BRAKE AND BLINKER LIGHTS DETECTION FOR VEHICLE SAFETY APPLICATIONS

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Introduction

Input: a image or video of traffic on the road.

Output: a image or video has been detected signal lights.

Input

Output

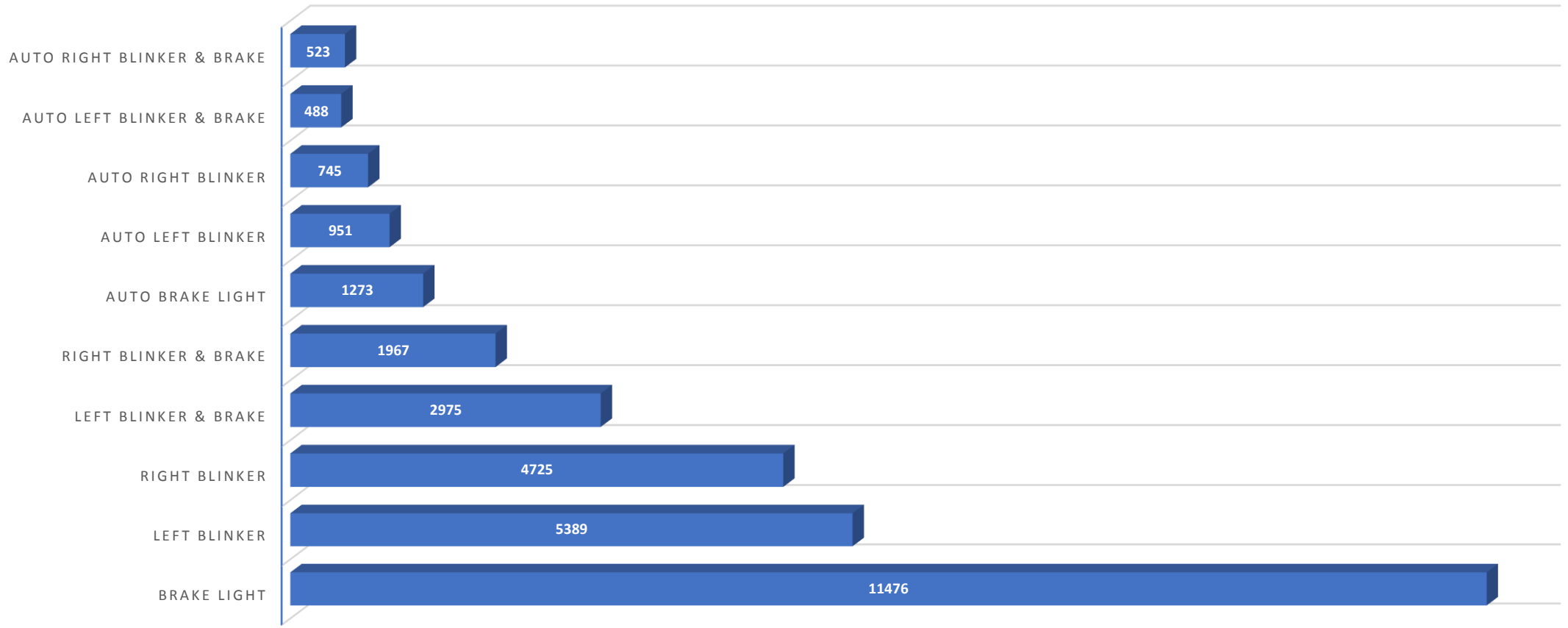
Dataset

Collected data: 6392 images
30512 annotated object (average 4-7 objects/image)

