Optimized ALPR with hyperparameter tuning using evolutionary algorithm for vehicle identification and re-identification.

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Introduction

Vehicle Identification and re-identification is a case study in several applications that range from suspicious vehicle recognition to high-speed car chase. The unique identity that differentiates a similar looking vehicle is its license plate. This is treated as object detection task in computer vision where localization and identification of the license plate and then character recognition task performed from the license plate detected in the image.

This is an optimization of existing detection technique for license plate detection using an evolutionary algorithm.

- To improve its accuracy, we identify the best parameters for training the model with license plate dataset.
- As a result, the detection yields higher accuracy compared to a given set pretrained parameters.
- The accuracy improved to 98.6% ,compared to 80% with the default set parameters.
- The license plate was further recognized using OCR method.

This provides an auto-optimization of the object detection for the given dataset producing high accuracy leading to better recognition, vehicle identification and re-identification.

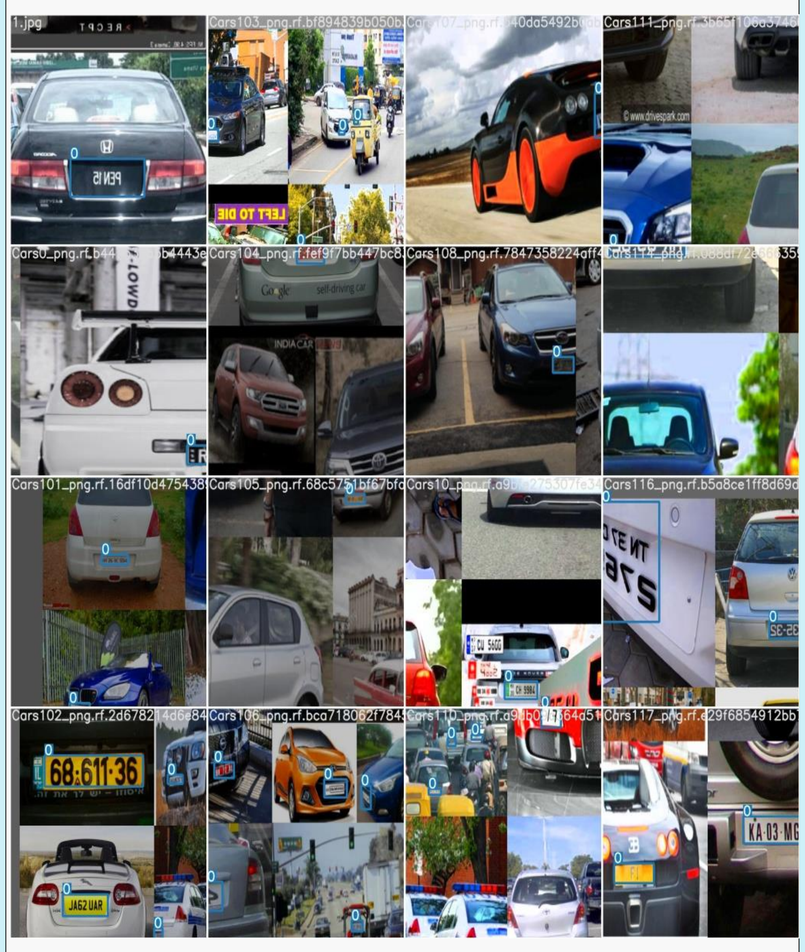
Materials

The materials used for this experiment include the following :

Software: Python programming environment with Pytorch and Cuda 10.2 toolkit enabled for GPU enabled computing.

Hardware: GPU computing enabled device with NVIDIA RTX2070 graphics.

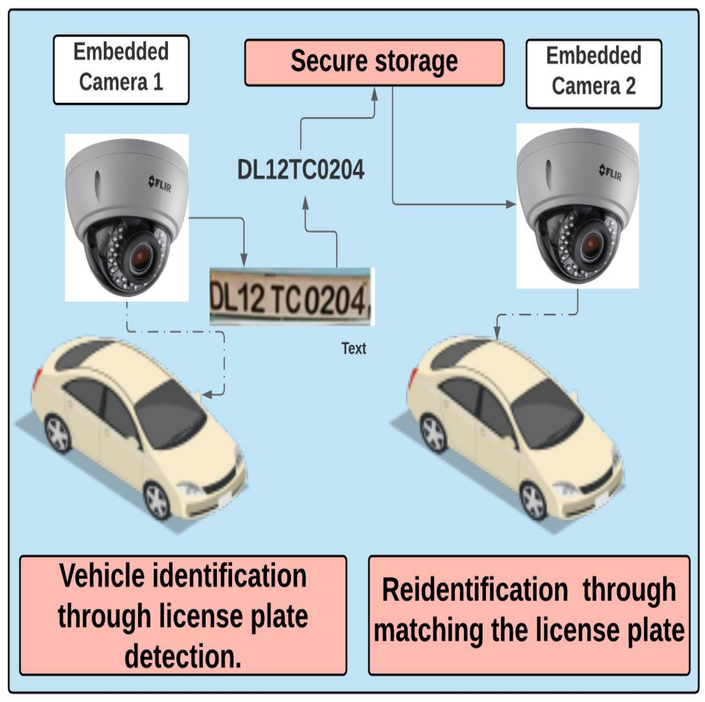
Dataset : Stanford Cars Dataset [3] which was annotated for license plate detection in .txt format, with bounding box coordinates for license plate.



