

Smart City Parking: Using AI, IoT, and Cloud for Real-Time Space Management

Adarsh Kulkarni¹, Amit Kshirasagar^{1*}, Yash Mankar¹, Ganesh Kshirasagar¹

Abstract

Limited parking places and ineffective management make parking in crowded cities frequently frustrating. Congestion and time loss result from traditional parking systems' lack of real-time updates. We suggest a smart parking system that uses Firebase, a real-time database that guarantees real-time updates, to address this. A smartphone app and sophisticated sensors placed in parking spots make up our solution. Users can use the app to determine parking availability in real time, reserve a spot in advance, and utilize GPS to find their parking spot. Sensors determine whether a parking space is occupied and immediately update the database to guarantee correct and current data. Our system's key features include cashless payments, secure user authentication, and data analytics to forecast parking demand and maximize space use. By combining these technologies, our smart parking system greatly increases user convenience, lowers traffic, and improves parking efficiency. With a more intelligent, data-driven approach, this system is intended to simplify urban parking management, which will benefit both drivers and parking lot operators. Our smart parking system integrates these technologies to increase efficiency, lessen traffic, and give drivers smooth experience.

Keywords: Car parking app, android app development, GPS, sensors, database

INTRODUCTION

In an era marked by rapid urbanization and the perpetual challenge of managing limited space, efficient parking solutions have become imperative for modern cities. Every major city is experiencing an alarming increase in parking issues, which are becoming more and more common. The Car Parking App emerges as a transformative tool, offering a streamlined and user-centric approach to the perennial problem of finding parking spaces. As urban landscapes evolve, the traditional methods of locating and securing parking spots no longer suffice. The Car Parking App seeks to redefine the parking experience by harnessing the power of technology, providing users with a seamless, convenient, and intelligent solution. Through real-time data, user-friendly interfaces, and innovative features, this app aims to revolutionize the way individuals navigate the often-frustrating landscape of urban parking, promising

*Author for Correspondence

Amit Kshirasagar
E-mail: amit.kshirasagar_skncoe@sinhgad.edu

Student, Department of Electronics & Telecommunication Engineering, Smt. Kashibai Navale College of Engineering, Vadgaon, Savitribai Phule Pune University, Pune, Maharashtra, India

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not only ease of access but also a more sustainable and connected future for urban mobility. The number of personal vehicles usage is increasing day by day. Due to this searching for a vacant parking area during peak hours is not only time-consuming but also results in wastage of fuel. The drivers keep searching for a proper parking lot that leads to increased traffic. Increasing volume of vehicular exhaust creates a negative impact on the environment. Hence reservation-based smart parking has become the need of the day [1–4].

Currently, most existing parking lots do not have a system in place. Most of them are managed by hand and are a bit ineffective. Every user's demand

should be (i) should be more efficient (ii). User's friendly (iii). They should provide more security. The idea behind our Android Application – “valid spot” is to help the user for online parking booking. The Smart Parking Application aims at helping users to find the most suitable area for parking, make reservations and extend them, if required. A sensor node detects whether a parking space is available and keeps track of and updates the status continually. The information is subsequently transmitted via a wireless sensor network to an embedded web server. After then, the data is sent in real time over Wi-Fi connectivity to a central web server [5, 6].

This technology ensures a seamless and hassle-free parking experience by enabling drivers to quickly search for available parking spaces using their cellphones or other mobile devices.

In this application user can view various parking areas also he can select it to view whether parking slot is available or not. If the parking slot is available in parking, then user can book it for some specific time slot also, this system provides an additional feature of cancelling the bookings. It also utilizes the open ground for parking with security.

There is an increasing need for effective parking solutions as cities grow and the number of vehicles increases. Traditional parking systems use manual management, which is ineffective and time-consuming. Drivers spend a lot of time looking for open spaces, which results in more fuel being used and needless emissions. To maximize the utilization of available parking spaces, smart parking systems combine cloud platforms, IoT-based sensors, and AI-driven analytics to give real-time data on parking availability.

