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IoT Based Smart Car Parking System

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Abstract: The numbers of vehicles increasing in urban places, there have been major issues with parking management such as traffic jam, too much time spent waiting, unnecessary fuel consumption, and poor utilization of parking space. In this research, an IoT Based Smart Car Parking System has been design which can facilate real-time parking management system in an efficient manner through embedded systems and IoT technology. This system has been implemented using two ESP32 modules which serve as the central processing and communication units for parking activities. There are six parking spaces which contain IR sensor to monitor and manage the entry and exit of vehicles. Additionally, two servo motors have been used to automate the functioning of entry and exit gates. There are also one LCDs which display real-time information about the availability of parking spaces and other notifications by the system. Further, keypad modules are utilized for OTP-based vehicle entry/exit management system. The smart parking system is linked with a mobile application via wireless IoT technology allowing one to monitor parking availability, make reservations for parking spaces, and obtain One-Time Passwords (OTPs). The OTP authentication technique allows increasing security and eliminating any possibility of unauthorized access, while the automated gate control system allows minimizing human errors. ESP32 devices ensure the interaction between the system and the mobile application and help manage parking efficiently. It can be stated that there are many benefits associated with such a system which include more efficient parking space utilization, minimization of traffic, improvement in user experience, greater parking security, and real-time monitoring among others. In addition, the system described above is cost-efficient, scalable, and suitable for use in smart cities, shopping centers, hospitals, airports, universities, etc. This research proves that IoT, automation technologies, and embedded systems are effectively used in intelligent transport management.

Keyword: *"The IoT-Based Smart Parking System Allows for Automation, Security, and Real-Time Parking Through the use of Sensors, ESP32 Microcontrollers, Wireless Connectivity, and Mobile Application Interfaces."*

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I. INTRODUCTION

Increasing of vehicles in the world is most serious problems faced by many growing cities because of the increasing number of cars. Drivers often take up a lot of time looking for available parking slots, resulting in traffic congestion, wasted fuel, environmental pollution, and inconveniences. Traditional parking systems are usually manually operated and cannot monitor the situation in real-time, thus not being efficient enough for today's smart city environment. However, modern technologies like the Internet of Things, embedded systems, and wireless communications enable building smarter parking facilities that can help improve the process of parking. The use of the Internet of Things technology implies connecting devices and sensors that will be able to communicate with each other and provide data in real-time mode. The significance of smart parking facilities in intelligent transportation systems is based on the reduction of human intervention in the process and better management of parking resources.

IoT-Based Smart Car Parking System is an intelligent parking management system that will make use of IoT technology and ESP32 microcontrollers for managing parking lots. It makes use of the infrared sensors placed in different parking spots in order to check whether a parking spot is occupied or not. Servo motors are used for automatic gate operation, while LCD displays help in providing real-time data about the car parking lots. For increasing the level of security in the system, one-time password (OTP) based authentication is considered using keypad modules. In addition to this, users can book their slots in the car parking lot using the smartphone app which utilizes wireless IoT technology. Once the booking process is completed successfully, a unique OTP is created which needs to be validated. By incorporating the above features like real-time monitoring, automatic gates, wireless connectivity, and mobile-based bookings, the proposed system is compatible with today's advanced parking facilities. This system ensures minimal delays in parking, maximizes the usage of parking space, and gives an easy-going experience for the users. Since

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the proposed system is highly scalable and affordable, it can be applied in parking structures of malls, hospitals, airports, schools, universities, corporate offices, and smart cities. In conclusion, this study highlights the actual application of IoT in parking management and shows how smart parking systems can help in efficient urban traffic management and smart infrastructure construction.

II. LITERATURE REVIEW

Modern literature concerning IoT-enabled smart parking systems has mainly concentrated on the concept of real-time monitoring and detection of parked vehicles with wireless communication methods. Scientists have designed smart parking solutions that utilize embedded control devices, infrared sensors, and cloud computing applications for intelligent parking. The suggested design incorporates dual ESP32 controllers, one-time password authentication mechanism, automatic gate operation, and mobile app functionalities into the current designs.

