# Report: Image Processing and Computer Vision 2018

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***Abstract*—TODO: Write an abstract or remove it later.**

## I. Subtask 1

The First Page of your Report (strict limit):
a) Annotate the test images to generate ground truth, then test the face detectors performance (with the given parameters as provided by face.cpp) on five given example images: dart4.jpg, dart5.jpg, dart13.jpg, dart14.jpg and dart15.jpg. Produce the five result images with bounding boxes drawn around detected face candidates and include them in your report.
b) Calculate and note in your report the TPR (true positive rate) for the images dart5.jpg and dart15.jpg, that is the fraction of successfully detected faces out of all valid faces in an image. Discuss in your team and briefly note in your report 1) some practical difficulties in assessing the TPR accurately, 2) why it is always possible to achieve a TPR of 100% on any detection task, and 3) implement a small piece of code to calculate the F1-score of your face detection system accurately and meaningfully from ground truth and a test run on any given test image set.

### A. Face detection


Fig. 1. Image face4.jpg

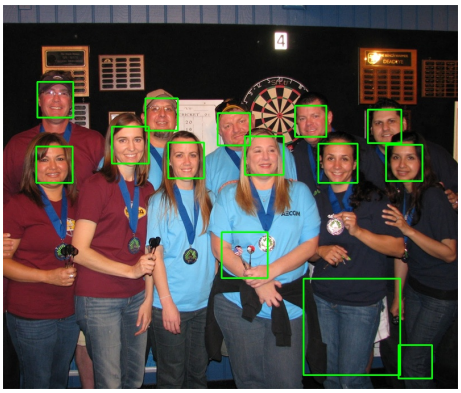


Fig. 2. Image face5.jpg

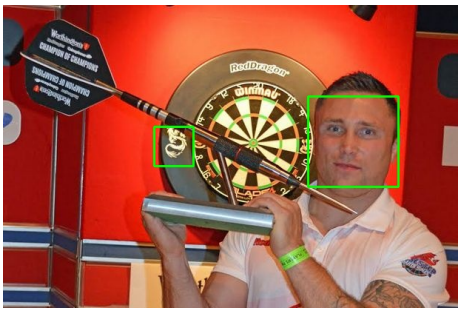


Fig. 3. Image face13.jpg


Fig. 4. Image face14.jpg

### B. TPR calculation

Calculating the true positive rate:

$$TPR = \frac{TP}{P} = \frac{TP}{TP + FN}$$

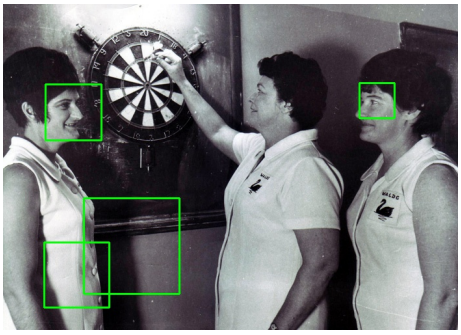


Fig. 5. Image face15.jpg

where :
$TPR$ = True positive rate
$TP$ = The number of cases correctly recognised
$P$ = The number of actual positive cases in the data
$FN$ = The number of false negatives, or the number of actual true cases not recognised