BENEFITS OF SMART CITY PARKING SYSTEMS

Reduced Traffic Congestion

By guiding drivers to available spots, smart parking minimizes the time spent searching for parking.

Lower Fuel Consumption & Emissions

Optimized parking management leads to reduced idling and lower CO₂ emissions, contributing to a greener environment.

Enhanced User Convenience

Mobile apps enable drivers to reserve parking spaces in advance, make cashless payments, and receive real-time updates.

Efficient Space Utilization

AI-driven parking management ensures that available spaces are used effectively, reducing the need for additional infrastructure.

Improved Urban Planning

Real-time parking data helps city planners and policymakers make informed decisions about infrastructure development and traffic management.

LITERATURE SURVEY

Implementation Details of Module

Efficient parking management has become a crucial challenge due to the increasing number of vehicles in urban areas. Traditional parking methods often lead to traffic congestion, wasted fuel, and increased pollution, making the need for smart parking solutions more urgent. Recent advancements in wireless sensor networks (WSNs), cloud technology, and the Internet of Things (IoT) have contributed significantly to improving parking systems, making them more efficient and user-friendly [7–11].

Smart Parking with Slot Reservation

Modern parking systems integrate slot reservation through mobile applications, allowing users to book parking spaces in advance. This approach minimizes the time spent searching for parking and reduces traffic congestion. Research shows that automated.

Billing and security features – such as vehicle number verification – can enhance the parking experience while preventing unauthorized access. Multi-level parking structures further optimize space utilization, making parking more efficient in densely populated cities.

Role of IoT in Parking Systems

IoT-based smart parking systems use sensors to detect vehicle presence and transmit real-time data to a central system. This information helps drivers locate available parking spaces, reducing unnecessary vehicle movement and improving overall traffic flow. Studies highlight the importance of real-time updates in ensuring better parking space management and providing drivers with seamless experience.

Wireless Sensor Networks (WSNs) in Parking

Wireless sensor networks play a significant role in modern parking systems. These networks consist of low-power, self-sufficient sensors that automatically detect available parking spots and update availability in real-time. Unlike traditional systems that require manual monitoring, WSN-based solutions minimize human intervention and improve accuracy. Additionally, these sensors help conserve energy by operating efficiently without constant power consumption.

Cloud and Mobile Application Integration

Cloud-based parking management has gained attention for its ability to process and store real-time parking data. Mobile applications connected to these cloud systems allow users to check availability, reserve slots, and receive navigation assistance. This technology not only improves accessibility but also streamlines the entire parking experience by reducing the need for physical ticketing and manual monitoring.

Limitations of Traditional Parking Systems

Older parking systems rely on manual monitoring or ticket-based entries, often causing delays and traffic congestion. Without real-time updates, drivers waste time searching for parking, leading to increased fuel consumption and pollution. The inefficiencies in these systems have driven the demand for automated, technology-driven parking solutions.

Emerging Smart Parking Technologies

To overcome the limitations of traditional methods, researchers have developed infrared (IR) sensor-based and IoT-enabled parking systems. These systems offer real-time tracking, automated payments, and mobile-based reservations, making parking management more efficient. Studies suggest that smart parking solutions improve urban traffic conditions by ensuring optimal space utilization and reducing vehicle movement.

The Future of Smart Parking Systems

The increasing number of personal vehicles has made smart parking a necessity rather than a luxury. The integration of AI, cloud computing, and advanced sensors in parking systems is expected to further enhance efficiency and security. Features like automated slot detection, digital payments, and reservation flexibility will continue to shape the future of urban parking.

The rapid advancements in wireless sensor networks, IoT, and cloud-based solutions have significantly improved parking management. By reducing traffic congestion, optimizing space utilization, and enhancing security, smart parking systems contribute to a more sustainable and convenient urban environment. As technology evolves, these solutions will become even more efficient, helping cities tackle parking challenges with innovative, data-driven approaches [1–6].

