Project: Object Detection in an Urban Environment

https://github.com/LimHaeryong/Object-Detection-in-an-Urban-Environment

Project overview

In this project, I trained a model which detects and classify objects. I used provided Waymo dataset of images of urban environments containing annotated vehicles, pedestrians and cyclists.

Object detection is one of the most important things of self-driving car. Because To plan behavior and generate trajectories, Object detection is necessary.

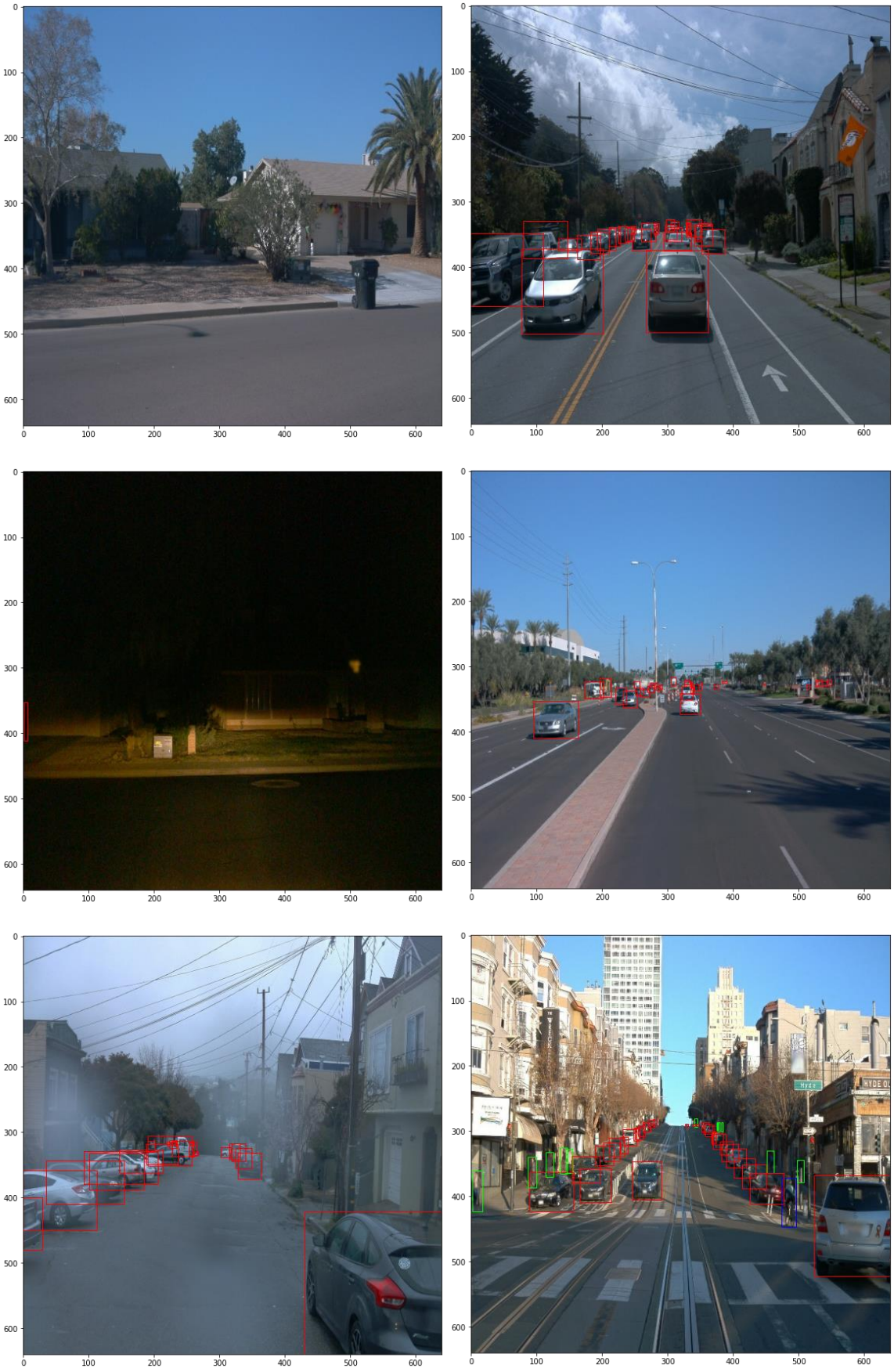
I trained a reference model which was not a good result. Then I improved that model changing optimizer, learning rate schedule and augmentations.

