CMP9135M — Computer Vision

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Abstract—
Index Terms—

TASK 1 — IMAGE PROCESSING

Task 1.a — Automated ball objects segmentation

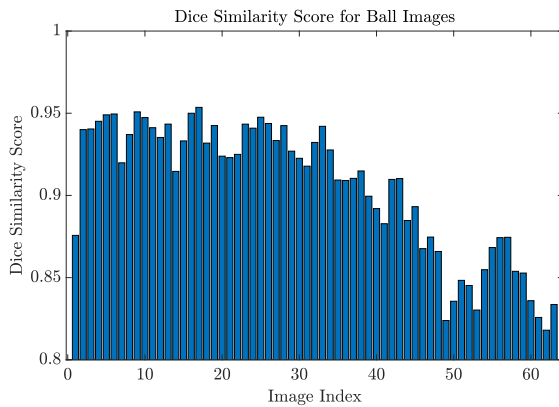*Task 1.b — Segmentation evaluation*

Fig. 1: Dice Similarity score for all 63 images

TASK 2 — FEATURE CALCULATION

Task 2.a — Shape features

For this task, the following shape features were calculated:

1) Solidity: The proportion of the pixels in the convex hull that are also in the object.

$$\text{Solidity} = \frac{\text{Area of the object}}{\text{Area of its convex hull}}$$

2) Non-compactness: Compactness is the proportion of the region's pixels to all of the bounding box's pixels. So non-compactness is the inverse of this.

$$\text{Non-compactness} = 1 - \frac{\text{Area of the object}}{\text{Area of bounding box}}$$

3) Circularity: The roundness of the object.

$$\text{Circularity} = \frac{4\pi * \text{Area of the object}}{(\text{Perimeter of the object})^2} * \left(1 - \frac{0.5}{r}\right)$$

Where $r = \frac{\text{Perimeter of the object}}{2\pi} + 0.5$

4) Eccentricity: The eccentricity is the proportion of the distance between the foci of the ellipse and the length of its major axis. An eccentricity of 0 means its a perfect circle. An eccentricity of 1 means its a line.

$$\text{Eccentricity} = \frac{\text{Distance between foci of ellipse}}{\text{Length of major axis of ellipse}}$$
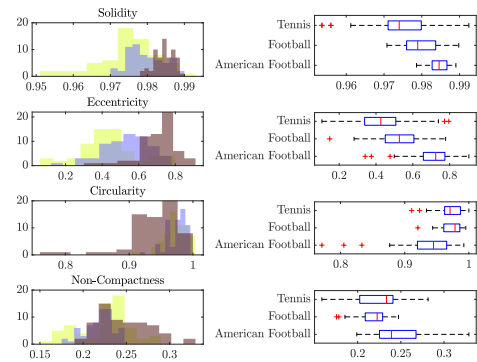

Fig. 2: Histograms and boxplots showing the Solidity, Non-Compactness, Circularity, and Eccentricity of the three ball types.
Legend:

- yellow: tennis
- blue: football
- brown: american football

Figure 2 displays histograms and boxplots representing the distribution of four different shape features (solidity, non-compactness, circularity, and eccentricity) for each ball type (tennis, football, and American football).
Going through each shape feature one by one.

There is a lot of overlap between the three ball types for solidity. The tennis ball has the lowest median solidity, followed by the football, and then the American football. The tennis ball has the highest range of solidity values, followed by the football, and then the american football.

For Eccentricity, the order of the median values is the same as for solidity but there is less overlap between the three ball types. This measure seems better at distinguishing the american football from the other two ball types as the american football is not a sphere like the other two balls.

Circularity like eccentricity is better at distinguishing the american football from the other two ball types, with the tennis

ball and football having a similar Q1 and Q3 values. This is also due to the american football not being a sphere like the other two balls.

Finally, non-compactness is the worst at distinguishing between the three ball types as there is a lot of overlap between the three ball types. The mean of the non-compactness values for each ball lie within 0.025 of each other.
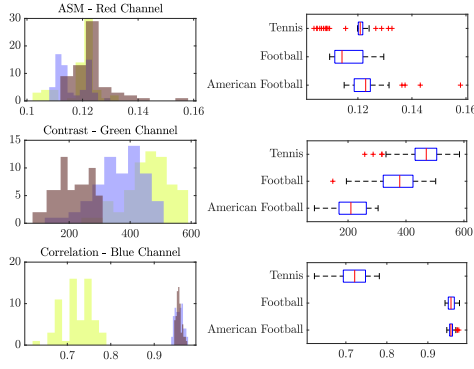
Task 2.b — Texture features

