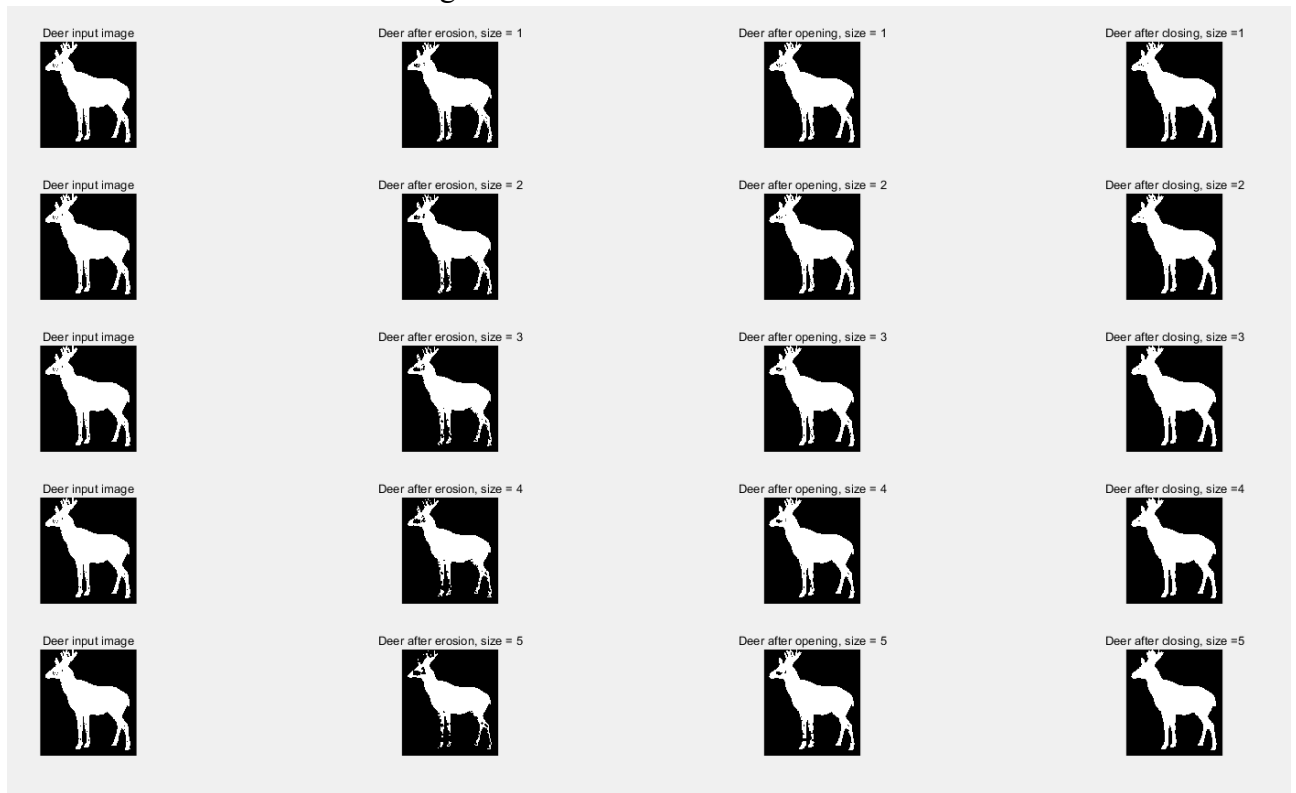
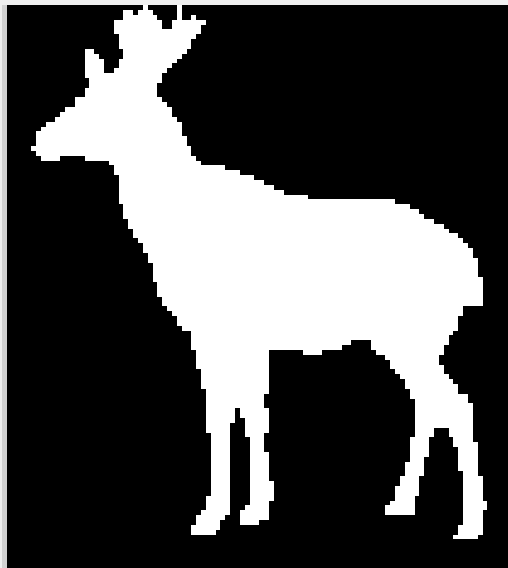


Q1.

