Smart and Effective Management of Street Parking

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Abstract -Smart Parking is a smart parking management system designed to provide an efficient and hassle-free parking experience for users. The application allows users to register, log in, and locate parking spots through an interactive map. A digital wallet feature enables seamless transactions, and users receive instant receipts upon successful payments. Road safety notifications enhance user awareness by alerting them to potential hazards. The Admin Module simplifies parking management by allowing administrators to add, update, and monitor parking locations. Admins can oversee toll listings and ensure smooth operation. This project addresses the inefficiencies of traditional parking systems, offering an advanced alternative with automation and convenience. The app is developed using the Kotlin framework for Android, ensuring a user-friendly experience. By integrating essential functionalities such as digital payments, location tracking, and safety notifications, Smart Parking enhances urban mobility and parking efficiency. It is an innovative solution aimed at improving parking accessibility and management for both users and administrators.

Key Words: Digital wallet, Notifications, Kotlin Framework, Android.

1.INTRODUCTION

With the increasing pace of urbanization and the corresponding rise in vehicle ownership, finding a suitable parking space has become a daily challenge for many commuters. This not only wastes time and fuel but also contributes to traffic congestion and environmental pollution. Conventional parking systems are often inefficient, relying on manual intervention and lacking the ability to provide real-time information to users. These limitations call for an intelligent, technology-based approach to simplify parking and toll management in urban areas. In response to these challenges, this paper introduces **Smart Parking**, an Android application developed using the Kotlin programming language. The system is designed to provide users with a seamless parking experience by integrating features such as real-time location tracking of parking spots via interactive maps, secure digital wallet-based payments, and timely notifications related to road safety. In addition to assisting users, the application also provides an admin interface for managing toll booths, parking availability, and other operational functions.

The Smart Parking application aims to bridge the gap between increasing demand for efficient parking and the lack of integrated solutions in existing systems. Unlike many applications that offer only navigation or payment capabilities, this system combines multiple services into a single platform to enhance usability and reduce complexity. The solution also supports digital transformation efforts by promoting cashless transactions and automating toll operations.

The objectives of this project include minimizing time spent in finding parking, improving urban traffic flow, ensuring safety through alert systems, and enabling effective toll management. It also seeks to contribute to the development of smart cities by promoting digital infrastructure in transportation. The project demonstrates how mobile technologies can be leveraged to address real-world problems effectively.

This paper is organized into several sections. Section II explores related work and existing systems. Section III discusses the proposed methodology and system design. Section IV explains the implementation details, and Section V presents the results, conclusions, and future scope of the project.

2. LITERATURE SURVEY

Several research efforts have been made toward the development of intelligent parking systems using emerging technologies such as IoT, RFID, and image processing. Below is a summary of some of the significant works related to the proposed Smart Parking system.

Denis Ashok et al. [1] introduced a smart parking energy management system for structured environments like multistoried office parking. Their system utilizes IoT technology integrated with Honeywell sensors and controllers to detect empty parking spaces. Lamps indicate vacant spots to guide users efficiently, while occupancy data is stored on the cloud for centralized access. The system minimizes energy consumption through automated lighting and reduces manpower needs, thus enhancing user convenience and operational efficiency.

Lomat Haider Chowdhury et al. [2] presented a smart parking management solution tailored for urban environments in Bangladesh, where manual parking systems dominate. Their approach involves RFID cards for entry registration and automatic fare calculation based on parking duration. The system includes a user interface for administrators and displays available slots through an LED display. Performance evaluations were conducted using local and remote cloud servers to assess response times.

Balwant K. Patil et al. [3] proposed a semi-automated centralized car parking system designed to guide drivers toward available parking spaces via traffic-free routes. Unlike conventional systems, their solution minimizes congestion and waiting time by incorporating intelligent route selection. Though fully automated systems are costly, the authors suggest a cost-effective hybrid approach to reduce human effort while optimizing parking operations.

