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Parkwise: Locate And Avoid

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Abstract: Unauthorized vehicle parking in designed no-parking zones poses significant challenges for city enforcement authorities. This paper proposes a smart parking enforcement system – Parkwise – which utilizes IR sensors, ESP32 and LoRa- WiFi modules to detect unauthorized vehicles and instantly transmit vehicle information to a central monitoring center. The system enhances real-time surveillance, facilitates rapid enforcement and significantly improves traffic regulations in urban environments. As we progress with this project, we want to establish an intelligent parking system that can quickly handle disorganized parking.

Index Terms - Smart parking, Unauthorized parking detection, IR sensor, ESP32, Lora module, Real-time monitoring, Smart city.

I. INTRODUCTION

In recent years, the rapid increase in urban population and vehicle ownership has led to a significant rise in traffic congestion and unauthorized parking violations, particularly in metropolitan cities. One of the most common yet under-addressed issues contributing to this urban chaos is unauthorized vehicle parking in restricted or no-parking zones. These violations not only hinder smooth vehicular movement but also pose serious safety risks, especially in emergency access lanes, residential streets, and high-traffic public areas.

Traditional parking management systems focus primarily on slot availability and user convenience, with little emphasis on preventive measures or enforcement mechanisms to deter unauthorized parking. Moreover, manual enforcement methods, such as issuing fines or towing, are labor-intensive, time-consuming, and often inefficient due to delayed response or lack of real-time visibility.

The persistent nature of unauthorized parking highlights the urgent need for innovative solutions that go beyond conventional methods. Addressing this challenge requires a seamless blend of technology, scalability, and cost-effectiveness to achieve real-time parking regulation. By leveraging advancements in Internet of Things (IoT), wireless sensor networks, and long-range low-power communication protocols, cities can adopt smarter approaches to urban traffic and parking management.

It is within this context that the "ParkWise: Locate and Avoid" system is conceived. Designed to mitigate the problem of unauthorized parking, this system integrates cutting-edge technologies to offer proactive monitoring, detection, and reporting of parking violations, paving the way for a more organized and efficient urban infrastructure.

II. MOTIVATION

The increasing number of vehicles in urban areas has led to frequent occurrences of unauthorized parking, especially in no-parking zones near schools, hospitals, and narrow residential streets. This not only causes traffic disruptions but also blocks emergency routes, putting lives at risk. Traditional methods of monitoring such violations rely heavily on manual efforts, which are time-consuming,

inconsistent, and resource-intensive.

Our motivation stems from the need to create a proactive and intelligent system that can automatically detect unauthorized parking without human intervention. By combining sensor technology with wireless communication protocols like LoRa and Wi-Fi, we aim to build a solution that ensures timely alerts, accurate data transmission, and centralized monitoring of such violations.

The idea is to help authorities and residential societies avoid conflict, improve enforcement, and promote responsible parking behavior through a smart, scalable, and cost-effective system.

III. OBJECTIVES

The core objective of the ParkWise project is to develop a smart, reliable, and preventive system to monitor and manage unauthorized parking activities in no-parking zones. This is achieved through a combination of hardware detection, wireless communication, and real-time alerting. The detailed objectives are as follows:

- 1) **To detect unauthorized vehicles in no-parking zones:** Implement Infrared (IR) sensors to monitor vehicle presence in restricted areas, ensuring the system provides real-time detection with minimal false positives, regardless of environment conditions.
- 2) **To trigger an immediate local alert system:** Implement a system where a buzzer is activated as soon as an authorized vehicle is detected, serving as an instant audio alert to discourage illegal parking.
- 3) **To wirelessly transmit vehicle data using LoRa and Wi-Fi:** Use LoRa (Long Range) modules to ensure low-power, long-distance transmission of vehicle details (e.g., vehicle number or sensor status) to a base station. And enable WiFi-based data logging to update the central cloud dashboard or local monitoring system.
- 4) **To support dynamic zoning:** Allow authorities to enable or disable certain no-parking zones remotely based on time schedules (e.g., daytime restrictions only). And also update sensor behavior dynamically based on zone status.
- 5) **To enable smart reporting and analytics:** Generate daily, weekly, and monthly reports on violation frequency, peak hours, and zone-specific trends. Provide actionable insights to optimize no-parking enforcement strategies.
- 6) **To reduce manual enforcement workload and increase operational efficiency:** Minimize the need for human surveillance by using automation. And empower local authorities and security teams to focus on action and follow-up, rather than detection.

IV. LITERATURE SURVEY

In recent years, a range of smart parking systems have been proposed to tackle the growing parking challenges in urban areas. Most of these systems focus primarily on parking slot availability, navigation assistance to guide drivers to vacant spots, or automated payment solutions for smoother parking experiences. These solutions have significantly contributed to reducing traffic congestion and improving urban mobility.