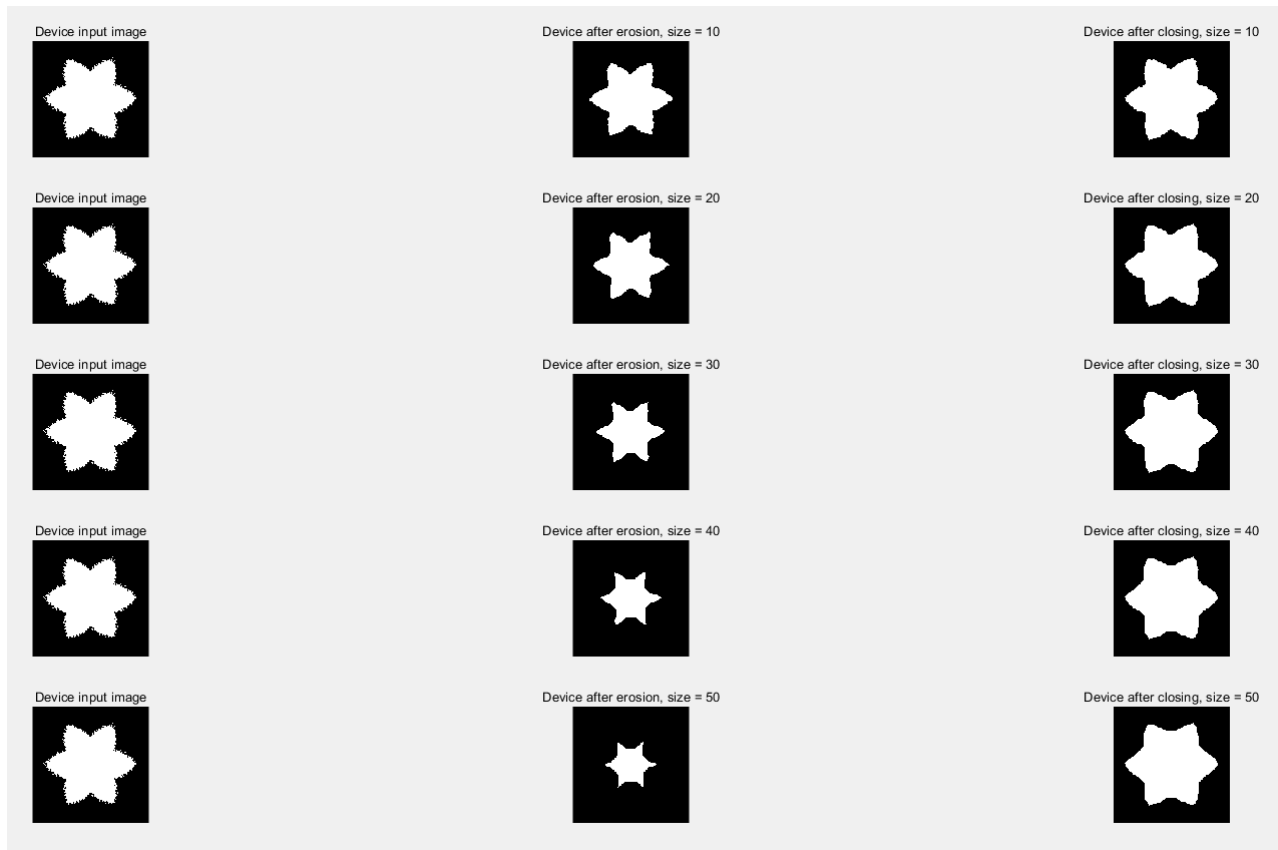
- a. I used 3 morphological operations, then compared the results by cross checking, I implemented 1 to 5 sizes of disk to do erosion, then apply opening and closing. I think when size is 5 for closing is the best result.



