Instrumentation and Processing for Biomedical Applications

Identification of Aortic Walls and Struts in OCT Images

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This project focuses on the development and implementation of a comprehensive method for the identification and analysis of aortic structures in cardiovascular Optical Coherence Tomography (OCT) imaging. The primary goal is to accurately detect the walls of the aorta and identify the associated stents and struts within these structures.

Methodology

To remove or process unwanted areas, we use the following techniques:

1. **Hough Line Transformation**
   - Perform Hough line transformation on the Canny edge-detected image.
   - Extract lines using hough_line_peaks.
   - For each line, calculate its slope and intercept.
   - Interpolate values along the line and modify pixel colors in the original image.

2. **Hough Circle Transformation**
   - Perform Hough circle transformation on the Canny edge-detected image.
   - Extract circles using hough_circle_peaks.
   - For each circle, obtain its center coordinates and radius.
   - Fill the circle with black color in the original image.

To achieve the first objective, the identification of the aortic region circle and the calculation of the radius, area, perimeter, and circularity of the aortic area, the following techniques were applied in the following order:

1. **Polar Transformation**
   - Perform polar transformation on the current image using cv2.warpPolar.
   - Apply a Gaussian blur to the polar-transformed image.

2. **Thresholding and Contour Detection**
   - Threshold the blurred polar-transformed image to create a mask.
   - Find contours in the mask.
   - Filter contours based on area, keeping only those with an area greater than 500.

3. **Extract Filtered Contours**
    - Extract contour points and filter points based on the row position.
    - Stack the filtered contours to obtain information such as radius, area, appearance, and degree of circularity.

4. **Binary Image Conversion**
    - Convert the area image to a binary image by subtracting it from 1.
    - Find contours in the binary image using cv2.findContours.

5. **Contour Visualization**
    - Create a color mask channel by merging the binary image with three channels.
    - Draw contours on the mask channel using cv2.drawContours.
    - Extract the first contour from the list of contours.

6. **Contour Analysis**
    - Calculate area, perimeter, radius, and circularity using OpenCV functions on the extracted contour.
    - Area is computed using cv2.contourArea.
    - Perimeter is computed using cv2.arcLength.
    - Radius is calculated as the square root of the area divided by π.
    - Circularity is computed using the formula: (4 * π * area) / (perimeter^2).

7. **Overlay Information on Image**
    - Overlay contour analysis information on the mask channel image.
    - Display information such as radius, area, perimeter, and circularity on the image.

Results

In Figure 1, the Hough Line Transformation and Hough Circle Transformation are applied to discard unwanted areas. The figure also illustrates the identification of the aortic region circle.

