AI to Detect Criminal Vehicles

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Introduction

As we enter the world where security matters are of crucial importance, it was essential for the community safety to have proper tools to watch the vehicle related actions. High rates of carjackings as well as unauthorized access to secure zones have raised interest in reliable systems that would help to promptly detect possible dangers.

The “AI to Detect Criminal Vehicles” project was then created to address these needs using OCR technology and Computer Vision together with the YOLOv8 object detection algorithm. This system is designed to increase security as it is able to identify vehicles through their license plates with status of being registered, missing, or under Enquiry and act accordingly and in real time.

Project Overview

Goals and Objectives

The main objective of this project is to design an intelligent system for security in public and secure areas through proper analysis of the vehicles. The system is designed to:The system is designed to:

- **Enhance Vehicle Security:** Detect vehicle classes in real-time with an emphasis on registered vehicles, missing cars and vehicles on which there are inquiries using technologies such as OCR and CV.
- **Improve Monitoring Capabilities:** It will also help track stolen or those affiliated to criminal activities by easily recognizing and reporting them.
- **Control Access:** Enhance physical security of all areas which should be restricted by identifying vehicles that are not allowed in the area and send an alarm to the security personnel accordingly.
- **Ensure Data Accessibility:** This format of storing vehicle data will be in the form of CSV hence security personnel and stakeholders will be able to easily retrieve any information regarding to the stored vehicle information.

Scope

This project will address the security requirement of public and sensitive sectors including tollgates, and malls, tarring lots, and other related places that require monitoring of vehicles. The system's scope includes:

- **Real-Time Vehicle Identification:** This is, be on the lookout for and be able to recognize vehicles that come into the specified zones.
- **Immediate Response:** Urgent alerts and feedback should be given to the security personnel whenever the cars are of the unauthorized or suspected type.
- **Data Storage and Accessibility:** Make and keep records of all the vehicle details that can be updated, retrieved or audited whenever it is necessary.

Methodology

The development of the "AI to Detect Criminal Vehicles" system followed a structured approach, which included: The development of the "AI to Detect Criminal Vehicles" system followed a structured approach, which included:

- **Data Collection and Annotation:** Explaining how to uses Roboflow to gather and label a variety which relates to vehicle license plates.
- **Model Training:** Actually training the system on Google Colab using an advanced form of object detection algorithm known as YOLOv8. The model was trained for more than twenty five epochs to increase the model’s credibility and accuracy.

- **System Integration:** Implementing the trained model, to have a complete working built system that can accept data stream and offer feedbacks in real time.

Background Information

The project is based on the development of recent improvements of OCR and CV technologies, which have been used in some fields including toll booth activation, traffic control, and security systems. Thus, incorporating these technologies with the YOLOv8 model, we designed the system that meets the requirements of vehicle security monitoring to offer a novel approach to reducing vehicle crimes.

Tools and Technologies

The following are some major tools and technologies used in this project called "AI to DetectCriminal Vehicles ":

- **Roboflow:** This is a platform utilized in creating the dataset. In this case, vehicle license plate images needed to be selected, annotated, and preprocessed. Roboflow facilitated the export of the dataset in YOLO format essential for model training.
- **Google Colab:** This is the web-based environment that supplied us with the necessary computational power for training model YOLOv8. Google Colab had very nice integration with TensorFlow and PyTorch, hence making it an ideal environment where all our machine learning tasks could be done.
- **YOLOv8:** You Only Look Once is the detection algorithm used in the training process of the model. YOLOv8 has been used because of its tremendous efficiency in finding and classifying objects inside an image, hence suitable for real-time vehicle identification.

Dataset creation

Regarding this, the preparation of the dataset was the most crucial step. Hence, the quality and accuracy of the dataset result in the model's performance. The steps involved are as follows:

1. **Dataset Acquisition:** The license plate dataset was availed from Roboflow, which came along with a rich collection of vehicle images.