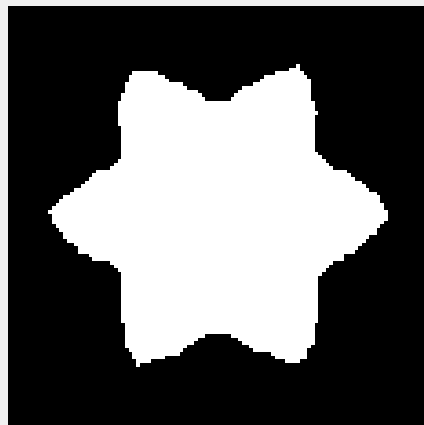
Deer after closing, size =5



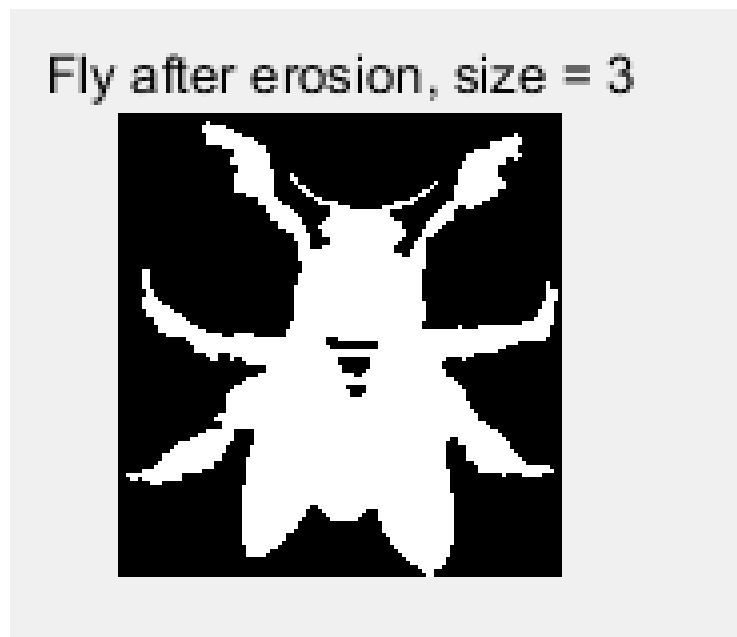
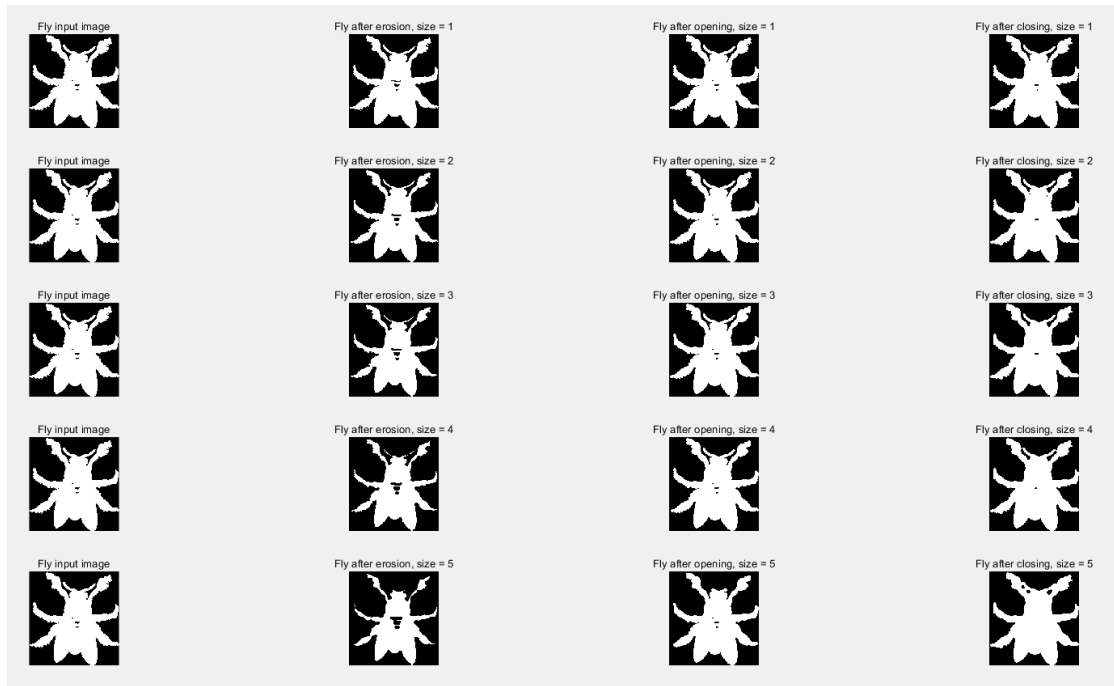
- b. I used 10 to 50 sizes of disk to do erosion, then apply opening and closing. I think size is 30 for closing is the best result.



