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Smart Parking System with RFID Technology

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ABSTRACT

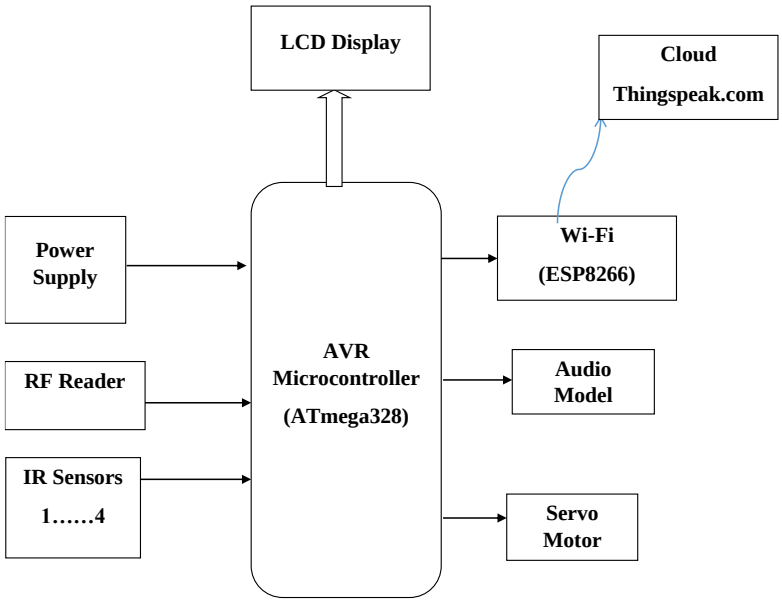
With the rapid-fire- fire- fire growth of collaborative populations and vehicle power, effective parking operation has become a critical challenge in ultramodern megalopolises. This paper presents a new Smart Parking System integrated with Radio Frequency Identification(RFID) technology to streamline vehicle identification and automate parking operations. The proposed system employs RFID markers embedded in vehicles and RFID compendiums at entry and exit points to enable real-time vehicle shadowing, access control, and automated billing. Unlike traditional parking systems, this result minimizes mortal intervention, reduces business, and enhances stoner convenience. A centralized database manages parking niche vacancy and stoner credentials, while a mobile-friendly interface allows addicts to reserve places every day. The integration of RFID ensures secure access while maintaining accurate logs for responsibility and analytics. This approach demonstrates a scalable, low- conservation, and cost-effective system to optimize parking structures in both public and private surroundings.

INTRODUCTION

Traditional parking systems, which often rely on human attendants at entry points, frequently lead to traffic congestion, delays, and inefficiencies. Additionally, the use of disposable paper tickets contributes to environmental pollution and creates potential safety hazards around parking facilities. To address these issues, RFID and Internet of Things (IoT)-enabled automated parking solutions have emerged as effective alternatives. These systems operate using a rechargeable RFID card assigned to each vehicle. Upon arrival, the card is scanned by an RFID reader at the entrance. The system's microcontroller processes the card's data to verify its authenticity and check the available balance. If the card is found to be invalid or insufficiently funded, an alert is triggered and the entry gate remains closed, preventing unauthorized access. Conversely, if the card is valid, the system authorizes entry by opening the gate and notifying the driver, while simultaneously logging the transaction. This approach not only improves traffic flow and reduces human error but also contributes to cleaner and more secure parking environments.