Table 1 Modern Literature Concerning IoT-Enabled Smart Parking Systems

SL.NO	AUTHOR/YEAR	TITLE OF RESEARCH	TECHNOLOGY USED
1.	A. Khanna et al/ 2016	IoT Based Smart Parking system	IoT, sensors, displays
2.	k. Shaheen et al/ 2005	Smart parking benefits study	Intelligent Transportation System
3.	J. Rico et al/2013	IoT in smart parking Application	IoT, Embedded systems
4.	P. Sadhukhan et al/2017	Automated smart parking system	Arduino, Esp, IR Sensor

III. METHODOLOGY

The smart car parking system using the Internet of Things concept offers a convenient approach to handling modern parking requirements. With the help of ESP32 controllers, IR sensors, OTP authentication, and mobile application connectivity, security and monitoring of parking lots are made convenient.

- *System Design*

The smart parking system suggested here utilizes two ESP32 microcontrollers for carrying out the functions of monitoring and controlling parking activities. This system includes sensors, servo motors, LCDs, keypad and mobile application that will help in managing parking activities through automation.

- *Parking Slots Detection*

There are six IR sensors used in parking slots for detecting any parked vehicles. These sensors keep sending parking slot information to the ESP32 microcontrollers on a continuous basis.

- *Mobile Application*

A mobile application is interfaced with the system using wireless IoT connection. Users can find parking slots using the application, reserve slots, get OTPs from this application and also control Gate through mobile application.

- *OTP Authentication Process*

The keypad modules are employed in the OTP authentication process at the entrance and exit gates. The ESP32 microcontroller checks the OTP validity before permitting entry of the vehicles into the parking facility.

- *Automated Parking Gate Control System*

The two servo motors are employed in the automated control of the gate operation process. The automated gates function automatically once the OTP is verified.

- *Real-Time Monitoring System Display*

LCD monitors are utilized in the presentation of information concerning the vacant and occupied parking spots.

- *Wireless Data Transmission*

The two ESP32 controllers employ wireless communication between themselves and the mobile app interface for real-time data transmission.

- *System Testing*

The developed system is subjected to testing under varied parking scenarios to determine its efficiency and reliability. This includes tests to confirm the precision of the sensors, OTP authentication, and gate functionality.

- *Abbreviation Table*

Table 2 Abbreviation Table

Abbreviation	Full Form
IoT	Internet of things
ESP-32	Espressif 32-bit microcontroller
IR	Infrared
LCD	Liquid crystal display
OTP	One time password

