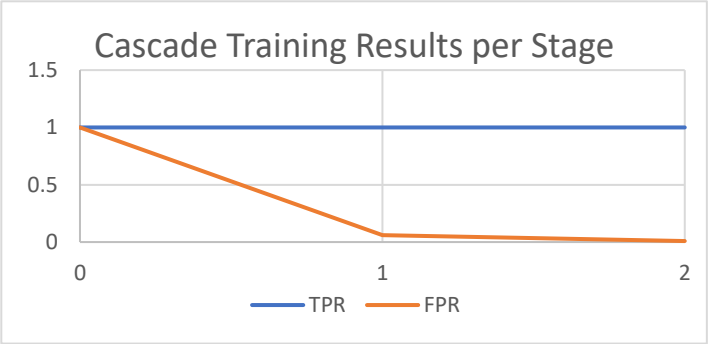
IPCV REPORT

PART 1



This graph displays the output from the training tool used to build a classifier in stages. The graph clearly demonstrates ability to maintain accuracy TPR=1 while effectively reducing false positives, which is crucial for a reliable detection system. The decrease in FPR from stage 1 to stage 3 indicates the successive stages of the cascade are proficient at discarding non-dartboard regions.

Image	TPs	F1
0	1	0.125
1	1	0.25
2	1	0.1538
3	1	0.222
4	0	0
5	1	0.1176
6	0	0
7	1	0.1333
8	2	0.1739
9	1	0.2222
10	1	0.0666
11	3	0.3529
12	0	0
13	1	0.1428
14	2	0.0634
15	1	0.3333
AVG	1.0625	0.1473

This table shows the True Positives and F1 score of the viola jones model. The difference between the observed results on the training performance can be seen in the True Positives and F1 scores of the Viola Jones detection on the given images. The difference may occur from the classifier overfitting on the training data, being less effective on unseen images. Another reason for this difference could be the variation between unseen images and training images, for instance, there may be different obscurities or noise within the image, perhaps different lighting and angels may also affect the ability of the classifier to identify dartboards.

3 Images showing Viola Jones detections and ground truths, green and red respectively:

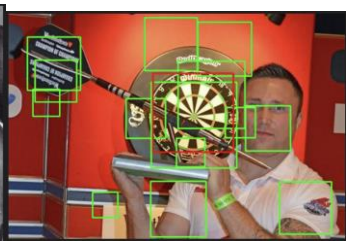




Image	TPs	F1	diff. TPs	diff. F1
0	0	0	-1	-0.125
1	1	1	0	0.75
2	0	0	-1	-0.15384
3	0	0	-1	-0.22222
4	0	0	0	0
5	1	0.666	0	0.54901
6	0	0	0	0
7	0	0	-1	-0.13333
8	0	0	-2	-0.17391
9	1	1	0	0.77777
10	1	0.333	0	0.26666
11	1	0.5	-2	0.14705
12	0	0	0	0
13	1	1	0	0.8571
14	1	0.2	-1	0.1365
15	0	0	-1	-0.3333
AVG	0.4375	0.29375	-0.625	0.146407849

Integration with Shape Detectors

New implementation's merits and shortcomings:

- Detector manages to remove a significant proportion of the false positives.
- Uses multiple scores to determine potential dartboards
  - Susceptible to noise, different kinds of noise in each image which lead to uncertainty when combining evidence to detect dartboards
  - Detects less true positives

Image 13 demonstrates the merit of my shape detector implementation best.

