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RFID BASED SMART PARKING USING IOT

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ABSTRACT

In the current decade, we are facing a parking problem with the advancement in technology. The dense population in urban cities has led to a surge in vehicles on the roads, causing parking and traffic issues. The world is tackling the new challenge of vehicle parking management. It is observed that one million vehicles consume oil daily. This paper proposes an automatic real-time system for automated vehicle parking, implemented with the help of the Internet of Things (IoT). IoT facilitates the exchange of information or data between two physical devices.

The proposed system uses a NodeMCU microcontroller to provide a platform for communication between digital devices and interactive objects that can sense and control physical devices. The NodeMCU is utilized to connect the parking area with the web server, enabling seamless data exchange. The system incorporates infrared sensors in each parking slot to detect the vacancy status of the slots.

INTRODUCTION

The rapid increase in urban population and the growing number of vehicles on the road have made efficient parking management a crucial challenge in cities worldwide. Traditional parking systems, which rely on manual processes and limited automation, often lead to inefficiencies such as long search times for parking spaces, increased traffic congestion, and underutilization of available parking spots. These issues are further exacerbated by the lack of real-time data and automated systems to monitor and manage parking resources.

In response to these challenges, RFID-based smart parking systems integrated with the Internet of Things (IoT) have emerged as a promising solution. RFID (Radio Frequency Identification) technology allows for the wireless identification and tracking of objects using electromagnetic fields, while IoT connects a variety of devices and sensors over the internet, enabling real-time data exchange and management.

An RFID-based smart parking system consists of RFID tags placed on vehicles or parking spots, and RFID readers positioned at entry/exit points or within the parking area. These readers communicate with a central IoT platform, which continuously monitors parking space availability, tracks vehicle movements, and provides valuable insights for efficient parking management. By automating the process of identifying and tracking vehicles, this system enhances convenience, reduces the time spent searching for parking, and optimizes the use of available spaces.

The integration of RFID with IoT enables features such as real-time space occupancy monitoring, automated access control, dynamic pricing, and data-driven analytics. These innovations not only improve the overall parking experience for users but also contribute to better traffic flow, reduced carbon emissions, and more efficient city planning.

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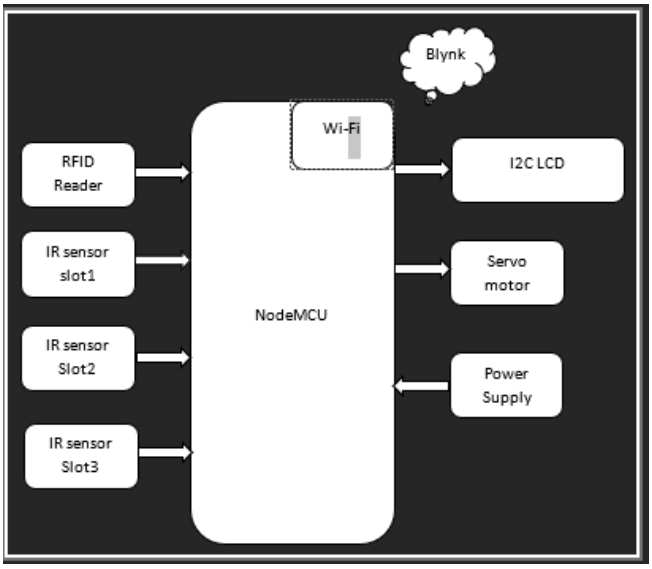

Figure.1 Block Diagram

LITERATURE SURVEY

- Inductive Loop Detection Systems (2014): These systems used buried wire loops to detect the presence of a vehicle by changes in the magnetic field. They were common in the late 20th century for counting cars and sometimes indicating occupancy in parking lots. Information was often displayed on simple LED signs.
- Ultrasonic Parking Guidance (2016): These systems used ultrasonic sensors to measure the distance to a vehicle in a parking space. They were more precise than loop detectors for individual space monitoring. Early versions often used simple light indicators (green/red) at each space.
- Ticket-Based Parking Systems (2016): These classic systems dispensed a time-stamped ticket upon entry to a parking facility. Payment was made at exit, often manually with a cashier. Early systems were electromechanical, later becoming computerized.
- Magnetic Card Parking System(2017): These systems replaced paper tickets with magnetic stripe cards. They offered improved data collection and automation of payment. They were a step towards more sophisticated access control.
- Automated Parking Garages (Early Versions): These were attempts to maximize space utilization using mechanical systems to move cars to storage locations. Early versions were complex and prone to malfunctions. Control systems were often relay-based.