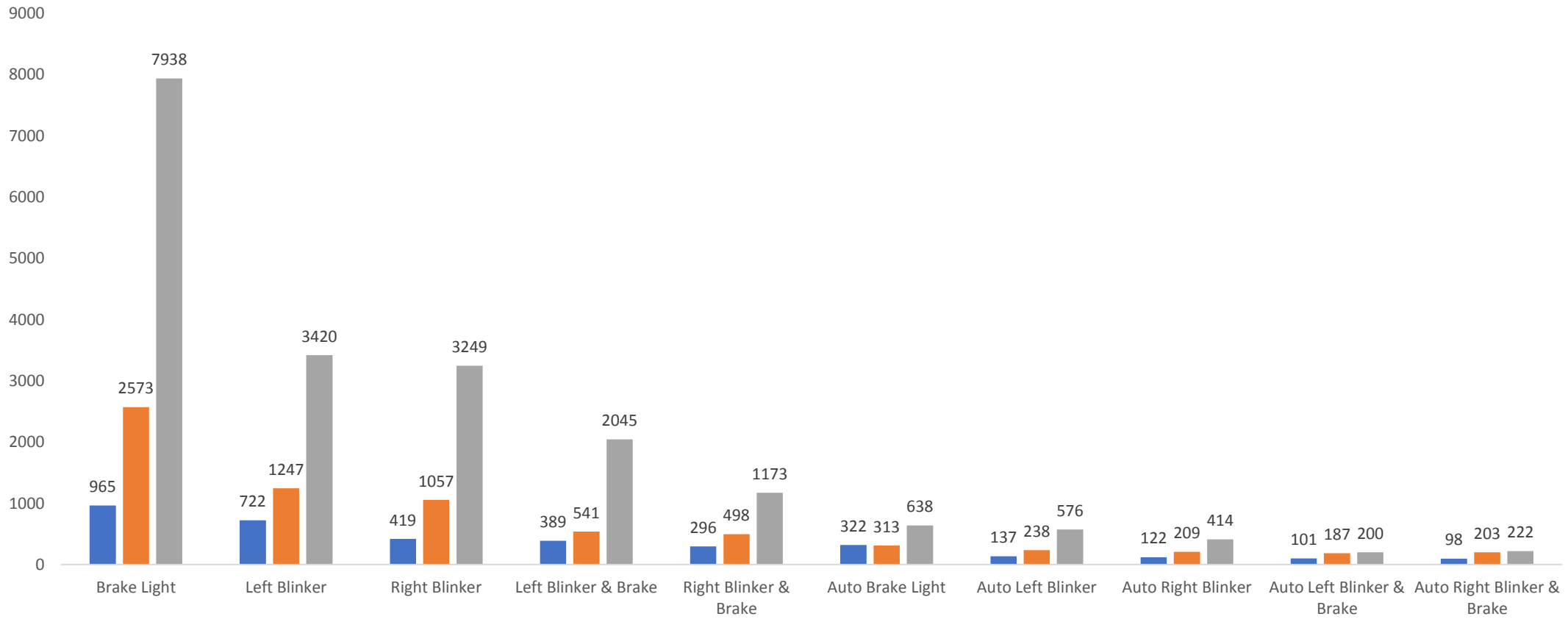
Training set: 4473 images
Validation set: 1280 images
Test set: 639 images

	Motobike	**Automobile**
Phanh	Brake Light	Auto Brake Light
Xi nhan trái	Left Blinker	Auto Left Blinker
Xi nhan phải	Right Blinker	Auto Right Blinker
Xi nhan trái và Phanh	Left Blinker & Brake	Auto Left Blinker & Brake
Xi nhan phải và Phanh	Right Blinker & Brake	Auto Right Blinker & Brake

