



# IoT-Based Indoor Position Identification System using Wi-Fi Signals

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**ABSTRACT:** Indoor position identification has become an essential requirement in modern Internet of Things (IoT) environments where Global Positioning System (GPS) signals are unavailable or unreliable. GPS-based systems fail to provide accurate localization inside buildings due to signal attenuation caused by walls, ceilings, and other structural obstructions. Traditional indoor positioning techniques often suffer from limited accuracy, signal instability, and lack of real-time monitoring capabilities. Manual monitoring of indoor movement is inefficient, time-consuming, and prone to errors, particularly in large environments such as colleges, offices, hospitals, and commercial buildings. To overcome these challenges, the proposed system introduces an IoT-based indoor position identification framework using Wi-Fi signals and Received Signal Strength Indicator (RSSI) fingerprinting techniques. The system collects RSSI values from multiple Wi-Fi access points operating under the IEEE 802.11 standard to estimate indoor locations accurately. Raspberry Pi devices are used to facilitate Wi-Fi communication and data acquisition. The collected signal data is stored in an IoT cloud database for real-time monitoring and analysis. The fingerprinting approach compares real-time RSSI values with pre-collected reference data to determine precise indoor positions. The system is designed to be low-cost, scalable, and energy-efficient without requiring additional specialized hardware. Experimental evaluation demonstrates improved positioning accuracy and reliability in indoor environments. This automated approach reduces dependency on manual supervision and enhances real-time tracking efficiency. It supports smart campus management, asset tracking, and indoor navigation applications. Overall, the proposed system represents a significant advancement in IoT-based indoor localization using Wi-Fi signal strength analysis.

**KEYWORDS:** IoT, Indoor Positioning, Wi-Fi, RSSI, Fingerprinting, IEEE 802.11

## I. INTRODUCTION

Indoor localization has emerged as a critical research area due to the rapid expansion of IoT-enabled smart environments. While GPS technology provides reliable outdoor navigation, it performs poorly inside buildings because satellite signals are weakened or blocked by structural obstacles. As a result, accurate indoor position identification remains a challenging problem in smart infrastructure systems. Several technologies such as Bluetooth, RFID, Zigbee, and WLAN have been explored to address indoor positioning challenges. Among these, Wi-Fi-based localization has gained significant attention because Wi-Fi infrastructure is already widely available in most buildings and supported by smart devices.

This project, "IoT-Based Indoor Position Identification System Using Wi-Fi Signals," focuses on utilizing Wi-Fi RSSI fingerprinting techniques to accurately estimate indoor positions. The system collects RSSI values from multiple access points and compares them with a pre-established database to determine user or object location. By integrating Raspberry Pi devices and IoT cloud platforms, the system enables real-time monitoring and position visualization through a web interface. The use of RSSI-based fingerprinting improves localization precision while maintaining low implementation cost. By automating indoor tracking using Wi-Fi signals, this project aims to provide a reliable and scalable solution for smart campus systems, hospital monitoring, office asset management, and secure indoor navigation. The increasing demand for smart indoor tracking solutions has made accurate and efficient localization systems essential in modern IoT applications. Traditional manual monitoring approaches are inefficient and lack



scalability. To address these limitations, this project presents an IoT-integrated indoor positioning system that leverages Wi-Fi signal strength analysis for accurate and real-time location identification. The proposed system reduces operational complexity while enhancing monitoring efficiency and reliability in indoor environments.

## 1.1 SCOPE OF THE PROJECT

The proposed project aims to develop an IoT-based indoor position identification system using Wi-Fi RSSI fingerprinting techniques for environments where GPS signals are unavailable. It focuses on accurately estimating indoor locations by analyzing signal strength values collected from multiple Wi-Fi access points. The system supports real-time monitoring through IoT cloud integration, enabling remote tracking and data analysis. By utilizing Raspberry Pi devices for access point communication and signal acquisition, the framework ensures cost-effective deployment without additional hardware requirements.

The project can be applied in educational institutions, corporate offices, hospitals, banks, and other large indoor environments requiring efficient monitoring and tracking systems. It enables secure user authentication, centralized administration, and real-time reporting functionalities. The system can be extended to multi-floor buildings and complex architectural layouts by expanding the fingerprint database. Future enhancements may include integration with smart building automation systems and mobile application-based indoor navigation. Overall, the scope encompasses real-time indoor localization, cloud-based data storage, scalable deployment, and efficient monitoring using Wi-Fi signal strength analysis within IoT environments.

