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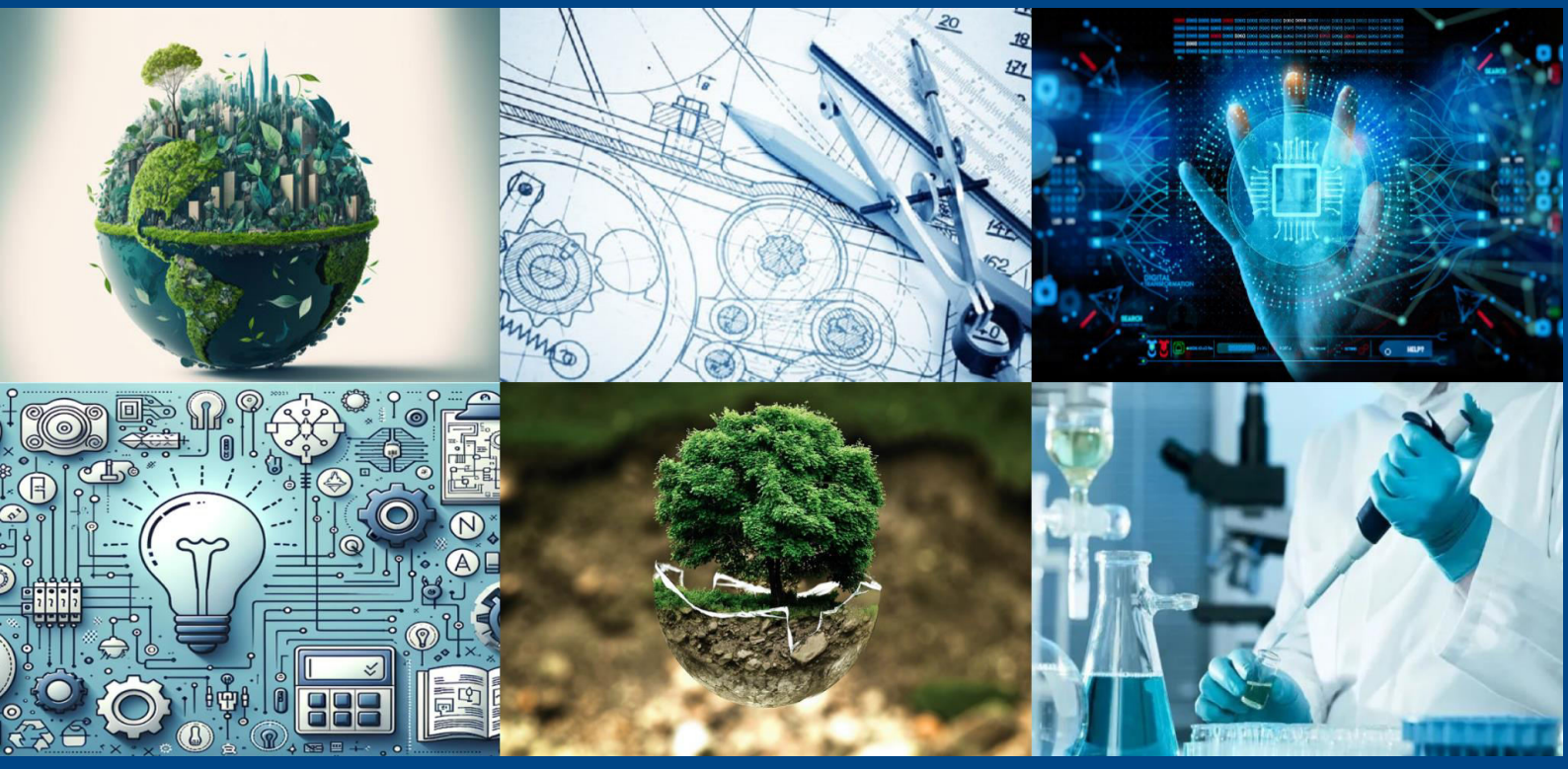

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Smart Parking System IoT Based using RFID

