

Smart Traffic Control Using Computer Vision

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Abstract: *A Smart Traffic Control System using Computer Vision utilizes cameras, image processing techniques, and machine learning algorithms to monitor, analyze, and manage traffic flow automatically. Unlike conventional traffic systems, this approach does not rely solely on pre-defined signal timings. Instead, it dynamically adjusts traffic signals based on real-time traffic density and road conditions. Cameras installed at intersections capture live video feeds, which are processed using computer vision algorithms to detect vehicles, count traffic density, identify congestion levels, and monitor violations such as red-light jumping or illegal lane changes.*

The core of this system lies in image processing and object detection techniques. Computer vision models such as Convolutional Neural Networks (CNNs), YOLO (You Only Look Once), or other deep learning-based detection frameworks are used to identify vehicles in video frames. These models can classify different types of vehicles, including cars, buses, trucks, motorcycles, and bicycles. By analyzing the number and movement of vehicles in each lane, the system determines the level of traffic congestion in real time. Based on this analysis, an intelligent controller adjusts the duration of traffic signals to prioritize lanes with higher vehicle density, thereby improving traffic flow and reducing waiting times.

In addition to traffic density estimation, the system can also perform advanced functionalities such as accident detection, emergency vehicle recognition, and traffic rule enforcement. For example, if an ambulance or fire truck is detected approaching an intersection, the system can automatically switch the traffic signal to green for that lane, ensuring faster emergency response times. Similarly, computer vision algorithms can detect accidents or unusual traffic patterns and immediately alert traffic authorities for quick intervention.

Another significant advantage of computer vision-based traffic systems is their ability to collect and analyze traffic data over time. The collected data can be used to generate traffic patterns, predict peak traffic hours, and assist city planners in designing better road infrastructure. Integration with Internet of Things (IoT) devices and cloud-based systems can further enhance the system's capabilities by enabling remote monitoring, centralized traffic control, and real-time data sharing across multiple intersections.

Furthermore, this system contributes to environmental sustainability by reducing idle time at intersections, lowering fuel consumption, and minimizing carbon emissions caused by traffic congestion. It also improves road safety by detecting traffic violations and providing automated surveillance, which can discourage reckless driving behavior.

Despite its many advantages, implementing a smart traffic control system using computer vision also presents certain challenges. These include varying weather conditions, low-light environments, occlusions between vehicles, and the requirement for high computational power to process real-time video data. However, advancements in deep learning, edge computing, and high-performance hardware are continuously improving the reliability and efficiency of such systems.

Keywords: Smart Traffic Control System, Traffic Management, Artificial Intelligence, Image Processing, Emergency Vehicle Detection, YOLO Object Detection

