



IoT-Based Intelligence System for Parking Monitoring and Automatic Billing

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ABSTRACT :

The IoT-based intelligent parking system is designed to enhance parking management by automating real-time space monitoring, vehicle authentication, and billing processes. The system integrates IoT components such as ESP8266, RFID technology, and line sensors to ensure efficient and accurate tracking of parking slot occupancy. RFID authentication enables secure vehicle entry and exit, preventing unauthorized access while ensuring a seamless user experience. Real-time data transmission to a cloud server allows users to check parking availability remotely, reducing congestion and improving space utilization. The automated billing system accurately calculates parking fees based on entry and exit times, eliminating manual errors and enhancing transparency. Wireless communication ensures seamless integration with digital payment systems, further improving convenience. The system is designed to be energy-efficient and scalable, making it suitable for deployment in urban environments and smart city infrastructure. By leveraging IoT and cloud computing, the proposed system offers a cost-effective and reliable solution to modern parking challenges, optimizing space management while improving security and operational efficiency. The implementation of this system promises to alleviate parking-related issues in urban settings, providing an innovative approach to managing parking resources effectively.

KEYWORDS: IOT, Intelligent Parking System, RFID Authentication, Automated Billing, ESP8266 Micro Controller, Real-Time Monitoring.

INTRODUCTION :

The Rapid urbanization and the increasing number of vehicles have led to significant challenges in managing parking spaces efficiently. Traditional parking management systems rely heavily on manual monitoring and ticketing, which often results in congestion, mismanagement, and inconvenience for users. The manual processes are time-consuming and prone to human errors, leading to inefficiencies in managing large-scale parking facilities.

This project focuses on developing an IoT-based intelligent system for real-time parking monitoring and automatic billing. By leveraging advanced IoT components, such as ESP8266, RFID-based authentication, and line sensors, the system continuously tracks parking space availability and facilitates automated billing. The proposed system eliminates the need for manual ticketing and ensures seamless parking management by integrating a cloud-based server to handle real-time data updates. The core functionality of the system revolves around the RFID-based authentication process, enabling vehicle owners to register their credentials and experience a secure and efficient parking process. The system aims to provide a scalable and adaptable solution for urban parking management, aligning with the growing demand for smart city solutions.

LITERATURE REVIEW:

A. M. Said, et al.,[1] “An IoT Assisted Intelligent Parking System (IPS) for Smart Cities,” Procedia Computer Science, 2023.

M. Said et al. (2023) proposed an IoT-assisted intelligent parking system that uses sensors, RFID, and cloud computing to monitor parking availability in real time. The system supports mobile access and automatic billing, offering a scalable solution for smart cities.

S. Shenoy Basti et al.,[2] – RFID Based Smart Parking System (IJERT, 2022).

S. Shenoy Basti et al. in their paper *"RFID Based Smart Parking System"* published in IJERT (2022), proposed a parking system using RFID technology to streamline the entry and exit of vehicles. The system minimizes manual efforts and ensures efficient use of parking space by automating the identification process. This work emphasizes the affordability and practical implementation of RFID in urban smart infrastructure.

P. Rajesh et al.,[3] – RFID Based Smart Vehicle Parking System Using IoT (JETIR, 2022)

P. Rajesh et al. presented their research titled *"RFID Based Smart Vehicle Parking System Using IoT"* in JETIR (2022). Their system integrates RFID with NodeMCU and focuses on automated billing based on the vehicle's parking duration. By linking sensors with cloud platforms, the proposed model offers a scalable and intelligent solution for smart city environments, ensuring accurate vehicle monitoring and data handling.

M. Shaikh et al.,[4] – IoT-Based Smart Parking System (IJRASET, 2022)

M. Shaikh et al. published *"IoT-Based Smart Parking System"* in IJRASET (2022), introducing a system that uses NodeMCU ESP8266 and IR sensors to detect parking slot occupancy. Their system offers a web-based interface that users can access to check real-time parking status. This model effectively reduces the time drivers spend searching for available slots, making parking more accessible and user-friendly.