## 1.2 OBJECTIVES

The primary objective of this project is to develop an IoT-based indoor position identification system using Wi-Fi RSSI fingerprinting techniques for accurate localization in indoor environments where GPS signals are unavailable. It aims to accurately estimate and identify indoor positions of users or objects by analyzing Received Signal Strength Indicator (RSSI) values collected from multiple Wi-Fi access points. The project seeks to utilize fingerprinting methods to improve localization accuracy and reliability in dynamic indoor conditions affected by obstacles and signal fluctuations. Another objective is to integrate Raspberry Pi devices and IoT cloud platforms for real-time data collection, processing, and monitoring of indoor positions. The system also intends to store and manage location data securely in a cloud database for continuous tracking and analysis. It aims to reduce dependency on manual supervision and traditional monitoring methods, minimizing human effort and operational inefficiencies. Ensuring robustness across different indoor layouts with varying structural obstacles and signal interference is a key objective. The project also targets improved positioning precision in environments such as colleges, offices, hospitals, and banks, where real-time tracking is essential. It seeks to combine Wi-Fi signal strength analysis with IoT-based monitoring for a comprehensive and scalable indoor localization framework. Another objective is to generate interpretable outputs through a web-based interface, displaying identified locations and tracking information in real time for practical implementation. The framework is designed to be cost-effective, energy-efficient, and adaptable for large buildings and multi-floor environments. It also aims to demonstrate improved performance compared to traditional indoor positioning techniques that rely solely on unstable RSSI measurements without fingerprinting optimization. Overall, the project strives to create an efficient, accurate, scalable, and practically deployable indoor position identification system using Wi-Fi and IoT technologies.

## II. LITERATURE SURVEY

**2.1. H. Liu, H. Darabi, P. Banerjee, and J. Liu** – This research presents a comprehensive survey of wireless indoor positioning techniques and systems. The study analyzes various localization technologies including Wi-Fi, Bluetooth, RFID, and Ultra-Wideband (UWB) for indoor environments where GPS signals are unavailable. The authors discuss positioning approaches such as triangulation, trilateration, and fingerprinting, highlighting the advantages of Received Signal Strength (RSS)-based methods due to their compatibility with existing Wi-Fi infrastructure. The survey addresses challenges such as multipath fading, signal attenuation, and environmental interference that affect localization accuracy. Experimental comparisons show that fingerprinting techniques provide better precision in complex indoor layouts compared to simple distance-based estimation methods. This study demonstrates that Wi-Fi RSSI-based indoor positioning is a practical and scalable solution for real-time indoor localization applications.

**2.2 P. Bahl and V. N. Padmanabhan** – This study introduces the RADAR system, an early Wi-Fi-based indoor positioning framework that utilizes RSS fingerprinting for user location detection. The proposed method collects signal strength values from multiple access points and constructs a radio map database for position estimation. During the



online phase, real-time RSS values are compared with the stored fingerprints to determine the closest matching location. The approach significantly improves indoor positioning accuracy compared to basic signal propagation models. The paper emphasizes that leveraging existing Wi-Fi infrastructure reduces deployment cost and enhances feasibility in enterprise environments. Through experimental validation in office buildings, the study confirms that Wi-Fi fingerprinting is effective for indoor tracking applications, making it a foundation for modern IoT-based localization systems.

**2.3. M. Youssef and A. Agrawala** – This research presents the Horus WLAN location determination system, which enhances indoor positioning accuracy by modeling signal strength probability distributions. Unlike deterministic fingerprinting methods, the proposed probabilistic approach accounts for signal fluctuations caused by obstacles and environmental dynamics. The system improves location estimation by analyzing statistical variations in RSS values collected from multiple access points. The study highlights challenges such as signal instability and interference in indoor environments and proposes robust modeling techniques to minimize localization errors. Experimental results demonstrate significant improvements in positioning precision compared to traditional RSS matching techniques. This research contributes to the development of more reliable and adaptive Wi-Fi-based indoor positioning systems.

**2.4. K. Kaemarungsi and P. Krishnamurthy** – This paper focuses on modeling indoor positioning systems based on location fingerprinting techniques using Wi-Fi signal strength. The authors analyze the impact of environmental factors such as walls, furniture, and human movement on RSS measurements. The study proposes statistical modeling approaches to enhance fingerprint database accuracy and reduce estimation errors. By examining signal distribution characteristics and noise patterns, the framework improves reliability in dynamic indoor conditions. Comparative analysis with traditional path-loss models reveals that fingerprint-based localization achieves superior performance in complex building structures. The paper concludes that accurate RSS modeling combined with systematic data collection significantly enhances indoor localization effectiveness, supporting scalable IoT-based tracking systems.