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ABSTRACT: Parking congestion is a growing challenge in urban areas, leading to inefficiencies, fuel wastage, and frustration among drivers. This project aims to develop a Smart Parking System using IoT to enhance parking management and ease the process for users. The system will enable organizations that provide parking spaces to display real-time availability to users through an online platform. The system utilizes Arduino NodeMCU as the primary development board, interfacing with sensors to detect available parking slots. The collected data will be transmitted to a cloud-based server, allowing users to access parking availability through a web or mobile application. Furthermore, will analyse the behaviour of regular customers and optimize space allocation dynamically, improving efficiency for frequent users. Additionally, an SMS notification system will inform users about parking slot availability and reservations, enhancing user experience. Key components of this system include: - IoT-enabled sensors to monitor parking slot occupancy in real-time. - Arduino NodeMCU and C programming for hardware integration and system control. - Cloud-based data storage and web/mobile interface for seamless user access. - SMS notification system for real-time alerts and booking confirmations. This smart parking system aims to reduce congestion, optimize space utilization, and provide a hassle-free parking experience, making urban mobility more efficient and convenient

I. INTRODUCTION

The Internet of things (IOTs) is a vital technology, it is playing a crucial role in the day-to-day life of human beings. With the help of this technology, now day's humans are getting effective output with very little effort. It reduces the man-made errors made by humans due to negligence. As technology advances, smartphones are an inevitability for every human being. The proposed parking system effectively manages the parking space and it will manage collision among the vehicles at the same time. IoT-based smart parking organized the parking lot very efficiently. It helps the user to find a free space in the parking slot within no time. It ultimately leads to saving time and fuel for the users. For the development of an innovative parking system, Wireless Sensor Network (WSN) represent two of the most capable IoT technologies i.e. Ultra-High Frequency (UHF), Radio Frequency Identification (RFID), etc. Due to low-cost, low-power technology RFID is used. RFIDs are used to transmit data when powered by the electromagnetic field generated by a reader mainly involving passive devices, named tags. In this technique, the customers were also guided to an unfilled parking space using video displays entrance of the parking structure. With empty and occupied slots, these displays show a visual representation of the parking lot, which are green and red respectively. The customer has furnished with such a tag that he gets because once he registers, this tag has been connected with his prepaid account as well as contains confidential information, and this tag uses an RFID system and has been mounted on the surface of the windshield of the customer. A parking fee has been instantly deducted from the user's account based on the period consumed inside the parking area. RFID has been used to register every other customer for once, as well as an RFID tag has been attached to his vehicle instead of repetitively creating a token. There is no wait time in the RFID system, which would be distinctive to him (as if Aadhar number). These same consumers transfer via the entrance easily and park everyone vehicles. When a vehicle has been opted to stay, the IR sensor releases the database and moves via the entrance door to see a big display with stay living parking spaces.

II. LITERATURE REVIEW

Smart parking systems aim to reduce traffic congestion, optimize space utilization, and provide real-time parking information to users. Recent advancements in the Internet of Things (IoT), embedded systems, and cloud technologies have contributed significantly to the development of intelligent parking solutions.

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In [1], the authors proposed a smart parking framework using RFID and IR sensors to monitor vehicle entry and exit. RFID was employed for user authentication while IR sensors were used to detect vehicle presence in each slot. This system minimized manual monitoring and improved parking efficiency.

The work in [2] implemented a NodeMCU-based smart parking prototype that provided real-time data via a web interface. The system used ultrasonic sensors to detect vehicle presence and NodeMCU to transmit data to a Firebase cloud database. It successfully demonstrated the integration of hardware with cloud services to provide a real-time parking solution.A cloud-integrated parking model using MQTT protocol was described in [3]. The system enabled centralized control of multiple parking units and allowed users to check slot availability through a mobile app. Data latency and scalability were also addressed using optimized cloud architecture.

In [4], a smart parking solution was developed using Arduino, IR sensors, and GSM module for SMS-based notifications. Though effective in terms of functionality, it lacked real-time web or app-based interfaces, highlighting the limitations of SMS-based alerts in modern use cases.

Furthermore, [5] presented a low-cost smart parking system using NodeMCU and Blynk app. The system demonstrated efficient real-time slot monitoring, data visualization through mobile application, and user-friendly features. It also emphasized energy efficiency by incorporating sleep modes and sensor calibration techniques.

