COL780: Computer Vision

Assignment-1 Report

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1. Number of micro-sutures

Our first task was to count the number of sutures in the given image. As the provided image contains a lot of background noise, before starting the count, I did some preprocessing, which I have explained in detail below.

1.1 Image Pre-Processing

1. Resizing the Image:

The images in the data set contain different sizes (height and width) in my further processing; I have used the filters of different sizes. For better results, i have resized the image by fixing the height and calculated the width according to the original ratio between height and width.

Height=300
Ratio= (original width/original height)
Width=Height*ratio

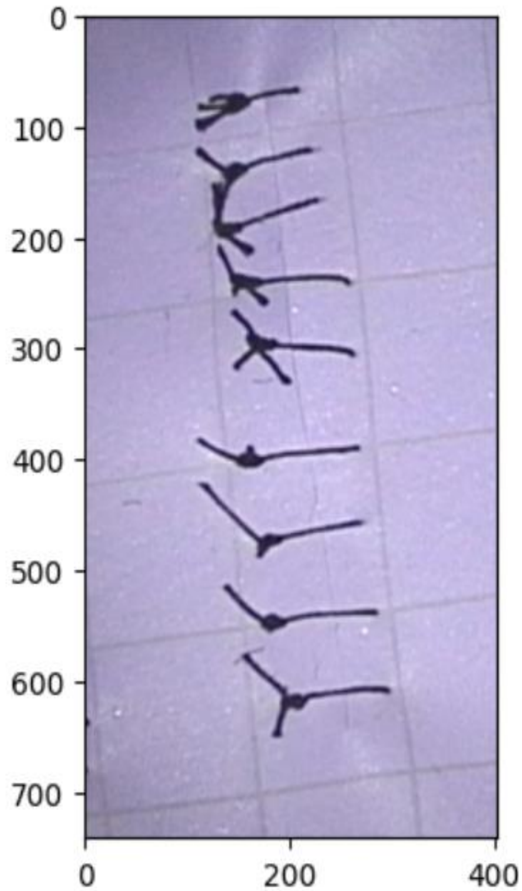


Fig 1.1 before Resize

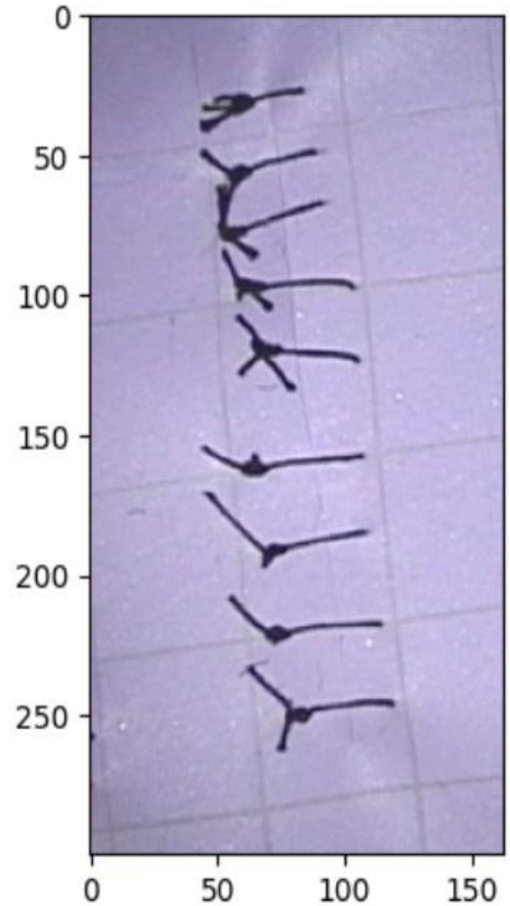


Fig 1.2 after Resize

2. Gray Scale Conversion:

After resizing the image I have converted, the RGB image to a gray scale image for easier computation. I have multiplied the each layer with a fixed constant and summed up the all three layers for obtaining the gray scale image.

GRAY SCALE= (0.299*R) + (0.587*G) + (0.114*B)

After converting the RGB image Fig 1.2 to gray scale image Fig 1.3 it is as below