The dataset consists of different kinds of cars with license plate annotated for US license plates [3].

- The images come in various orientation and make and model.
- The data set is split into training, testing and validation with 241 images for training.

Method



Once a suspicious vehicle is spotted the number plate is identified it is secured and stored in a secured cloud where another camera can access the license plate for re-identification.

Identification

Fine tuning YOLOV5l Object detection.

Optimization & Fine-Tuning:

- The model was optimized and fine tuned using genetic algorithm against an optimization function for around 1000 generations initialized with default hyperparameters and Adam optimizer.
- The transfer learning was performed with these parameters with 300 iterations.

Table 1 represents the initial hyperparameters set for evolutionary algorithm. Table2 represents optimized parameters for training.

Learning Rate	Optimizer	Train Epoch	Loss Function
0.01	ADAM	300	Focal loss

Table1 : Initial Training parameters for hyperparameter tuning

Learning Rate	Optimizer	Train Epoch	Loss Function
0.0114	ADAM	300	Focal loss

Table2 : Optimized Training parameters for hyperparameter tuning

License plate Recognition: A tesseract library was utilized to identify the license plate information by converting the license identified as image to text.

Results

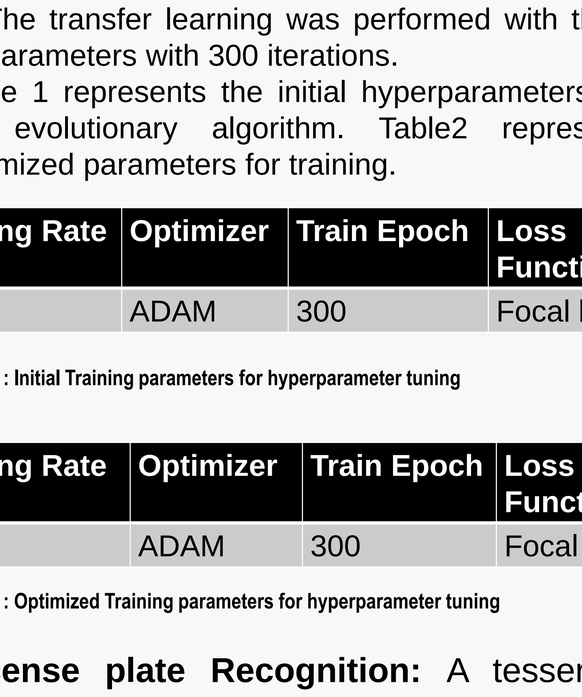


Figure 2. mAP, precision and recall during the training process.

Precision	Recall	mAP@0.5	mAP@0.95	FPS
0.483	0.993	0.986	0.757	8.7ms

Table 2, Testing results.

Figure 3, License plate detected test images with ground truth annotated

Figure 2, depicts the training results after hyper parameter tuning with precision, recall, mean average precision at 50% intersection of union. Figure 3 are the license plate detected images. Table 2, are final testing results in terms of precision, recall, mean average precision and the number of frames per second the model can process.

Conclusion

With hyperparameter tuning, the phase 1 of object detection achieved higher performance compared to without. With hyperparameter adjustment, the model achieved higher accuracy and better speed in identifying the license plate. This improved the detection of the vehicle enabling all the vehicles to be identified and license plate information extracted and securely stored in a blockchain decentralized database enhanced privacy of the identification system along with it.

References

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[4] Sestrem Ochôa, I., Reis Quietinho Leithardt, V., Calbusch, L., De Paz Santana, J. F., Delcio Parreira, W., Oriel Seman, L., & Zeferino, C. A. (2021). Performance and Security Evaluation on a Blockchain Architecture for License Plate Recognition Systems. *Applied Sciences*, *11*(3), 1255.