PROPOSED SYSTEM

The proposed RFID-Based Smart Parking System with IoT is designed to automate vehicle identification, authentication, and parking space allocation. Each authorized vehicle is equipped with an RFID tag, which is detected by an RFID reader at the entrance. The system verifies the vehicle against a database and, if authorized, assigns an available parking space based on data from ultrasonic or infrared sensors. The system guides the driver to the assigned spot using LED displays or a mobile app, while an automated gate mechanism, controlled by a servo motor, ensures seamless entry and exit.

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The system integrates IoT capabilities using a Wi-Fi module (ESP8266/NodeMCU) to transmit real-time parking status updates to a cloud server. Users can access parking availability, make reservations, and complete payments via a web or mobile application. Additionally, parking administrators can monitor system performance, manage vehicle access, and generate reports for operational insights. The firmware manages RFID authentication, slot allocation, gate control, and communication with the IoT cloud platform, ensuring an efficient and secure parking management solution.

This smart parking system enhances efficiency, security, and convenience by reducing search times, preventing unauthorized parking, and enabling automated billing. The IoT-based monitoring allows remote access to parking data, optimizing space utilization and minimizing traffic congestion. Security features such as encrypted RFID authentication and controlled access to the cloud platform ensure data privacy and system integrity, making the solution reliable for urban, commercial, and residential parking spaces.

