COL780
Assignment 1

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February 5, 2024

Contents

1 Task-1: Number of micro-sutures

The images were loaded using the OpenCV library function as grayscale images. As an example image, the following image was obtained after loading.
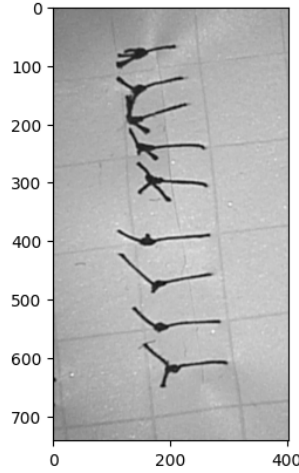
Figure 1: Loaded Image

1.a   Preprocessing Step

The next step taken was to adjust the contrast of the image, I created a function for the same which took two parameters α and β. The α parameter was set to 2.0 and the β parameter was set to 20. Following which the grid lines got removed from the image and a clearer image of just the sutures was obtained
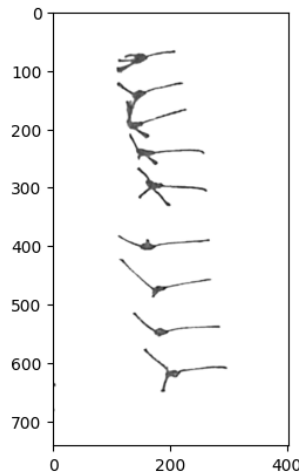

Figure 2: Contrast Adjusted Image

The next step in pre-processing taken was to reduce the noise using a Gaussian Blur. The kernel size was chosen to be 5x5 with the standard deviation as 1 was chosen empirically.
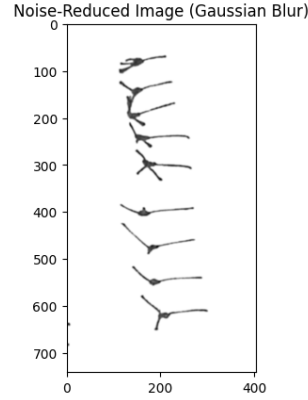
Figure 3: Blurred Image

1.b Edge Detection

After the image got blurred, the next step was to identify edges. A Canny Edge detector was used for identifying the edges of the blurred image. The threshold values were found out empirically and the best obtained values were 90 and 180 for the lower threshold and the upper threshold value respectively.
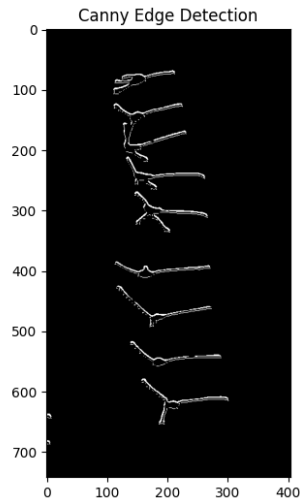

Figure 4: Edge Map

1.c Filtering and Refinement

Once the edges were detected, there were a few discontinuities in the image. So, I thought that dilating the image would help in filling the gaps in the edges by adding pixels to the boundaries. The kernel size use for dilating was 3x3 and the number of iterations was 1
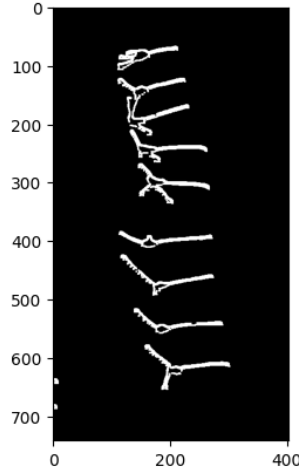
Figure 5: Dilated Image

The image was then converted to binary image such that any pixel having a value more than 0 was assigned label 1 and the rest of them remained 0.

1.d Suture Counting

For counting the number of sutures I initially tried by running the connected components algorithm but it seemed that there was a lot of noise being captured as the number of components came out more than 100. Hence, I tried out with detecting the contours of the sutures. The contours were then drawn on a black image with the contours being green in colour.
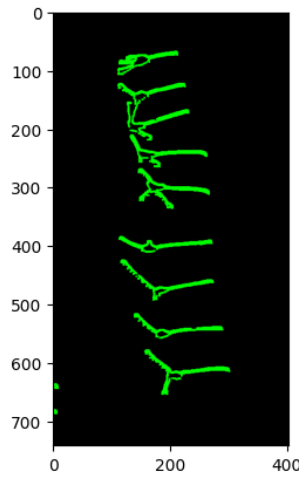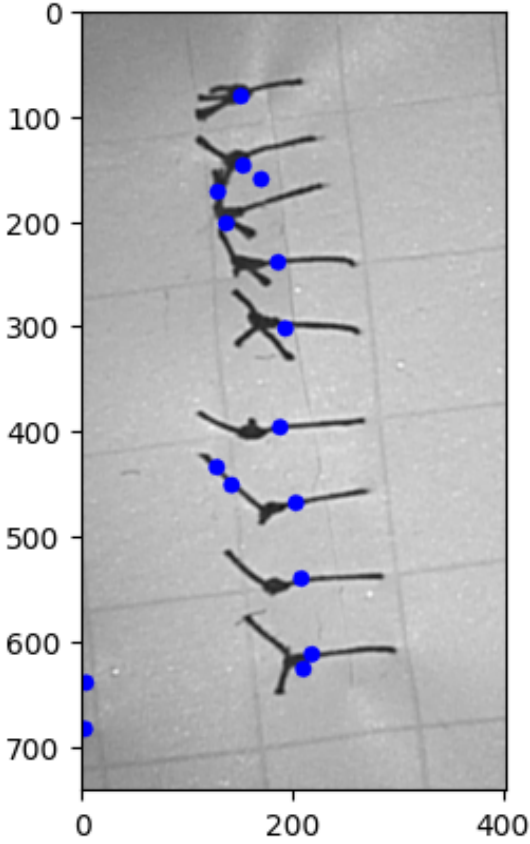