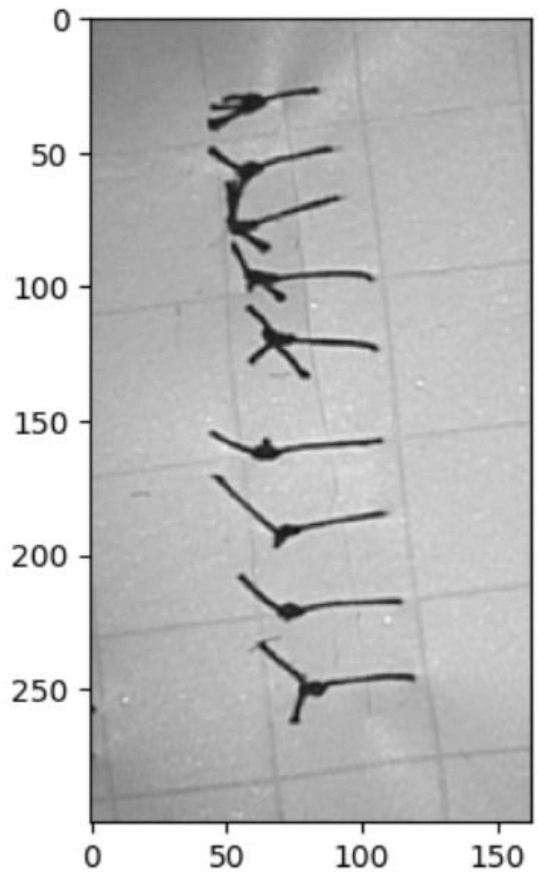


Fig 1.3 Gray Scale

3. Gaussian Smoothing:

Gaussian smoothing is a technique used in image processing to reduce noise and blur images. It involves convolving the image with a Gaussian kernel. This process effectively reduces high-frequency noise while preserving the overall structure of the image.as the given images have alot of noise i have used the 3X3 Gaussian kernel with variance equals to 3

$$\text{Gaussian Kernel} = \begin{matrix} [0.1069973 & 0.11310982 & 0.1069973] \\ [0.11310982 & 0.11957153 & 0.11310982] \\ [0.1069973 & 0.11310982 & 0.1069973] \end{matrix}$$

Variance=3

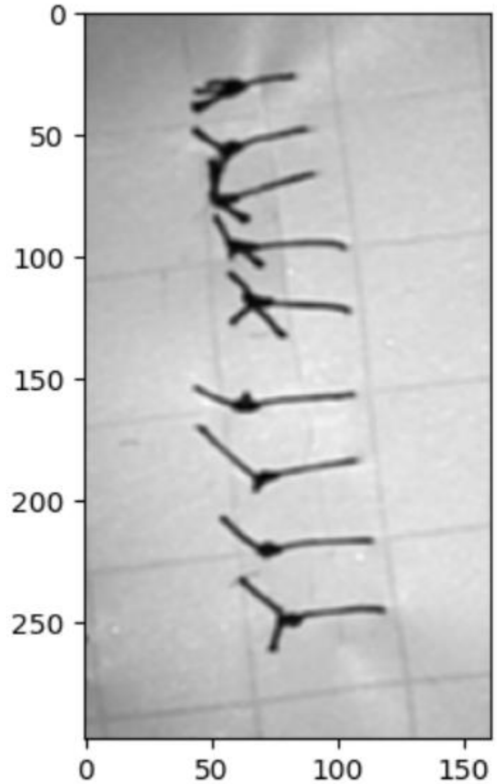


Fig 1.4 Gaussian Smoothing

1.2 Edge Detection

1. Sobel X:

Sobel X filter is used to calculate the gradient along the horizontal axis, which gives us the edges alining along the vertical axis. I have done the convolution operation on the image, which is obtained after Gaussian smoothening Fig 1.4.this operation removes all the noise in horizontal direction and gives us the axis alining along vertical the image obtained after applying the sobel X filter is Fig 1.5.

[1/8, 0/8,-1/8]
Sobel X Filter = [2/8, 0/8,-2/8]
[1/8, 0/8,-1/8]