Device after closing, size = 30

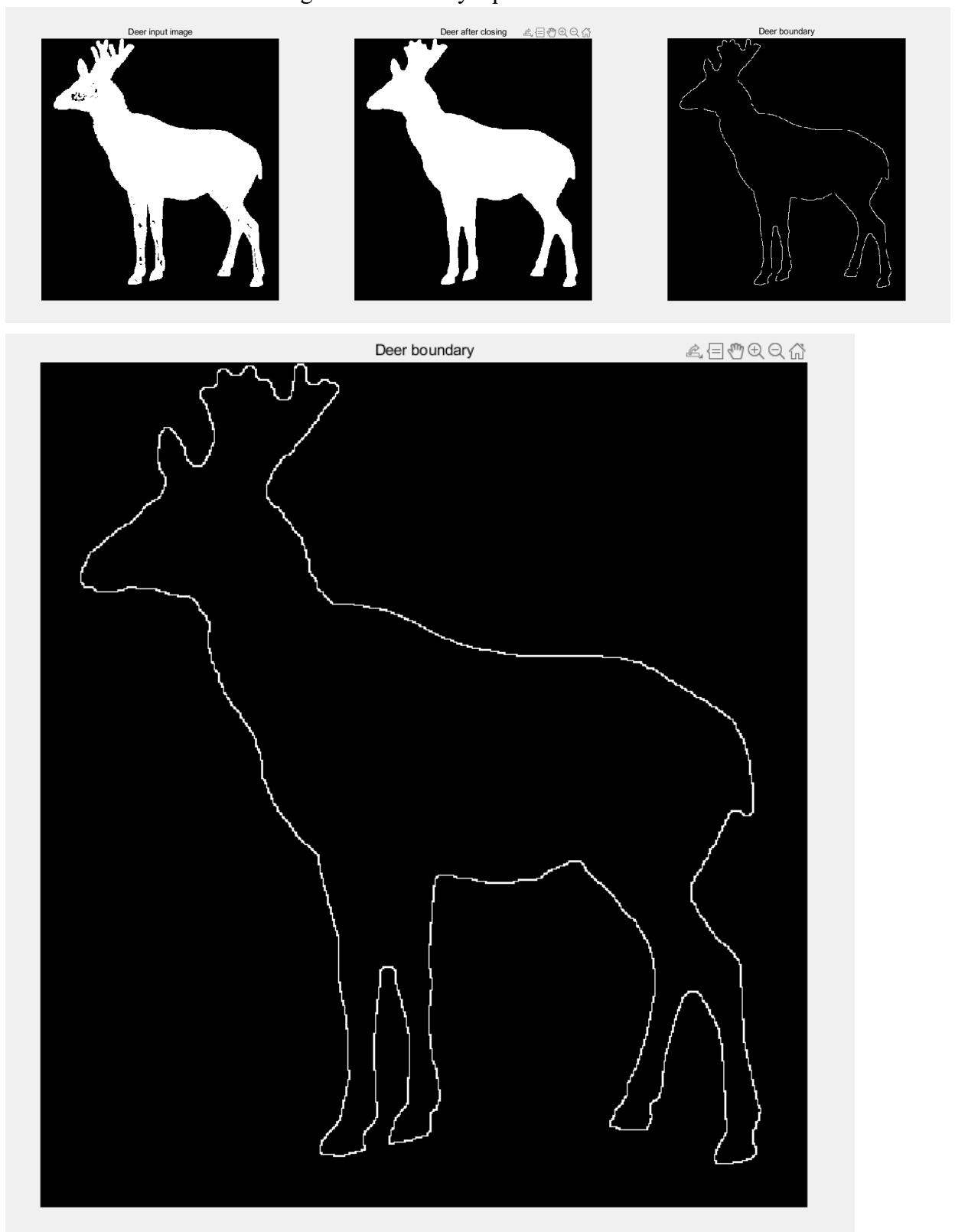


- c. I used 3 morphological operations, then compared the results by cross checking, I implemented 1 to 5 sizes of disk to do erosion, then apply opening and closing. I think when size is 3 for erosion is the best result.