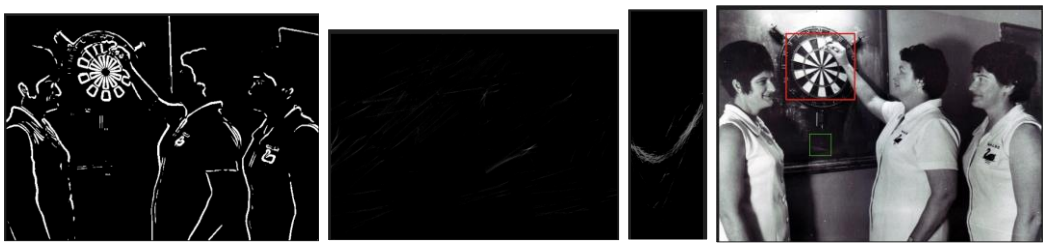
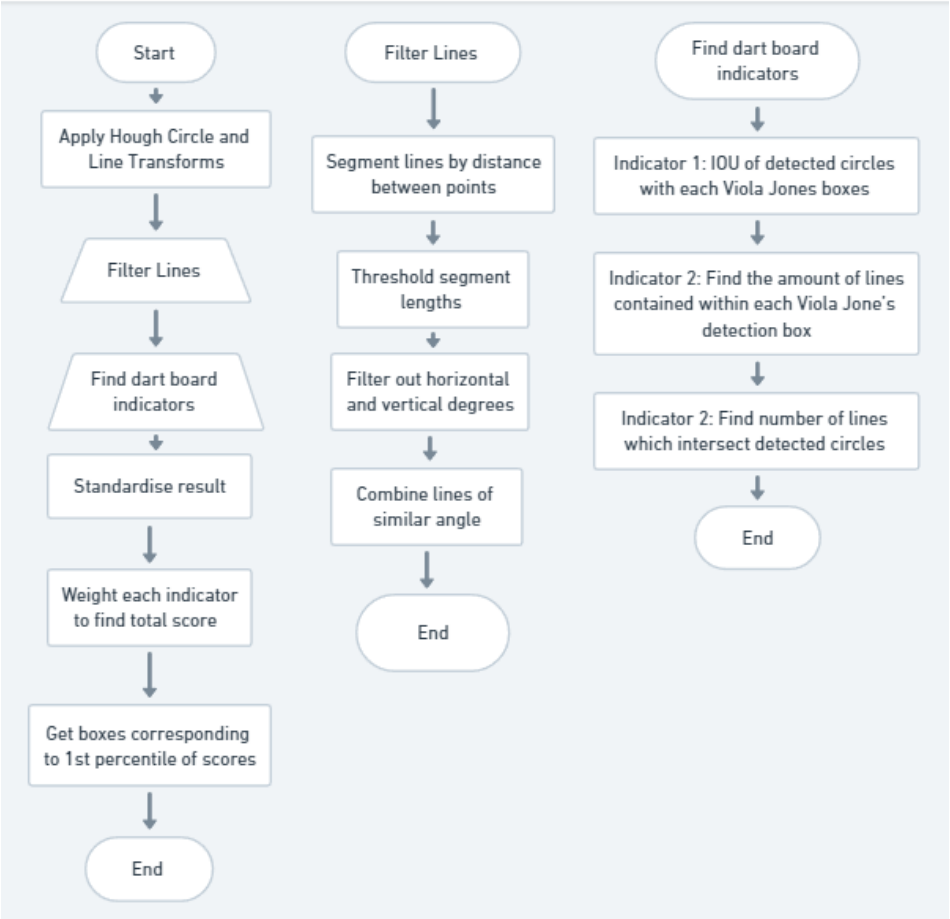


Image 15 demonstrates the shortcomings of my shape detector.

Image magnitude | Hough Space: Circle & Line | Image with detected and ground truth

Detection Pipeline:



- Segment lines which have gaps between to find corresponding lines in image
- Reduce noise by filtering lines by length
- Remove horizontal and vertical lines to reduce noise
- Combine Lines of similar angles to reduce computational power
- Find IOU of detected circle centers with Viola Jones box to indicate potential boxes containing circle center
- Find the number of lines within Viola Jones box as concentrated amount of lines may indicate a potential dartboard as majority of noise has been filtered out
- Find the number of lines which intersect detected circles, utilizing dartboard geometry to indicate potential dartboard locations
- Standardise each indicator result, enabling comparisons of indicators
- Multiply indicators by weight to adjust which have more influence over detection of dartboard
- Find top ranking scores which highly suggest location of dartboard, use the Viola Jones box associated with this score

Improving my Detector

- Due to different sizes of dartboard rather than template matching I decided to implement feature matching to recognize specific patterns and textures, using the FLANN algorithm.
- Implements a detection which doesn't focus on object geometry and orientation unlike Hough shape detection and Viola Jones, creating a more robust detection
- To combine the detections I ensured that each box is considered as a potential match if one of the following criteria were met (this method managed to mitigate false positives):
    - Crt1: Boxes consisted of a high percentage of the maximum amount of detected feature-matching points (colour blue in visual example) within one box
    - Crt2: Boxes contained a few feature-matching points and a large number of lines (colour red in visual example)
    - Crt3: Boxes contained a reasonable amount of feature-matching points and achieved a high indicator score

Image	TPs	F1	diff. TPs VJ	diff. Tps Hough	diff. F1 VJ	diff. F1 Hough
0	1	1	0	1	0.875	1.125
1	1	1	0	0	0.75	0.25
2	1	0.6666	0	1	0.5128	0.8205
3	1	1	0	1	0.7777	1.2222
4	0	0	0	0	0	0
5	1	1	0	0	0.8823	0.4509
6	0	0	0	0	0	0
7	1	1	0	1	0.8666	1.1333
8	0	0	-2	0	-0.1739	0.1739
9	1	1	0	0	0.7777	0.2222
10	1	0.3333	0	0	0.2666	0.0666
11	1	0.5	-2	0	0.1470	0.3529
12	0	0	0	0	0	0
13	1	1	0	0	0.8571	0.1428
14	1	0.3333	-1	0	0.2698	0.1968
15	1	1	0	1	0.6666	1.3333
AVG	0.75	0.6145	-0.3125	0.3125	0.4672	0.4681

Merits and Shortcomings

- Removes almost all false positives and finds the best possible Viola Jones detected boxes
- However, this implementation is limited by the Viola Jones detection, if there are initially poor detections without any matches, the implementation wont be able to generate a new detection box for the dartboard , evident in images 4,8,12, please see table above.
- Not very proficient at detecting dartboards form an angle, could be solved by the implementation of a Hough Ellipse detector

Visualising Technique

Img 1: Shows initial detection from Hough Shape detection implementation, the features detected, final detection
Img 2: If a criteria has been met a bounding box is shown where (Crt1, Crt2, Crt3 are blue, red and green respectively)
Img 3: The green circle represents detected circle centre from Hough Transfrom