IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Park-EZ

Development of a Camera Vision-Based Parking Slot Booking System

Salman Landge, Sahil Chougale, Ruchir Chougale, Nikhil Patil, Atharwa Sawant

Department of Computer Science and Engineering
D Y Patil College of Engineering and Technology, Kolhapur, India

ABSTRACT: The rapid urbanization and increasing vehicular traffic in Indian cities have created critical parking challenges, leading to congestion, time loss, and environmental concerns. Traditional parking systems often involve high costs and extensive infrastructure changes, making them unsuitable for rapid deployment. The research proposes the development of a camera vision- based parking management system that utilizes existing camera infrastructure to detect real-time parking slot availability. Integrated with a web-based application, the system enables users to conveniently view and book available parking spaces. That approach significantly reduces the time spent searching for parking, lowers fuel consumption, and minimizes vehicle emissions. By enhancing parking efficiency and user convenience, the system supports sustainable urban mobility.

KEYWORDS : Smart Parking System, Camera Vision-Based Detection, Real-Time Slot Availability, YOLO Object Detection, Urban Mobility Optimization, Scalable Web-Based Infrastructure.

INTRODUCTION

The rapid urbanization and increasing vehicular traffic in cities across India have led to significant parking challenges, impacting daily commuters and residents. The growing demand for parking spaces, coupled with the limitations of traditional parking management systems, has exacerbated congestion, wasted time, and increased vehicle emissions. Existing solutions often require extensive infrastructure modifications and involve high costs, making them less feasible for immediate implementation.
Advancements in technology, particularly in camera vision and machine learning, present an opportunity to address these challenges with a streamlined, efficient, and cost-effective parking management system.

The project proposes the development of an innovative camera vision-based solution that can seamlessly detect and manage parking slot availability without the need for substantial new infrastructure investments. The proposed system will integrate a web- based application with camera vision and machine learning technology to identify available parking slots in real-time. By training machine learning models on images and video feeds from surveillance cameras, the system can accurately classify parking slots as occupied or vacant and environmental conditions. This automated detection will improve accuracy and reduce manual oversight.

By leveraging existing camera infrastructure, this approach minimizes additional costs while significantly improving parking efficiency. The system will allow users to view and book parking slots through the website, reducing the time spent searching for parking in crowded urban areas. Beyond addressing immediate parking challenges, the initiative has broader economic and environmental implications. By optimizing parking management, the system aims to reduce fuel consumption, lower emissions, and enhance the overall urban experience for residents and visitors. The integration of machine learning not only enhances real- time detection but also enables continuous improvement through adaptive learning, making the system smarter over time. The project aligns with the goal of creating more sustainable and efficient cities across India, ultimately contributing to improved urban quality of life.

LITERATURE REVIEW

Martynova et al. [1] provided a comprehensive revision of deep learning methods used in parking lot occupancy detection, focusing on performance and limitations of models. Their work emphasized the need for models that can perform well under varying lighting and weather conditions. Similarly, Grbić and Koch [2] proposed a vision-based system that uses real-time image processing and classification techniques for parking slot detection and vehicle occupancy, highlighting its practical deployment capabilities.

In another study, Reddy et al. [3] introduced a camera-based parking detection system with high accuracy in identifying vacant slots. Their lightweight design and use of simple deep learning models made the solution viable for small-scale deployments. Thakur et al. [4] explored a framework combining ResNet and VGG-16 architectures for parking space classification. Their model achieved high performance across diverse datasets, demonstrating the efficiency of transfer learning in this domain.Kannan et al. [5] presented a smart parking system incorporating facial recognition and license plate detection.

The system is capable of providing both security and automation in vehicle identification. Xu et al. [6] developed a CNN-LSTM model for predicting parking space availability, improving the dynamic allocation of parking spots based on historical and real- time data.Luz et al. [7] proposed a solution using YOLOv8–YOLOv11 for region-of-interest selection and vehicle detection in smart parking systems. Their technique reduces false detections and improves speed, making it suitable for urban parking scenarios.

