

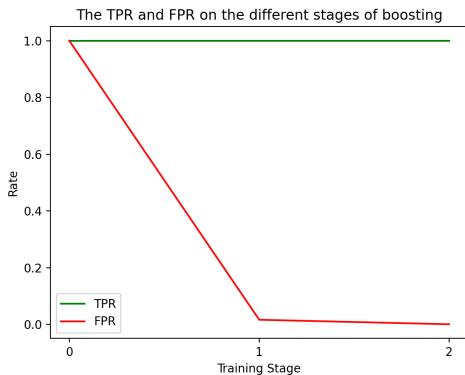
Report

Sonny Cooper (ed22699)

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1 Viola Jones No-Entry Sign Detector

1.1 Training the classifier



Shown in the graph, the values for *TPR* at each stage remain constant at 1. This implies that all "No Entry" signs are being detected from training stage 0. The *FPR*, on the other hand, drops with each stage, demonstrating that the number of false positives (incorrectly identified "No Entry" signs) is being reduced.

1.2 Effectiveness on dataset



(a) Good detection with background clutter.



(b) Occlusion affecting detection.



(c) Detection failing in good conditions.

The performance achieved from the Viola Jones classifier varies greatly with some expected failures, such as images where occlusion is present, and some unexpected failures where all no entry signs are clear. However, there are instances where the detector works well. The detector seems undisturbed by background noise, this makes sense as Viola Jones is a sliding window detector and so should not be affected by noise not present in the suitable windows.

TPR and T1 Scores of Dataset																Mean	
Image	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean
TPR	0.5	1.0	1.0	0.5	1.0	0.1	0.0	0.0	0.5	0.0	0.33	0.0	0.13	0.0	0.0	0.5	0.35
F1 Score	0.5	0.67	0.67	0.5	1.0	0.18	0.0	0.0	0.67	0.0	0.5	0.0	0.22	0.0	0.0	0.5	0.34

The table above shows that overall, the performance achieved by just the Viola Jones detector is poor with a TPR mean score which implies, on average, the no entry sign will likely not be detected. The F1 score also implies a poor model with low recall and precision.

The values achieved do not reflect those shown when training the classifier, this is likely due to the test set being difficult with changes in luminosity, occlusion and view-point variation likely causing this impact.

2 Integration with shape detectors

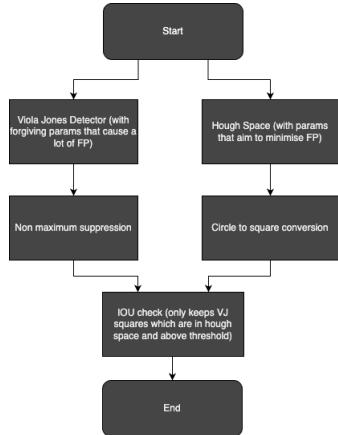
2.1 Hough Space

For the image was grey scaled and blurred before being passed into the written Sobel edge detector, this was then used to generate the Hough space. As seen below this Hough space's 3D array creates intense points around the centres of each of the signs. Note the angled sign which is more elliptical forms a less sharp point in the space, implying running the code on signs which are not front on may hinder performance, meaning the integration with Viola Jones may be less effective on these signs.



Figure 2: Binary threshold image and Hough space for image 6

2.2 Integration of Hough space with Viola Jones



- Viola Jones uses forgiving parameters as FP will be removed in IOU
- Non-maximum suppression means multiple poor VJ detections that lie on a circle has less of an impact as reduced to one square
- Hough space uses strict parameters to minimize the chance of passing FP through IOU
- circles are converted to squares as IOU of squares are easier to calculate
- IOU should remove FP as it is unlikely to have a FP that lies on a circle

2.3 Performance



(a) Eliminated stubborn area near shoe



(b) The only false positive



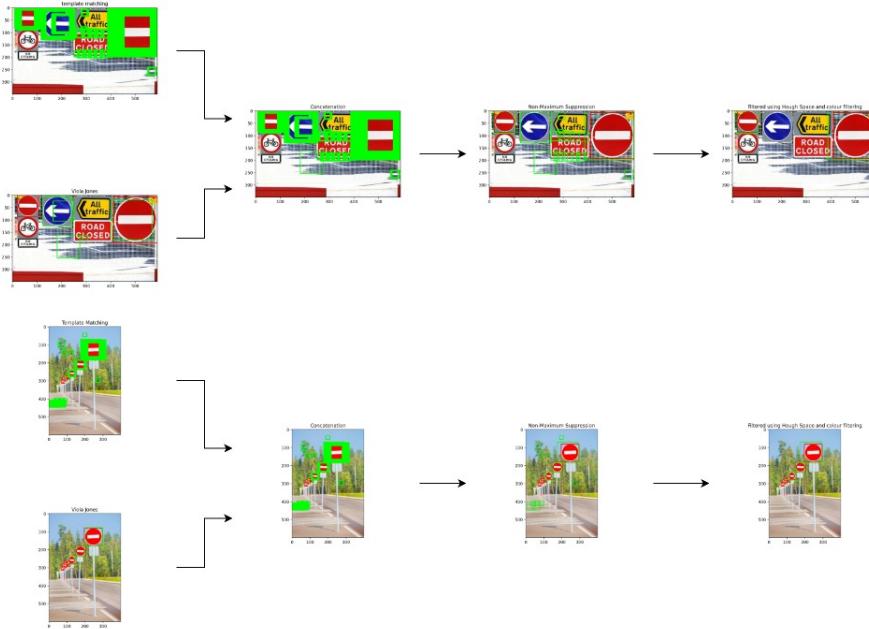
(c) Improved performance

- Improved mean TPR by 0.02
- Improved mean F1 score by 0.09
- The false positive rate was decreased with only one misclassification throughout the entire test set
- The false negative rate was increased as some correct Viola Jones detections were discarded due to the circle not being detected (occurrences with ellipses)

TPR and T1 Scores of Dataset																	
Image	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean
TPR	0.0	1.0	1.0	0.5	0.5	0.0	0.25	0.0	0.5	0.5	0.33	0.0	0.38	0.0	1.0	0.0	0.37
F1 Score	0.0	1.0	1.0	0.5	0.67	0.0	0.4	0.0	0.67	0.67	0.5	0.0	0.55	0.0	1.0	0.0	0.43

3 Detector Improvements

3.1 Implementation



- Template matching (with low threshold) ensures more possible signs are detected
- Non-maximum suppression ensures the concatenation of the two techniques doesn't get too busy
- Colour filtering ensures that circles that are not red aren't detected (this removes the final false positive)

3.2 Performance

- Improved mean TPR by 0.13 from previous stage
- Improved mean TPR by 0.15 from start
- Improved mean F1 score by 0.15 from previous stage
- Improved mean F1 score by 0.24 from start
- The false positive rate was again decreased with now no false detections
- Like in the previous stage, it is still limited by the Hough space's circle detection
- The template appears to find (in most cases) all the Viola Jones boxes and more. Due to this, it may be more efficient to remove Viola Jones from this solution, improving speed

TPR and T1 Scores of Dataset																	
Image	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean
TPR	0.0	1.0	1.0	1.0	0.5	0.0	0.25	0.0	0.67	0.5	0.67	0.5	0.38	0.0	1.0	0.5	0.5
F1 Score	0.0	1.0	1.0	1.0	0.67	0.0	0.4	0.0	0.8	0.67	0.8	0.67	0.55	0.0	1.0	0.67	0.58