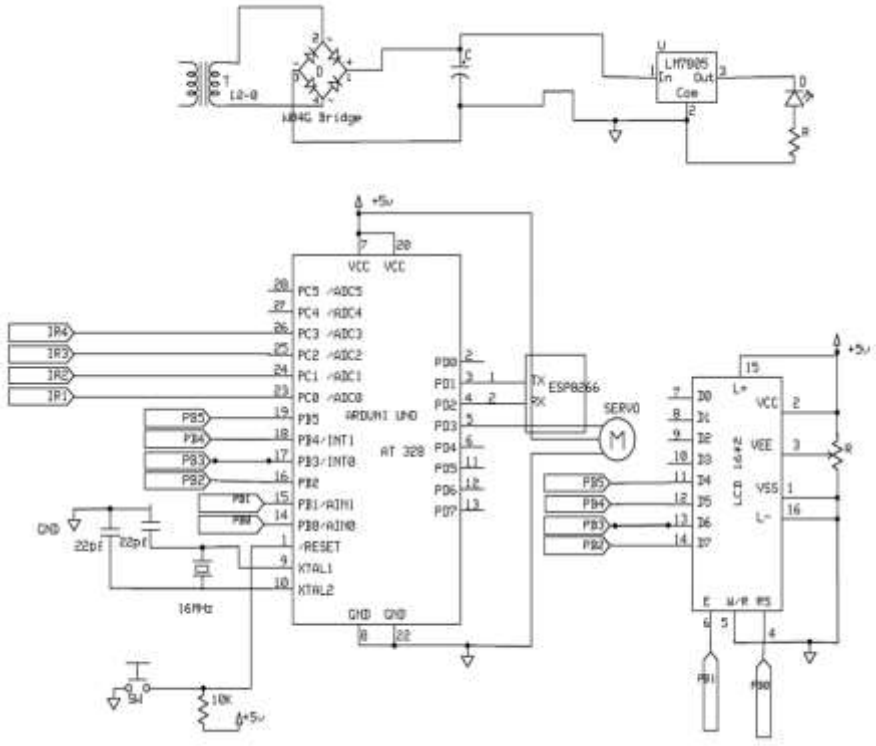
PROPOSED SYSTEM

The core of the proposed smart parking system is the ESP12 Node MCU microcontroller, which serves as the central processing unit. It works in conjunction with an RFID reader and RFID tags that are uniquely assigned to each vehicle. These tags store essential information, including the vehicle's registration number, the owner's name, and contact details, particularly useful for managing user accounts and resolving issues. The system also features a display module connected via the I2C communication protocol, along with an additional LCD screen that provides real-time system feedback to users. As a vehicle approaches the entrance or exit point, the RFID reader scans the tag and relays the data to the microcontroller for validation. Based on this input, the system updates the status of the parking session. The LCD screens actively display the number of available and occupied parking spots, offering drivers immediate insight into the parking lot's condition. Furthermore, with built-in Wi-Fi capabilities, the NodeMCU continuously uploads parking data to an associated web portal, ensuring that real-time information is accessible remotely for both users and administrators.



Block Diagram: SMART PARKING SYSTEM WITH RFID TECHNOLOGY

Each authorized user is issued an RFID tag linked to their vehicle, which stores key details such as the vehicle ID, owner's name, contact information, and current account balance. As a vehicle approaches the entry or exit point, an RFID reader scans the tag, capturing the stored data. An LCD provides real-time messages and instructions to the driver. The system is powered by an ESP12 Node MCU microcontroller, which features integrated Wi-Fi capabilities to enable live data updates to a connected website. Additionally, the LCDs he current count of available parking slots. The hardware configuration is centered around the Node MCU development board, which communicates with connected components through the I2C (Inter-Integrated Circuit) protocol. The setup allows the microcontroller to operate in both master and slave modes via I2C, ensuring flexible communication with peripheral devices. The I2C bus runs with a standard clock frequency of 100 kHz. Key hardware components include the LCD, a servomotor for gate control, infrared sensors for vehicle detection, and an RFID scanner. The software is programmed to verify I2C communication and ensure all modules interact seamlessly for efficient system performance.