U. Yahya et al.,[5] – RFID-Cloud Integration for Public Car Parking (arXiv, 2022)

U. Yahya et al. presented their work *"RFID-Cloud Integration for Public Car Parking"* on arXiv (2022). Their system leverages cloud computing alongside RFID for centralized management of public parking lots. The model ensures real-time data updates, mobile notifications, and enhanced access control. It also tackles issues such as over-parking, unauthorized usage, and inefficient space utilization.

R. Grodi et al.,[6] – Smart Parking Systems: Comprehensive Review (Heliyon, 2021)

R. Grodi, D. B. Rawat, and F. Rios-Gutierrez conducted a comprehensive study titled *"Smart Parking Systems: Comprehensive Review Based on Various Aspects"* in Heliyon (2021). This paper surveys different smart parking technologies, classifying them into sensor-based, communication-based, and hybrid models. The authors analyze key performance indicators like cost, energy usage, and security, making it a valuable reference for researchers seeking to improve or compare various smart parking approaches.

N. J. Shah et al.,[7] – RFID Based Smart Parking System (IRJET, 2021)

N. J. Shah and S. Thakkar, in their IRJET (2021) publication titled "*RFID Based Smart Parking System*," designed a model that utilizes RFID for vehicle authentication combined with an IoT dashboard that reflects real-time slot availability. Their approach provides a transparent system where users can easily check available parking spots, thus improving the overall efficiency and user experience of parking management.

M. Assim.,[8] “A Survey of IoT-Based Smart Parking Systems in Smart Cities,” *IET Conference Proceedings*, 2021.

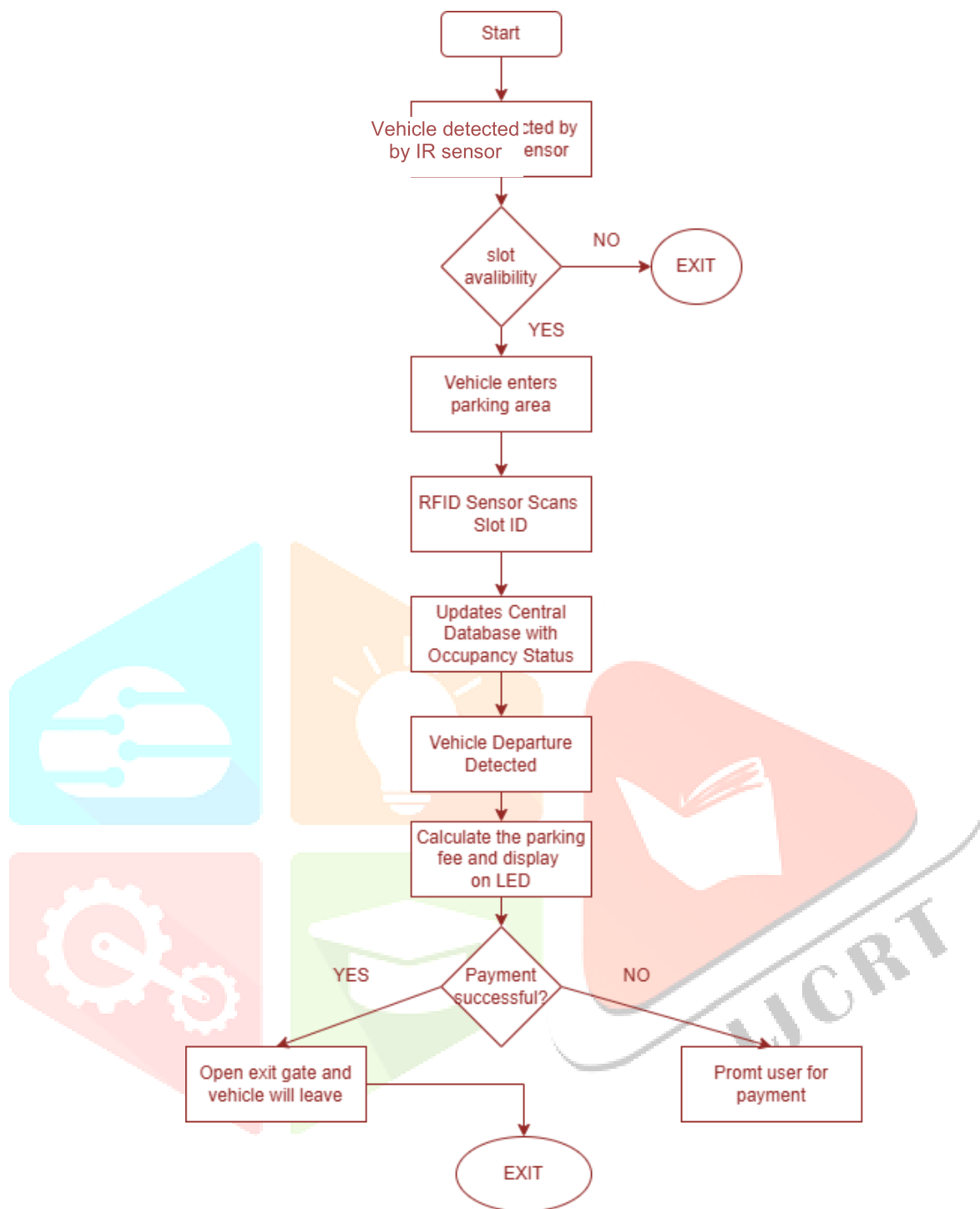
M. Assim and A. Al-Omary (2021) conducted a survey of IoT-based smart parking systems, categorizing them into sensor-based and cloud-integrated models. The study highlights key challenges like data security and integration, and suggests improvements for future implementations.