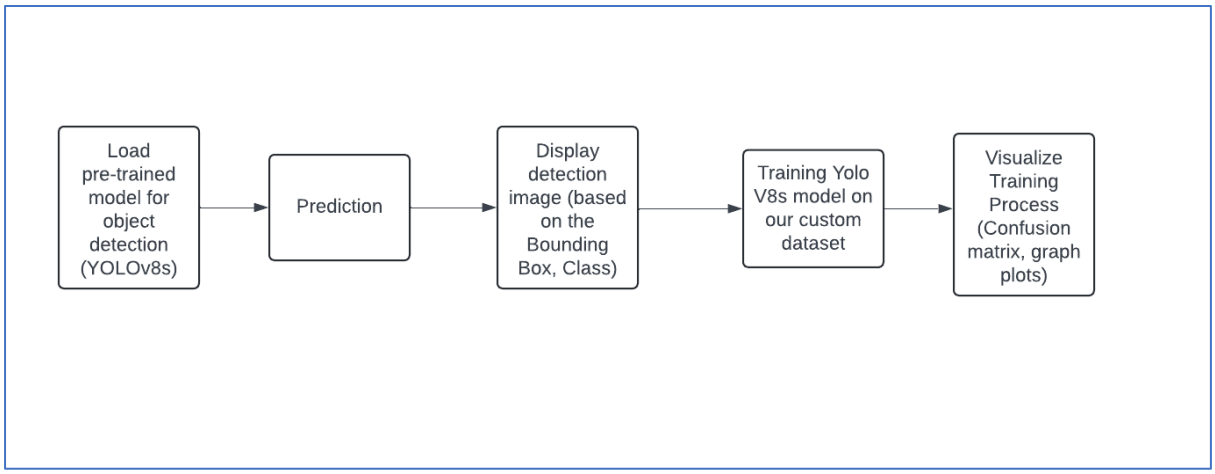
2. **Image Selection:** From the captured dataset, a portion was filtered according to the clarity, angle of the shot, and visibility of license plates.

3. **Annotation:** Accordingly, using annotation tools from Roboflow, we labeled the name of classes for each license plate by giving its coordinates (x, y) along with width and height dimensions for bounding boxes around the plate.

4. **Preprocessing:** While exporting the images, they were auto-oriented and resized at a standard size of 640×640 pixels. This was important to unify the dataset for training purposes. Citation: All images are auto-oriented and then resized at a standard size of 640×640 pixels during export.

5. **Labeling:** The labels have very important information that the YOLO model requires during training. Every label has the class of an object and its coordinates with dimensions that form the basis for correct object detection.

- **Training YOLO Model on Custom Dataset**



In this diagram, we delve into the specifics of training the YOLOv8s model on our customer dataset to enhance the system's ability to accurately detect and classify vehicle license plates.

Preparation of Dataset:

- Roboflow was used to curate the dataset for YOLOv8s model training. License plates in images were annotated with bounding boxes so that the model could find and classify plates properly at inference time.
- The data was divided into training, validation, and test sets so that the model is balanced concerning the learning and generalization of features.

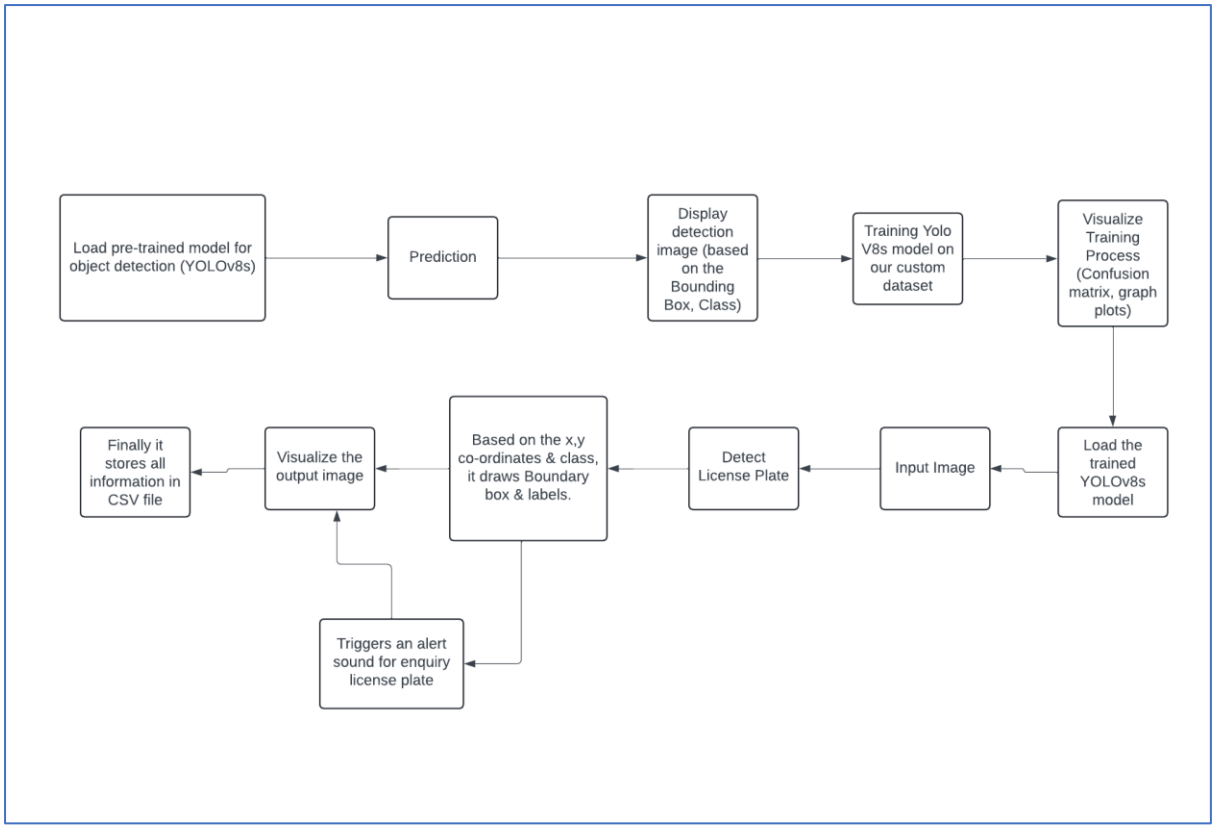
Training Process:

- YOLOv8s model was selected as it gives the right balance between speed and accuracy. Besides, this version is deemed appropriate for real-time object detection applications.
- Training of this model on Google Collab took 25 epochs with a batch size of 16. We used a learning rate schedule whereby the learning rate decreased as time progressed to allow the model to converge.
- A number of techniques for augmentation had been used to make the model more robust: random flips, rotations, and colour changes.

Evaluation:

- A validation set was held out during training with which to monitor performance. With regard to the above, precision, recall, and mean average precision metrics were monitored for the function.
- Once satisfactory performance was achieved, it further underwent testing on unseen data to verify its ability to generalize to new images.

System Architecture



The system architecture for the "AI to Detect Criminal Vehicles" is designed to efficiently process real-time inputs and provide timely alerts for any detected threats.

Architecture overview:

- **Data Input:** Real-time video feeds or images coming from strategically placed cameras across the system's operational environment are fed into the system processing pipeline.
- **YOLOv8s Model Inference:** Perform inference on input data using pre-trained model YOLOv8s and detect vehicle license plates and classify them.
- **Post-processing:** The detection of license plates should be searched in the database for status, that is to say, whether they are registered, missing, or under enquiry.
- **Alert:** The system will trigger an alert for any license plate detected matching an enquiry or flagged entry. It gives an alert with a sound, accompanied by the captured picture.
- **Data Storage:** The data collected along with images are stored in a CSV format for later review and analysis.

Model Development

The development of the AI model has gone through key phases in order to provide the whole effectiveness of the system below, which include but are not limited to the following:

1. **Model Selection:** YOLOv8 was selected since it is fast and suitable for object detection tasks. Its real-time processing capability for images made it the best fit for this project.

2. **Model Training:** The model was trained with Google Colab using the annotated dataset. The training ran for 25 epochs, optimizing loss metrics comprising box loss, classification loss, and differential loss.

3. **Validation and Evaluation of the Model:** The performance of the model was monitored during training through its validation datasets. It included tracking metrics of accuracy and loss to ascertain whether the model learned appropriately.

4. **Prediction and Testing:** Later, the model was tested on new images to see the accuracy of the model in detecting the license plates. The results showed that the model

was successful in identifying vehicles and drawing bounding boxes around the detected objects.

5. **System Integration:** The model trained was integrated with the system for real-time vehicle monitoring and identification. Various simulated environments have been tested to check preparedness for the deployment of this system.

System Benefits

Below are the key benefits of the "AI to Detect Criminal Vehicles" system:

- **Better Security:** Informs ahead of time about an unauthorized vehicle, thus preventing the crime and improving public security.
- **Prompt Reaction:** The quick vehicle detection and classification allow for quick security action taken upon any threat.
- **Data Accessibility:** The vehicle information is maintained in a structured manner. Thus, it facilitates the authorities to keep a track record of previous incidents.
- **Scalability:** The proposed license plate recognition system can be deployed at many places, such as toll gates, malls, parking lots, and many more public spots.
- **Customer Convenience:** On the user side, the user can view and, thereafter, check the details of the vehicle at the given user interface. This also ensures transparency in the process and ease for the user.

Future Planning and Enhancements

In this regard, some future enhancements are conceived for the system to remain efficient and up-to-date; these are:

- **Enhanced Model Training:** The model shall be trained further such that it recognizes even more diverse types of vehicles, including make and model to ensure higher flexibility and accuracy.
- **Technological Enhancements:** The code shall be perpetually updated by the latest in Artificial Intelligence and machine learning to be ahead in the competition.
- **Wider Deployment:** More deployment where expanded into very sensitive areas, hence strengthening its security and surveillance.

- Improvement of User Interface: Enhancement of user interface; this would be friendly and smooth enough for the security guards, management, and other stakeholders.