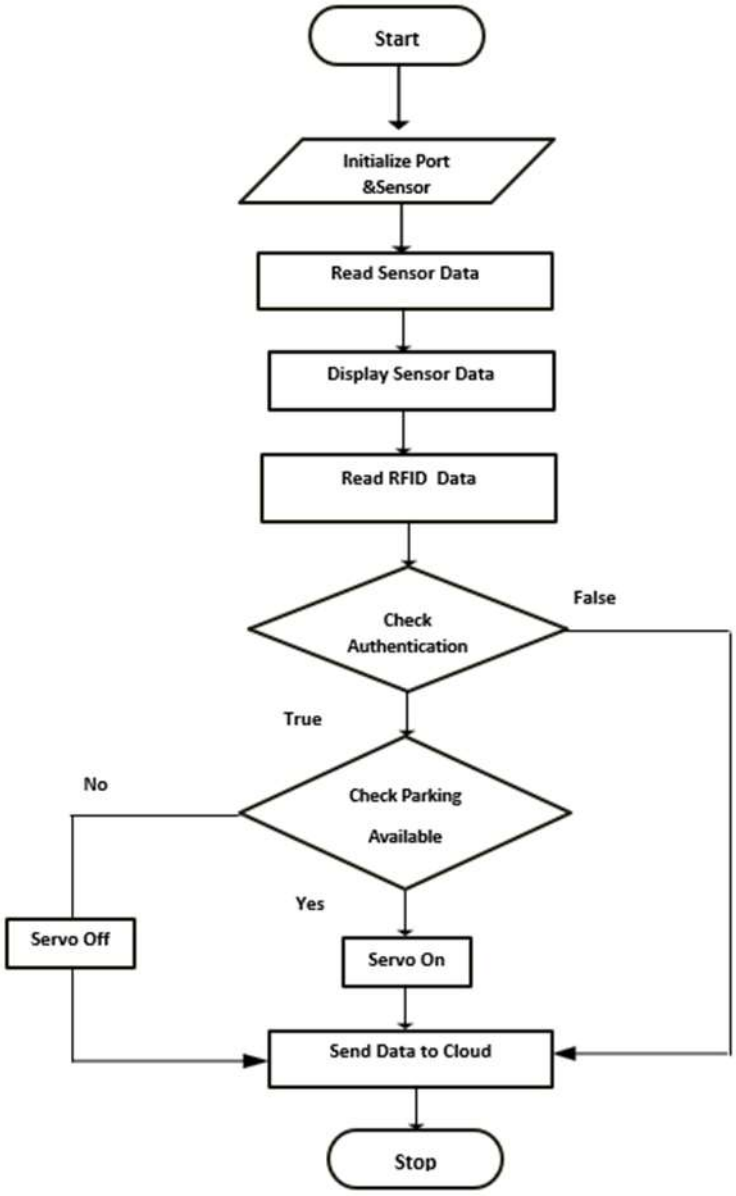


Circuit Diagram: SMART PARKING SYSTEM WITH RFID TECHNOLOGY

Flow Chart for Vehicle Allocation

The system utilizes an Arduino Uno board, which comes with a set of 14 digital I/O ports and 6 channels for analog input. All sensor interactions and device management are executed through custom code developed within the Arduino Integrated Development Environment (IDE).

A logical sequence governs the parking assignment operation. When a vehicle arrives, the system first determines whether parking slots are still available. If a free slot exists, the vehicle's RFID tag is read to extract its identification data. Once validated, a parking space is assigned, the central database hosted on a server is immediately updated, and the count of remaining spaces is decreased accordingly.



Flow Chart: SMART PARKING SYSTEM WITH RFID TECHNOLOGY

CONCLUSION

Modern smart cities are exploring the implementation of a one-day parking solution designed to efficiently regulate vehicle movement and reduce congestion. Although the concepts of IoT and cloud computing have been evolving for years, they continue to reach new levels of innovation. A prime example is this intelligent parking system, which leverages a unified IoT and cloud infrastructure to tackle parking challenges. A standout feature of the accompanying web platform is its ability to display real-time parking slot status, reflecting user reservations made through the system. Overall, this approach offers tangible benefits and enhances the experience for end users.

FUTURE SCOPE

The future holds significant potential for the advancement of IoT-driven smart vehicle parking systems utilizing RFID technology. As these systems become more deeply integrated into smart city frameworks, they can offer dynamic updates, improve parking efficiency, and help streamline traffic management. One promising development is predictive parking, where machine learning and advanced analytics anticipate space availability, guiding drivers more efficiently and helping reduce both search time and vehicle emissions. With growing emphasis on environmental sustainability, such systems could operate using renewable energy sources and incorporate energy-efficient, low-emission sensors. Furthermore, user data security is expected to be reinforced through advanced measures like end-to-end encryption and the incorporation of blockchain technology, ensuring both privacy and trust in the system.

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