Pixel Pioneers

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The problem our project addresses:

In response to the growing technological advancements in the western world, we have recognized a disparity in technological access in countries with a poorer economy. To address this issue, we wanted to introduce highly impactful and affordable technological solutions to the aforementioned countries. To achieve this we have decided to create a lightweight machine vision model that can run efficiently even with limited resources. Therefore, the machine learning problem that our project addresses is License Plate Detection and Classification.

Datasets used, description of the data (both input and output) with examples:

- ○ **Car Object Detection:**
  https://www.kaggle.com/datasets/boulahchichenadir/cars-object-detection
    - ■ Input: An with one or more cars
    - ■ Output: Annotated image of each car outlined


- ○ **License Plate Recognition:**
- ○ https://universe.roboflow.com/objects-in-the-wild/license-plate-recognition-lhqow/browse?queryText=&pageSize=50&startingIndex=50&browseQuery=true
    - ■ Input: An image of a car with the license plate
    - ■ Output: Annotated and cropped image of the license plate
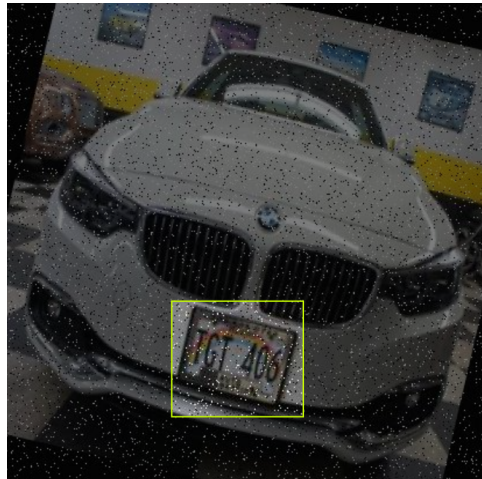
- ○ **License Plate Digit Classification:**
  https://www.kaggle.com/datasets/aladdinss/license-plate-digits-classification-dataset
    - ■ Input: License plate image
    - ■ Output: Image of each character outlined in the license plate
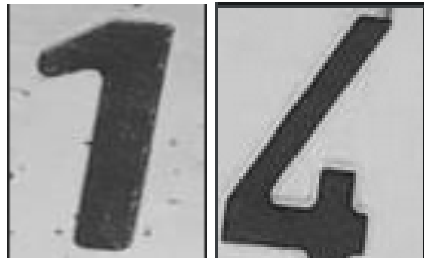
- ○ **License Plate Character Detection OCR:**
  https://www.kaggle.com/datasets/francescopettini/license-plate-characters-detection-ocr
    - ■ Input: Individual character on the license plate
    - ■ Output: the classification of the character

Overview of our implementation:

Our implementation is divided into the following 3 models, where the input into the first model will be an image containing a car or several cars, then the output of the model will be the input into the next model and so on:

- **Car Object Detection**
  - This model detects a vehicle. The image will then be cropped to the detection box
- **License Plate Detection**
  - Once a vehicle is detected, this model is used to detect the license plate on the detected vehicle
- **License Plate Digit Detection and Classification**
  - Next, this model is used to further detect the individual digits on the previously detected license plate, as well as classify them

Novel Approaches:

We used transfer learning by training our datasets on the pretrained weights of the Detecto model, as it did not make sense for us to reinvent the wheel for a detection problem. Furthermore, this model is trained on larger data which is beyond what we can do with our limited compute resources.

We also used image augmentation to prevent overfitting as this was a problem we were facing during training. This was done in order to artificially extend our datasets by applying transformations such as resizing, flipping and saturation augmentation.

Incompleteness/problems we could not solve:

Our model still faces some issues that we could not solve in our given timeframe. One problem is that if there are multiple cars within one image, we sometimes face a scenario where the license plate for one car will be in the background of the annotation for another car. So when this is passed into our second model, the same license plate will be detected twice. Another issue is that our digit classification is not highly accurate. Although our detection works quite well, we often see errors in classification when the image quality is poor.

Evaluation results:
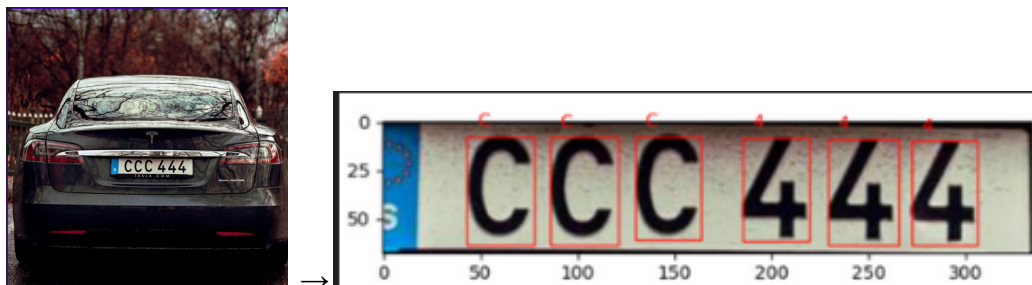
- Vehicle Detection:
  - Loss: 0.09543197432387496
- License Plate Detection

- **Loss: 0.10040177303124909**
  - License Plate Digit Detection and Classification:
    - **Loss: 0.5562988320508828**

Individual contributions of the team members:

All group members worked on all components of the project, although each group member was responsible for overseeing the training of one of the 3 models:

- **Vivek -** Car Object Detection
- **Nawal -** License Plate Detection
- **Yajan -** License Plate Digit Detection & Classification