However, despite the technological progress, relatively few studies have addressed the critical issue of unauthorized parking violations in no-parking zones, which remains a persistent problem in many cities. Unauthorized parking often leads to blocked emergency lanes, restricted pedestrian pathways, and increased road accidents. Moreover, existing smart parking solutions often assume that drivers willingly follow parking rules once guided to an available spot, overlooking the need for active monitoring and enforcement in restricted areas.

Addressing no-parking violations requires a different technological approach — one that combines real-time detection, instant alerting, remote monitoring, and data logging for enforcement. Hence, there is a clear research gap in developing integrated systems specifically designed to detect, deter, and document unauthorized parking activities effectively.

Our work aims to bridge this gap by proposing a preventive and smart no-parking management system that uses a combination of IR sensors, local audio alerts (buzzers), wireless communication (LoRa and Wi-Fi), and a centralized monitoring dashboard to manage violations proactively.

1) Smart Parking System Using IoT (2020)

This study proposed the use of sensors and microcontrollers to detect parking slot availability. Though efficient in real-time monitoring, it lacked features to handle parking violations in restricted areas.

2) Vehicle Detection and Monitoring using IR and Ultrasonic Sensors (2021)

It introduced a low-cost method for vehicle detection using IR and ultrasonic sensors. However, it was limited by range and did not integrate wireless data transfer or alert systems.

3) Cloud-Integrated Parking Systems (2021)

Proposed cloud storage for parking data using Wi-Fi-enabled microcontrollers. This approach inspired our dashboard feature for centralized monitoring.

4) LoRa-Based Vehicle Monitoring System (2022)

Focused on tracking vehicles using GPS and LoRa. While useful for fleet management, it didn't address unauthorized static vehicle detection or alert mechanisms.

Gap Identified: Most existing systems lack an integrated detection-alert-transmission-monitoring loop specifically targeting unauthorized parking. Our system bridges this gap by combining IR sensors, buzzer alerts, LoRa-Wi-Fi communication, and a web dashboard into a unified solution.

Strengths and weaknesses of the referred papers are discussed in table 1

Table 1. Literature Survey

Paper Referen ces.	Strength	Weakness
[1]	Efficient real-time monitoring of parking slot availability	No focus on unauthorized parking or violation detection.
[2]	Low cost, simple vehicle detection using basic sensors.	Limited detection range, no wireless transmission or alert system.
[3]	Low range, low power tracking using LoRa communication	Focused on moving vehicles (GPS tracking), not static unauthorized parking detection
[4]	Centralized cloud storage of parking data, WiFi based monitoring.	No mechanism for local alerts or immediate violation deterrence.

V. PROPOSED WORK

The ParkWise: Locate and Avoid system offers a smart infrastructure for detecting and reporting unauthorized parking in restricted zones. It integrates a combination of infrared (IR) sensors for vehicle detection, buzzers for instant local alerts, and LoRa and Wi-Fi modules for reliable, low-power wireless communication.

When an unauthorized vehicle is detected in a no-parking zone, the system immediately triggers an audio alert to deter the driver and simultaneously transmits violation data to a centralized web-based dashboard. This dashboard logs details such as time of detection, zone ID, and vehicle presence, enabling authorities to monitor and take necessary actions efficiently.

The system is designed to be cost-effective, energy-efficient, and easily scalable across multiple zones. By using modular hardware components (such as ESP32 microcontrollers and LoRa modules), ParkWise

ensures flexibility for future upgrades, including integration with license plate recognition (LPR) systems, CCTV surveillance, and automated fine issuance.

Furthermore, ParkWise aims to minimize the need for manual surveillance, reduce operational workload for enforcement teams, and enhance compliance with traffic regulations by creating a preventive presence in no-parking areas. The system's real-time monitoring, instantaneous deterrence mechanisms, and data-driven insights make it a comprehensive solution for modern urban parking challenges.

5.1 System Overview

The system integrates multiple hardware components to ensure seamless operations:

- **IR Sensors:** Detect unauthorized presence in no-parking zones.
- **ESP32 Microcontroller:** Processes sensor inputs and manages communication protocols
- **LoRa module:** Enables long-range transmission of vehicle detection signals to receiver stations.
- **Wi-Fi Module:** Facilitates data upload to a cloud database at the receiver end.
- **Buzzer:** Provides real-time deterrence by activating immediately upon detection.

5.2 Workflow

The workflow of the system operates in the following sequence:

- Vehicle enters a restricted no-parking zone, triggering the IR sensor.
- The ESP32 microcontroller activates the buzzer and prepares a data packet containing violation details.
- Data is transmitted to a remote receiver station using the LoRa module.
- Wi-Fi at the receiver station uploads the data to a cloud database.
- A LCD displays vehicle entry information for real time monitoring and administrative actions

5.3 Hardware Components

The system incorporates the following hardware elements:

- ESP32 (NodeMCU)
- IR Sensor
- Buzzer
- LoRa Transmitter and Receiver

5.4 Software Tools

Embedded programming for the system is carried out using Arduino IDE, ensuring efficient processing and communication across hardware components.