### III. EXISTING SYSTEM

The existing indoor positioning systems primarily rely on GPS-based technologies or simple RSSI measurement techniques without advanced fingerprinting optimization. GPS is highly effective for outdoor navigation; however, it fails in indoor environments due to signal blockage caused by walls, ceilings, and structural obstacles. Alternative wireless technologies such as Bluetooth, RFID, and Zigbee have been implemented for indoor tracking, but they often require additional hardware installation and higher deployment costs. Many Wi-Fi-based systems depend solely on raw RSSI values for distance estimation, which leads to inconsistent accuracy due to multipath fading, signal attenuation, and interference from surrounding objects.

Traditional indoor localization approaches lack integration with IoT cloud platforms for real-time monitoring and centralized data management. RSSI values in indoor environments are highly unstable and affected by environmental changes, resulting in reduced reliability. Existing systems also face challenges in scalability when deployed in multi-floor buildings or large institutional campuses. Furthermore, manual monitoring and data interpretation are often required to validate position estimates, increasing operational complexity and reducing efficiency. The absence of optimized fingerprint databases and real-time web-based visualization limits the practical usability of many indoor positioning systems. Overall, while current Wi-Fi-based localization methods provide a foundation for indoor tracking, they suffer from signal instability, limited precision, and lack of scalable IoT integration, restricting their effectiveness in modern smart environment applications.

#### 3.1 DISADVANTAGES

**Limited Accuracy and Reliability:** Existing indoor positioning systems relying solely on raw RSSI values suffer from signal fluctuations, multipath fading, and interference, leading to inconsistent and inaccurate position estimation.

**Lack of Robust Signal Modeling:** Traditional systems fail to implement optimized fingerprinting or probabilistic modeling techniques, reducing precision in dynamic indoor environments.

**Dependence on Manual Monitoring and Infrastructure Constraints:** Many systems require manual supervision, additional hardware installation, or complex calibration processes, making deployment costly and less scalable across multi-floor or multi-building environments.

### IV. PROPOSED SYSTEM



The proposed system introduces an IoT-based indoor position identification framework using Wi-Fi RSSI fingerprinting techniques for accurate localization in GPS-denied indoor environments. Wi-Fi access points are used to collect Received Signal Strength Indicator (RSSI) values from multiple locations within a building. A fingerprint database is created during the offline phase by storing RSSI values corresponding to known reference points. During the online phase, real-time RSSI readings are compared with the stored fingerprints to estimate the current position accurately.

The system integrates Raspberry Pi modules and IoT cloud platforms for real-time data transmission, storage, and monitoring. Advanced matching algorithms are applied to improve positioning precision and reduce errors caused by signal instability and environmental interference. By combining Wi-Fi fingerprinting with IoT-based monitoring, the proposed system overcomes the limitations of traditional RSSI-based localization methods, providing accurate, scalable, and cost-effective indoor positioning. Multi-location data collection ensures robustness across different building layouts, structural obstacles, and signal variations. The framework enables faster, automated, and reliable indoor tracking while minimizing manual intervention and operational complexity.

#### 4.1 ADVANTAGES

**Accurate Indoor Localization:** Provides improved positioning precision using Wi-Fi RSSI fingerprinting without relying on GPS.

**Real-Time Monitoring and Automation:** IoT integration enables continuous tracking and remote monitoring through cloud platforms.

**Cost-Effective and Scalable:** Utilizes existing Wi-Fi infrastructure, reducing deployment cost and allowing implementation in large multi-floor buildings.

**Robust Against Environmental Variations:** Designed to handle signal interference, multipath effects, and structural obstacles effectively.

#### 4.2 SYSTEM ARCHITECTURE

The system architecture consists of Wi-Fi access points, Raspberry Pi modules for data collection, a fingerprint database for RSSI storage, a processing unit for position estimation, and an IoT cloud platform for real-time monitoring and visualization. The architecture operates in two phases: offline fingerprint database creation and online real-time position estimation.

### V. MODULES

- a. Data Acquisition
- b. Data Preprocessing
- c. RSSI Fingerprint Database Creation
- d. Position Estimation Module
- e. IoT Cloud Integration Module
- f. Performance Evaluation

#### 5.1 MODULE DESCRIPTIONS

##### 5.1.1. Data Acquisition

This module focuses on collecting Wi-Fi RSSI values from multiple access points within the indoor environment. Data is gathered at predefined reference points across different rooms and floors of the building. Multiple samples are recorded at each location to account for signal variability and environmental interference. The data collection process ensures coverage of diverse indoor conditions, including obstacles such as walls, furniture, and human movement. Each dataset includes timestamp and access point identifiers for accurate mapping. Proper labeling of reference locations is performed to facilitate fingerprint database creation. This module ensures that sufficient and diverse signal data is available for building a reliable indoor positioning system.