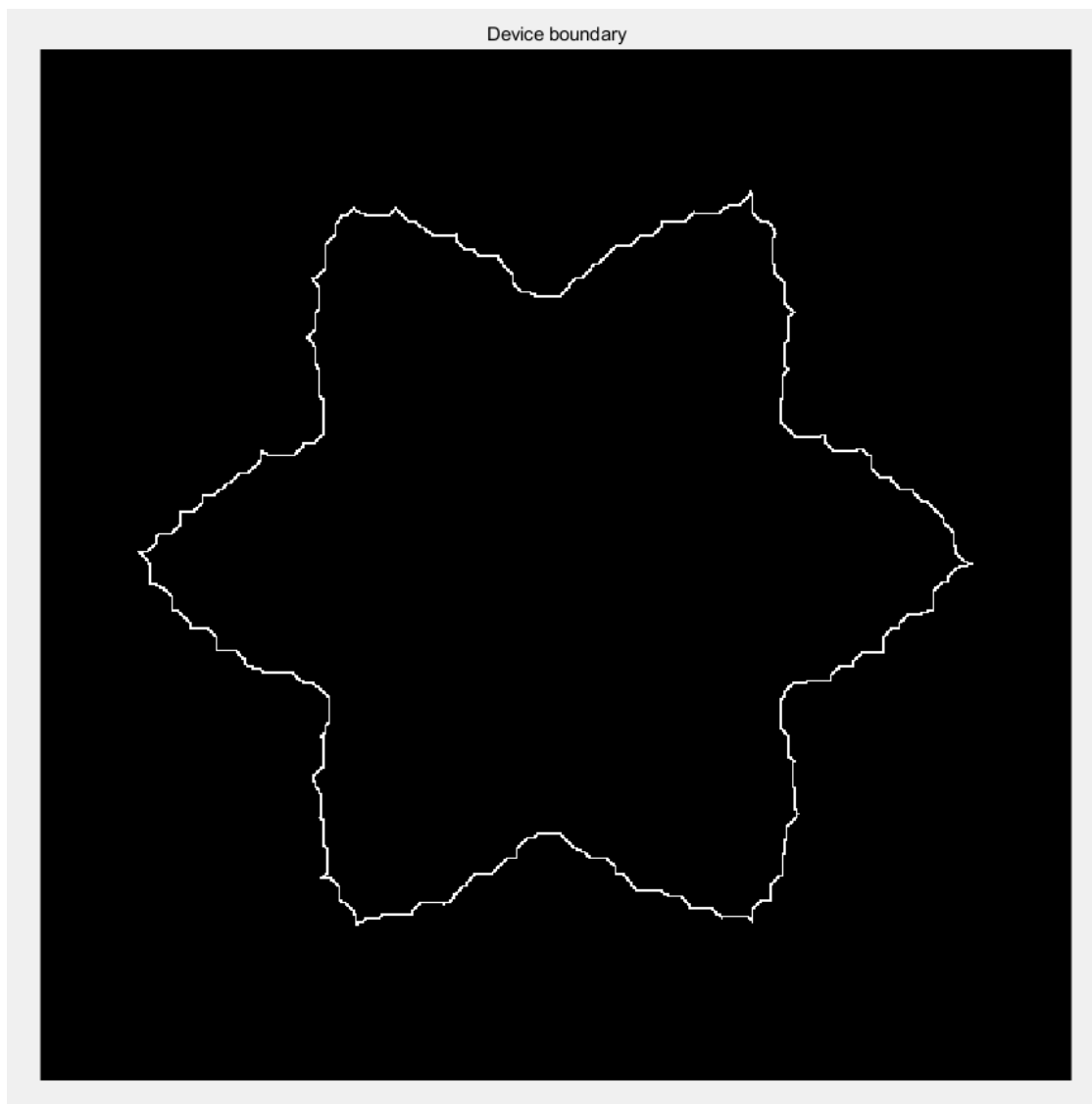
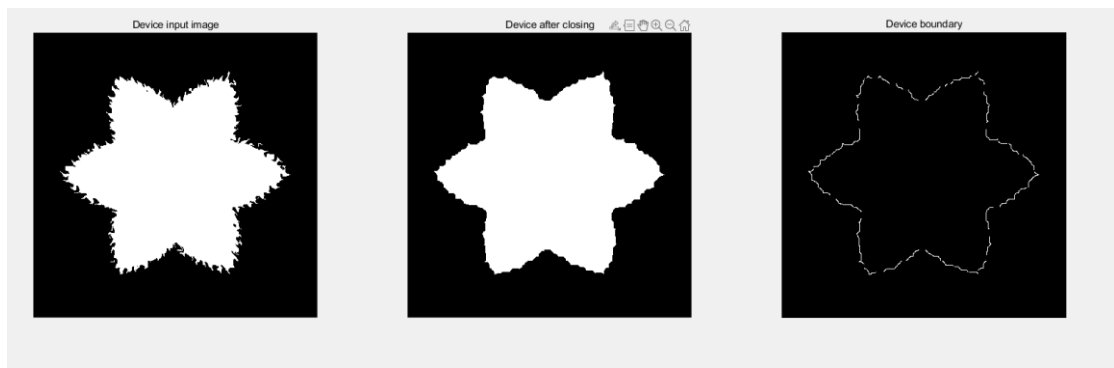


Q2.