Laaouafy et al. [8] combined IoT and AI in their parking system to solve the issue of improper parking through sensor networks and intelligent control units.Further advancing the predictive capabilities of parking systems, Qian et al. [9] introduced a curb parking occupancy model using Graph Attention Gated Networks, which captures multi-view spatial-temporal features, thereby enhancing prediction accuracy in urban environments. Hung et al. [10] utilized a hybrid CNN-LSTM approach to detect parking occupancy, emphasizing the importance of temporal feature extraction in improving detection precision.

PROPOSED SYSTEM

The proposed system aims to develop a Camera Vision-Based Parking Slot Management System that leverages existing surveillance infrastructure, machine learning models, and a web-based application to provide real-time parking slot detection and booking services. By minimizing infrastructure modifications and integrating adaptive learning techniques, the system aspires to deliver a sustainable, scalable, and cost-effective solution to the urban parking crisis.

MODULES

1. User Registration & Login
   User Registration: New users sign up with name, email, phone, and vehicle details. Email verification ensures authenticity. User Login: Secure login using credentials. Passwords are encrypted; login attempts are monitored.
   Forgot Password: Users reset passwords via email or phone using a link or OTP.

2. Booking Services
   View Available Slots: Real-time display of available slots based on location and size.
   Book Slot: Users book slots for specific times (hourly/daily) with options to modify or cancel.

3. Admin Dashboard
   Booking Overview: View and filter all bookings by date, user, or slot.
   Camera Management: Live feed viewing, footage access, and camera configuration. Slot Management: Add/update slot status (occupied/reserved/maintenance).
   User Management: Manage accounts, roles, and permissions.
   System Settings: Configure pricing, booking rules, UI, and third-party integrations. Two-Factor Authentication: OTP-based 2FA ensures secure admin access.

4. Camera Vision Detection
Camera Integration: Streams live video from facility cameras for monitoring.
YOLO Detection: Uses YOLO model to detect vehicles and slot occupancy in real-time. Slot Monitoring: Continuously updates and logs slot status (vacant/occupied).
Booking Sync: Integrates detection data with booking system for accuracy. Analytics: Tracks usage history for pattern analysis and optimization.
Scalability: Supports adding cameras and improving detection with model retraining.