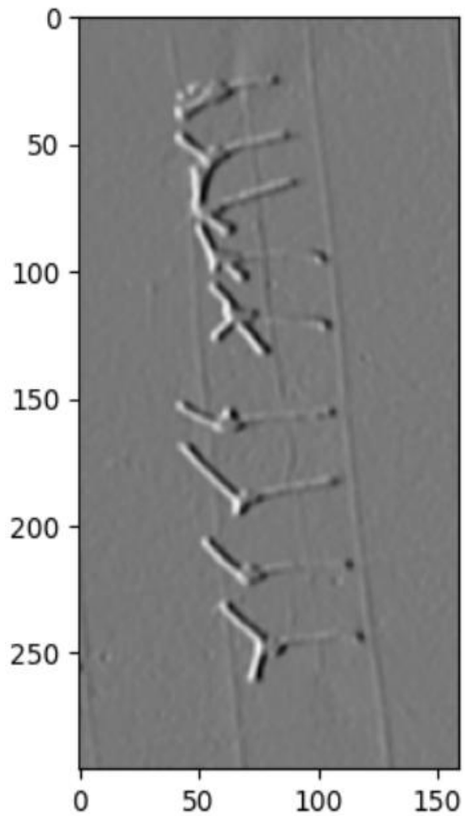


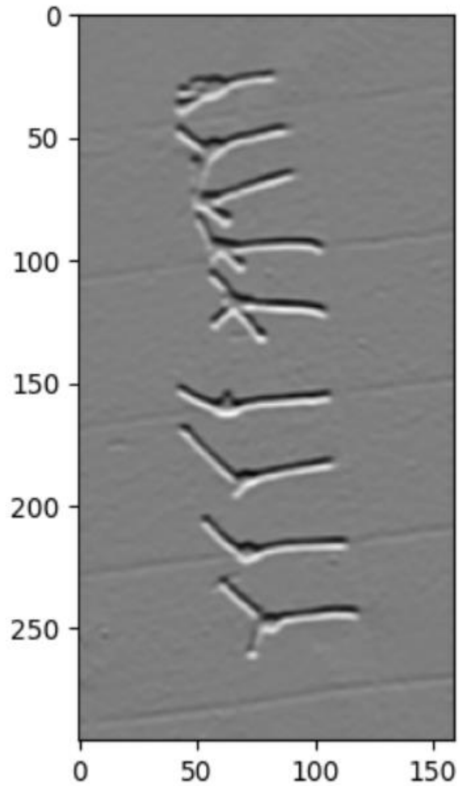
Fig 1.5 Image after Sobel X Filter

2. Sobel Y:

Sobel Y filter is used to calculate the gradient along the vertical axis, it gives use the edges aligning along the horizontal axis. I my case i have modified the sobel Y filter to get a strong edges of suture if i have used the standard filter I am getting the thin edges around the suture. I need the edges of each suture to completely represent the suture as a solid one not the borders. After convolving the Fig 1.4 with the standard Sobel Y filter i have gotten the image Fig 1.6 and after convolving with the modified filter the image is Fig 1.7

Standard Sobel Y Filter = [-1/8,-2/8,-1/8]
[0/8, 0/8, 0/8]
[1/8, 2/8, 1/8]

Modified Sobel Y Filter = [1/8,-2/8,-1/8]
[0/8, 0/8, 0/8]
[1/8, 2/8, 1/8]



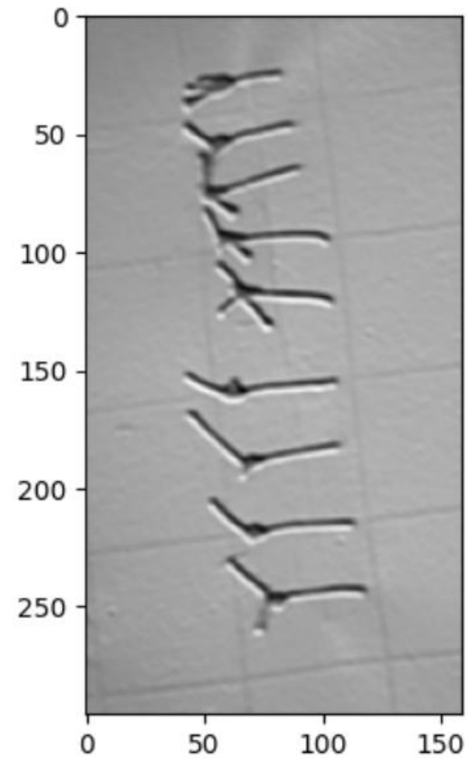


Fig 1.6 image using standard sobel Y   Fig 1.7 image using modified sobel Y

3.Magnitude:

After Sobel operation i have obtaining the Fig 1.5 and Fig 1.7 images using this i have calculated the magnitude of image by constructing each pixel with the square root of the sum of squares. After this operation, i obtained the Fig 1.8. In this image, we can clearly observe the each suture whose black intensity is high and the whole back ground is at low intensity which further helps me in thresholding the image to obtain the clear solid suture which are differentiated from the background.

Magnitude(x,y) = sqrt (sobel x^2 + sobel y^2)