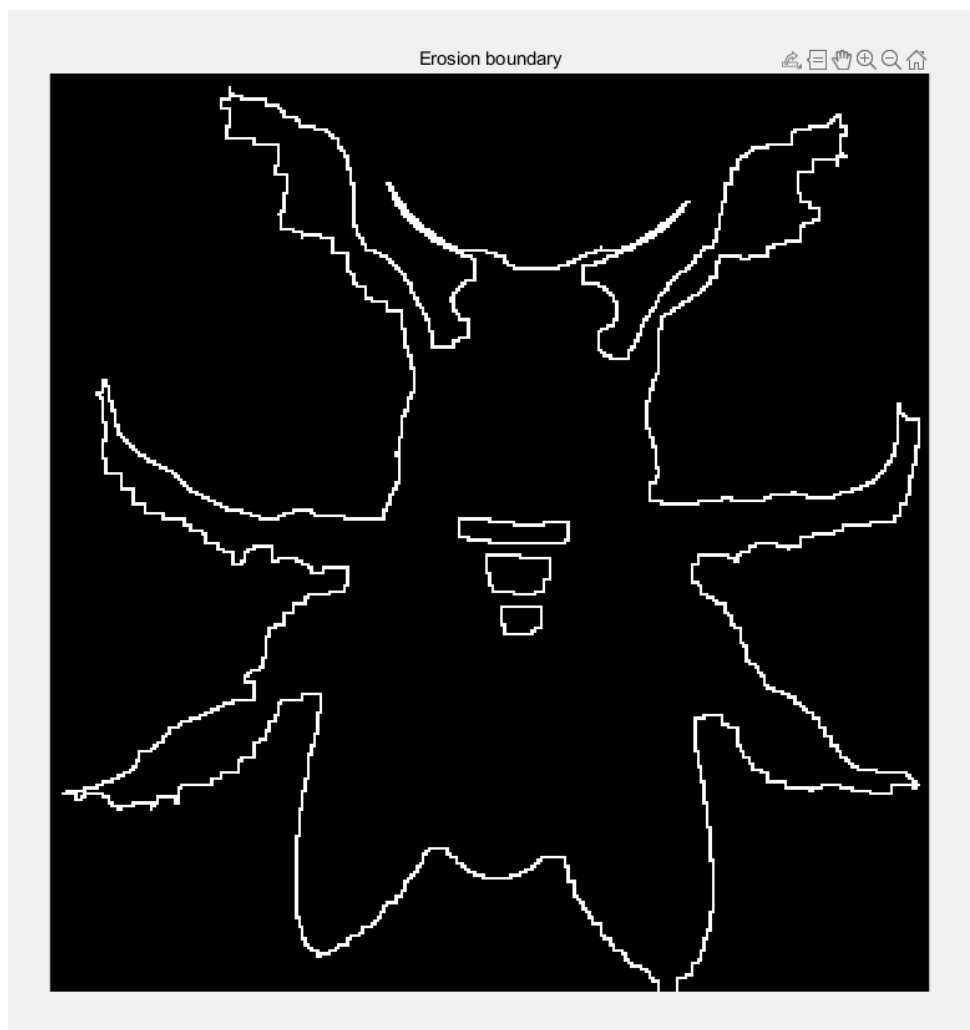
- a. I used disk size of 5 for closing then erosion by square size of 3

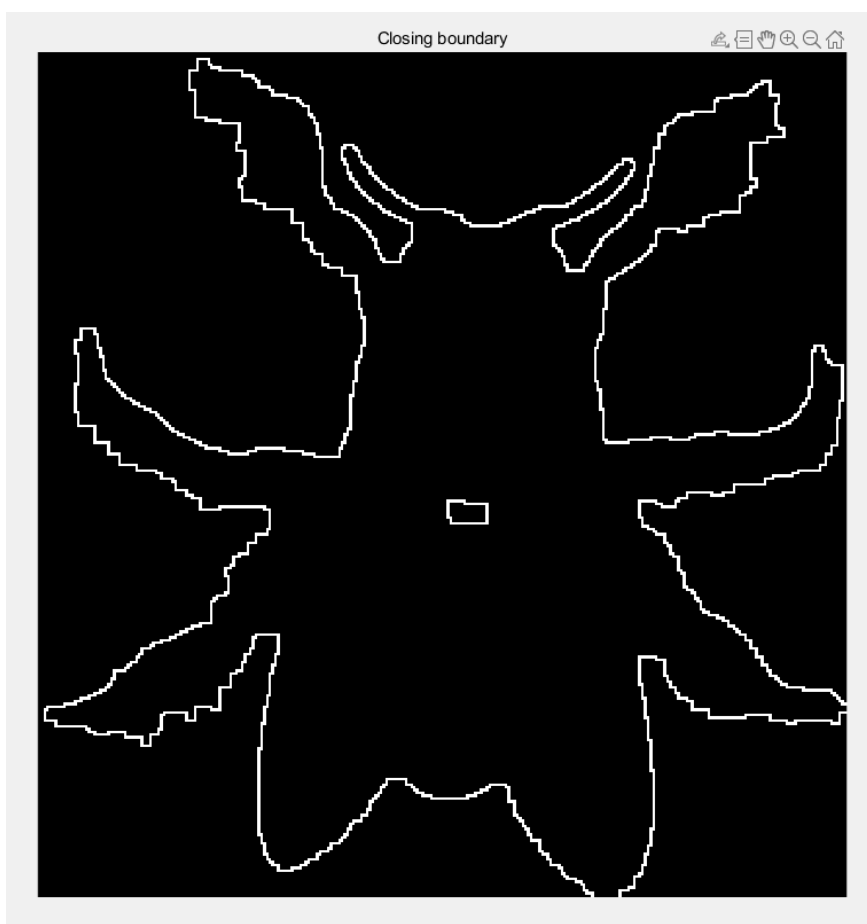