Dataset

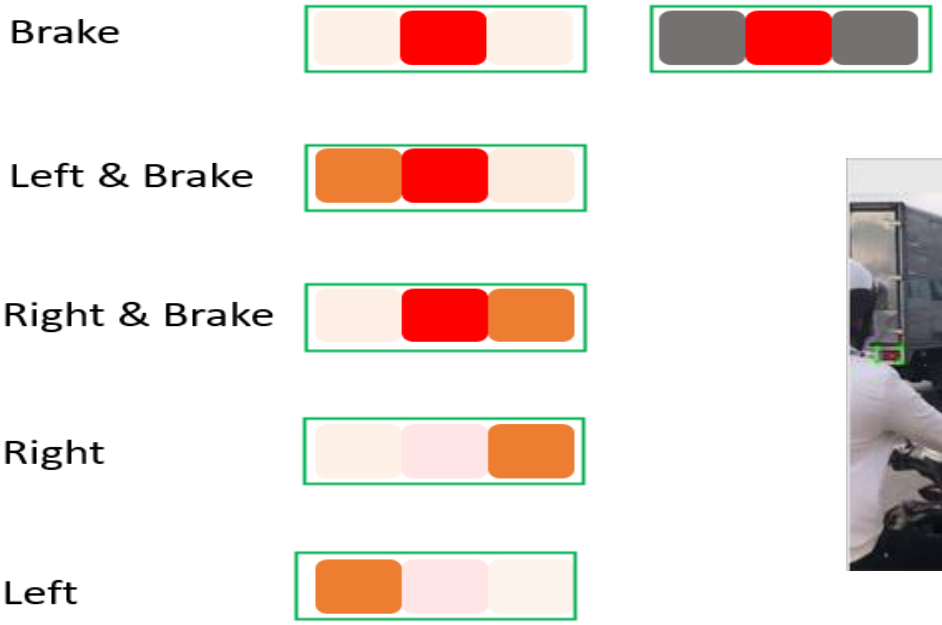

AUTO RIGHT BLINKER & BRAKE
523
AUTO LEFT BLINKER & BRAKE
488
AUTO RIGHT BLINKER
745
AUTO LEFT BLINKER
951
AUTO BRAKE LIGHT
1273
RIGHT BLINKER & BRAKE
1967
LEFT BLINKER & BRAKE
2975
RIGHT BLINKER
4725
LEFT BLINKER
5389
BRAKE LIGHT
11476

Dataset


9000
8000
7000
6000
5000
4000
3000
2000
1000
0
965
2573
7938
722
1247
3420
419
1057
3249
389
541
2045
296
498
1173
322
313
638
137
238
576
122
209
414
101
187
200
98
203
222
Brake Light
Left Blinker
Right Blinker
Left Blinker & Brake
Right Blinker & Brake
Auto Brake Light
Auto Left Blinker
Auto Right Blinker
Auto Left Blinker & Brake
Auto Right Blinker & Brake