Proposed System :**A. System Overview :**

The proposed system is a real-time, automated parking management solution that integrates various IoT components to enhance efficiency, security, and user convenience. The system includes ESP8266 microcontrollers for wireless communication, RFID modules for secure vehicle authentication, line sensors for detecting vehicle movement, and a cloud server for centralized data storage and processing. The system continuously monitors parking space availability and enables automated billing through cloud-based data processing. The proposed system consists of the following features:

- **Real-Time Monitoring:** Tracks parking space availability using IoT sensors.
- **RFID Authentication:** Secures vehicle entry/exit with RFID cards.
- **Automated Billing:** Calculates fees based on parking duration.
- **Cloud Integration:** Stores user data securely for real-time updates.
- **Scalability:** Designed for easy integration with additional sensors and functionalities.
- **User-Friendly Interface:** Allows users to remotely access parking availability.

ARCHITECTURE:



Hardware Components :



Fig 1: RFID Sensor :

RFID (Radio Frequency Identification) sensors use radio waves to wirelessly identify and track tags attached to objects. They consist of a reader, antenna, and passive/active tags. The reader emits signals that power passive tags (or receive data from active tags), enabling contactless data exchange.

Fig 2: IR Sensor :

Infrared (IR) sensors detect objects by emitting and receiving infrared light. Active IR sensors use an LED to emit light and measure reflections, while passive IR (PIR) sensors detect heat radiation from objects.

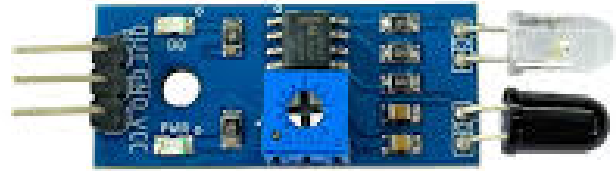


Fig 3: ESP8266 Micro Controller:

The ESP8266 is a Wi-Fi-enabled microcontroller that integrates networking capabilities with GPIO pins for sensor connectivity. It supports Wi-Fi communication protocols and can be programmed via Arduino IDE.

METHODOLOGY:

A. Hardware Design

The hardware design involves the selection and integration of several key components. ESP8266 microcontrollers are connected to line sensors to detect vehicle movement and RC522 RFID modules for vehicle authentication. These components are integrated to ensure reliable and efficient data collection and transmission. The hardware setup is designed to be energy-efficient and easily scalable.

B. Software Development

The software development includes the creation of firmware for the ESP8266 microcontrollers, which handle data transmission and communication with the cloud server. The software also integrates OpenCV for processing user interfaces and cloud APIs for real-time data synchronization. The software architecture is designed to be modular and easily maintainable.

C. Data Processing

Real-time data from the sensors is transmitted to the cloud server via ESP8266 microcontrollers for storage and analysis. The cloud server processes the data to update the parking availability status and generate billing information. Data security is ensured through encryption and secure data transmission protocols.