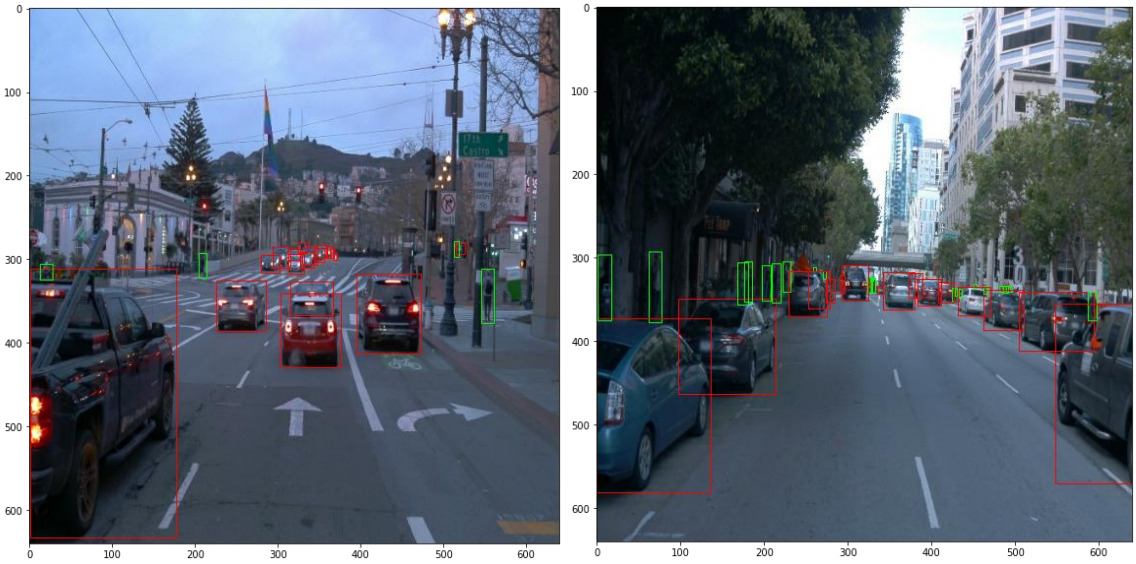
Dataset

1. Dataset analysis

The dataset is camera images with annotated box and classification. Dataset contains many conditions like rainy, cloudy and night. There are three annotated objects pedestrian, cyclist and vehicles.

A bar graph shows the number of classes in the 100 images. The number of cyclists is very small. So trained model would have weakness of detecting cyclists.





2. Cross validation

Total 96 tfrecord files were used to train model. They were split into 86 train images and 10 validation images. Almost 10% of data were used for validation to check overfitting.