Fig. 3: Histograms and boxplots showing the average Angular Second Moment, Contrast, and Correlation associated with one colour channel for each ball type. Angular Second Moment on the red channel, Contrast on the green channel, Correlation on the blue channel. Same Legend as Figure 2.
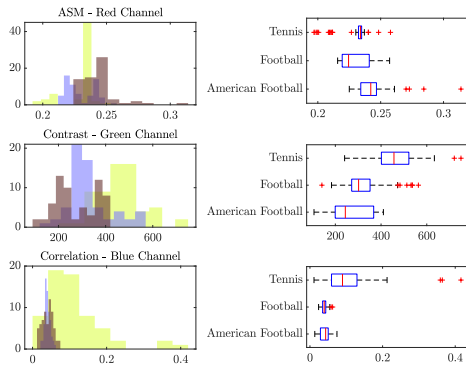

Fig. 4: Histograms and boxplots showing the ranges of Angular Second Moment, Contrast, and Correlation associated with one colour channel for each ball type. Angular Second Moment on the red channel, Contrast on the green channel, Correlation on the blue channel. Same Legend as Figure 2.
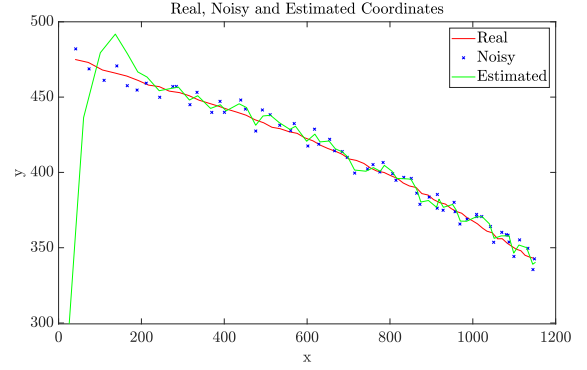

Fig. 5: plot of the estimated trajectory of coordinates $[x, y]$, together with the real $[x, y]$ and the noisy $[na, nb]$ for comparison

Task 2.c — Discriminative information

TASK 3 — OBJECT TRACKING

Task 3.a — Kalman filter tracking
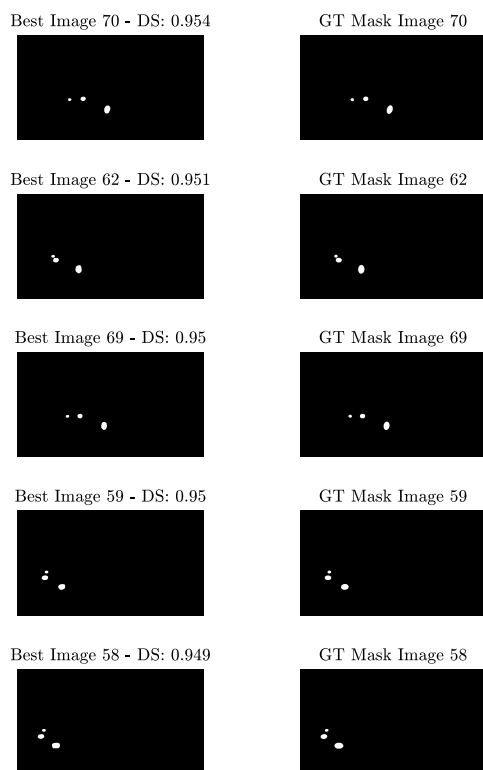
Task 3.b — Evaluation

APPENDIX

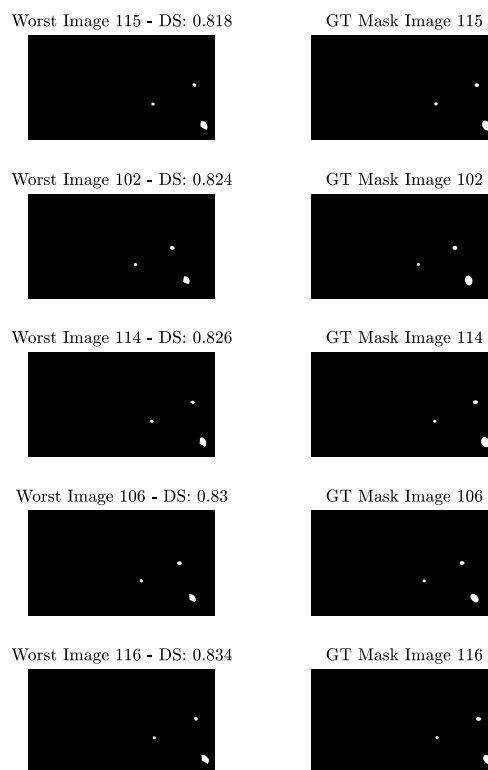Fig. 6: Best 5 segmented ball images compared to the ground truth

Fig. 7: Worst 5 segmented ball images compared to the ground truth