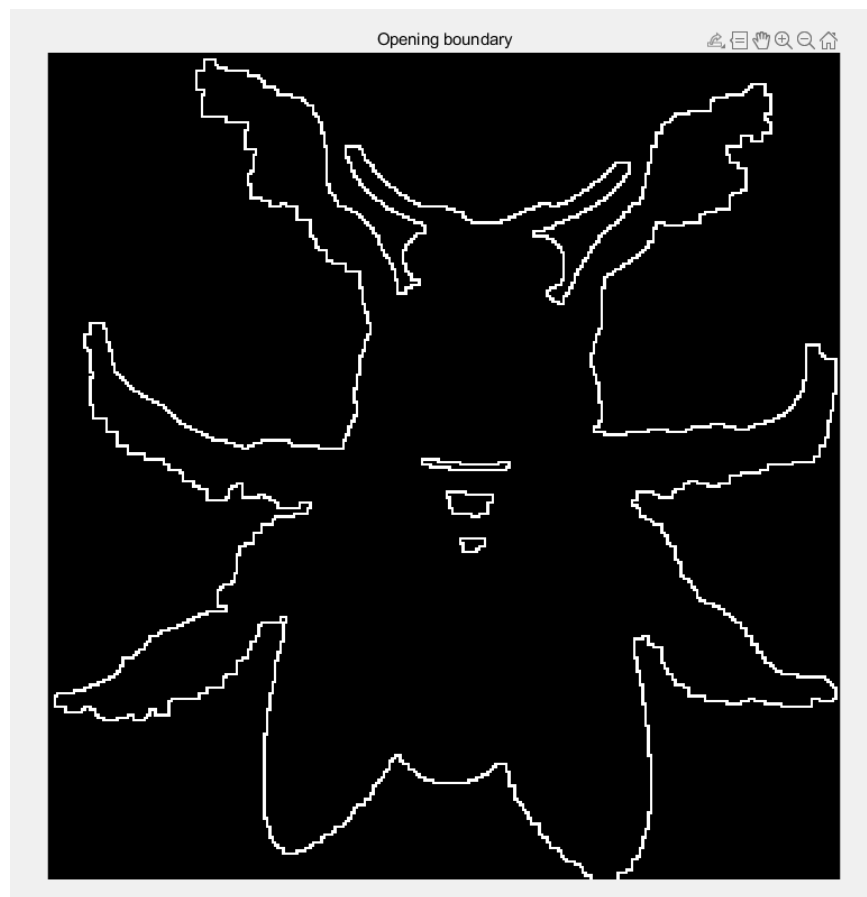


- b. I used disk size of 10 to do closing and square size of 3 to do erosion.