T.C. Kalaiselvi et al. [4] addressed parking challenges at railway stations in India using advanced techniques such as image processing, Raspberry Pi, OCR for license plate recognition, and ultrasonic sensors. The system provides users with a QR-based exit mechanism and digital payment options, enhancing convenience. Emphasis is placed on environmental sustainability and real-time slot detection, making the system scalable and adaptable to other transport hubs.

Wael Alsafery et al. [5] focused on smart parking within smart cities using IoT and machine learning. Their research critiques the common reliance on cloud-based data processing due to its high energy and transmission costs. Instead, they propose local data filtering and fusion before transmission, which reduces bandwidth and improves system efficiency. The system also provides real-time traffic congestion data and nearest parking availability, thereby reducing time spent searching for parking. These studies collectively highlight the importance of integrating technology to address parking inefficiencies. They also emphasize different facets of smart parking—ranging from sensor-based detection and automated payment systems to data optimization and user-friendly interfaces—which inform and support the objectives of the present work.

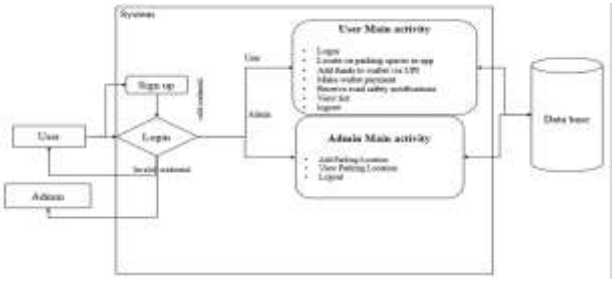
3. PROPOSED METHOD

The proposed smart parking system aims to address the limitations of conventional parking systems by integrating **IoTbased hardware, real-time monitoring, image processing, and cloud connectivity**. The system utilizes **ultrasonic sensors** for accurate slot occupancy detection, **Raspberry Pi** for local processing, and **OCR (Optical Character Recognition)** to recognize vehicle license plates. The system ensures real-time updates on parking availability displayed through **OLED screens** and provides a **QR-code based digital payment** option for a seamless exit process. Historical data is stored using the Pickle module for intelligent parking management decisions. The entire setup is eco-conscious and scalable for integration with other services such as railway station management or urban transport infrastructure.

3.1 Advantages of the Proposed System The proposed system offers several advantages:

- **Real-Time Slot Detection:** Accurate detection of vacant slots using ultrasonic sensors improves parking efficiency.
- **Reduced Human Intervention:** Automation in slot detection, license plate recognition, and payments reduces reliance on manual labor.
- **Time and Energy Efficient:** Directing users to available slots minimizes time spent searching and reduces fuel consumption.
- **Cashless Transactions:** QR-code-based digital payments enhance user convenience and support financial transparency.
- **License Plate Recognition**: OCR-based vehicle identification ensures security and effective slot tracking.
- **Cloud-Enabled Insights**: Data collected is stored and processed efficiently, enabling advanced analytics and better parking management.
- **Environmentally Friendly**: Reduced vehicle idling and paperless payments contribute to sustainability.
- **Scalable Architecture**: The system is designed for integration with larger urban infrastructure and smart city initiatives.

3.2 Architecture



4.METHODOLOGIES

The development of the proposed Smart Car Parking System follows a modular and systematic approach that combines hardware integration, software development, and real-time data processing. The methodology involves the following key steps:

4.1 System Architecture Design

The smart parking system is built on a layered architecture that enables automated slot detection, monitoring, and payment. At the core of the design is a Raspberry Pi microcontroller, which acts as the central processing unit. The system begins with ultrasonic sensors deployed at each parking slot to detect whether a slot is vacant or occupied. These sensors send realtime signals to the Raspberry Pi. Additionally, a camera is placed at the entrance to capture the license plate of incoming vehicles. Using Optical Character Recognition (OCR), the system converts the license plate image into text, which is stored for future reference. Data is serialized using the Pickle module to keep track of each slot's status and the history of parked vehicles. The design also includes an OLED display at the entrance to inform users about current parking availability, and the exit process incorporates QR-based payment, making the entire system automated and user-friendly.

