Image Processing and Computer Vision

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Abstract—**This report outlines the tasks completed for Image Processing and Computer Vision assignment one. The assignment has been split into four sub-tasks. In task one, we experiment with the Viola-Jones object detector to detect faces.**
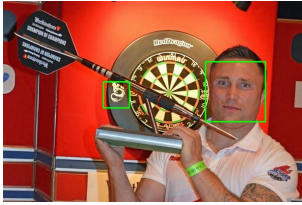
I. THE VIOLA-JONES OBJECT DETECTOR

We first annotated an image data set containing sixteen images for ground truth. Each image within the data set contains faces, dartboards or a combination of both. In this first task, we use the Viola-Jones object detector to find faces within the images.
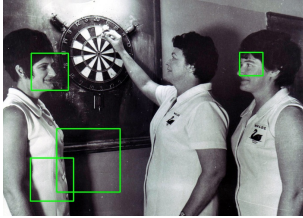

(a) darts4.jpg
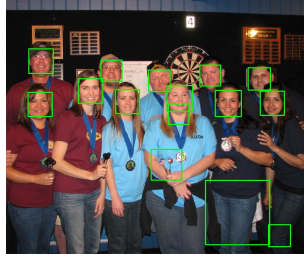
(b) darts5.jpg

(c) darts13.jpg

(d) darts14.jpg

(e) darts15.jpg

Fig. 1: Five images from the test data set. Green rectangles have been drawn where the Viola-Jones classifier has detected a face.

The true positive rate for images *darts5.pg* and *darts15.jpg* are 11 and 1 respectively.

Practically, the true positive rate is difficult to assess because we because we need to define our own ruleset for what counts as a detection. For this task, we have defined a true detection as an area that shares a 50 per cent overlap with a ground truth label. This value was chosen to maximise the f1 score when classifying faces from the test data set. The results varying the percentage overlap can be seen in table x.

TABLE I: All values of percentage overlap gave an identical F1 score, when detecting faces from the test data set.

Overlap Threshold (%)	F1 score
0	0.568
60	0.541
65	0.541
68	0.541
69	0.519
70	0.514
80	0.459

Although the true positive rate can be used to indicate a classifiers accuracy, it does not reflect its true performance. It is always possible to get a 100 per cent detection rate on any classification task as we can select all possible areas of an image, regardless if they contain a target or not. The key to a good classifier is to get a high true positive rate, whilst keeping the false positives minimal. We can use the F1 score to measure the relationship between the precision and the recall of the model. The F1 score can therefore be considered to be a more reliable measure of classifier performance.

The F1 score of the Viola-Jones classifier, when detecting faces in the test data set is

II. THE DARTBOARD DETECTOR
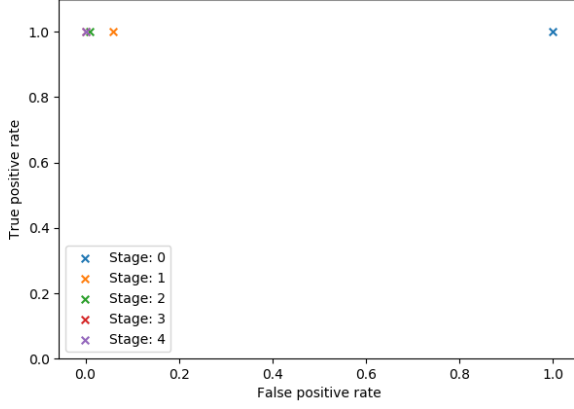
A. Subtask a

Fig. 2: True positive rate plotted against false positive rate, when training the cascade classifier on images of dartboards. Each stage of training has been plotted as its own point.

TABLE II: F1 scores for all images, when detecting for dartboards using a cascade classier trained on dartboards.

Image Name	F1 Score	
	500 Training Images	1000 Training images
dart0.jpg	0.5 00	0.250
dart1.jpg	0	0.500
dart2.jpg	0.250	0.400
dart3.jpg	0.538	0.333
dart4.jpg	0.4 00	0.250
dart5.jpg	0.154	0.200
dart6.jpg	0.333	0.500
dart7.jpg	0	0.250
dart8.jpg	0.160	0.250
dart9.jpg	0.222	0.200
dart10.jpg	0.400	0.545
dart11.jpg	0.222	0.222
dart12.jpg	0.667	0.500
dart13.jpg	0.200	0.333
dart14.jpg	0.087	0.138
dart15.jpg	0.667	0.500
Average f1 score	0.276	0.336

III. INTEGRATION WITH SHAPE DETECTORS

We used a circular hough transform in addition

TABLE III: F1 scores for all images, when detecting for dartboards using a cascade classier trained on dartboards.

Image Name	F1 Score	Precision	Recall
dart0.jpg	1.000	1.000	1.000
dart1.jpg	1.000	1.000	1.000
dart2.jpg	1.000	1.000	1.000
dart3.jpg	0.333	0.200	1.000
dart4.jpg	1.000	1.000	1.000
dart5.jpg	1.000	1.000	1.000
dart6.jpg	1.000	1.000	1.000
dart7.jpg	1.000	1.000	1.000
dart8.jpg	1.000	1.000	1.000
dart9.jpg	0.000	0.000	0.000
dart10.jpg	1.000	1.000	1.000
dart11.jpg	0.222	0.125	1.000
dart12.jpg	0.667	0.500	1.000
dart13.jpg	1.000	1.000	1.000
dart14.jpg	0.500	0.333	1.000
dart15.jpg	0.667	0.500	1.000
Average	0.774	0.729	0.938

IV. FURTHER IMPROVEMENTS