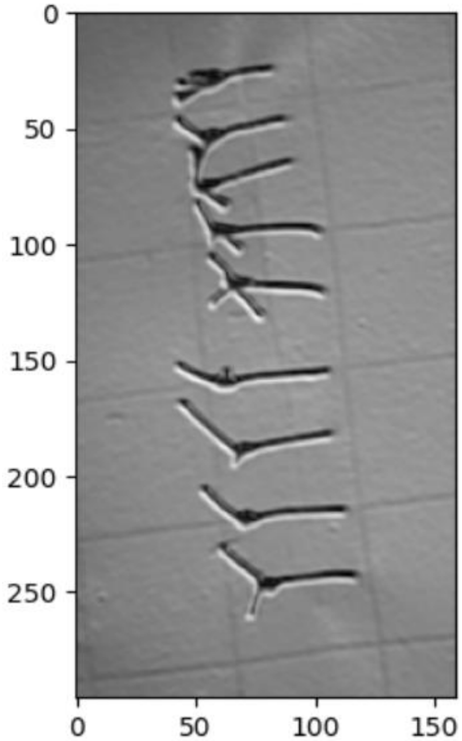


Fig 1.8 Magnitude Image

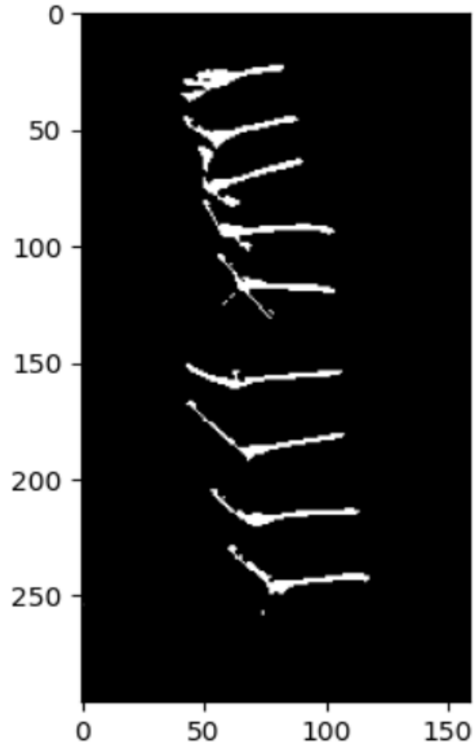


Fig 1.9 Image after Thresholding

4.Thresholding:

One the Fig 1.8 which is obtained by taking the magnitude i have done the thresholding to differentiate sutures and background. I have fixed the threshold value as 30 i.e the pixels which are greater then threshold i made them zero (0) and the other to 255. Which representing my suture as complete white and background as black. I have selected the threshold value after many trials which works fine for almost all images in the data which almost removes the noise.the image obtained by this operation is Fig 1.9.

1.3 Dilation and Erosion operations

1.Filter-1 Dilation:

On thresholded image i have used the **3x3** maximum Dialation filter to make the sutures continuous where ever there is a break with in the suture,we can observe that some of the sutures are discontinious this operation helps to make them continious.which also makes the sutures thicker.Fig 1.10 represent the obtained image.

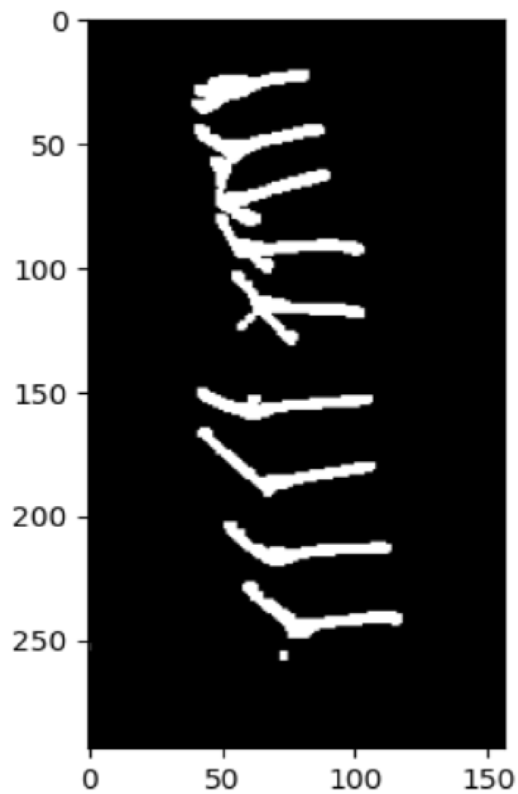


Fig 1.10 Image after Dilation filter1

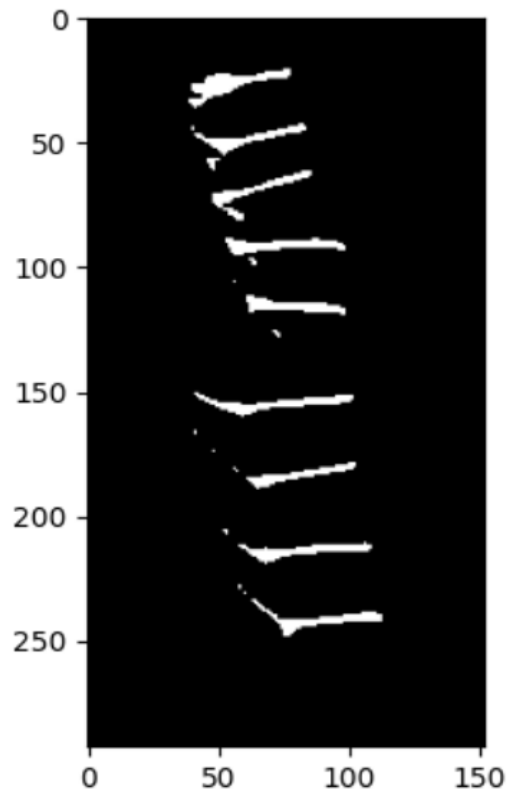


Fig 1.11 Image after erosion filter2

2.Filter-2 Erosion:

I have used the **2x6** min Erosion filter to remove the extra suture left.This is the large noise in the image which i considered to be removed which does not contribute to suture.and also it helps to differentiate one suture from the other in case they are attached with each other this is the reason to take a horizontal filter to resolve this issue.Fig 1.11 is the image obtained after this operation.

3.Filter-3 Dilation:

After filter 2 i have removed the extra suture left and also it made some sutures to break to reconstruct them i have used the vertical 3x1 max Dilation filter and for accurate differentiating of suture i have used a long horizontal 4th filter to make sure the presents of suture (not from vanishing) after 4th filter i have used this horizontal filter.after this filter the Image is shown in Fig 1.12.

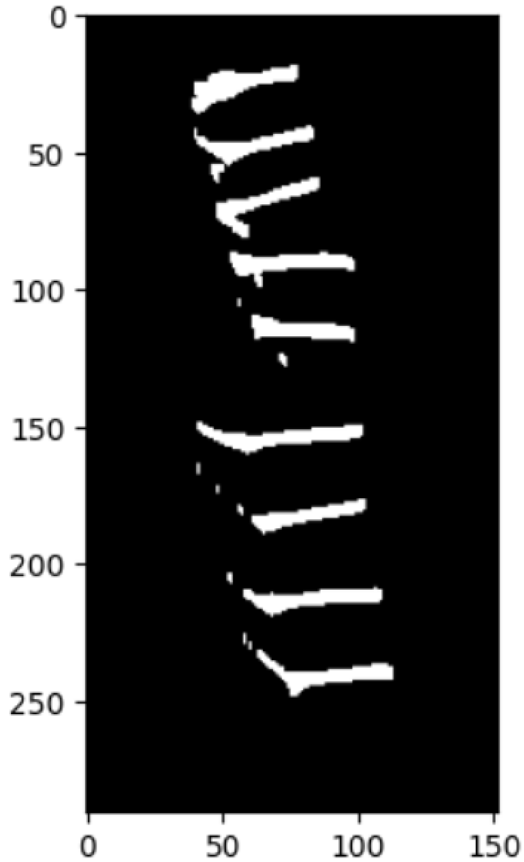


Fig 1.12 Image after Dilation Filter3

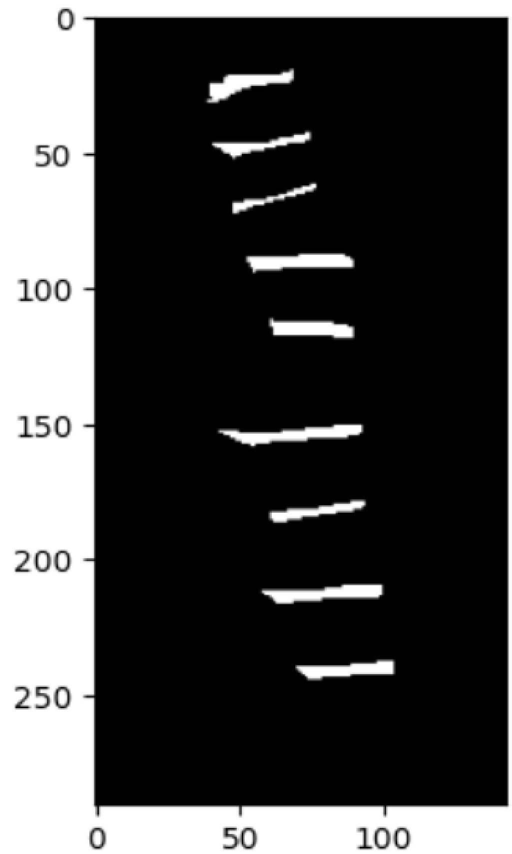


Fig 1.13 Image after erosion filter4

4.Filter-4 erosion:

After 3rd filter some of the sutures are connected to completely get rid and also to remove the noise obtained after filter 3 i have used a horizontal 1x10 min erosion filter It is observed in Fig 1.13 and Fig 1.14.this can be clearly observed in Fig 1.14.