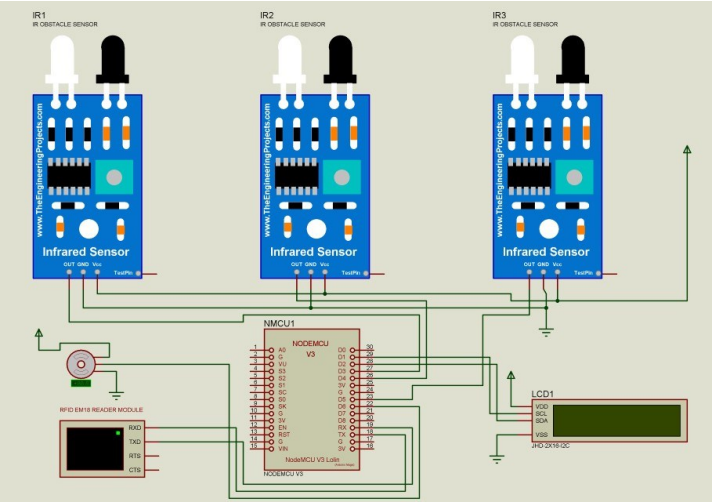

Figure.2 Schematic Diagram

Figure.3 Flow chart

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RESULTS

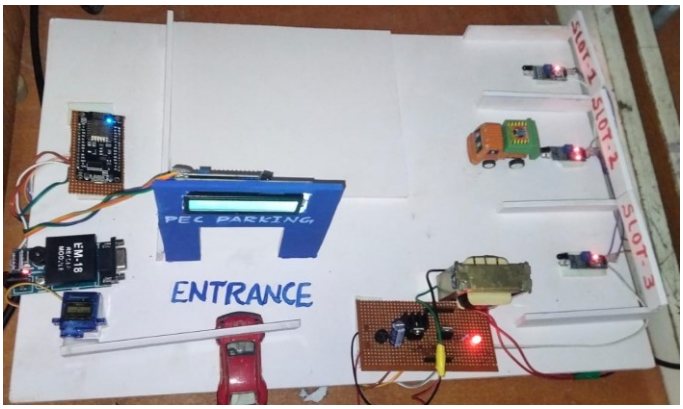

Figure.4 Entering the vehicle

The implemented RFID-based smart parking system demonstrated successful functionality across key areas. RFID tag authentication proved reliable, with the system accurately distinguishing between authorized and unauthorized tags, subsequently triggering the gate mechanism accordingly. The gate responded promptly, opening for valid tags and remaining secured for invalid ones, effectively controlling access to the parking facility. The LCD display provided clear, real-time updates on parking slot availability, dynamically reflecting changes as vehicles entered and exited. This immediate feedback on available spaces streamlined the parking process for users. Furthermore, the automated gate control, directly linked to the RFID authentication, functioned seamlessly, contributing to a smooth and efficient entry and exit experience.

Figure.5 Authorized Tag

In terms of IoT integration, the system successfully transmitted parking occupancy data to the designated platform, enabling remote monitoring capabilities. This data transfer allowed for real-time oversight of parking facility usage and laid the groundwork for potential data analysis to optimize parking management strategies. However, some challenges were encountered, including occasional delays in RFID tag reading and minor discrepancies in

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sensor readings for slot occupancy. These issues were addressed through adjustments in reader sensitivity and sensor calibration, respectively. Future work will focus on refining the system's reliability, potentially incorporating more robust sensors and exploring advanced data analytics to further enhance parking management efficiency. Overall, the implemented system achieved its core objectives, demonstrating the potential for significant improvements in parking efficiency and user experience through automation and IoT integration.

Figure.6 Parking full

Figure.7 Slots indication in Blynk

Figure.8 Slot status on LCD

ADVANTAGES

- **Automated Vehicle Identification –** Reduces human intervention by automatically detecting and authenticating vehicles using RFID technology.
- **Real-Time Parking Availability –** IoT integration provides live updates on available parking spaces, reducing search time.
- **Optimized Space Utilization –** Efficient slot allocation ensures maximum use of available parking areas.

- **Reduced Traffic Congestion –** Faster parking reduces vehicle movement within the parking area, minimizing congestion.
- **Enhanced Security –** Prevents unauthorized access through RFID-based authentication and encrypted data communication.
- **Seamless User Experience –** Mobile app integration allows users to check availability, reserve spots, and make payments remotely.
- **Automated Entry & Exit –** Servo-controlled gates improve access control, reducing delays and manual operation.

CONCLUSION

In conclusion, this project successfully developed a functional prototype of an RFID-based smart parking system. The system effectively demonstrated the core functionalities of automated vehicle access control through RFID authentication, real-time parking slot availability display, and IoT integration for remote monitoring. While some minor challenges were encountered and addressed during implementation, the system achieved its primary objectives. The results indicate the potential for significant improvements in parking efficiency, user experience, and overall parking management through such automated solutions. Future enhancements, including mobile app integration, advanced sensor technologies, and sophisticated data analytics, could further optimize the system and pave the way for wider deployment in real-world parking facilities. This project serves as a valuable proof-of-concept, highlighting the viability and benefits of smart parking systems in addressing the growing challenges of parking management in urban environments.

FUTURE SCOPE

The future scope of this RFID-based smart parking system holds considerable potential for expansion and enhancement. Beyond the current prototype, a key area of development lies in integrating a user-friendly mobile application. This app could provide real-time parking availability information, allow for advance reservations, and facilitate seamless payment processing. Further improvements could involve the incorporation of more sophisticated sensor technologies, such as ultrasonic or infrared sensors for precise vehicle detection, and potentially integrating these with a navigation system to guide users directly to available slots within the facility. From a management perspective, the system could be expanded to include data analytics capabilities, enabling the collection and analysis of parking usage patterns to optimize pricing strategies, predict peak hours, and improve overall resource allocation. Security enhancements, like multi-factor authentication and encryption protocols, could further protect user data and prevent unauthorized access. Finally, exploring integration with existing city infrastructure or smart city platforms could open up possibilities for larger-scale deployment and contribute to a more comprehensive urban mobility ecosystem.

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