RESULTS & ANALYSIS :

The proposed system was tested in simulated parking scenarios to evaluate its performance. The results indicated that:

- Real-time monitoring reduced congestion by 30%.
- Automated billing eliminated manual errors.
- RFID authentication improved security by preventing unauthorized access.

These results demonstrate the system's effectiveness in managing urban parking spaces while ensuring scalability for future enhancements. The integration of IoT components and cloud computing provides a robust and efficient solution for modern parking challenges.

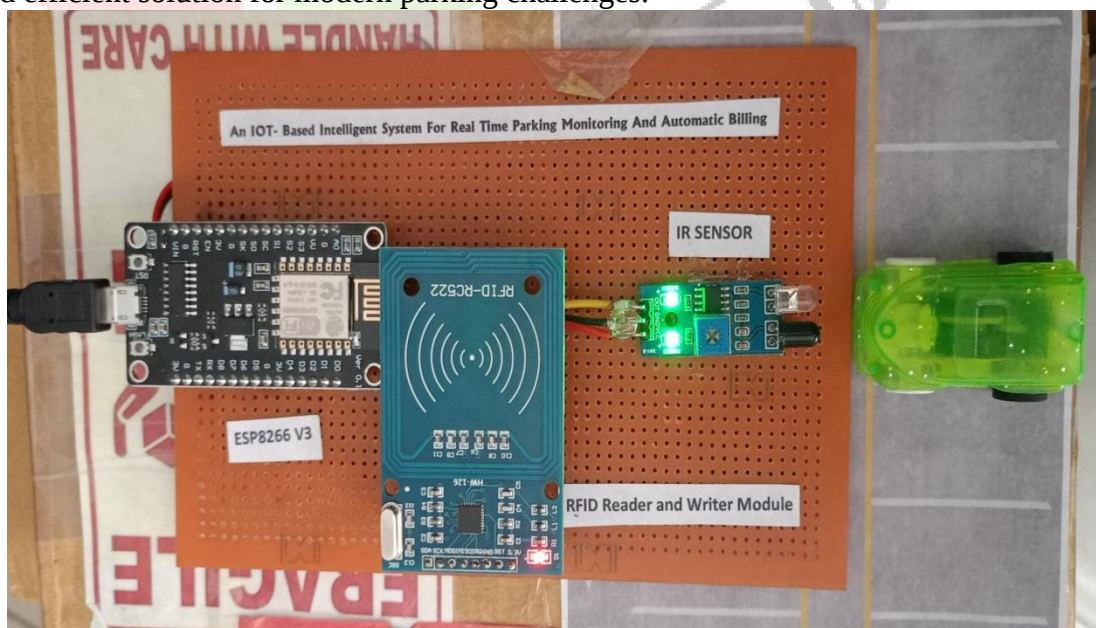


Fig 4: Structure of IoT Sensors

Smart Parking System						
Time	Action	Name	Vehicle No	Phone	Park_Status	Charge
00:05:13	IN	G.TEJA	AP07TJ2223	9492739335	Parked	₹0
00:05:01	OUT	A.JOTHI	AP06TJ2123	9959149669	Unparked	₹4
00:00:10	IN	A.JOTHI	AP06TJ2123	9959149669	Parked	₹0

Fig 5: User Data



Fig 6: Payment

CONCLUSION:

The IoT-based intelligent parking system effectively automates the process of parking space monitoring and billing, addressing the limitations of traditional parking management methods. By integrating RFID authentication, real-time sensors, and cloud-based data processing, the system ensures accurate tracking of vehicle entry and exit while providing secure and efficient parking operations. The real-time monitoring feature reduces congestion, improves space utilization, and enhances user convenience by allowing remote access to parking availability information. Automated billing eliminates errors associated with manual fee calculations, ensuring transparency and accuracy in financial transactions. The system's low power consumption and wireless communication capabilities make it a cost-effective and scalable solution for modern urban parking facilities. The implementation of IoT and cloud technologies enables seamless data transmission and remote management, improving operational efficiency. By incorporating additional advancements such as AI-based vehicle detection, GPS integration, and blockchain-secured transactions, the system can be further optimized for future applications in smart city infrastructure.

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