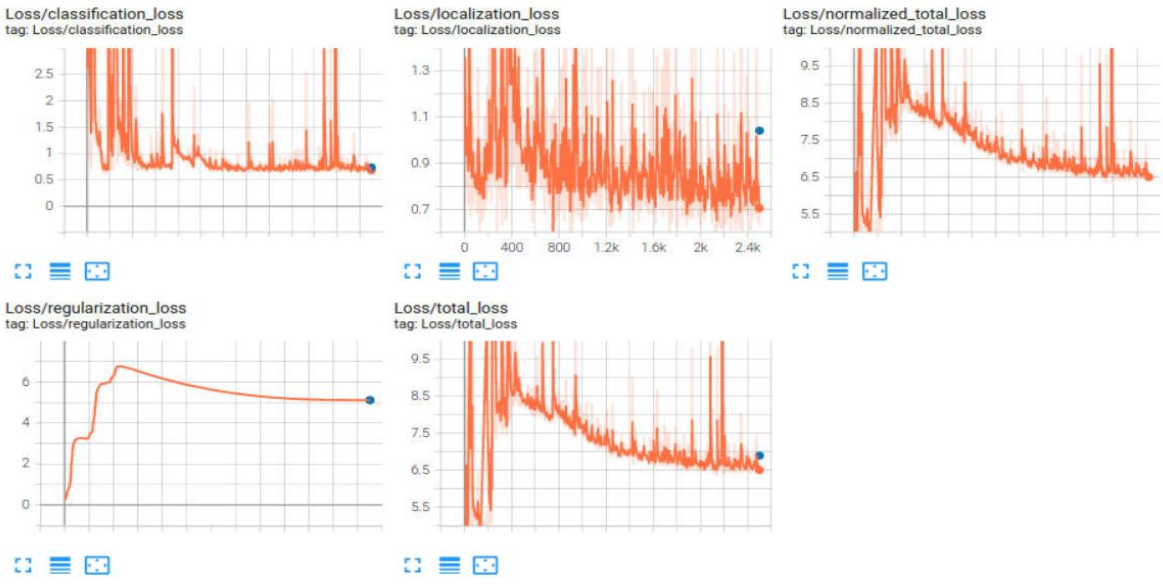
Training

1. Reference experiment

Tensorboard graphs of reference model are as below. I created animation but there were no bounding boxes. It means model is not trained well. So it needs more improvements.

Model have no overfitting because validation loss is same as train loss.

So it needs more iterations or other optimizer or other learning rate with scheduler.



2. Improve on the reference

Experiment 1

At first, I made changes as below.

I changed optimizer from momentum into adam. Also changed lr scheduler as below.

```
adam_optimizer {
  learning_rate {
    cosine_decay_learning_rate {
      learning_rate_base: 0.005
      total_steps: 10000
      warmup_learning_rate: 0.001
      warmup_steps: 200
```

2. I added data augmentation options.

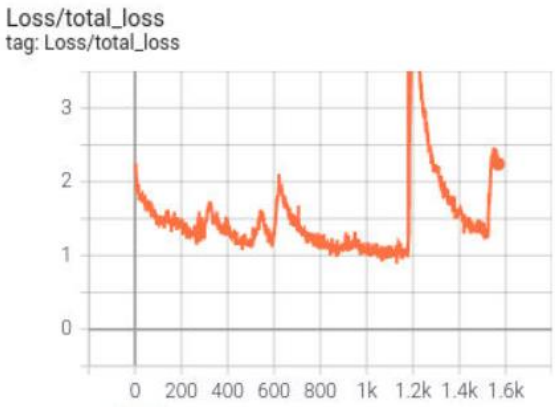
I used total 4 augmentation options.

Random_horizontal_flip, random_crop_image, random_adjust_brightness and random_black_patches.

Crop image parameters are as below and other parameters are default values.

```
  random_crop_image {
    min_object_covered: 0.0
    min_aspect_ratio: 0.75
    max_aspect_ratio: 3.0
    min_area: 0.75
    max_area: 1.0
    overlap_thresh: 0.0
```

During training, Loss value was suddenly increased and loss value seemed not going lower. So I stopped training and changed learning rate and augmentations.



Experiment 2

I used manual step learning rate instead of cosine decay. Learning rate of 0.0005 at initial, 0.0001 at 1000 steps, 1e-5 at 3000 steps.

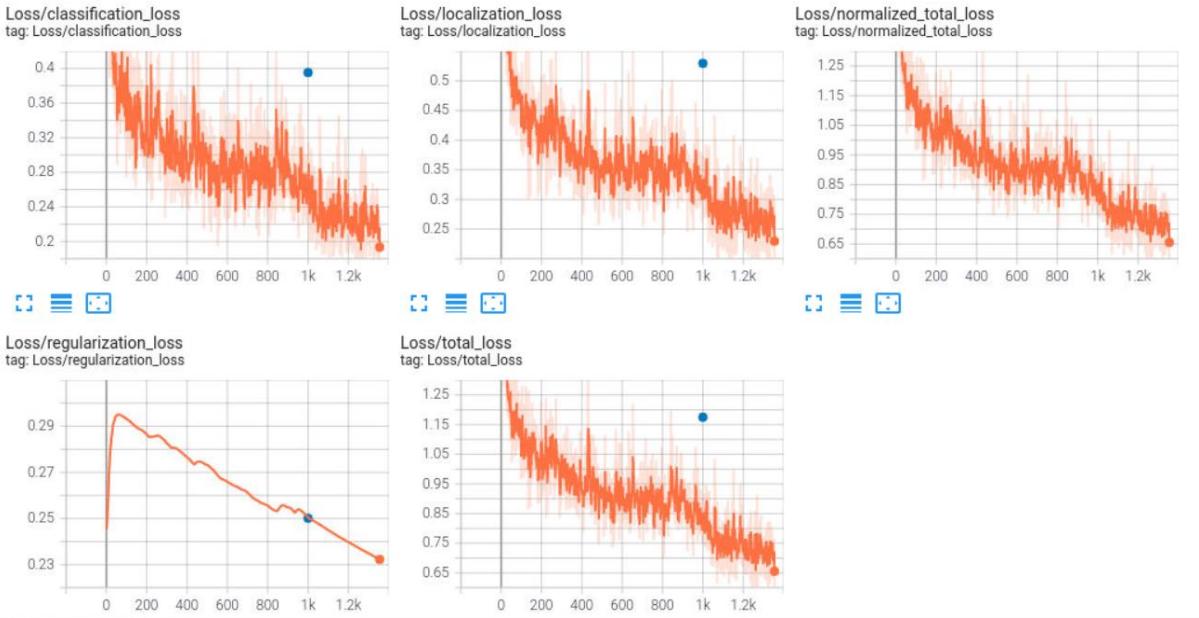
I also changed augmentation options. I used random horizontal flip, ssd random crop, random adjust contrast, random black patches. I used default parameter values except random black patches. The parameters of random black patches are as below.

