Smart Parking Management and Vehicle Monitoring using OpenCV and Computer Vision

Aasif Abdul Hameed
BS Abdur Rahman Crescent Institute of Science and Technology, Chennai, India

Abstract

An Intelligent Parking Management and Vehicle Monitoring System using OpenCV and realtime computer vision techniques is proposed to address parking congestion, inefficient space utilization, and security challenges within campus environments. The system leverages live video feeds from surveillance cameras installed at parking entrances, exits, and internal zones to automatically detect, classify, and monitor vehicles entering and exiting parking areas using image processing and deep learning–based object detection algorithms. OpenCV is utilized for real-time frame processing, vehicle counting, number plate recognition, and parking occupancy analysis, enabling accurate identification of available parking slots. The system provides dynamic parking status updates, reduces manual intervention, minimizes traffic congestion, and enhances campus security by detecting unauthorized, improperly parked, or suspicious vehicle activities. By integrating real-time analytics with an intelligent monitoring framework, the proposed solution ensures efficient parking management, improved user experience, and scalable deployment for smart campus infrastructures.

In addition to parking management, the system addresses challenges related to night-time vehicle detection, where limited lighting conditions significantly affect visibility and detection accuracy. To overcome this issue, a novel multi-granularity detection approach is adopted that dynamically adapts to varying illumination conditions, ranging from bright daytime scenarios to extreme low-light environments. The approach combines bounding-box-based detection, used when vehicle appearance is sufficiently visible, and point-based detection, used when visual details are severely degraded. The detection framework is implemented using a multihead neural network built on a shared Hourglass backbone, capable of learning from both bounding-box and point-based annotations during training.

Extensive experimental evaluations conducted on combined datasets such as BDD100K, PVDN, and a self-acquired dataset (FNTVD) demonstrate improved robustness, accuracy, and real-time performance at 45.45 FPS. These results indicate that the proposed system is well-suited for practical deployment in real-world campus environments, supporting intelligent transportation management, enhanced security, and future smart campus development.