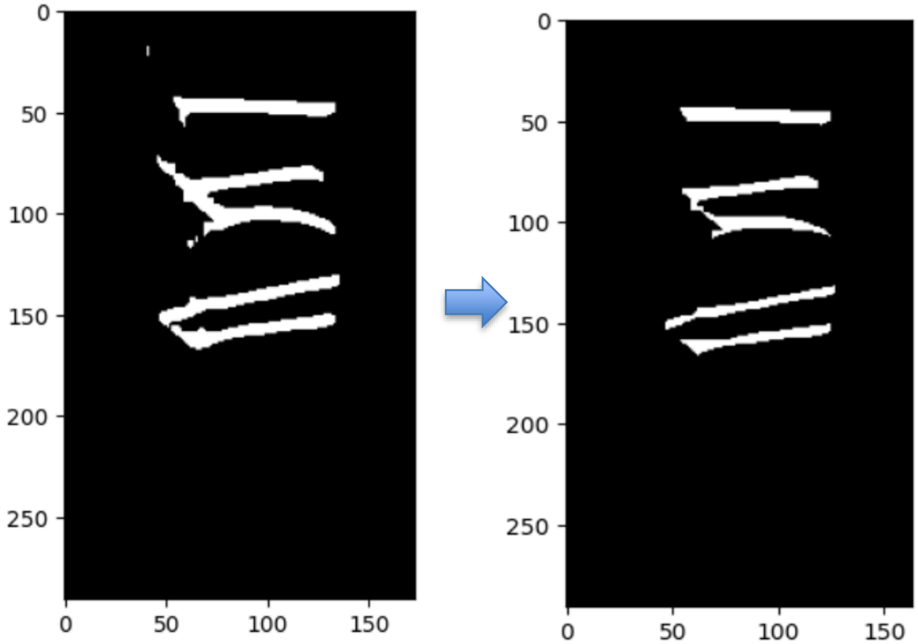
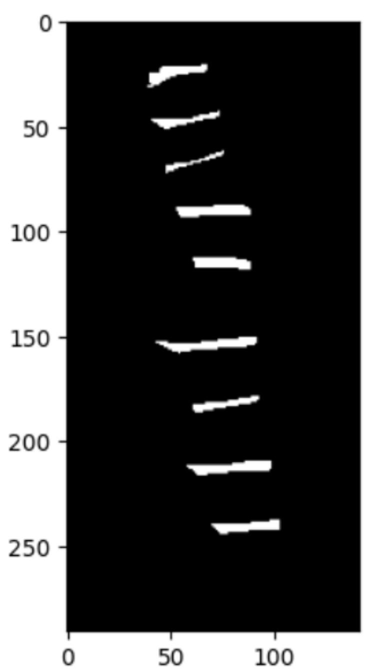


Fig 1.14 Images after erosion filter4

5.Filter-3 erosion:

There are some images in which are sutures are still not differentiated in order to seperate them i have used a small horizontal 1x2 min erosion filter.which can be observed in Fig 1.16.



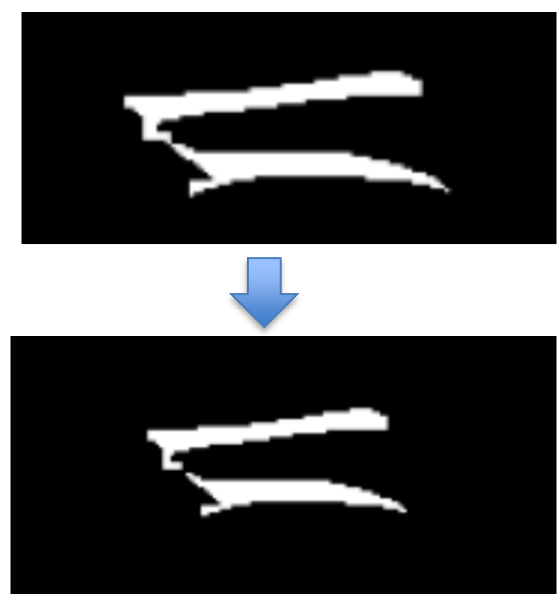


Fig 1.15 Image after erosion filter5

Fig 1.16 Image after erosion filter5

1.4 Suture Count

1.Connected Components:

After successful differentiating each suture in the image i have used the connected components iterative approach algorithm to find the cluster which contain 255 pixels(white clusters). I have iterated from bottom to up in image to get the left bottom starting most point of each suture which is needed to calculate the angel of suture.i have also summed up all the coordinates in the component to find the centroid of the each sutureis an.i took the clusters whose size is grater than 100 which is selected after observing the clusters formed in the images from the dataset.

Starting point of suture=left bottom pixel of each suture

count=count +1 (if cluster size > 100)

2.Why not used harris?:

By using the harris corner detection i observed many corner have been detected for each suture which does not help me in getting the corners.connected components worked well and more accurate compared to Harris which is obtained dividing the total corners by a constant value.

