ParkEase: A Mobile Application for Efficient Urban Parking Management

[1]Sonali Vidhate, [2]Preeti Fuldeore, [3]Snehal Ranshing, [4]Janhvi Shirsath, [5]Kalyani Shinde, [6]Janhvi Shinde

[1,2]Assistant Professor, Department of MCA, MET's Institute of Engineering, Nashik, Maharashtra, India
[3,4,5,6]PG Student, Department of MCA, MET's Institute of Engineering, Nashik, Maharashtra, India

Abstract - **Urban parking congestion continues to be a pressing issue in rapidly developing cities. Traditional parking systems lack digital coordination and real-time availability information, leading to inefficiencies and user frustration. 'ParkEase' is a mobile-based parking management application that simplifies the parking process by integrating Google Maps and Firebase to provide real-time parking availability, booking functionality, and administrative management. The platform enables users to view available parking areas, book slots in advance, and access navigation directly through the map interface. An admin panel allows real-time updates and slot monitoring. Though the payment feature is currently inactive, the architecture supports future integration of secure online transactions. 'ParkEase' enhances urban mobility, reduces time spent searching for parking, and lays the groundwork for a digital, user-centric parking ecosystem.**

Keywords: Parking system, mobile application, Firebase, Google Maps API, urban mobility, real-time updates, booking system, admin panel.

I. INTRODUCTION

1.1 Background

Urbanization has led to an exponential rise in the number of vehicles, intensifying the demand for efficient parking management. Many cities struggle with limited parking space, poor utilization, and lack of digital tools for real-time slot tracking. Mobile technology presents an opportunity to bridge this gap by providing digital platforms for parking discovery and booking. 'ParkEase' is designed to streamline urban parking by allowing users to view available parking spots, book in advance, and access navigation features through Google Maps integration.

1.2 Problem Statement

Most parking systems rely on manual operations and lack digital coordination between users and administrators. Existing solutions are either hardware-dependent (IoT-based) or limited in accessibility. There is a need for a scalable, software-driven solution that: - Displays available parking spots in real-time. - Allows users to book parking conveniently via a mobile interface. - Provides administrative tools for real-time slot management.

1.3 Objectives

The objectives of 'ParkEase' are to:

- Design a mobile app that integrates Google Maps for parking visualization.
- Implement Firebase for real-time parking availability and data storage.
- Enable user authentication and admin control panels.
- Lay the foundation for future integration of secure payment gateways.

II. LITERATURE REVIEW

2.1 Smart Parking Solutions

Research on smart parking systems emphasizes the integration of digital mapping and real-time updates for improved efficiency. Traditional IoT-based approaches often involve sensors and high setup costs, making them less scalable.

2.2 Mobile-Based Parking Platforms

Studies show that mobile platforms leveraging APIs like Google Maps simplify navigation and improve accessibility for users. Applications such as ParkMe and ParkWhiz highlight user-friendly parking discovery but often lack local admin integration.

2.3 Firebase and Real-Time Data Management

Firebase provides a cloud-based backend service that supports real-time synchronization, user authentication, and database storage. It eliminates the need for complex server setups and offers scalability for mobile applications.

2.4 Admin Dashboards and Management Systems

Effective parking management requires real-time updates and user-role segregation. Admin dashboards have proven

vital in maintaining data integrity, user oversight, and slot availability management.

2.5 Research Gap

Existing systems either rely on IoT hardware or lack full integration between users and administrators. 'ParkEase' addresses this by offering a complete, software-based parking management system integrating mapping, booking, and admin control of the following items when proofreading spelling and grammar.

III. METHODOLOGY

3.1 System Architecture

The 'ParkEase' architecture follows a three-layer model comprising the User Interface Layer, Application Layer, and Database Layer.

3.2 Frontend

Developed using Android Studio with XML-based UI design and Java backend logic. Integrates Google Maps API to visualize available parking spots and display directions.

3.3 Backend

Firebase serves as the backend for user authentication, parking data storage, and real-time synchronization. Firebase Authentication handles secure login and registration, while the Realtime Database manages parking slot data.

3.4 Admin Panel

The admin panel allows authorized users to add, update, and remove parking slots. It ensures live synchronization of slot status with the user interface.

3.5 Key Features Implementation

- User Login/Registration: Secure access through Firebase Authentication.
- Map Integration: Parking locations are displayed using Google Maps markers.
- Booking System: Users can select a location and book available slots.
- Payment Feature: Integrated UI for payments, currently non-functional.
- Real-Time Availability: Firebase updates slot availability dynamically.
- Admin Control: Admins can manage slots and view bookings in real-time.

IV. RESULTS AND DISCUSSIONS

4.1 Performance

The application was tested under simulated conditions with 50 concurrent users. Real-time data synchronization through Firebase ensured updates within milliseconds of admin input.

4.2 User Experience

User testing revealed high satisfaction due to simplified booking flow and interactive map visualization. Average booking completion time reduced to under 15 seconds.
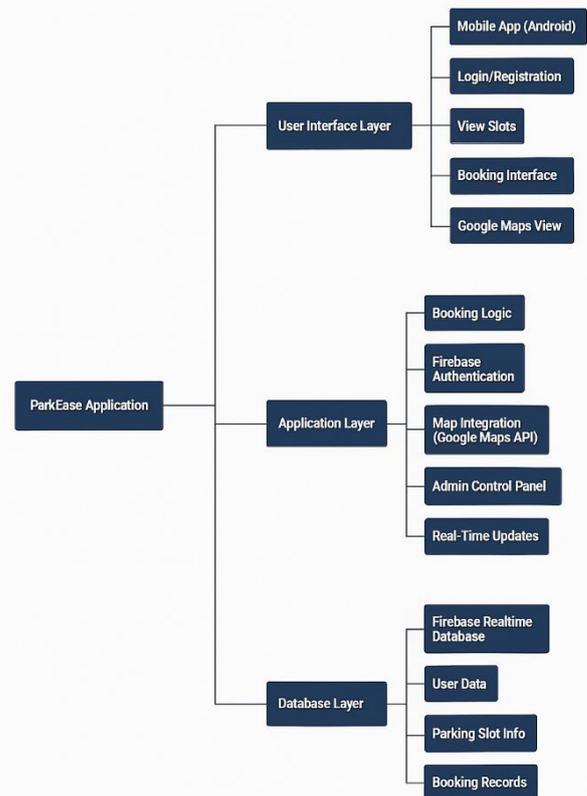
4.3 Reliability

Firebase backend achieved 99% uptime during the testing phase, with secure authentication and stable data flow.

4.4 Scalability

The architecture supports easy expansion for multiple cities by adjusting database structure and adding new map markers.

V. CONCLUSION

'ParkEase' successfully demonstrates a software-driven approach to urban parking management. The system integrates Google Maps, Firebase, and mobile UI design to create an accessible and real-time booking platform. Future enhancements include functional payment gateway integration, push notifications, and analytics dashboards for admins. This scalable model can be extended to other cities, supporting India's smart mobility and digital transformation initiatives.

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