System's flowchart is shown in Figure 1. The integration of design and drawing in the realm of car parking app marks a significant leap forward in the field of organised systems. Design plays a crucial role in crafting user interfaces that are not only aesthetically pleasing but also user-friendly, ensuring seamless interaction between server and user. Designing and drawing a car parking app involves several key components.

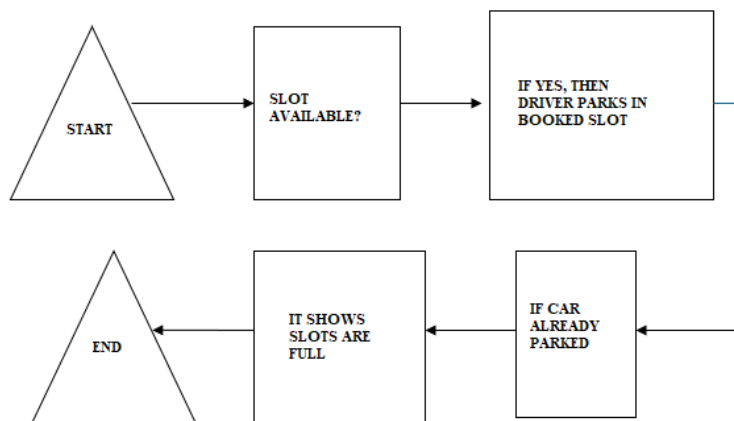


Figure 1. Flow chart of the proposed system.

Define the User Flow

- Identify the primary actions users will take within the app, such as searching for parking, making a reservation, or paying for parking.
- Map out the user flow, outlining the sequence of screens and interactions users will encounter from opening the app to completing their parking transaction.

Sketch Wireframes

- Start by sketching rough wireframes of each screen in the user flow using pen and paper or digital tools like Sketch or Adobe XD.
- Focus on layout and functionality rather than visual design at this stage. Include essential elements such as navigation bars, search bars, buttons, input fields, and information displays.

Design High-Fidelity Mock-ups

- Once you have a solid wireframe, create high-fidelity mock-ups using design software like Figma, Adobe XD, or Sketch.
- Incorporate branding elements such as logos, colours, and typography to give the app a polished look and feel.
- Pay attention to visual hierarchy, spacing, and alignment to ensure a clean and intuitive user interface.

Include Key Features and Screens

Consider including the following key features and screens in your app design:

- *Home Screen:* Welcome users and provide quick access to main features.
- *Parking Search:* Allow users to search for available parking spots based on location, time, and other filters.
- *Parking Details:* Display detailed information about each parking spot, including location, availability, pricing, and amenities.
- *Reservation:* Enable users to reserve a parking spot in advance, specifying the date, time, and duration of their stay.
- *Payment:* Provide secure payment options for users to pay for their parking reservation within the app.

Software and Hardware Requirements for the Smart Parking App

Software Requirements

- *Android Studio* – The latest version is required as the main development environment.
- *Java Development Kit (JDK 8 or higher)* – Essential for writing and running Java-based Android applications.

- *Android SDK* – Provides necessary tools and libraries for Android app development.
- *Emulator (AVD – Android Virtual Device)* – A virtual Android device for testing the app without a physical phone.
- *Git (Version Control)* – Helps manage project versions, track changes, and collaborate efficiently.

Hardware Requirements

- *Operating System* – Compatible with Windows, macOS, or Linux.
- *RAM* – Minimum 8 GB, but 16 GB is preferred for smooth app development and emulator usage.
- *Storage* – At least 4 GB free space for development tools, plus extra for project files and emulator images.
- *Processor* – Intel i5/i7 or AMD equivalent with virtualization support (Intel VT-x/AMD-V) for faster performance.

These requirements ensure efficient development, testing, and smooth performance of the smart parking app.