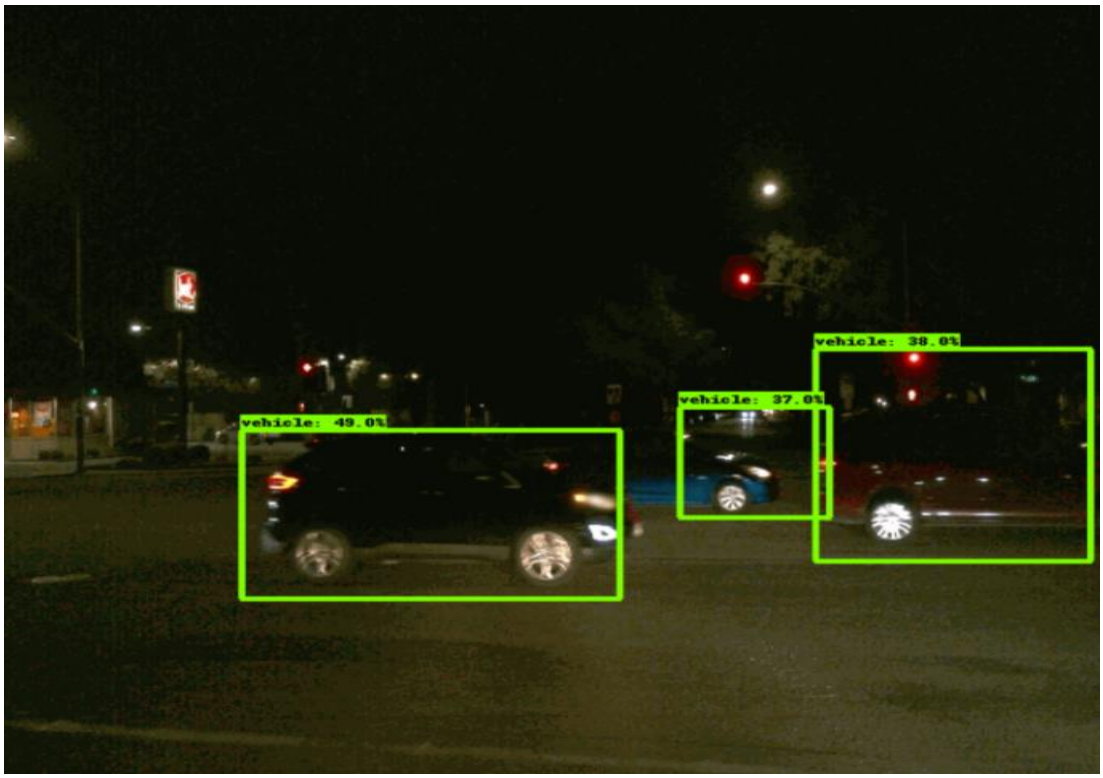
```
  random_black_patches {
    probability: 0.1
    size_to_image_ratio: 0.05
  }
}
```

Augmented images are as below.

After 1000 steps, I evaluated model and checked validation loss is much bigger than train loss. So I stopped train. Result is as below.

And



Additionally, mAP values about medium and large boxes are 0.29 and 0.27. But small boxes are 0.02. It seems it cannot detect small objects.

Also created video file seems not bad. If you see the capture as below it detected vehicles well. But it need to be improved further.