Dataset

- Data is labeled according to the following rules:
- Tool: LabelImg



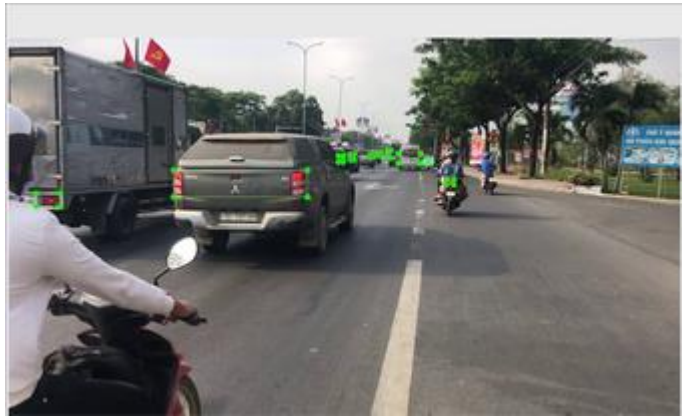


image_14186 (1) - Notepad

File Edit Format View Help

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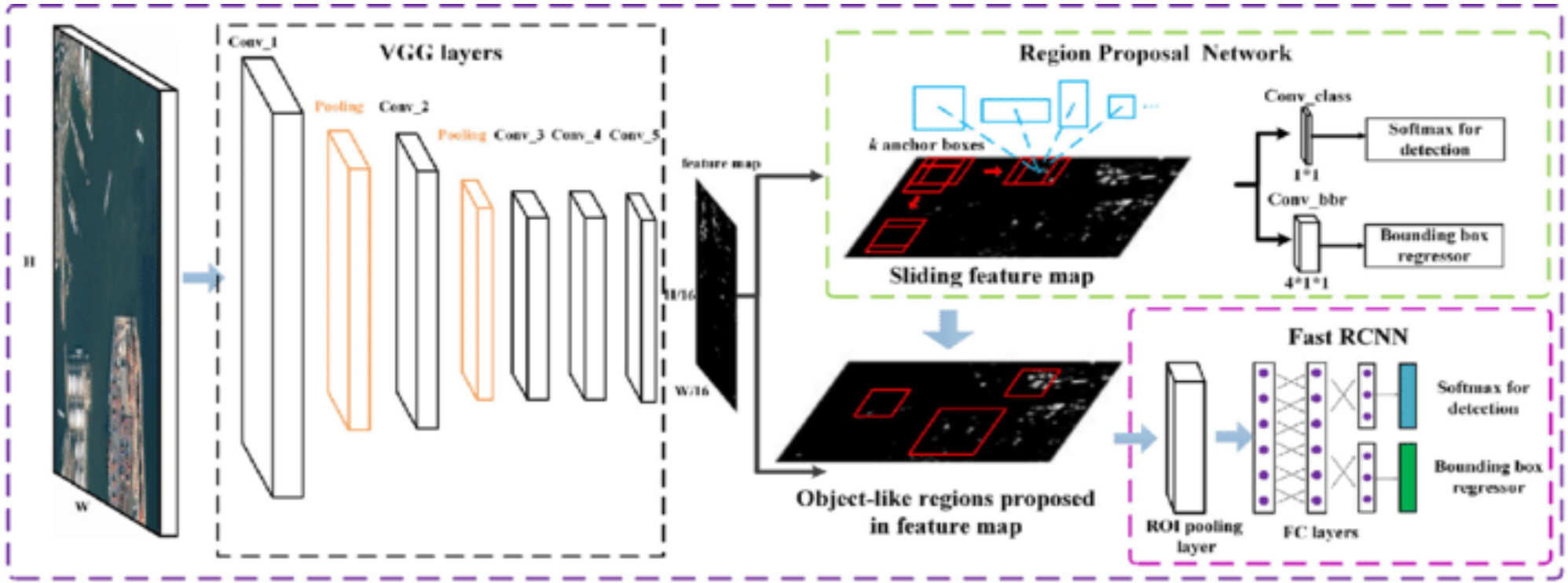
5 0.059115 0.428704 0.035937 0.033333
5 0.345313 0.385648 0.198958 0.071296
5 0.495312 0.320833 0.007292 0.015741
5 0.511719 0.315278 0.004687 0.013889
5 0.539844 0.311574 0.004687 0.006481
5 0.551042 0.307870 0.004167 0.008333
5 0.567187 0.308333 0.004167 0.020370
5 0.596615 0.318519 0.032813 0.025926
0 0.657552 0.382870 0.011979 0.013889
0 0.625000 0.326852 0.006250 0.005556
```

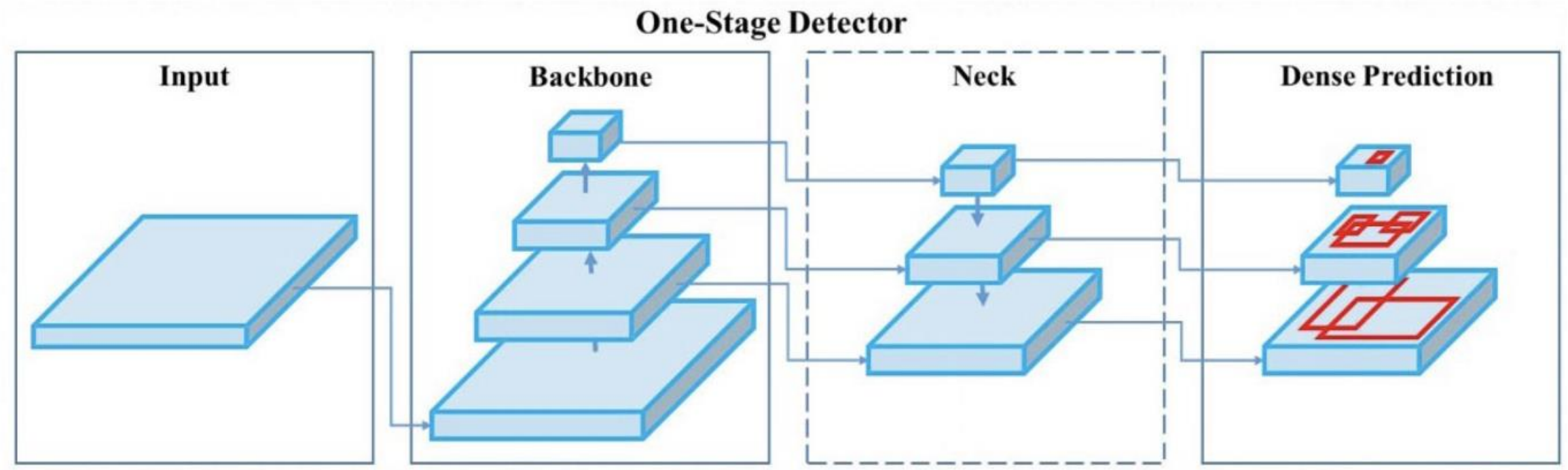
Approach

- For the best experiment results, we use 3 models and compared the results:
  - Faster R-CNN
  - YOLOv4
  - YOLOv5
- The obtained results are evaluated based on IoU (Intersection over Union) and mAP (mean Average Precision).

Faster R-CNN


H
W
Conv_1
VGG layers
Pooling
Conv_2
Pooling
Conv_3
Conv_4
Conv_5
feature map
H/16
W/16
Region Proposal Network
k anchor boxes
Sliding feature map
