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IOT Smart Parking System using ESP32

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ABSTRACT: Rapid urbanization has resulted in a significant increase in the number of vehicles, leading to severe parking management problems in cities. Traditional parking systems lack real-time monitoring and efficient space utilization, causing traffic congestion, fuel wastage, and time loss. This project proposes an IoT-based Smart Parking System using ESP32 that enables real-time detection, monitoring, and management of parking slots. Ultrasonic sensors are used to detect vehicle presence in each parking slot, and the ESP32 microcontroller processes sensor data and transmits it to a cloud server using Wi-Fi. The parking status is displayed on a web/mobile dashboard, allowing users to quickly identify available parking spaces. The system improves parking efficiency, reduces traffic congestion, and supports smart city infrastructure development.

KEYWORDS: IoT, Smart Parking System, ESP32, Ultrasonic Sensor, Cloud Monitoring, Smart City Introduction

I. INTRODUCTION

With the rapid growth of urban populations and vehicle ownership, parking space management has become a major challenge in metropolitan areas. Drivers spend a considerable amount of time searching for vacant parking spaces, which increases traffic congestion, fuel consumption, and air pollution. Conventional parking systems rely on manual supervision and static signboards, which are inefficient and error-prone.

The **Internet of Things (IoT)** offers a promising solution by enabling real-time data collection, processing, and communication between devices. Smart parking systems use sensors, microcontrollers, and cloud platforms to automate parking space detection and monitoring. The **ESP32** microcontroller is well suited for IoT applications due to its built-in Wi-Fi, low power consumption, and high processing capability.

This project focuses on designing an **IoT Smart Parking System using ESP32**, which automatically detects parking slot availability and updates the information on a cloud-based platform. The system helps drivers find available parking spaces quickly and assists parking administrators in efficient resource management.

Objectives of the Project:

- To design an automated parking monitoring system using IoT
- To detect real-time parking slot availability
- To display parking status remotely using cloud technology

II. METHODOLOGY

The proposed IoT-based smart parking system consists of hardware sensors, an ESP32 controller, and a cloud monitoring interface.

System Architecture

The system operates by installing **ultrasonic sensors** at each parking slot to detect the presence or absence of a vehicle. The ESP32 reads sensor data and determines the slot status. This information is sent to a cloud server using Wi-Fi, where it is displayed on a dashboard.

Components Used

- ESP32 Microcontroller
- LCD Display
- Power Supply (5V/3.3V)
- Wi-Fi Network
- Cloud Platform (ThingSpeak / Firebase / Blynk)
- IR Sensor
- Traffic Light
- Servo Motor

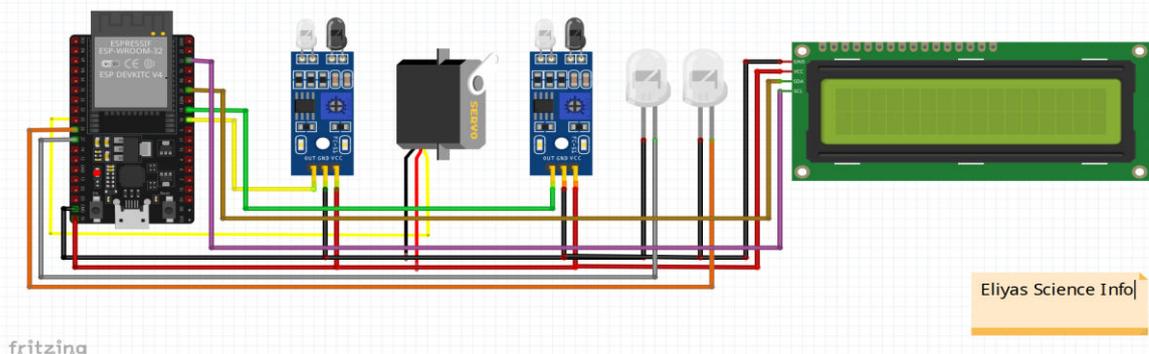
Working Principle

1. Ultrasonic sensors measure the distance between the sensor and the vehicle.
2. If the measured distance is below a predefined threshold, the slot is marked as **occupied**.
3. If the distance is greater than the threshold, the slot is marked as **vacant**.
4. ESP32 processes the sensor data and sends real-time status to the cloud server.
5. Users can view available parking slots through a web or mobile application.

III. SYSTEM DESIGN AND BLOCK DIAGRAM

Block Diagram Description

- The ultrasonic sensors are connected to the ESP32 microcontroller. The ESP32 acts as the central processing unit, collecting sensor data and transmitting it to the cloud via Wi-Fi. The cloud server stores and visualizes the data for user access.
- **Main Functions:**
- Vehicle detection
- Slot status classification
- Wireless data transmission
- Real-time monitoring



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- The system is implemented using ESP32 programmed via Arduino IDE. Each ultrasonic sensor is assigned to a parking slot. The ESP32 continuously monitors sensor readings and updates the parking status.
- During testing:
- When a vehicle occupies a slot, the status changes to **Occupied**
- When the vehicle leaves, the status updates to **Available**
- Data refreshes in real time on the cloud dashboard

V. RESULTS AND DISCUSSION

- The experimental results demonstrate that the proposed IoT-based smart parking system operates accurately and reliably. The ultrasonic sensors effectively detect vehicle presence with minimal error. Real-time data transmission via ESP32 ensures immediate updates on parking slot availability.
- The system significantly reduces the time required to locate a vacant parking space. It also minimizes traffic congestion in parking areas and improves overall parking efficiency. The cloud dashboard provides a clear and user-friendly interface for monitoring parking status.

VI. CONCLUSION

The IoT Smart Parking System using ESP32 successfully provides an efficient and automated solution for parking space management. By integrating ultrasonic sensors, ESP32, and cloud technology, the system enables real-time monitoring of parking availability. Compared to traditional parking systems, the proposed model offers improved accuracy, reduced human intervention, and better scalability.

This system is highly suitable for smart city applications, shopping malls, offices, hospitals, and residential complexes. Future enhancements may include mobile app integration, RFID-based vehicle identification, and payment automation.

VII. FUTURE SCOPE

- Integration with mobile navigation apps
- Automatic parking fee calculation
- AI-based parking prediction
- Solar-powered smart parking system

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