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ParkSwift - Smart Parking System Using Flutter Firebase, and Augmented Reality

Mr. Anshutosh Kangare[1], Mr. Vaibhav Mali[2] , Mr. Yash Kulkarni[3], Mr. Piyush Sonar[4], Prof. Anirudha Kolpyakwar[5]
Department of Computer Science Engineering[1-5]
Sandip University, Nashik

Abstract: *In rapidly growing metropolitan areas, finding available parking spaces has become a significant challenge due to increasing vehicle density and limited infrastructure. This issue leads to severe traffic congestion, excessive fuel consumption, and increased environmental pollution. Drivers often spend considerable time searching for parking slots, which not only wastes resources but also contributes to urban inefficiency. Existing systems lack real-time tracking and intelligent management of parking availability, resulting in poor utilization of parking spaces.*

To address these challenges, there is a critical need for an intelligent parking management system that can provide real-time information about slot availability, optimize space usage, and guide users efficiently. Such a system can leverage modern technologies like IoT, sensors, and data analytics to enhance urban mobility, reduce traffic congestion, minimize fuel wastage, and contribute to a cleaner and smarter city environment.

Keywords: Smart Parking System, Real-Time Slot Tracking, Traffic Congestion, Fuel Wastage, Urban Mobility, Internet of Things (IoT), Parking Management, Smart Cities, Sensor-Based Systems, Environmental Pollution

I. INTRODUCTION

Rapid urbanization and the continuous growth in the number of vehicles have created significant challenges for parking management in metropolitan areas. One of the most common problems faced by drivers is the difficulty in finding available parking slots, especially in crowded city centers. This issue not only causes inconvenience to users but also leads to increased traffic congestion, as vehicles spend considerable time circulating in search of parking spaces.

The lack of an efficient parking management system results in unnecessary fuel consumption and contributes to environmental pollution. Traditional parking methods rely on manual monitoring or static information, which fails to provide real-time updates about slot availability. As a result, drivers often experience delays, frustration, and inefficiency in utilizing existing parking infrastructure.

In recent years, advancements in technology such as the Internet of Things (IoT), wireless communication, and smart sensors have opened new possibilities for addressing these challenges. Intelligent parking systems can monitor parking spaces in real time, provide accurate availability information, and guide drivers directly to vacant slots. Such systems not only improve user convenience but also help in reducing traffic congestion, fuel wastage, and carbon emissions.

This research paper focuses on the design and implementation of a smart parking solution that leverages modern technologies to enable real-time slot tracking and efficient parking management. The proposed system aims to optimize the utilization of parking resources, enhance urban mobility, and contribute to the development of smart and sustainable cities. Rapid urbanization and the continuous increase in the number of vehicles have created significant challenges for transportation and parking management in metropolitan areas. As cities expand and population density rises, the demand for parking spaces has grown disproportionately compared to the available infrastructure. One of the most

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pressing issues faced by daily commuters is the difficulty in locating vacant parking slots, particularly in busy commercial zones, residential complexes, and public places.

This problem has far-reaching consequences beyond individual inconvenience. A large number of vehicles circulating in search of parking contributes directly to traffic congestion, especially during peak hours. Studies indicate that a considerable portion of urban traffic is caused by drivers looking for parking spaces. This unnecessary movement leads to excessive fuel consumption, increased travel time, and elevated levels of air and noise pollution. Consequently, it negatively impacts the environment, public health, and overall efficiency of urban transportation systems.

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II. RELATED WORK

Several research efforts have been carried out to address the challenges associated with parking management in urban environments. Early parking systems primarily relied on manual monitoring and basic automation techniques, which lacked efficiency and real-time capabilities. These traditional approaches often resulted in poor space utilization and increased congestion due to the absence of dynamic information.

With the advancement of wireless communication and embedded systems, researchers introduced sensor-based parking solutions. These systems use ultrasonic, infrared, or magnetic sensors to detect the presence of vehicles in parking slots. The collected data is transmitted to a central system, enabling better monitoring of parking availability. While these approaches improved accuracy, many of them were limited by high installation costs and scalability issues.

Recent studies have focused on the integration of the Internet of Things (IoT) to develop smart parking systems. IoT-based solutions allow real-time data collection and communication between devices, making it possible to track parking slot availability dynamically. Many researchers have proposed mobile and web applications that provide users with live updates, navigation assistance, and booking options. These systems significantly reduce the time required to find parking and help in minimizing traffic congestion.

In addition, cloud computing has been widely adopted to store and process large volumes of parking data. Cloud-based platforms enable centralized management, data analytics, and remote accessibility. Some research works also incorporate machine learning algorithms to predict parking availability based on historical data, time, and location. These predictive models enhance the efficiency of parking systems by allowing users to plan their parking in advance.