4.2 Hardware Implementation

The hardware setup consists primarily of ultrasonic sensors, a Raspberry Pi 3 microcontroller, an entry camera, and an OLED display. Each ultrasonic sensor is connected to a GPIO pin on the Raspberry Pi and placed in an individual parking slot. These sensors are used to detect whether the slot is empty or occupied. The entry camera is positioned to capture license plate images of vehicles as they enter the parking area. The OLED screen is mounted at the entrance to provide real-time updates about slot availability. Power supply modules and jumper wires are used to connect and integrate all the components effectively. The Raspberry Pi processes the sensor and camera data, and stores it in a Pickle file, enabling the entire hardware setup to function in coordination with the software system for seamless operation.

4.3 Software Implementation

The software is developed primarily using Python due to its rich library support and compatibility with the Raspberry Pi. The program controls the ultrasonic sensors for real-time slot monitoring and processes images captured by the camera using OCR libraries like Tesseract to extract vehicle numbers. The Pickle module is used for data serialization, allowing the system to store and retrieve information about vehicle entry time, number plate, and slot status. The OLED display is programmed to update automatically based on slot availability. Additionally, the QR code generation for payments is handled through Python libraries, enabling users to scan and pay directly through UPI apps. This integration of various modules makes the software efficient, interactive, and fully automated.

4.4 Working Principle

When a vehicle enters the parking lot, the camera captures its number plate, and OCR is used to convert it into digital text. The system checks the slot availability using data from ultrasonic sensors. If a slot is available, the system assigns the slot and stores the vehicle number along with the entry time in a Pickle file. The OLED display shows the number of available slots in real time to guide drivers. On exit, the system records the time and calculates the total duration the vehicle was parked. Based on this, it generates a QR code with payment details. The user can scan the code and make the payment digitally, which completes the process without any

manual intervention. This principle ensures accuracy, convenience, and full automation.

4.5 Flow Chart

The system flow starts when a vehicle arrives at the entrance. The camera captures the license plate, and the OCR module extracts the number. Simultaneously, ultrasonic sensors check each slot to determine availability. The Raspberry Pi processes this data and assigns a vacant slot if available, storing the vehicle number and time of entry. The OLED screen displays the current parking status. Upon exit, the vehicle number is detected again, and the system calculates the total time spent. It then generates a QR code with the amount to be paid. After the user completes the payment, the slot is marked vacant and the data is updated. This flow ensures a smooth user experience and efficient parking management.

5.RESULT

The smart parking system was successfully implemented and tested in a controlled environment. The ultrasonic sensors accurately detected the presence or absence of vehicles in each slot and updated the slot availability in real-time. The camera at the entrance was able to capture clear images of vehicle number plates, and the OCR module correctly extracted the text with a high accuracy rate under good lighting conditions. The OLED display provided users with instant information about available slots, reducing search time and improving user convenience. The Pickle file storage system efficiently tracked vehicle data such as entry time, slot number, and number plate. Upon exit, the system generated a QR code with the calculated parking fee based on the time duration, and the payment process was completed smoothly using UPI applications. Overall, the system operated with high reliability, demonstrating its effectiveness in managing parking spaces automatically and efficiently.

6.CONCLUSION

The proposed smart parking system demonstrates an efficient, user-friendly, and automated solution to address the growing challenges in urban parking management. By integrating IoT sensors, image processing, OCR, and cashless payment methods, the system minimizes human intervention while improving accuracy and convenience for users. Real-time slot detection using ultrasonic sensors, license plate recognition through camera and OCR, and automated fee calculation streamline the entire parking process. The system not only reduces congestion and search time but also promotes digital transactions and energy efficiency. With its modular design, the solution can be scaled and integrated into larger infrastructures like railway stations, malls, and office spaces. Future enhancements can include mobile app integration, cloud-based data analytics, and AI-driven slot predictions to further elevate system performance and user experience.

7. REFERENCES

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