Image Processing & Computer Vision:

Dartboard Challenge

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**Subtask 1: The Viola-Jones Object Detector**

1. **Introduction**

The first subtask was to understand, compile and build the Viola-Jones object detector on a pre trained classifier to detect faces. This was to gain the knowledge of how the detector worked and to test its ability on face detection.

1. **Ground Truth & Visualisation**

To start we gathered all the data for the ground truth faces. This required manually inputting the coordinates of the rectangles into the C++ programme. The results from 5 of the images running the Viola-Jones detector with ground truths in red can be seen below. Our definition of a ‘frontal face’ was clear visibility of two eyes. This meant that there were a few faces that were not highlighted in red due to not meeting our criteria.

1. **IOU, TPR and F1-Score**

We then both implemented some code that would calculate the intersection over union (IOU) of the Ground Truth rectangles vs the Viola-Jones rectangles. Due to OpenCV’s datatype ‘Rect\_’ calculating the intersection is an easy operation of Rect\_ & Rect\_. Hence making the union the area of both rectangles minus the intersection.

The use of the IOU is to measure the True Positive Count (TPR). This is calculated by the returned count of true positive faces divided by the Ground Truth count of faces. By setting a threshold and measuring the IOU of every detected faces vs every Ground Truth face we were able to count the number of detected true positives.

|  |  |  |
| --- | --- | --- |
| *Image* | *TPR* | *F1-Score* |
| Dart0 | N/A | N/A |
| Dart1 | N/A | N/A |
| Dart2 | N/A | N/A |
| Dart3 | N/A | N/A |
| Dart4 | 1.0 | 1.0 |
| Dart5 | 1.0 | 0.88 |
| Dart6 | 0 | N/A |
| Dart7 | 1.0 | 1.0 |
| Dart8 | N/A | N/A |
| Dart9 | 1.0 | 0.4 |
| Dart10 | N/A | N/A |
| Dart11 | 1.0 | 1.0 |
| Dart12 | N/A | N/A |
| Dart13 | 1.0 | 0.667 |
| Dart14 | 1.0 | 0.5 |
| Dart15 | N/A | N/A |

**Table 1: True Positive Ratio and F1-Score of**

**Viola-Jones face detection**

The results from Table 1 contain multiple N/A’s. This is due to that specific image not containing any faces, and hence the data cannot be used to describe the accuracy of the face detection.

The F1-Score is a measure of accuracy. It takes into account the true positive count, false positive count and false negative count. We were able to use all the data from the IOU and TPR to calculate this. The results show that the accuracy of the detector was not too low and did not produce too many false negatives. However, more data would be required to make a verdict on its accuracy due to only having a small dataset.

The practical difficulties in assessing the TPR is that the all of the faces in the images were detected and hence all the TPR’s are 100%. This doesn’t really help to judge the quality of the detector as we cannot distinguish anything between different images. The reason the TPR can always achieve 100% due to it not taking in false positives. This means an infinite number of faces could be detected at every point in the image still leading to a TPR of 100%.