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➢ *Circuit Diagram*

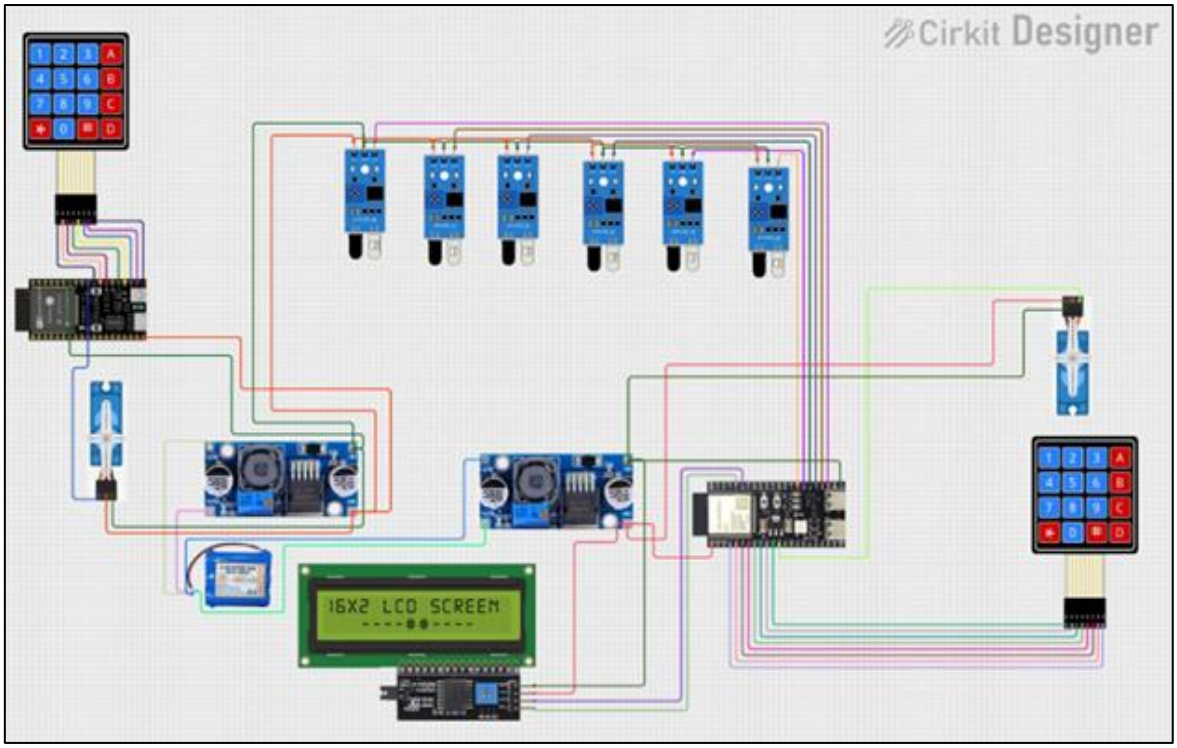

Fig 1 Circuit Diagram

➢ *Block Diagram*

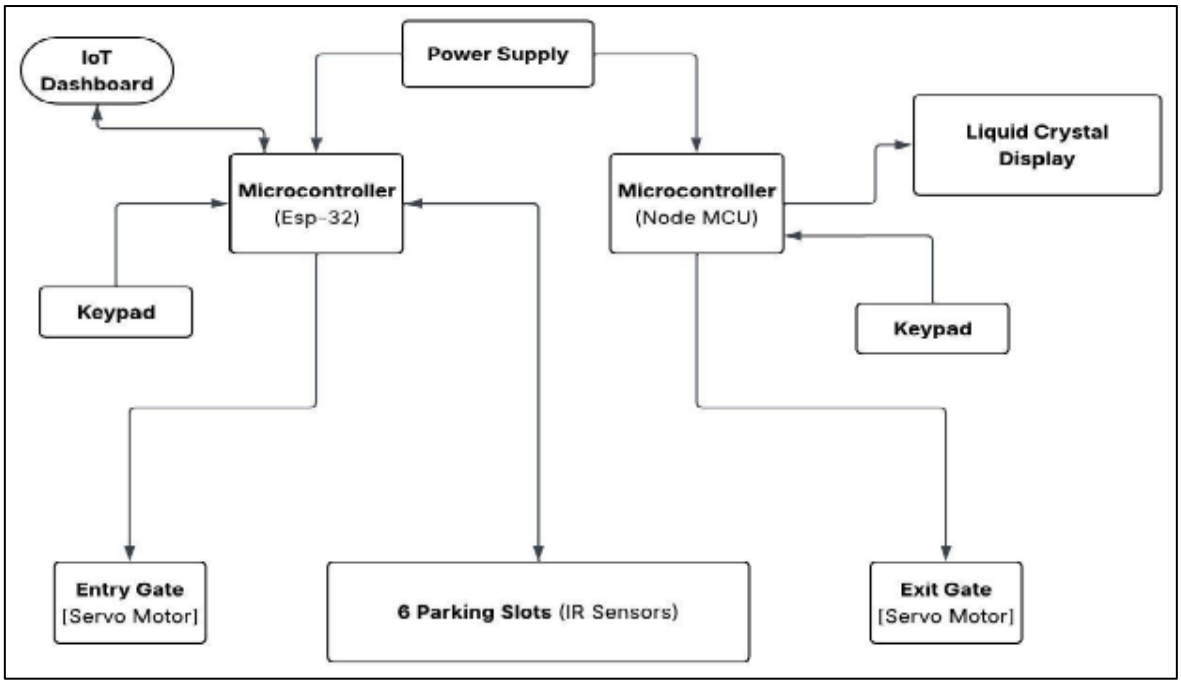

Fig 2 Block Diagram

IV. COMPONENTS DESCRIPTION

➢ *Esp-32*

The ESP-32 microcontroller serves as the main processing and communication unit for the proposed IoT-based smart car parking system. It processes data from IR sensors, controls the servo motor for gate automation, manages OTP verification through keypad modules, and updates parking information on the LCD displays. The ESP32 also offers wireless Wi-Fi connectivity for real-time communication between the parking hardware and the mobile app.

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➢ *Servo Motors*

The servo motors are incorporated in the suggested model for the automated opening and closing actions of the entry and exit gates. The servo motors will be actuated by the ESP32 microcontrollers according to the OTP authentication and presence of vehicles' signals.

➢ *IR-Sensor*

In the proposed system, the sensors that will be utilized include the infrared sensor. IR sensors detect whether there is any vehicle parked in a particular parking slot. Once the information has been detected by the IR sensors, the data is sent to the ESP32 microcontroller where the vehicle parking information can be monitored in real-time.

➢ *LCD Display*

There are two LCD displays that have been suggested for use within the system to convey real-time parking slot information and system updates to the user. Information displayed on the LCDs includes availability of parking slots, gate status, and other notifications regarding authentication process and occupied spaces.

➢ *Keypad Module*

This keypad module is used to authenticate users in the OTP-based system when entering and exiting the premises. This module allows users to enter the OTP that has been created. The ESP32 will then validate the OTP and grant access to the vehicle.

➢ *Buck Converter*

A buck converter will be implemented in the design for converting the input voltage into a regulated and lower output voltage according to the required operating voltage of the electronics. The power supply will be stabilized for the ESP32 microcontroller, sensors, LCD displays, and other hardware devices.