Vision-based parking systems have also gained attention in recent years. These systems use cameras and image processing techniques to detect available parking spaces. Although they provide high accuracy and require less hardware installation in individual slots, they may be affected by environmental conditions such as lighting and weather.

Despite these advancements, several challenges remain, including high implementation costs, data security concerns, and the need for reliable real-time communication. Many existing systems also lack integration with smart city infrastructure and fail to provide a fully scalable solution.

This research builds upon existing work by proposing an intelligent parking system that combines real-time slot tracking with efficient data management and user-friendly interfaces. The aim is to overcome the limitations of previous approaches and provide a cost-effective, scalable, and reliable solution for modern urban environments.

III. OBJECTIVE OF SYSTEM

The objective is to identify patterns in the language of individuals with depression by comparing their vocabulary to that of users.

- Detect available parking slots in real time
- Reserve slots through mobile app
- AR-based navigation to parking slots

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- Voice search & AI-based slot prediction

Admin panel for parking owners

- To design a system that provides **real-time information** about available parking slots to users.
- To reduce **traffic congestion** caused by vehicles searching for parking spaces.
- To minimize **fuel consumption and environmental pollution** by optimizing parking search time.
- To utilize **IoT and sensor-based technologies** for accurate detection of parking slot occupancy.
- To develop a **user-friendly interface** (mobile/web application) for easy access to parking information.
- To improve **parking space utilization** by efficiently managing available slots.
- To enable features such as **slot reservation and navigation guidance** for users.
- To create a **scalable and cost-effective system** that can be implemented in smart city environments.
- To enhance overall **urban mobility and convenience** for drivers.

IV. PROPOSED SYSTEM

The proposed system aims to develop an intelligent smart parking solution to address the growing difficulty of finding parking slots in metropolitan areas. The system is designed to reduce traffic congestion, fuel wastage, and environmental pollution by providing a real-time, efficient, and user-friendly parking management platform.

The solution enables users to easily search for available parking spaces, reserve slots in advance, and navigate directly to the selected location using integrated mapping services. This reduces the time spent searching for parking and improves overall driving convenience. For administrators, the system provides a comprehensive dashboard to manage parking slots, set dynamic pricing, and generate detailed reports for better decision-making and system monitoring.

The system is built using modern technologies such as Flutter for cross-platform mobile application development and Firebase for real-time database management and authentication. Integration with Google Maps API allows accurate location tracking and navigation, while ARCore enhances user experience through advanced visualization features. TensorFlow Lite can be utilized for intelligent predictions and smart recommendations based on user behavior and parking patterns.