2. Inter suture spacing

2.1 Finding centroids of each suture:

When the number of sutures are calculated using the connected component in the previous section i have mentioned this.while finding the clusters i the image i have summed up the x and y coordinates of the pixels which contribute to the cluster formation and found the mean of this coordinates by maintaining the pixel count in the cluster which gave me the centroid of the each suture the centroids are visualized in the Fig 2.1 with a blue circle.

I have also created a directory named **centroids_visualization** visualize the images in the given folder.

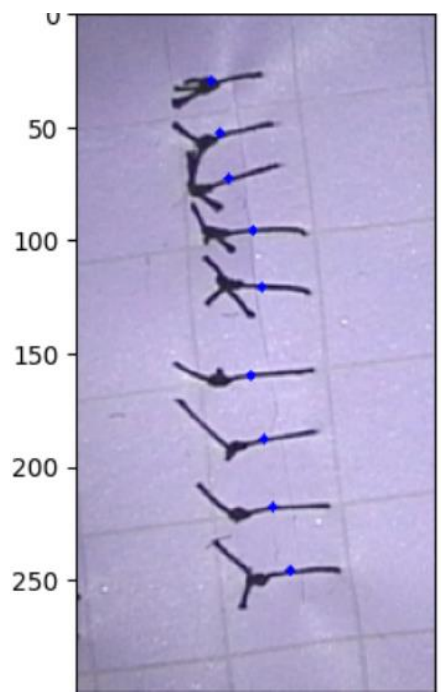


Fig 2.1 centroid visualization

sum of all x coordinates in each cluster = x

sum of all y coordinatesin each cluster =y

Number of pixels in each cluster =s

centroid(X,Y)=(x/s , y/s)

2.2 Mean and Varience:

After finding all the centroids of each suture in the image which is shown in Fig 2.1 i have calculated the distance between the adjacent sutures by using the stored data of coordinates. If let say i have n sutures then i will get the n-1 distances between the adjacent sutures.the distance is calculated by using the Euclidian distance formula.while calculating the distance i have divided the x difference by width of image and y difference with height of the image in order to normalize the distance.

Let suture-1 (s1) centroid coordinates= (x1 , y1)

Suture-2 (s2) centroid coordinates=(x2 , y2)
Euclidian distance between s1 and s2 is as follows:
width=width of image
height=height of image

Euclidian distance=sqrt(((x1-x2)/width)^2 + ((y1-y2)/height)^2)

After the calculation of Euclidian distance between adjacent sutures i got set D represent normalized distances for n sutures.

D=(d1,d2,d3 ….dn-1)

I took the mean of the set D which gives me the mean of the inter suture distance let it be M.using this mean M i have calculated the variance of the inter suture distance by using the general variance formula as below let use represent it by V.

M=mean= sum (D)/(n-1)
V=variance=sum ((D-M)^2))/(n-1)

The distance between each centroid is visualized in Fig 2.2.

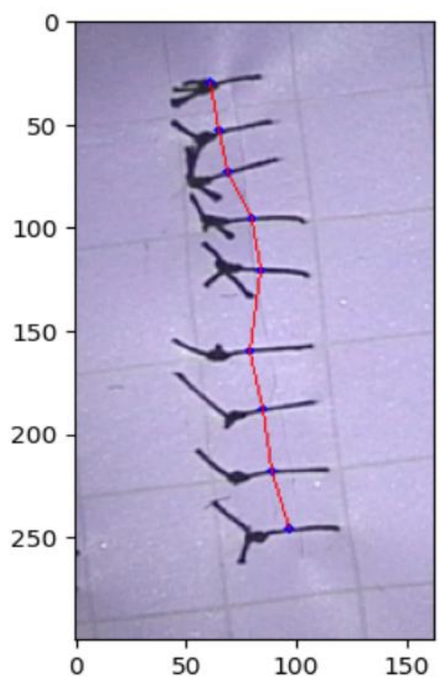


Fig 2.2 Distance visualization

3. Angulation of the suture:

3.1 starting point of suture and Angel Calculation:

To calculate the angel of suture i need two points one among them is the starting point of suture.i have calculated the starting point while i am counting the number of sutures in an image using the connected components. I have noted the point where each cluster is started while iterating form the bottom left of the image and assumed this point as my starting point of suture these points are visualised in Fig 3.1 and in Fig 3.2 both starting points and centroid are visualised for individual suture.