Conv_class
1*1
Softmax for detection
Conv_bbr
4*1*1
Bounding box regressor
Object-like regions proposed in feature map
Fast RCNN
ROI pooling layer
FC layers
Softmax for detection
Bounding box regressor

YOLOv4 & YOLOv5

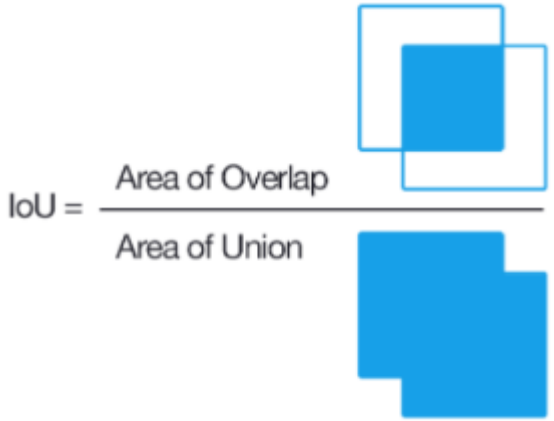


YOLOv4 & YOLOv5

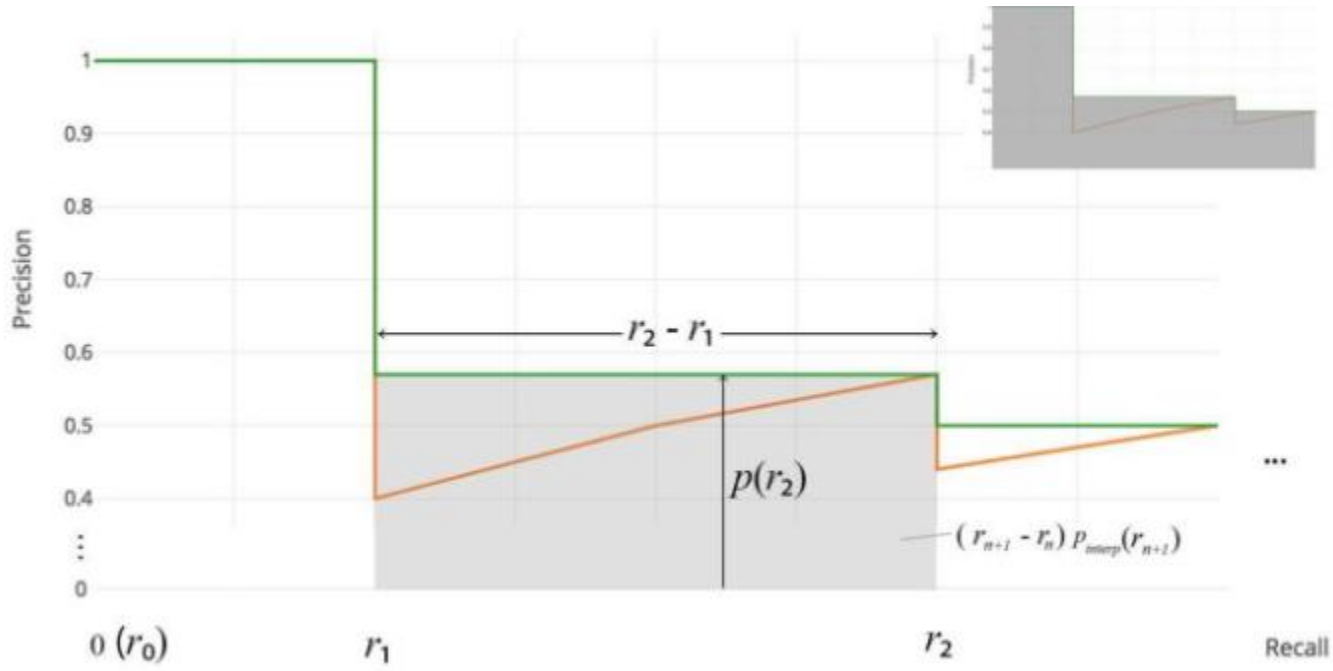
- Backbone: CSPDarknet53
- Neck: FPN, PAN, NAS-FPN, BiFPN…
- Head: tương tự như YOLOv3
- Bag of Freebies: data augmentation, class imbalance, cost function, soft labeling...
- Bag of Specials: feature, skip-connection, FPN (Feature Paramyd Network), NMS (Non Maximum Suppression)…

Intersaction over Union (IoU)

- Intersection over Union is an evaluation metric used to measure the accuracy of an object detector on a particular dataset.
- An Intersection over Union score *> 0.5* is normally considered a "good" prediction.



Mean Average Precision (mAP)



$$\mathrm{AP} = \sum (r_{n+1} - r_n)\, p_{interp}(r_{n+1})$$

$$p_{interp}(r_{n+1}) = \max_{\tilde{r} \geq r_{n+1}} p(\tilde{r})$$

Experiment results & Evaluation

- mAP

Model	mAP@0.5	mAP@0.75	F1-Score@0.5	F1-Score@0.75