Figure 6: Contours

The number of contours represented the number of sutures identified. In this case it was identified to be 16

2 Task-2: Inter-Suture Spacing

To calculate the inter-suture spacing, the centroid of each of the contours were obtained first. Then the distance between each of the consecutive centroids were reported as the inter-suture distance. From the list of the inter-suture distances, the mean and the variance of the distances were obtained for this image as 0.09469984345949957 and 0.0036338048875438262

(a) Centroids of the contours
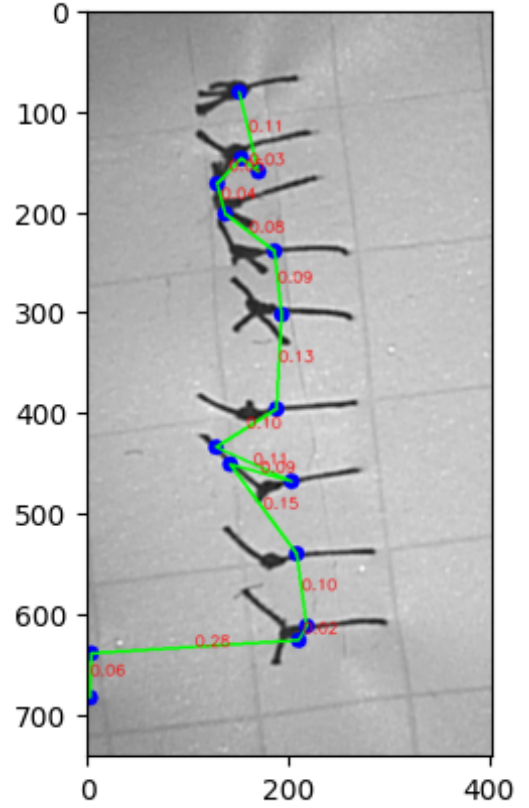
(b) The distances are added as labels beside the lines

Figure 7: Centroids are represented with blue dots

One issue that happened here was that the noise was being captured and I tried removing by increasing the blurring yet I did not obtain anything fruitful.

3 Task-3: Angulation of the Suture

A reference point was first chosen, I took the naive approach and just took the rightmost pixel of each contour to be the reference point. It came out to be a bit noisy.
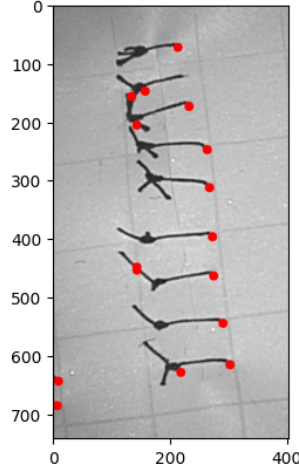
Figure 8: Reference Points

Then to calculate the angle formed by the line joining the reference point and the centroid with the X-axis, I took the arctan of the difference in y coordinates divided by the difference in x coordinates. The mean angle and the variance among the angles obtained are 20.470475719698737 , 492.62604017730985 respectively.

4   Task-4: Comparison of two micro-suturing outcomes

A csv file was generated for comparing the micro-suturing outcomes between two images. Lets consider an instance where the whole pipeline is failing.

According to our rule, the algorithm should output image 2 to have better sutures here yet it's clear that image 6 has better sutures. This is attributed to the fact that the number of sutures in image 2 detected are just 2, the variance comes out to be low because the values for both the sutures in image 2 are close.

The table for this is in the Image Comparison Table.

5   Conclusion

The whole pipeline requires to empirically try out multiple methods for preprocessing, edge detection, region growing to identify objects. There are various values parameters which needs to be tuned to suit our needs for making a robust system capable of performing correct identification of a good suture.

6   References

1) Chatgpt
2) Wikipedia
3) OpenCV
4) GeeksForGeeks

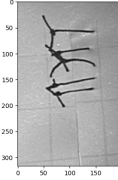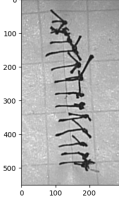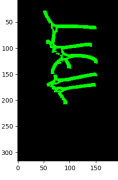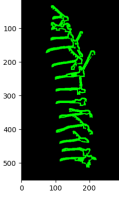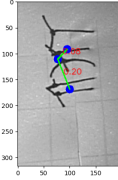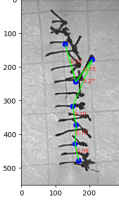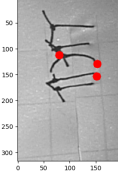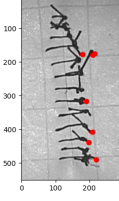|	
(a) Image 2 original picture	(b) Image 6 original picture
(c) Image 2 contours	(d) Image 6 contours
(e) Image 2 centroids and inter-suture distances	(f) Image 6 centroids and inter-suture distances
(g) Image 2 reference points	(h) Image 6 reference points
Mean inter-suture distance: 0.139	Mean inter-suture distance: 0.154
Variance of inter-suture distances: 0.003	Variance of inter-suture distances: 0.00442
Mean of angles: 27.67	Mean of angles: 28.603
Variance of angles: 67.090	Variance of angles: 312.005

Table 1: Image Comparison Table