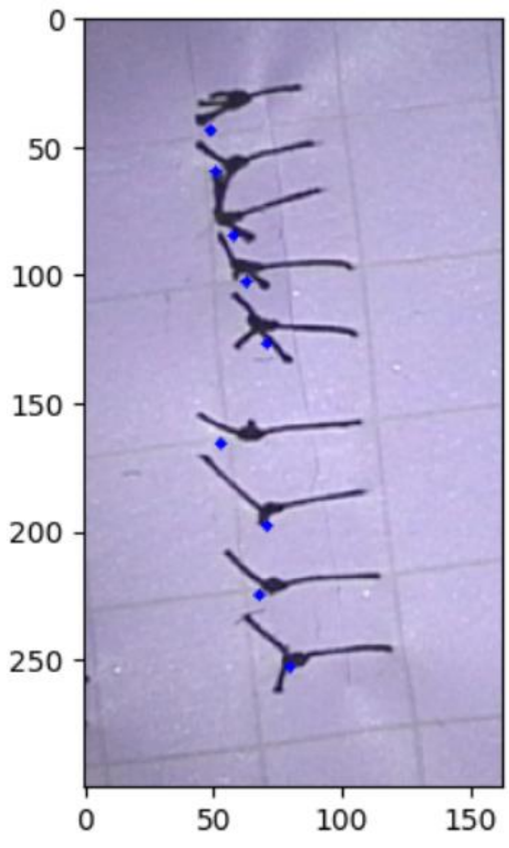


Fig 3.1 starting point visualisation

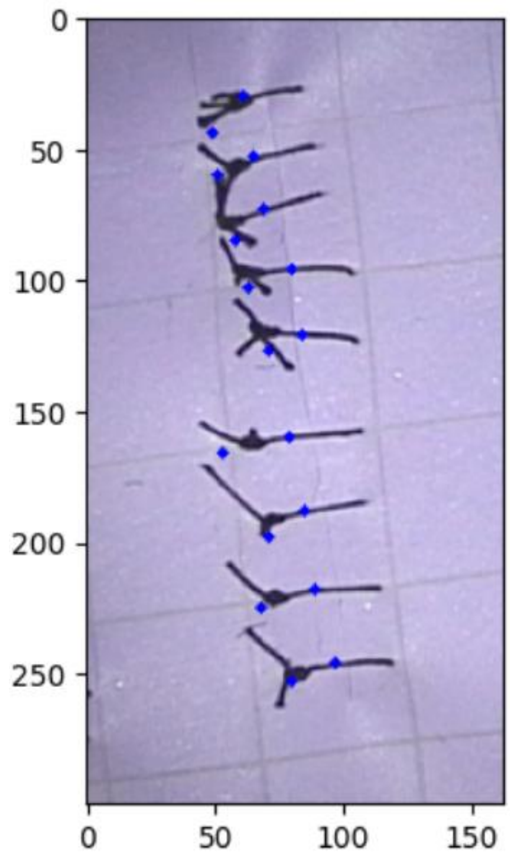


Fig 3.2 both centroid and starting point visualisatoin

Using the calculated centrtoids and starting points of eact suture i have calculated the angel of the line connecting the two points w.r.t the X-axis.the angel calculates using the traditional slop formula given two points in a plane as below.

angel=Tan inverse((y2-y1) / (x2-x1))

3.2 mean and variance of angel:

After the calculation of each angel of suture i have done the mean and variance of the calculated angel same as the mean and variance of the inter suture distance.

4. Comparing the two micro-suturing:

After calculating the mean and variance of the inter suture distance and the angulation of the sutures .i have used this calculated variance of the distance and angel of each micro suturing for considering which is the best.

4.1 comparing based on inter suture distance:

Based on the inter suture distance ,i compared the variance of intersuture distance of two micro suturing and the one whose variance is low is considered as the best suturing.let say v1 and v2 be variance of two micro suturing s1 and s2 respectively then i have decided the best one as below:

If v1<v2 s1 is best
If v2<v1 s2 is best

4.2 comparing based on Angulation of suture:

Based on the angulation,i compared the variance of angulation of two micro suturing and the one whose variance is low is considered as the best suturing.let say v1 and v2 be variance of two micro suturing s1 and s2 respectively then i have decided the best one as below:

If v1<v2 s1 is best
If v2<v1 s2 is best

5. Libraries used:

5.1 Numpy:

I have used the numpy library for the array storing,calculating the mean and other array manipulation.

5.2 cv2:

The cv2 library is used to read the image from the given path,to store the image,to resize the image,to visualize the starting point and centroid if suture also used to join the centroid to visualize the inter suture distance.

5.3 os:

The os library is used to read the files from the directory,to create a new directory.

5.4 csv:

The csv library is used to read and write a csv file.

5.5 math:

The math library is used to calculate the sqrt and angel (math.degrees and math.atan).

5.6 sys:

The sys library is used to read the arguments from the command line(sys.argv).

5.7 shutil:

The shutil library is used to remove the existing directory in the specified path (shutil.rmtree).