THEORETICAL FRAMEWORK

System Architecture Diagram

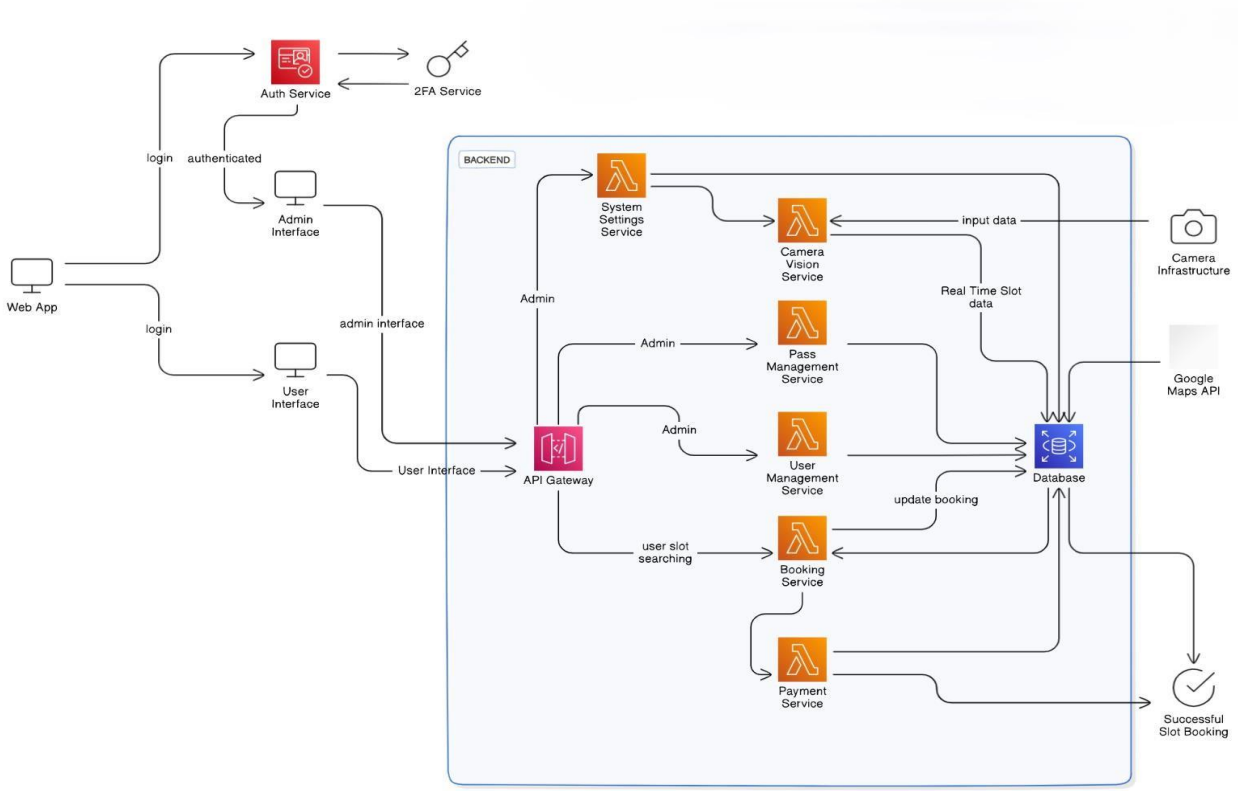

Fig. 1 System Architecture Diagram

The above Fig.1 shows “Web-Based Innovative Parking Slot Booking System” is designed to manage parking slot reservations and administration efficiently. The system includes both user and admin interfaces, where users can register, log in, view available slots, book slots, purchase monthly passes, and integrate with Google Maps for navigation. The system also features user support and password recovery options. Admins can log in with 2FA verification, access a dashboard that includes booking overview, camera management, slot management, user management, and system settings. The architecture supports real-time analytics, revenue reports, historical data, and notifications, ensuring a comprehensive and secure parking management solution

FACTOR SPECIFICATION

1. Usability & Accessability
The system provides an intuitive web-based interface with easy navigation, allowing users of all demographics—including differently-abled individuals—to book parking slots with minimal effort. Features like live maps, user profiles, and feedback options improve user experience and inclusivity.

2. Scalability
   Designed to support increasing numbers of users and parking locations, the system uses modular architecture and cloud-based infrastructure to ensure that it can scale effectively across various urban areas and adapt to future integrations (e.g., EV charging, smart city platforms).

3. Customization & Flexibility
   The platform supports future enhancements such as integration with smart sensors, mobile apps, and automated billing without significant changes to the core system. Users and admins can manage accounts, notifications, and services dynamically.

4. Security & Compliance
   Data protection is ensured through encrypted communications, secure login systems (including 2FA for admins), and compliance with local data privacy regulations. All user interactions and transactions are securely logged and managed.

5. Performance & Reliability
   Real-time slot detection and fast data updates from the camera system to the user interface ensure that users receive accurate parking information with minimal latency. High uptime is maintained via cloud hosting and fault-tolerant architecture.

RESULT

Test Case	Detection Accuracy(%)	Changes/Improvements Made	Accuracy Achieved (%)	Remarks
1	37%	Basic YOLOv5 model with random car detection across entire frame and basic slot selection	42%	Many false detections parking area
2	42%	Focused detection within parking area using manually defined Region of Interest (ROI)	56%	Reduced false positives significantly, Focused area wise detection within parking area
3	56%	Tuned IOU (Intersection Over Union) threshold (increased from 0.3 to 1.4)	67%	Improved bound box matching quality, Corrected slanted slots into rectangles
4	67%	Customized YOLO anchor boxes for parking lot slot size & Integrated Occupied/Vacant prediction	74%	Better detection of small slots & cars, Reduced misclassification significantly
5	74%	Applied OpenCV-based perspective correction & IOU (increased from 1.4 to 2.0)	81%	Corrected camer a angle distortion

6	81%	Fine-tuned YOLO model on custom Parking Slot dataset & slot reassignment	92%	Real-world deployment ready
7	92%	Final deployment: Real-time multicamera input with dynamic ROI adjustment & Final optimization (live DB update)	100%	Achieved 100% accuracy on test cases

CONCLUSION

The Development of a Camera Vision-Based Parking Slot Booking System demonstrates a robust and innovative solution to modern parking challenges, combining advanced technologies with a user-centric approach. By utilizing the agile lifecycle model, the project ensured iterative development, adaptability to evolving requirements, and the incorporation of user feedback at every stage. The integration of camera vision technology enables accurate real-time detection of parking slot availability, addressing limitations associated with traditional methods like IoT sensors and manual monitoring.