SYSTEM ARCHITECTURE

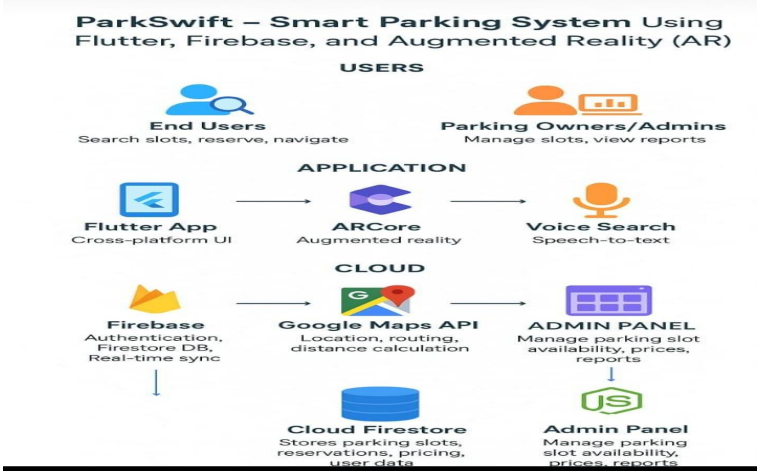

Fig 1. System Architecture

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RESULT

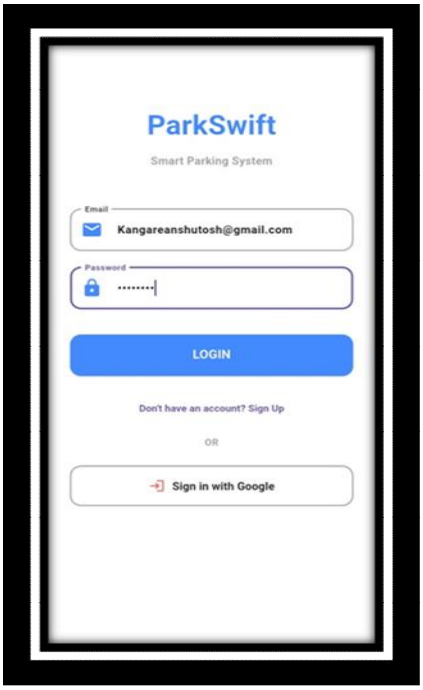

Fig 2. Login Page

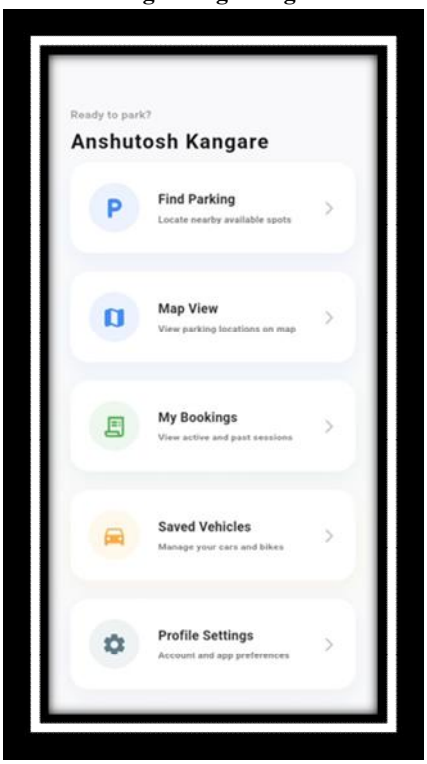

Fig 3.Dashboard

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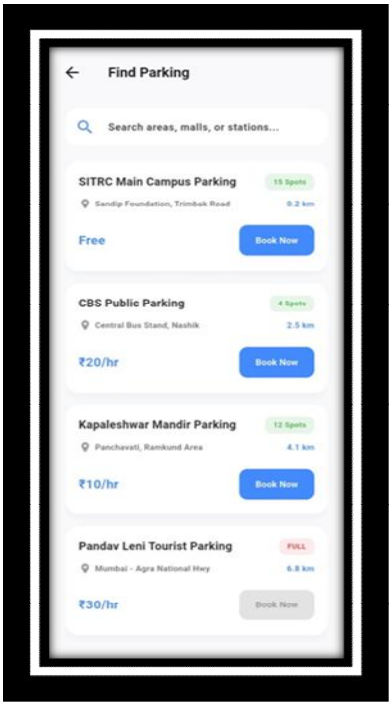

Fig 4.Find Parking

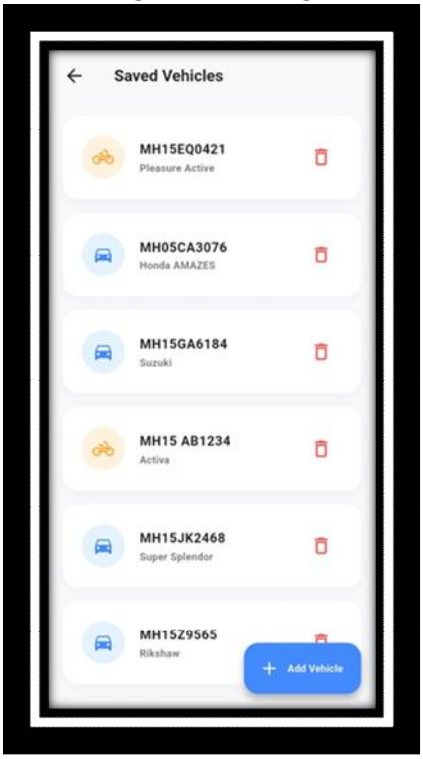

Fig 5.Saved Vehicles

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Fig 6. Parking Slots

V. CONCLUSION

The increasing difficulty in finding parking spaces in metropolitan areas has become a major concern, contributing to traffic congestion, fuel wastage, and environmental pollution. Traditional parking systems are inefficient and lack real-time capabilities, making it essential to adopt smarter and more intelligent solutions.

This research presented a smart parking system that leverages modern technologies to provide real-time slot tracking, reservation, and navigation features for users, along with efficient management tools for administrators. By integrating technologies such as Flutter, Firebase, Google Maps API, ARCore, and TensorFlow Lite, the proposed system ensures a user-friendly, scalable, and efficient approach to parking management.

The implementation of this system can significantly reduce the time spent searching for parking, optimize space utilization, and improve overall urban mobility. Additionally, its scalability through IoT sensor integration makes it suitable for future expansion in smart city environments.

In conclusion, the proposed intelligent parking system offers an effective and sustainable solution to modern parking challenges, contributing to reduced congestion, lower fuel consumption, and a cleaner urban environment..

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