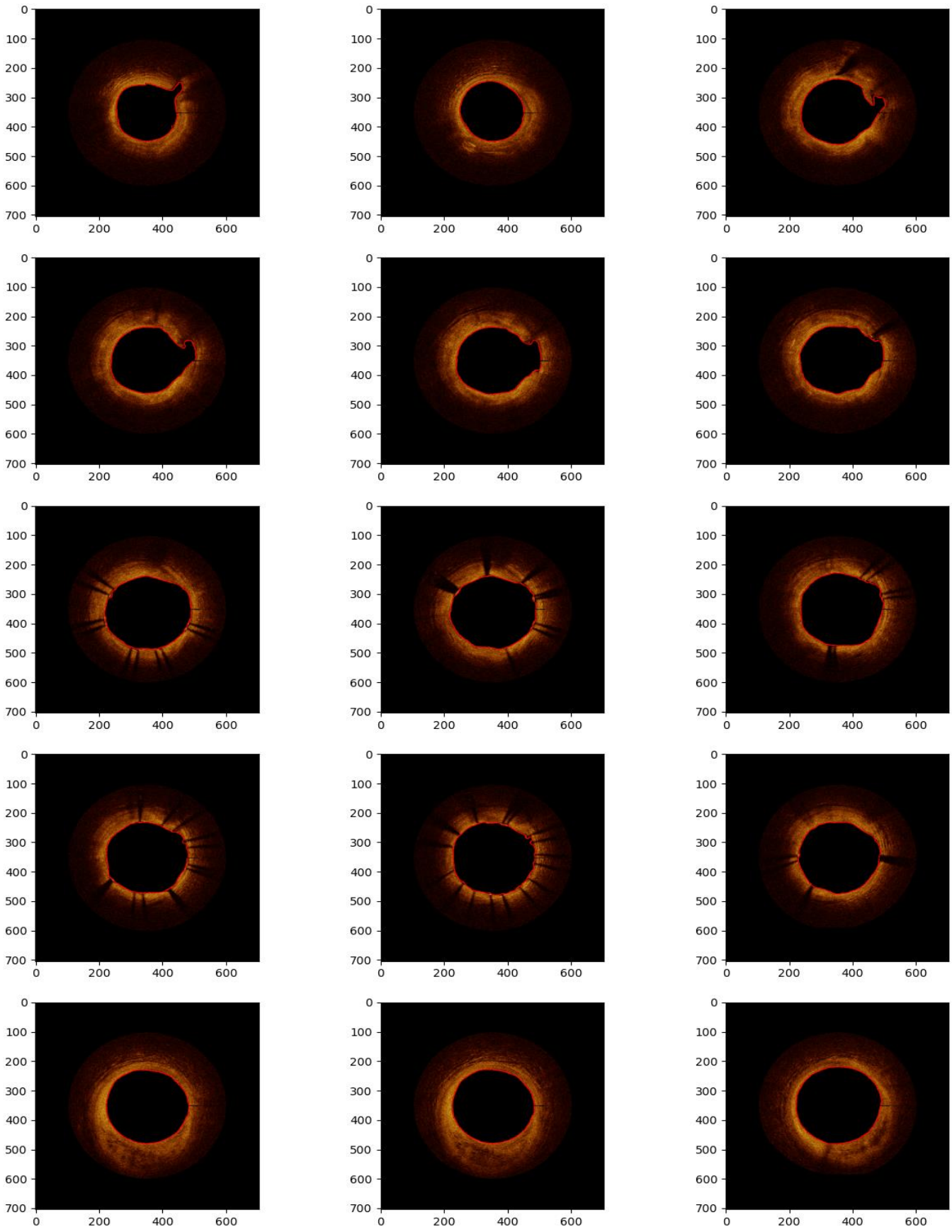

Figure 1 - Discarded non-interest area and identification of the area of the aortic region.

In Figure 2, we have the identification of the aortic area in a binary image with calculations for radius, area, perimeter, and circularity.

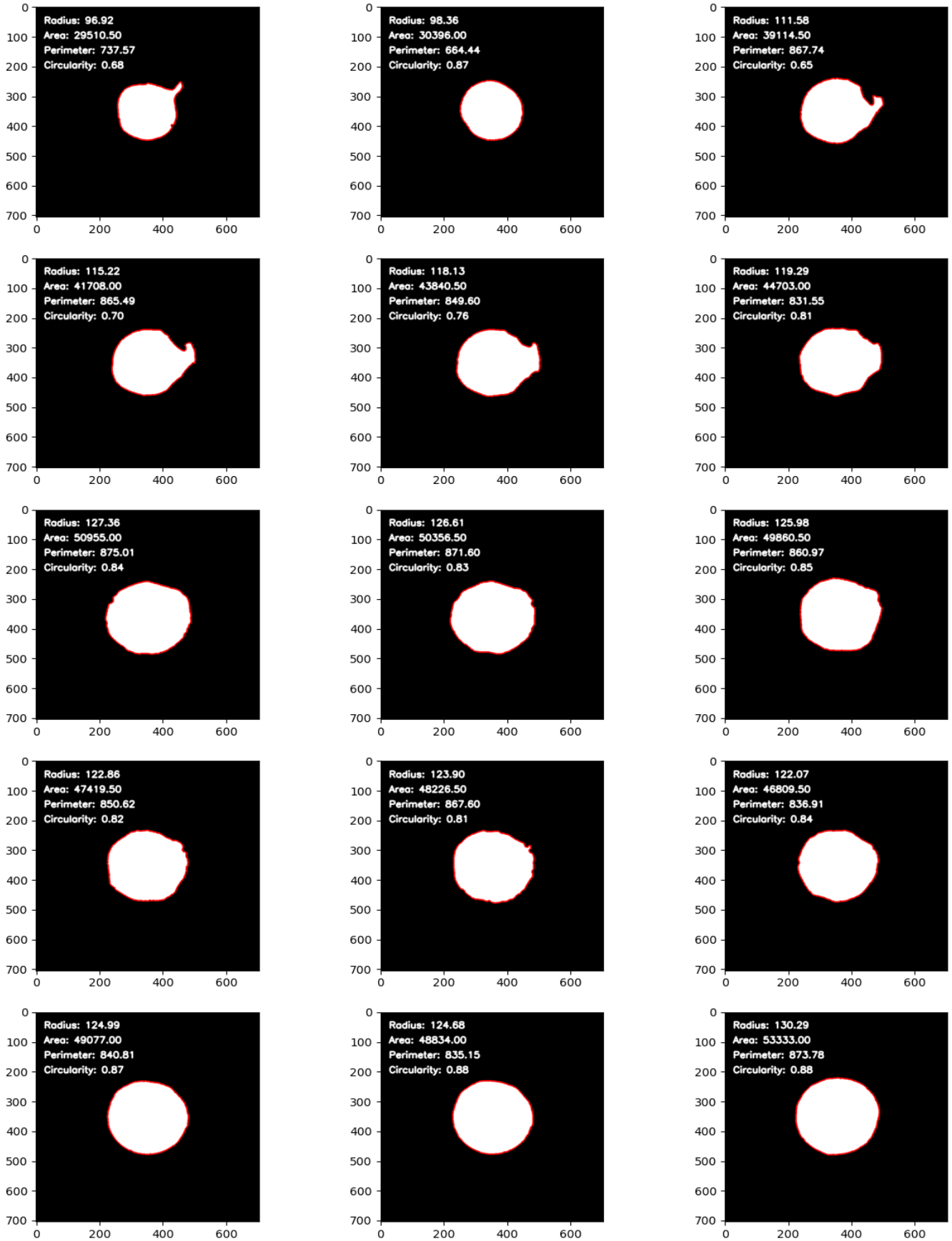

Figure 2 - Calculation of the radius, area, perimeter, and circularity of the aortic region.

Conclusion

The developed pipeline performs the identification of the aortic region and the calculation of the radius, area, perimeter, and circularity of the aortic area, proving to be exceptionally effective.

Files Overview:

- **Lab 1.ipynb**
- **Results.pdf**