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Fully Automated Traffic Light System with Image Processing

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Traffic congestion has become a serious global challenge due to rapid population growth and urbanization. Conventional traffic light systems based on fixed time intervals cannot handle dynamic vehicle flow effectively. Although adaptive systems such as SCATS and SCOOT use loop sensors to manage real-time adjustments, they depend on expensive infrastructure and limited sensing capability, making them unsuitable for many developing regions. This study proposes a fully automated traffic light control system that uses image processing and deep learning to dynamically manage traffic based on real-time conditions. The proposed system employs the YOLOv5 algorithm to detect and count vehicles from live images, automatically adjusting the green light duration according to lane density. A dataset of 11,129 high-definition images captured from 23 CCTV cameras in Hangzhou, China, was used for model training and evaluation. The system achieved Average Precision (AP) for cars of 87.44%, AP for buses of 88.54%, AP for trucks of 88.34%, Mean Average Precision (mAP) of 87.88%, and Intersection over Union (IoU) of 75.44%, confirming its reliability. Compared with conventional fixed-timer systems, this adaptive vision-based model improves efficiency and minimizes unnecessary waiting time. The results show that a computer-vision-driven adaptive approach offers a cost-effective and scalable alternative to existing sensor-based systems, enhancing road performance and commuter experience.

Keywords: CNN, Image processing, YOLOv5, Object detection.