Project Title: Image Captioning for Traffic Rule-Breaking

DS510 - Artificial Intelligence and Machine Learning Lab (AIML Lab)
Project Report

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Abstract

This project focuses on creating a robust and efficient system to detect and log traffic rule violations at night using advanced image captioning and computer vision techniques. The model identifies traffic light states, stop lines, and license plates and integrates the extracted data with a database to facilitate automated monitoring.

Problem Statement

The project aims to develop an image captioning model capable of identifying traffic rule-breaking events, especially in night time conditions. The primary goals are:

- **Traffic Light Detection:** Accurately identify the state of traffic lights in real-time.
- **Stop Line Identification:** Detect stop lines dynamically in night time traffic images.
- **License Plate Recognition:** Extract vehicle license plate text using Optical Character Recognition (OCR).
- **Database Integration:** Log violations and related data in a centralized MySQL database.

Motivation

Traffic violations, especially at night, are challenging to monitor manually. This project addresses these challenges by:

- Automating traffic rule monitoring to enhance safety.
- Improving real-time traffic management for law enforcement.
- Leveraging AI and computer vision to solve practical problems in urban areas.

Experimentation

The system integrates multiple computer vision and image processing techniques:

1. **Traffic Light Color Detection:** Using HSV thresholds to isolate red, yellow, and green states.
2. **Stop Line Detection:** Employing edge detection, Gaussian blur, and line equations to identify stop lines.
3. **License Plate Extraction:** Detecting license plates using Haar cascades and morphological operations.
4. **OCR Text Extraction:** Applying PyTesseract OCR for extracting text from license plates.

Implementation

The implementation involves the following steps:

- **Image Preprocessing:** Converting images to HSV, applying ROI cropping, and enhancing quality using thresholding.
- **Traffic Light Detection:** Identifying light states by applying color-specific binary masks.
- **Stop Line Detection:** Computing average slopes and intercepts of detected lines for precise detection.

- **License Plate OCR:** Enhancing images using contrast-limited adaptive histogram equalization (CLAHE) for better OCR accuracy.
- **Hough Line Transform:** Apply the Hough Line Transform to detect the stop line based on the processed edges and storing the line parameters into the queues.
- **Haar Cascade Classifier:** Now, through the Haar cascade classifier-a traditional non-deep learning approach proficient in pattern recognition-it processes the cropped grayscale image and identifies possible locations of license plates as rectangles due to prior training on identifying license plate patterns.

Results and Discussions

The system achieved:

- High accuracy in detecting traffic light states and stop lines in nighttime conditions.
- Efficient license plate text extraction using OCR.
- Successful integration with a MySQL database for real-time logging.

Future work could improve scalability and performance under adverse conditions like weather or overlapping vehicles.

Conclusion

The developed system demonstrates the potential of AI-powered solutions for automating traffic rule enforcement. With scalability, this framework can significantly enhance urban traffic management and safety.