➢ *Flow Chart*

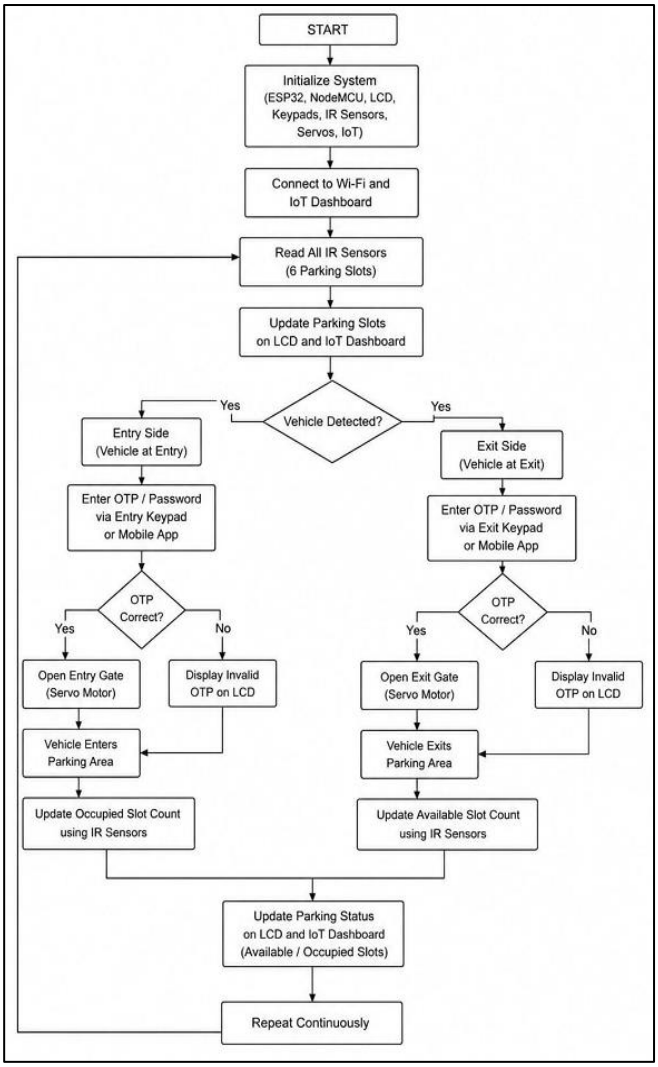

Fig 3 Flow Chart

➢ *Hardware Testing*

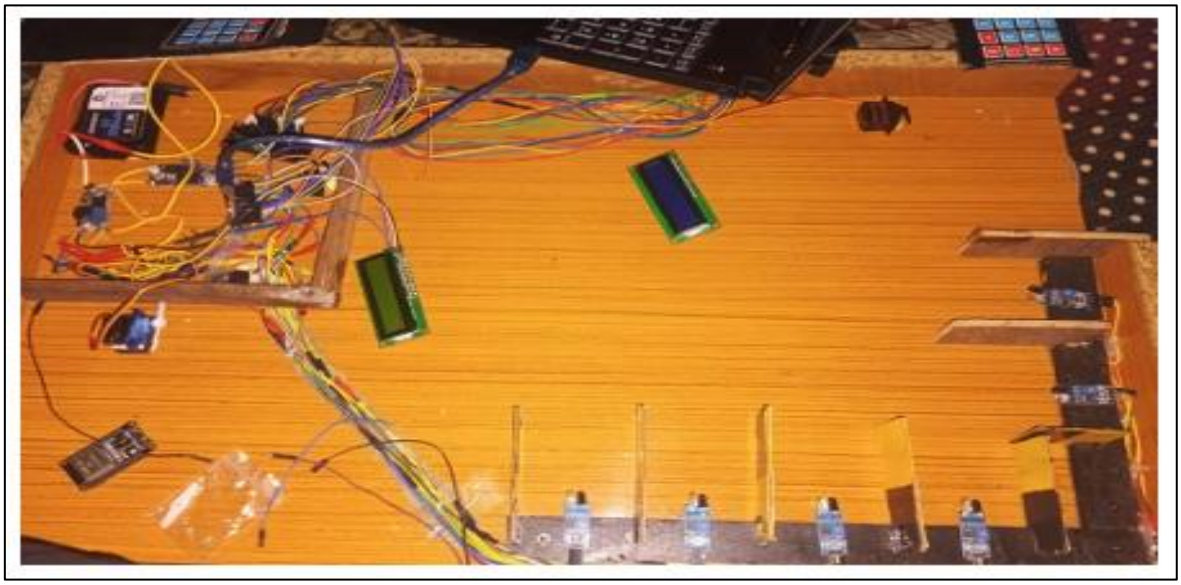

Fig 4 Hardware Testing

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V. RESULT AND DISCUSSION

The design and implementation of an IoT-Based Smart Car Parking Management System Using Espressif Systems ESP32 were successful. The infrared sensors performed accurately in detecting the presence of vehicles, whereas the servo motors worked efficiently in controlling the gates with respect to keypad and OTP authentication. The LCD screen and the mobile app played an integral role in providing information about the vacant slots.

The project exhibited quick responses, effective wireless transmission, and efficient car parking management. Although a few problems arose during the execution such as the fluctuating power supply of servos and instability of LCDs due to poor power supply, the above problems were addressed effectively through buck converters and common grounds.

VI. CONCLUSION AND FUTURE SCOPE

- *Conclusion*

The IoT-Based Smart Car Parking System offers an efficient and automated parking system utilizing ESP32, IR sensors, servo motor, LCD screen, and mobile app assistance. The system is capable of reducing traffic jams, saving time, improving parking management, and making parking more convenient for users.

- *Future Scope*

There are various improvements that can be made in the future to increase the efficiency of the system. These improvements include online slot booking, automatic payment systems, number plate recognition, GPS tracking, and cloud computing.

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