Detecting and Fetching License numbers from moving vehicles

Krishnakant Modani
George Mason University
4400 University Drive
Fairfax, Virginia 22030
https://www.gmu.edu/

Abstract

The automated detection and recognition of license plates on moving vehicles is a critical technology for applications ranging from traffic monitoring to security enforcement. We developed a robust system using the YOLO (You Only Look Once) framework for detecting vehicles and license plates and the SORT (Simple Online and Realtime Tracking) algorithm for tracking vehicles across frames. Optical character recognition (OCR) technology was applied to interpret the alphanumeric content of detected license plates.

1. Introduction

Automated license plate detection and recognition on moving vehicles is crucial for enhancing traffic management, law enforcement, and security monitoring. This technology allows for accurate vehicle tracking and efficient management in urban environments and security-sensitive contexts. Our approach leverages the YOLOv8 model for real-time detection of vehicles and license plates, combined with the SORT algorithm for tracking vehicles across video frames. We also integrate EasyOCR for interpreting alphanumeric characters on license plates. This method strikes a balance between accuracy and efficiency, demonstrating high proficiency in detecting and recognizing plates under diverse conditions. The results highlight the system's robust tracking and recognition capabilities, showing its potential to improve intelligent transportation systems and automated vehicle monitoring.

2. Approach

The pipeline for our automated license plate detection and recognition system is designed to be both efficient and robust, handling complex scenarios encountered in real-world settings. Here's a detailed breakdown of our technical approach:

2.1. Video Processing

We start by loading the video stream using the OpenCV library, which allows us to process individual frames. Each frame is a snapshot that needs analysis, and OpenCV provides the necessary tools for image manipulation and processing that are critical for the subsequent detection tasks.

2.2. Vehicle Detection

Each video frame is input into a pre-trained YOLOv8 model specifically configured to detect vehicles. This model is known for its speed and accuracy in detecting objects in images. YOLOv8 identifies and localizes vehicles by drawing bounding boxes around them, which are then used to extract specific regions of the frame for further analysis.

2.3. Vehicle Tracking

With vehicles identified, we employ the SORT (Simple Online and Realtime Tracking) algorithm to track these vehicles across frames. SORT uses the bounding boxes provided by YOLOv8 to assign unique tracking IDs to each vehicle, allowing us to maintain continuity even in dynamic scenes. This tracking ensures that we can follow a specific vehicle across the entire video, capturing its trajectory and behavior.

2.4. License Plate Detection

After vehicle detection, we apply a specialized license plate detection model trained to recognize and localize license plates within the vehicle bounding boxes. This focused detection is crucial as it directly targets the smaller areas where plates are located, enhancing the accuracy of the plate recognition that follows.

2.5. Image Pre-processing for OCR

Once the license plates are detected, the corresponding image regions are cropped and pre-processed using OpenCV. We apply thresholding techniques to enhance the contrast of the text against the plate background, facilitating clearer text recognition. This step is essential for improving the accuracy of text extraction in varying lighting conditions and plate orientations.

2.6. Text Extraction with OCR

The pre-processed license plate images are then processed by EasyOCR, an optical character recognition tool, to extract alphanumeric characters from the plates. EasyOCR converts the image data into string format, which can be analyzed and stored.

2.7. Data Storage and Analysis

The recognized license plate numbers, along with their associated vehicle tracking IDs and other relevant data, are written to a CSV file. This structured data storage allows for easy access and analysis, enabling further applications such as traffic pattern analysis, vehicle tracking, and law enforcement.

