track teachers' locations using Wi-Fi signals and transmit the data to a central server. The use of ESP32 microcontroller and the MQTT protocol makes our system low-cost and efficient. However, implementing teacher location tracking technologies also raises privacy concerns and technical challenges that need to be addressed. Future research can focus on developing more privacy-preserving and accurate location tracking technologies and integrating them with LMS to provide a more comprehensive view of the teaching and learning process.

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