

Vietnamese License Plate Recognition

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Introduction

We develop a Vietnamese license plate recognition model for smart parking systems

With the increasing number of vehicles in urban areas, traditional parking management systems face challenges such as inefficiencies, long wait times, and security issues. As cities expand, the demand for advanced parking solutions becomes crucial. This project tackles these challenges by developing a License Plate Recognition (VLPR) system specifically designed for Vietnamese vehicles.

Our goal is to create an LPR system that uses efficient deep learning algorithms to accurately and quickly recognize license plates. This solution effectively supports parking lots by shortening the entry and exit process, reducing waiting time, and minimizing human intervention.



Problem Identification

Output Input 30G56789 52F6-4378 A string containing the An image of a vehicle containing a clearly visible license plate content of the license plate

Constraints

- The license plate follows the standard format of Vietnamese vehicle plates.
- The image resolution is 1920x1080 (Full HD).
- The license plate occupies at least 5% of the image area.
- The license plate is clearly visible, not obscured, not overexposed, not poorly lit and not deformed.
- The image has in-plane rotations of the license plate no greater than 30 degrees along the x-axis.

Requirements

- The system must achieve at least 95% accuracy in recognizing Vietnamese license plates on the dataset provided by the customer.
- The processing time from receiving the image to outputting the license plate content must not exceed 5 seconds on the hardware configuration of the Apple MacBook Air with the M1 chip, released in 2020.

Decomposition

VietNamese License Plate Recognition

Input: an image of a vehicle containing license plate Output: a string containing the content of the license plate

Fig 1. Decomposition tree

Horizontal License Plate Region Extraction

Input: the original image Output: an image containing only the license plate aligned parallel with the horizontal axis

License Plate Content Recognition

Input: an image containing only the license plate aligned parallel with the horizontal axis **Output**: a string containing the content of the license plate

License Plate Detection

Input: the original image **Output**: a minimum bounding box of the license plate

License Plate Rotation

Input: the original image and the minimum bounding box of the license plate Output: the image of the license plate is cropped and rotated to align parallel with the horizontal axis.

Characters Detection

Input: an image of license plate Output: a list of minimum bounding boxes and corresponding classes of characters

License Plate Classification

Input: a list minimum bounding boxes of characters **Output**: "1" or "2" line

Datasets

Datasets & Metrics

1652 validations images.

recognizing license plate.

Combined Module

Input: the type of license plate, the list of minimum bounding boxes and corresponding classes of characters Output: a string containing the content of the license plate

Algorithms

License Plate Detection by YOLO-v5 Neck part fuses the Predict bounding box Crop license plate from Pass the image original Image based on Input image through backbone to 🗡 extracted feature → and assign class bounding box extract image feature infomation probabilities **Characters Detection by YOLO-v5** Predict bounding box Rotate the license plate so Neck part fuses Pass the image License Plate and assign class that it is parallel to the through backbone to the extracted classification extract image feature horizontal axis probabilities feature infomation 52-F6 Combined Module Output string 52F6-4378 Fig 2. Algorithm flowchart Yolov5

Metrics

For character and license plate detection:

 Recall Precision mAP

For final license plate recognition:

AccuracyTime

Evaluation

Number of test	Correct Prediction	Accuracy	Average Time
400 (images)	384 (images)	0.96	1.33s

1. The Character Detection Dataset consists of 3066 training images

2. License Plate Detection Dataset comprises 6607 train images and

3. License Plate Recognition Dataset comprising 400 images, is a

dataset collected by our team for final evaluation purposes. The

labels for each image consist of the license plate content provided

as a string, allowing us to evaluate the accuracy of our system in

dataset is annotated with a list of bounding boxes

corresponding classes of characters present on this image.

and 767 validation images, each containing a license plate. This

Table 1. Experiment on the License Plate Recognition Dataset

- Introduced by Ultralytics in 2020, YOLOv5 is an object detection method belonging to the YOLO family and classified as a One-stage Detector. It is widely employed in various realtime applications due to its ability to swiftly process images and accurately detect objects.
- Its architecture comprises 3 main components
 - The backbone for feature extraction.
 - **The neck** for feature aggregation.
 - The head for predicting bounding boxes and class probabilities.

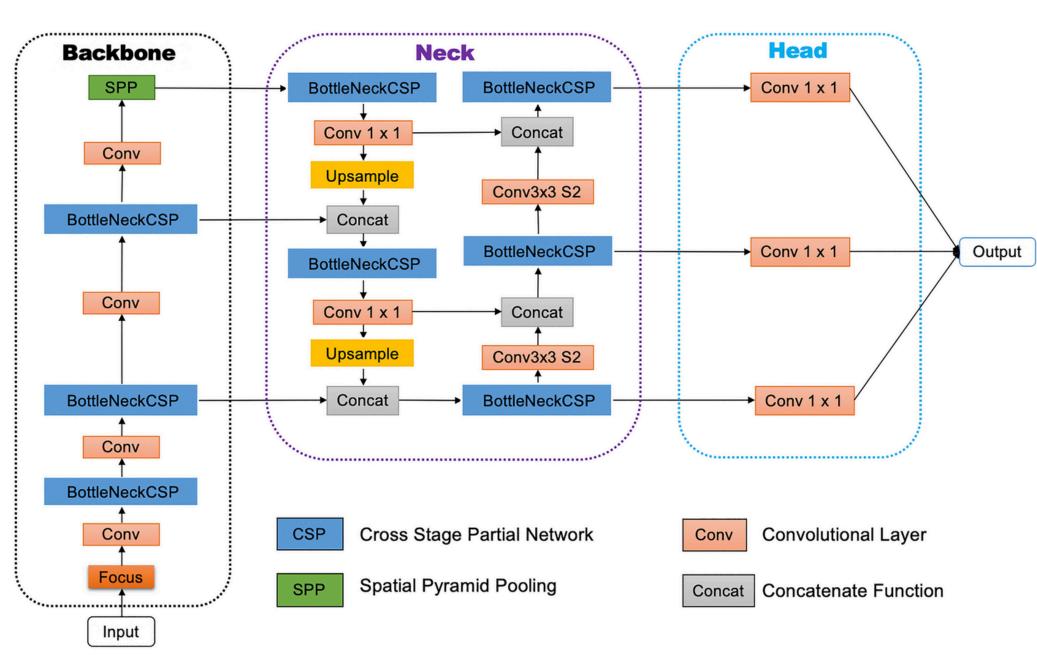


Fig 3. Yolov5 architecture

Conclusion

Through this project, we have learned how to apply computational thinking to solve specific real-world problems, such as Vietnamese license plate recognition. By using the YOLOv5 model, our team has found that this approach meets the initial requirements set by our team. However, for effective integration into real-world systems, we need to overcome several challenges such as poor image quality, low resolution, etc. and implement state-of-the-art methods to ensure the system performs optimally.