3. Results

With successfully running through our pipeline of workflow, we were able to achieve desired outcomes at every steps. Although it was challenging in many ways, but finally got to see the results, screenshots of which are shared below:

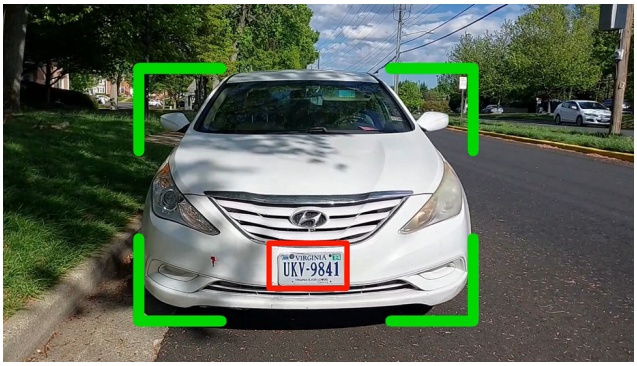

Figure 1. Demonstration of bounding boxes after car and license plate detection

After the successful detection of license plate, I made sure that the license plates maps to the correct vehicles. Once this is done, I worked on the cropping of the plate image and processed it. I thresholded the image to make it more efficient for the OCR to extract the alpha-numeric characters from it. Below is the sample of cropped and thresholded image :

Figure 2. This is not the screenshot of license plate of above car. This is just for demonstration

The final outcome is a video, with the bounding boxes on cars and plates, along with the decoded license plate number displayed at the top of the screen, the one with the highest confidence score is displayed.

Figure 3. Screenshot from final output video.

4. Related Work

Although the idea isn't so new to the world, but it was a good starting point to learn and make the concepts turn in actions. To make this happen, I went through some useful resources that helped me gain some deeper dive into the real-life scenarios and happening around the same concepts. Few of those resource links are mentioned below:

The Wikipedia article on automatic license plate detector gave some ideas on what components actually matters in these scenarios, what are the laws related to these, to what extent is this technology useful to the society. The detailed explanation of the same can be found on Wikipedia.

Another insightful reading was this Blog.

The pipeline designing idea was inspired by reading this article from mdpi

5. Resources

The project covers most of the key concepts of computer vision in action. The implementation of these algorithms are always challenging. Challenging, w.r.t. time spent on building the model from scratch, training the model, and then a rigorous testing. Inorder to focus on bringing the idea to reality in a tight time frame, we required the use of pre-built libraries. Below are the libraries that were helpful to bring this project to reality:

Yolov8 model for object detection in video - Yolov8

Dataset for Pre-trained License Plate Detector - roboflow

SORT algorithm for vehicle tracking in video - SORT

EasyOCR python library to extract the texts - easyOCR

CV2 library for loading and processing video - opencv

6. What I have learned

Working on this project, has made way for me to explore different entities of computer vision. My understanding of both the theoretical and practical aspects of computer vision has significantly deepened. Experiencing different techniques and algorithms working synchronously behind the scenes, like Gaussian filters, Canny edge detection, CNN, HOG, etc. gave me a good insights on how complex things can be made look easier. Most importantly, this project forced me to read lots of articles and some papers, to understand the working of it.

7. Conclusion

In conclusion, this project successfully integrates YOLOv8, SORT, and EasyOCR to detect and track license plates on moving vehicles effectively. We developed a robust system that performs reliably across various conditions, proving crucial for traffic management and security. Despite its success, challenges like low-light performance and non-standard plate angles still persist, suggesting directions for future research and enhancement. This work underscores the practical impact of advanced computer vision technologies in real-world applications and lays groundwork for ongoing innovation in the field. Additionally, I learned a bit of Latex. It was my first time that I used it. It seemed to be pretty cool and gave a some insights on how researches actually present their work formally to the world.

8. References

[1] Soomro, S.R.; Javed, M.A.; Memon, F.A. Vehicle Number Recognition System for automatic toll tax collection. In Proceedings of the 2012 International Conference on Robotics and Artificial Intelligence, ICRAI, Rawalpindi, Pakistan, 22–23 October 2012; pp. 125–129.

[2] M. Tahir Qadri, M. Asif "Automatic Number Plate Recognition System for Vehicle Identification using OCR," International Conference on Education Technology and Computer, pp 335-338, 2009.