dart5.jpg TPR =

$$\frac{11}{11+0} = 1 \therefore 100\%$$

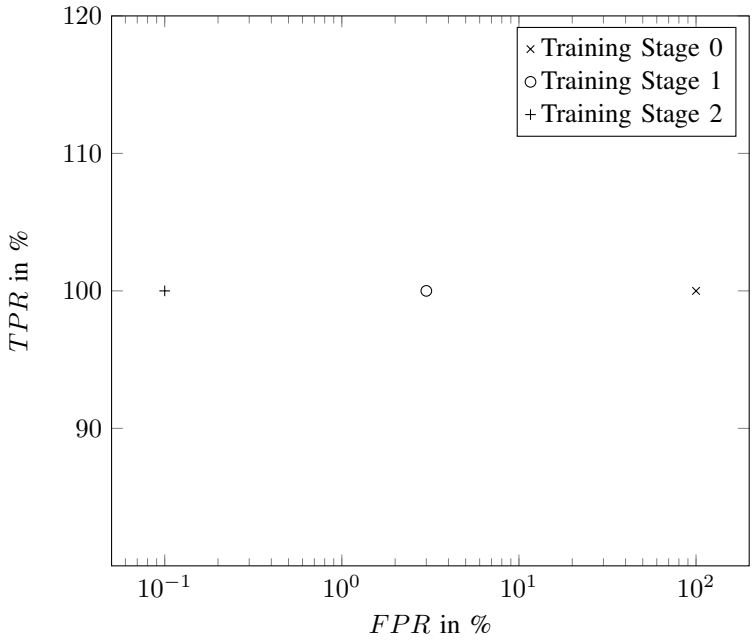
dart15.jpg TPR =

$$\frac{2}{2+1} = 0.\dot{6} \therefore 66.\dot{6}\%$$

It is always possible to achieve a TPR of 100% on any detection as

## II. Subtask 2

The Second Page of your Report (strict limit):
a) The training tool produces a strong classifier in stages. Per stage the tool adds further features to the classifier and prints the achieved TPR and FPR (false positive rate) for that point on the training data (see Figure). Collate this information into a scatter plot that plots TPR vs FPR on the training data for the three different stages. Produce this graph in your report and briefly interpret what it shows.
b) Test the dartboard detectors performance on all given example images. Produce the result images with bounding boxes drawn around detected dartboard candidates and include 4 of them in your report. In tabular form, calculate the overall F1 score per image and the average across all 16 images. Briefly discuss the performance achieved and compare it to the level of performance achieved in a).




As training progresses from stage 0 to 2 we see that the *true positive rate* (TPR) appears to remain constant. This is due to being parametrised with a minimum hit rate of 0.999, essentially ensuring that all dartboards are detected while the algorithm attempts to reduce the number of false positives. We can see that *false positive rate* decreases at an exponential rate between each of the training stages.

B

## III. Subtask 3

The Third Page of your Report (strict limit):
a) Show in your report for two of the given example dart images which best exhibit the merit and limitations of your implementation: 1) the thresholded gradient magnitude image used as input to the Hough Transform, 2) a 2D representation of the Hough Space, 3) the result images showing final detections using bounding boxes.
b) Evaluate your detector on all of the example images. Provide the F1-score of overall detection performance for


Fig. 6. Image dart1.jpg

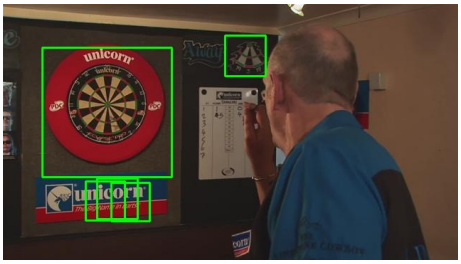



Fig. 7. Image dart2.jpg

Fig. 8. Image dart5.jpg

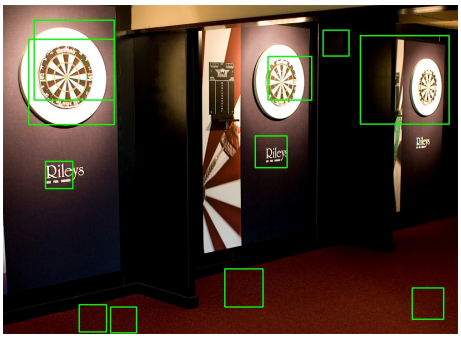



Fig. 9. Image dart10.jpg

the set of example test images in a table. Document your overall detection results (for instance by using precision/recall measures) and briefly note in bullet points the key merits and shortcomings of your implementation.

c) In a flow diagram, depict how you have combined evidence from the Hough Transform and Viola-Jones detector. In bullet points, explain briefly your rationale behind the way you have combined evidence.

## IV. Subtask 4

The Forth Page of your Report (strict limit):

a) In bullet points, explain briefly your rationale behind selecting the approach you have taken.

b) Visualize important aspects of your technique in two of the given example dart images selected to best exhibit the merit of your approach.

c) Evaluate your final detector on all of the example images, show the improvements in F1-score. Document your overall detection results and briefly note in bullet points the key merits and shortcomings of your final implementation.