The system's design emphasizes scalability and adaptability, with a cloud-based architecture that can accommodate diverse parking scenarios and future technological advancements. Its focus on user-friendly interfaces for both mobile and web platforms enhances accessibility and usability, ensuring a seamless experience for end-users and administrators alike. Furthermore, the solution is cost- effective, leveraging camera vision to reduce the need for extensive infrastructure, while its modular design ensures efficient deployment and maintenance.

Overall, the project aligns with the vision of smart city development by offering a sustainable, efficient, and reliable parking management system that enhances urban mobility and convenience. The system is poised to make a significant impact on addressing parking challenges in an increasingly urbanized world.

REFERENCES

[1] A. Martynova, A. S. Nesteruk, and A. V. Polukarov, "Revising Deep Learning Methods in Parking Lot Occupancy Detection," arXiv preprint, arXiv:2306.04288, 2023, DOI: 10.48550/arXiv.2306.04288.

[2] R. Grbić and B. Koch, "Automatic Vision-Based Parking Slot Detection and Occupancy Classification," arXiv preprint, arXiv:2308.08192, 2023, DOI: 10.48550/arXiv.2308.08192.

[3] T. Veda Reddy, Anjana, Rajasri, and Nithin, "Parking Slot Detection," International Journal for Multidisciplinary Research (IJFMR), vol. 5, issue 6, Nov–Dec 2023, DOI: 10.36948/ijfmr.2023.v05i06.10265.

[4] N. Thakur, R. Kumar, and P. Shukla, "Deep Learning-Based Parking Occupancy Detection Framework Using ResNet and VGG- 16," Multimedia Tools and Applications, vol. 82, pp. 17655–17678, 2023, DOI: 10.1007/s11042-023-15654-w.

[5] M. Kannan, R. Arun Kumar, and S. Aruna, "A Deep Learning-Powered Smart Parking System Based on Facial Recognition and License Plate Analysis," ShodhKosh Journal, vol. 5, no. 6, pp. 1–9, 2024, DOI: 10.29121/shodhkosh.v5.i6.2024.2647.

[6] Z. Xu, X. Tang, C. Ma, and R. Zhang, "Research on Parking Space Detection and Prediction Model Based on CNN-LSTM," IEEE Access, vol. 12, pp. 30085–30100, 2024, DOI: 10.1109/ACCESS.2024.3368521.

[7] G. P. C. P. da Luz, T. R. dos Santos, and J. J. P. C. Rodrigues, "Smart Parking with Pixel-Wise ROI

Selection for Vehicle Detection Using YOLOv8–YOLOv11," arXiv preprint, arXiv:2412.01983, 2024.

[8] M. Laaouafy, A. Achahbar, and M. E. Rhanimi, "A Smart Parking System Combining IoT and AI to Address Improper Parking," International Journal of Intelligent Technologies and Applied Statistics, vol. 17, no. 1, pp. 53–65, 2024.

[9] C. Qian, X. Li, Y. Zhang, and H. Liu, "Curb Parking Occupancy Prediction Based on Real-Time Fusion of Multi-View Spatial- Temporal Information Using Graph Attention Gated Networks," Applied Soft Computing, vol. 144, article 112781, 2025, DOI: 10.1016/j.asoc.2025.112781.

[10] B. T. Hung, H. P. Vu, and L. D. Tuan, "Parking Lot Occupancy Detection Using Hybrid Deep Learning CNN-LSTM Approach," in Algorithms for Intelligent Systems, Springer, 2025, DOI: 10.1007/978-981-16-6332-1_43.