# Literature Review: AI-Based Urban Parking Slot Prediction

The rapid urbanization and increasing number of vehicles have intensified the problem of parking space availability in cities worldwide. In response, researchers have increasingly focused on predictive models and intelligent systems to improve parking slot management using AI and machine learning techniques.

One prominent strategy includes using historical parking data combined with real-time inputs to predict future availability. Ahmed et al. (2021) demonstrated the potential of time-series analysis and Random Forest models to forecast parking slot occupancy, showing improvements in both accuracy and operational efficiency for urban municipalities. Their work established that preprocessing features such as time, location, and historical trends enhances the prediction accuracy.

Random Forest Classifier (RFC) is widely adopted in parking prediction models due to its robustness in handling both categorical and continuous data, and for managing non-linear relationships. Nascimento et al. (2022) applied RFC to sensor data collected from IoT-enabled smart parking systems. Their research reported a classification accuracy exceeding 90% in distinguishing between available and occupied slots.

Another stream of research includes the integration of deep learning and computer vision, particularly for visual confirmation and safety-based features. Liu et al. (2020) used convolutional neural networks (CNNs) with street camera data to automatically detect empty parking spaces and feed those results into availability prediction algorithms.

Some studies focused on chatbot-driven applications that facilitate user interaction and query resolution. Kumar and Thakur (2023) discussed an AI-powered chatbot that interacts with users to provide real-time predictions on slot availability using natural language inputs. Their system was powered by a Flask backend linked to a trained machine learning model and demonstrated high user satisfaction in trials.

For frontend development, Next.js has emerged as a preferred choice due to its server-side rendering and React compatibility, which allows for faster interactions and responsive UIs. Combined with Flask APIs and hosted on platforms like Render, such applications ensure scalable and low-latency performance.

Geospatial integration is another critical area of research. Integrating parking prediction systems with platforms like Google Maps or Mapbox enables users to visualize predictions on a real map, enhancing usability. Zhou et al. (2023) emphasized the importance of mapping interfaces in improving user trust and overall decision-making.

Recent advancements in real-time traffic analytics have also contributed to improved parking prediction systems. Radhakrishnan et al. (2023) leveraged live traffic sensor data for dynamically adjusting parking predictions, showing the adaptability of hybrid models in urban environments.

Mobile app development using cross-platform frameworks like Flutter has facilitated wider deployment of smart parking solutions. According to Singh and Pathania (2023), apps using Flutter and TensorFlow Lite provided offline inference capabilities and better user accessibility in low-connectivity areas.

Studies by Hoang et al. (2022) demonstrated the advantage of integrating weather and event-based context data to further improve the accuracy of parking slot availability forecasts, especially in metropolitan areas prone to seasonal congestion.

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