

Research on deep learning technology for recognizing empty parking spaces in smart parking lots

Tran Ngoc Anh

Abstract: This study investigates the application of deep learning technologies for the real-time identification of vacant parking spaces in smart parking lots. Leveraging convolutional neural networks (CNNs), the research proposes a robust computer vision-based system capable of processing live camera feeds to detect and classify parking occupancy status. A custom dataset of parking lot images under varying lighting and weather conditions was compiled and annotated. Several deep learning architectures, including VGG16, ResNet, and YOLO, were trained and evaluated for accuracy and inference speed. Experimental results demonstrate that the optimized model achieves over 97% classification accuracy with a processing latency suitable for real-time deployment. The system effectively distinguishes between occupied and empty spaces, even in partially occluded scenarios. This work provides a scalable and cost-effective solution for smart city infrastructure, reducing driver search time and traffic congestion. The findings confirm that deep learning offers a superior alternative to traditional sensor-based methods for parking space detection.

Keywords: Deep learning, parking spot recognition, smart parking lot, vacant spot detection