5.5 System Architecture

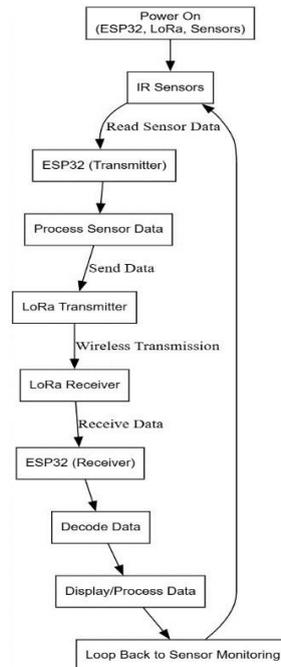


Figure 5.1: System Architecture

The architecture of the "ParkWise: Locate and Avoid" system is designed to efficiently manage sensor data transmission and processing. It involves the following workflow:

- **Initialization:** The ESP32 microcontroller, LoRa modules, and sensors are powered on to begin operations.
- **Sensor Detection:** IR sensors continuously monitor no-parking zones for unauthorized vehicle presence.
- **Data Processing and Transmission:** Upon detecting unauthorized parking, the ESP32 microcontroller (Transmitter) processes the sensor data and sends it to the LoRa Transmitter.
- **Wireless Communication:** The LoRa Transmitter wirelessly transmits data to the LoRa Receiver at a remote station.
- **Data Decoding:** The ESP32 microcontroller (Receiver) decodes the received data for further processing or display.
- **Real-Time Feedback:** A buzzer is triggered immediately to deter unauthorized parking while data is simultaneously uploaded to a cloud database via the Wi-Fi module for administrative review.
- **Data Visualization:** A LCD displays vehicle entry information for real time monitoring and administrative actions.

VI. FUTURE SCOPE

The "ParkWise: Locate and Avoid" system has immense potential for growth and enhancement in the realm of smart urban infrastructure. Future developments and applications can include:

- **IoT Integration for Interconnectivity:** Embed the system within larger IoT frameworks for smart cities, enabling interoperability with other urban devices like surveillance cameras, smart traffic lights, and environmental sensors.
- **Energy-Efficient Design:** Explore the use of solar-powered sensors and transmitters to make the system sustainable and reduce dependence on conventional power sources.

- **Expansion to Multi-Zone Monitoring:**

Scale the system to cover multiple no-parking zones across a city, enabling centralized monitoring and control through the web dashboard. This would enhance its applicability for large metropolitan areas.

- **Enhanced Security Features:**

Include tamper-proof hardware and encryption protocols to protect the system from potential security threats or interferences.

VII. RESULT

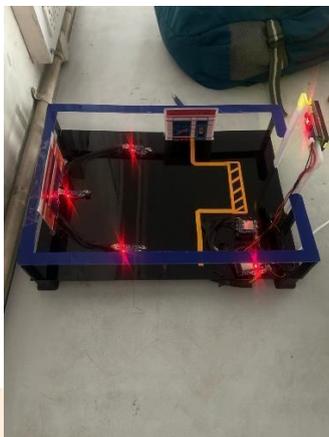


Figure 7.1: Parkwise model

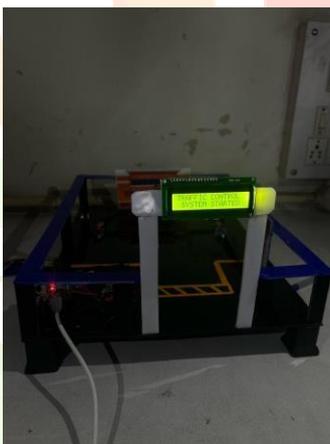


Figure 7.2: Display results on LCD Display

VIII. CONCLUSION

This project introduces a smart and scalable solution to the growing problem of unauthorized parking, addressing a critical urban challenge with innovative technology. By combining real-time detection, wireless communication, and centralized monitoring, ParkWise minimizes reliance on manual enforcement, enhances operational efficiency, and enables timely interventions. The system's low cost, ease of deployment, and adaptability to diverse public and private spaces make it a practical choice for widespread implementation. Furthermore, its integration and potential with future advancements, such as license plate recognition, fine automation and predictive analytics, positions it as a foundational component of comprehensive urban smart traffic management systems. As cities continue to evolve, ParkWise offers a pathway to more organized, sustainable, and user-friendly parking solutions, contributing to the larger vision of smart city infrastructure.

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