Faster R-CNN	0.810	0.5677	0.83	0.59
YOLOv4	0.962	**0.717**	0.94	**0.71**
YOLOv5	**0.981**	0.609	**0.96**	0.69

Model	Brake Light	Left Blinker	Right Blinker	Left Blinker & Brake	Right Blinker & Brake	Auto Brake Light	Auto Left Blinker	Auto Right Blinker	Auto Left Blinker & Brake	Auto Right Blinker & Brake
Faster R-CNN	0.7317	0.6500	0.6140	0.5249	0.6710	0.4483	0.4926	0.5270	0.4720	0.5459
YOLOv4	0.8268	0.8371	0.8005	0.8088	0.8234	**0.4886**	**0.5880**	**0.6872**	**0.6462**	**0.6633**
YOLOv5	**0.9730**	**0.9457**	**0.8714**	**0.8329**	**0.8544**	0.2370	0.3192	0.3478	0.3510	0.3640

Experiment results & Evaluation

- IoU

Model	Average IOU
Faster R - CNN	57.23
YOLOv4	65.08
YOLOv5	62.20

Conclusion

- YOLOv4 model is the best of the 3 experimented models because it gives relatively good results in all classes.
- Although YOLOv5 model gives good results in the motorcycle classes, the results in the auto classes are very bad.
- Faster R-CNN model gives low results in all classes

Future Works

- Increasing the amount of data.
- Applying method Kalman filter to boost accuracy.

Feature Work