##### 5.2.2. Data Preprocessing

In this module, collected RSSI data undergoes preprocessing to improve consistency and reliability. Noise filtering techniques are applied to remove extreme fluctuations and outlier values. Signal normalization is performed to standardize RSSI ranges across different access points. Missing values are handled using interpolation or averaging methods. Data smoothing techniques are implemented to reduce sudden signal spikes caused by interference. The



preprocessed data is organized systematically for efficient storage in the fingerprint database. This module enhances data quality, ensuring accurate and stable position estimation during the online phase.

### 5.2.3. RSSI Fingerprint Database Creation

This module constructs the indoor radio map by storing processed RSSI values corresponding to known reference points. The database contains multiple signal samples for each location to improve matching accuracy. During the offline phase, RSSI vectors are mapped to their respective coordinates within the building layout. Statistical measures such as mean and variance may be computed to model signal behavior at each point. This structured fingerprint database serves as the foundation for real-time localization. By using stored signal patterns, the system can accurately compare and estimate unknown positions during operation.

### 5.2.4. Position Estimation Module

The position estimation module compares real-time RSSI readings with stored fingerprints to determine the user's current location. Matching algorithms such as K-Nearest Neighbor (KNN) or distance-based estimation techniques are used to identify the closest reference point. The system calculates similarity between live RSSI vectors and database entries to estimate coordinates accurately. This module minimizes localization error by considering multiple access point signals simultaneously. The estimated position can be visualized on a digital floor map. This module forms the core functionality of the indoor positioning system.

### 5.2.5. IoT Cloud Integration Module

This module integrates the positioning system with an IoT cloud platform for real-time monitoring and data management. Position data is transmitted from Raspberry Pi devices to the cloud server through internet connectivity. A web-based interface is developed to display current location information and tracking history. The cloud platform allows remote access, centralized storage, and data analytics. Security mechanisms are implemented to protect transmitted data. This module enhances scalability and enables smart monitoring applications in offices, hospitals, and educational institutions.

### 5.2.6. Performance Evaluation

The performance of the proposed system is evaluated using metrics such as localization accuracy, mean positioning error, and response time. Comparative analysis is performed against traditional RSSI-based distance estimation methods. Multiple test scenarios are conducted across different indoor layouts to measure robustness and consistency. Error distribution is analyzed to identify improvement areas. Efficiency metrics such as processing time per estimation are recorded to assess real-time feasibility. This module ensures that the system meets accuracy, reliability, and scalability requirements for practical indoor deployment.

## VI. CONCLUSION

The proposed IoT-based indoor position identification system using Wi-Fi RSSI fingerprinting provides an efficient and automated solution for accurate localization in indoor environments where GPS signals are unavailable. It overcomes the limitations of traditional RSSI-based distance estimation methods by implementing structured fingerprint database creation and intelligent matching techniques. Wi-Fi access points effectively collect signal strength data, while preprocessing and fingerprint modeling enhance positioning precision and reliability. The system demonstrates improved localization accuracy, robustness, and scalability across different indoor layouts and environmental conditions. Integration with Raspberry Pi and IoT cloud platforms reduces the dependency on manual monitoring, enabling real-time tracking and centralized data management. Signal instability caused by multipath fading and interference is minimized through preprocessing and optimized matching algorithms. The framework supports practical deployment in institutions such as colleges, offices, hospitals, and commercial buildings. It is cost-effective, adaptable to multi-floor environments, and capable of handling large datasets efficiently. Performance evaluation confirms improved reliability and positioning precision compared to conventional indoor localization approaches. Overall, this system represents a significant advancement in IoT-enabled indoor positioning and smart environment monitoring applications.

## VII. FUTURE ENHANCEMENT



The system can be extended to support real-time continuous tracking with higher positioning accuracy using advanced machine learning algorithms. Integration of deep learning-based fingerprint matching techniques could further improve localization precision under dynamic environmental conditions. Multi-technology integration, including Bluetooth Low Energy (BLE) or Ultra-Wideband (UWB), can enhance robustness and reduce positioning errors. The framework can also incorporate predictive analytics for movement tracking and behavioral analysis within smart buildings. Future enhancements aim to make the system more adaptive, scalable, energy-efficient, and suitable for large-scale smart infrastructure and IoT-enabled environments.

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