The reviewed literature highlights various methodologies ranging from RFID authentication, cloud-based monitoring, GSM alerts, and app-based slot visualization. These studies laid the groundwork for the development of the proposed system, which integrates RFID-based vehicle identification, IR-based slot monitoring, NodeMCU-based IoT communication, and a PHP/MySQL-based real-time web dashboard for slot availability tracking and user notifications.

III. SYSTEM ANALSIS

The proposed system uses ESP12 Node MCU, RFID Vehicle reader, RFID tags/Vehicle, I2C module, and an LCD. ESP12 Node MCU board is acting as a brain for the proposed system. The RFID vehicle consists of various details of the users such as vehicle number of users, name of the owner of the vehicle, registered contact number of the owner of the vehicle, and the balanced amount of the owner. The card reader system extracts the details stored in the card as the Vehicle enters and exits. The LCD will display the output of the proposed model. ESP12 Node MCU has an inbuilt IOT module that can use the internet to interface with the website. IOT module used to tell continuous real-time that is to reflect on to the website. The number of free slots and the occupied slot will be displayed by the LCD.

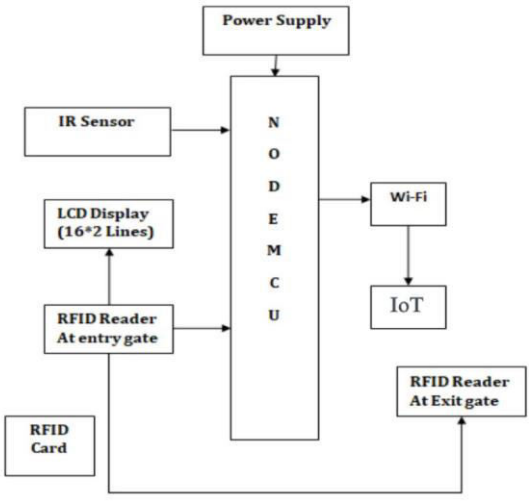

Figure.1: Block Diagram of IOT based smart Vehicle parking system-using RFID

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The RFID vehicle is given to each registered user, which stores various details such as Vehicle number; the vehicle belongs to, the registered contact number to communicate, and the amount available in the vehicle. The card reader system extracts the details stored in the vehicle as to the vehicle enters and exits. The LCD will display messages to the vehicle owner. ESP12 Node MCU has an inbuilt IOT module that can use the internet to interface with the website. IOT module is used to tell continuous real-time that are to be reflected on to the website. The LCD is used to display the number of available slots. Circuit diagram involves Node MCU development board. I2C Pins are used to hooking up all sorts of I2C sensors and peripherals. It supports Both I2C Master and I2C Slave. The functionality check of I2C interface will be done with the help of a program. The frequency generated by the clock signal is 100 kHz. It also involves LCD, DC motor, IR sensors, and RFID.

A. HARDWARE DESCRIPTION

NODE MCU MICROCONTROLLER

The NodeMCU (Node Microcontroller Unit) is a low-cost open-source IoT platform based on the ESP8266 Wi-Fi module. It plays a central role in the Smart Parking System by acting as the brain of the project—controlling sensors, processing data, and sending information to the cloud.

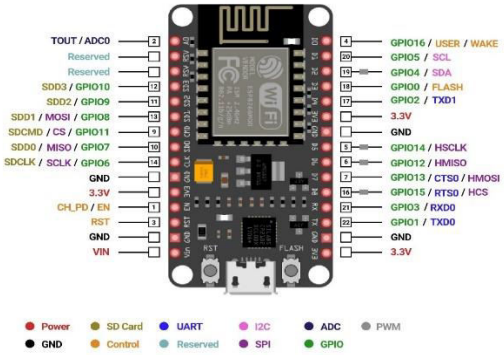

Figure.2: Node MCU Microcontroller

IR SENSOR

Infrared (IR) sensors are key components in smart parking systems for detecting vehicle presence in each parking slot. These sensors use infrared light to identify whether a slot is occupied or vacant, making them an affordable and effective solution for real-time parking management.