OUTPUT

This Figure 2. Shows the design of a mobile app for smart car parking system which helps users find and book parking spots easily. The app has six different screens, each guiding users through the process of reserving and managing their parking.

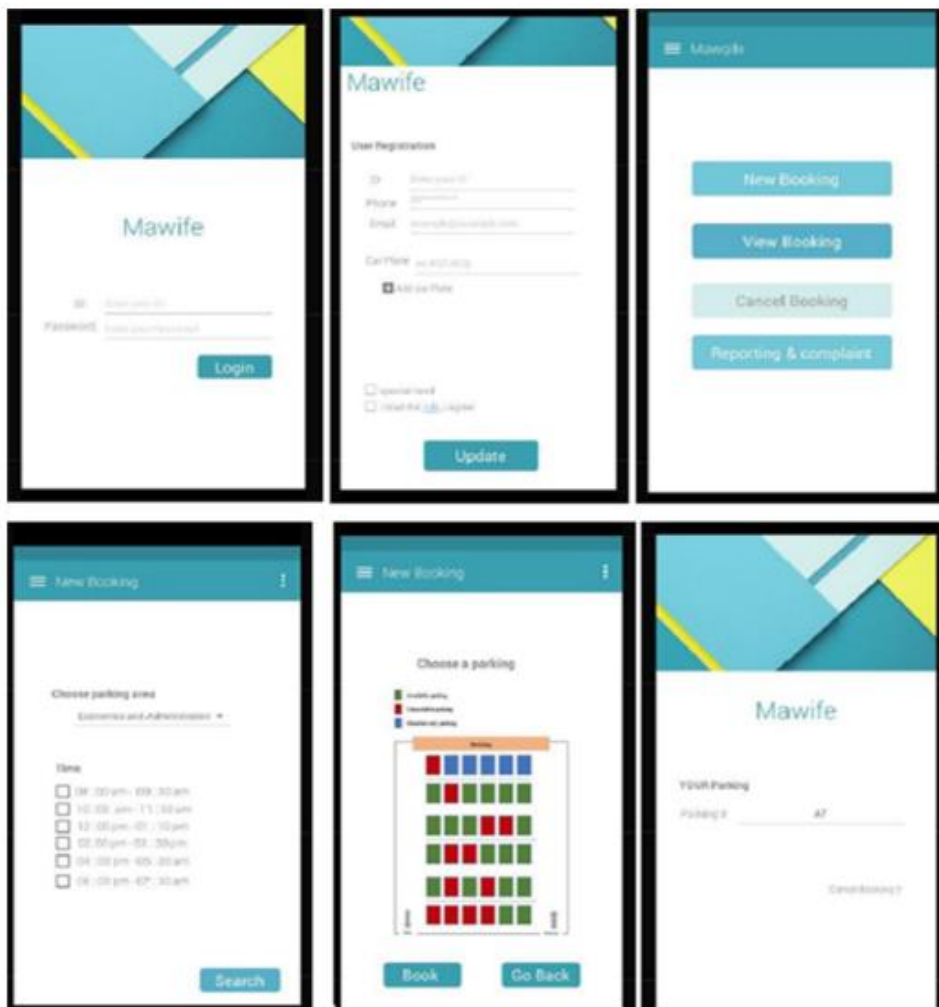


Figure 2. Mobile app interface screens.

CONCLUSIONS

The development and experimentation of the car parking system using Android Studio and Firebase have demonstrated the viability and robustness of creating a are the key takeaways and conclusions. The car parking system developed using Android Studio and Firebase is a robust, efficient, and user-friendly solution for managing parking spots. The system's real-time capabilities, combined with its secure and scalable architecture, make it well-suited for deployment in various environments, from small parking lots to large urban areas. By addressing the identified areas for improvement and continuing to iterate based on user feedback, the system can further enhance its performance and user satisfaction, providing a valuable tool for parking management in the digital age.

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