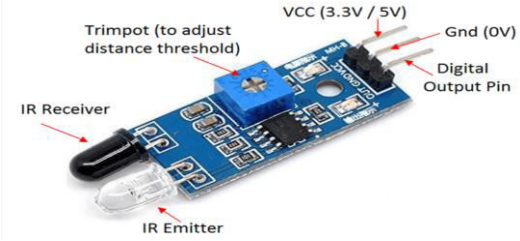

Figure.3:IR Sensor

RFID Module

RFID (Radio Frequency Identification) technology is widely used in modern smart systems for automatic identification and tracking. In a smart parking system, an RFID module can be implemented to identify vehicles, authorize entry, and automatically log usage, providing an extra layer of automation and security.

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Figure.4: RFID Module

LCD MODULE

It includes alphabets and numeric which is used to display almost 32 characters. Fig.5: LCD Display

Figure.5: LCD Module

B. WORKING FLOW CHART

The microcontroller Arduino Uno is having 14 digital input/output pins along with 6 analog pins. The communication and interfacing with the sensors are done with the help of Arduino IDE. The flow chart shows an overall working of vehicle allocation. For allocation of vehicles, check availability slot. If available then scan the RFID. After scanning the slot, allocate and update the server from the total slot will decrease by one.

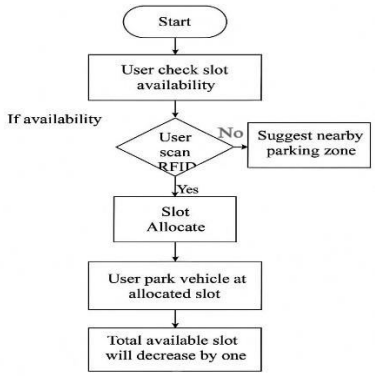

Figure.6:Flow chart

IV. RESULTS AND DISCUSSIONS

The performance and practicality of the IoT-based Smart Parking System were evaluated through prototype testing in a simulated environment. This section discusses the outcomes related to hardware responsiveness, data transmission, cloud integration, user interface effectiveness, and real-time feedback under various conditions.

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Figure 4.1: Connecting To Google

Step 1: Connecting to google

In the first step, the user is connecting to a microcontroller (likely NodeMCU or Arduino). The screen displays the message "Connecting to Google", indicating that the device is attempting to establish an internet connection, likely via Wi-Fi, to access Google's server or perform a cloud-based function such as database synchronization.

Figure4.2: Waiting for Cars

Step 2: Waiting for cars

The module connected to a microcontroller-based smart parking system. The message "WAITING FOR CARS" indicates that the system is actively monitoring for incoming vehicles. It likely uses IR or ultrasonic sensors to detect a car's presence and update the availability status once a vehicle enters the parking area. This is part of the system's real-time slot detection feature.

Figure 4.3: The output on display when vehicle check-in

Step 4: The output on display when vehicle check-in

A smart parking system confirming successful user authentication. The display reads:

- CID: TN-01 2345
- AUTH OK :)

Explanation:

- CID (Car ID): TN-01 2345 refers to the vehicle number, likely read via an RFID tag or license plate recognition.

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- AUTH OK :) indicates that the system has verified the vehicle's credentials and granted access to proceed—possibly to allocate a parking slot or open a gate.

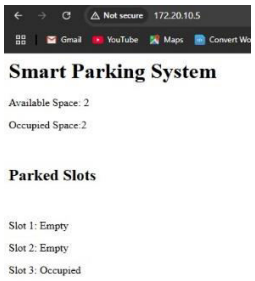

Figure 4.4 Web Server

This image shows a web-based user interface of a Smart Parking System, most likely hosted on a local IP address (172.20.10.5). This section provides **real-time status of individual parking slots**, helping users or the admin visually identify which slots are occupied or free.

Purpose of This Interface:

- Provides live monitoring of parking space usage.
- Likely connected to IR sensors or NodeMCU which detect car presence.
- Accessible over a local network via the IP address shown.

V. CONCLUSION

The proposed Smart Parking System successfully automates the process of vehicle detection, slot allocation, and real-time monitoring through the integration of IoT technologies. By using RFID for vehicle identification and IR sensors for slot detection, the system ensures efficient tracking of available parking spaces. The data is seamlessly logged and displayed using LCD screens and stored in the cloud for administrative access and analysis.

The project not only reduces manual intervention but also minimizes time spent searching for parking, improving the overall parking experience. The accurate tracking and real-time data updates support optimized parking space management and can be scaled for larger facilities such as malls, offices, or public parking zones.

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