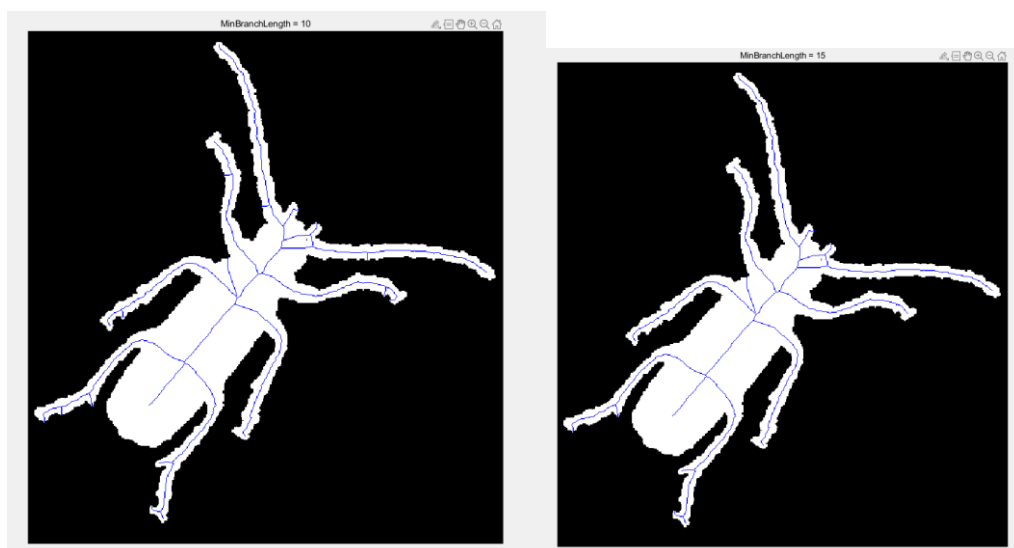
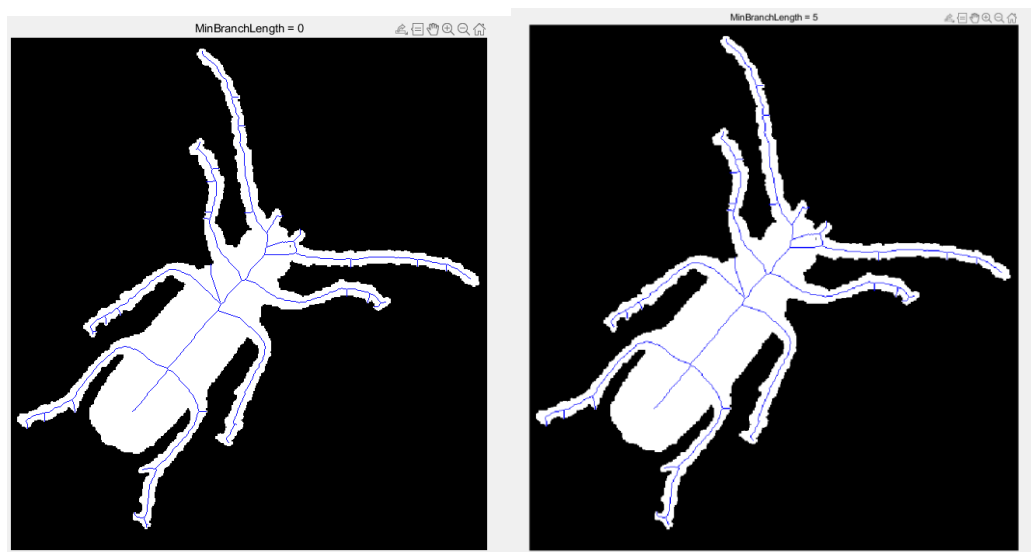
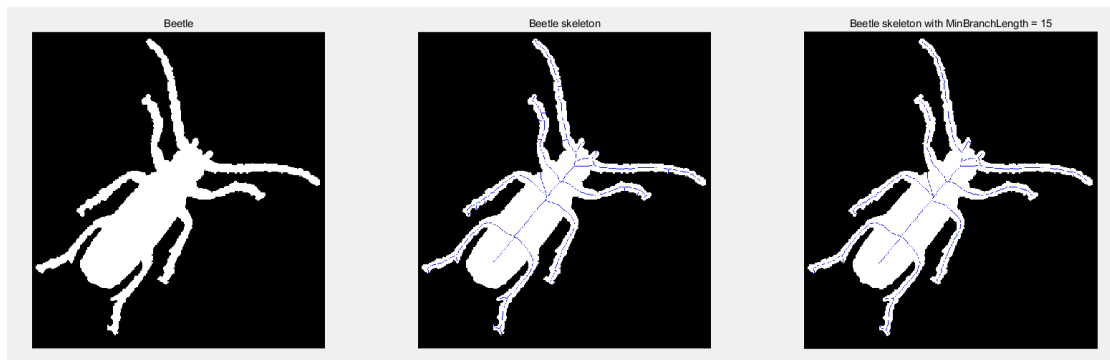
- c. Since it is hard to decide from Q1 of fly, so I choose disk size of 3 and square size of 3 to implement.

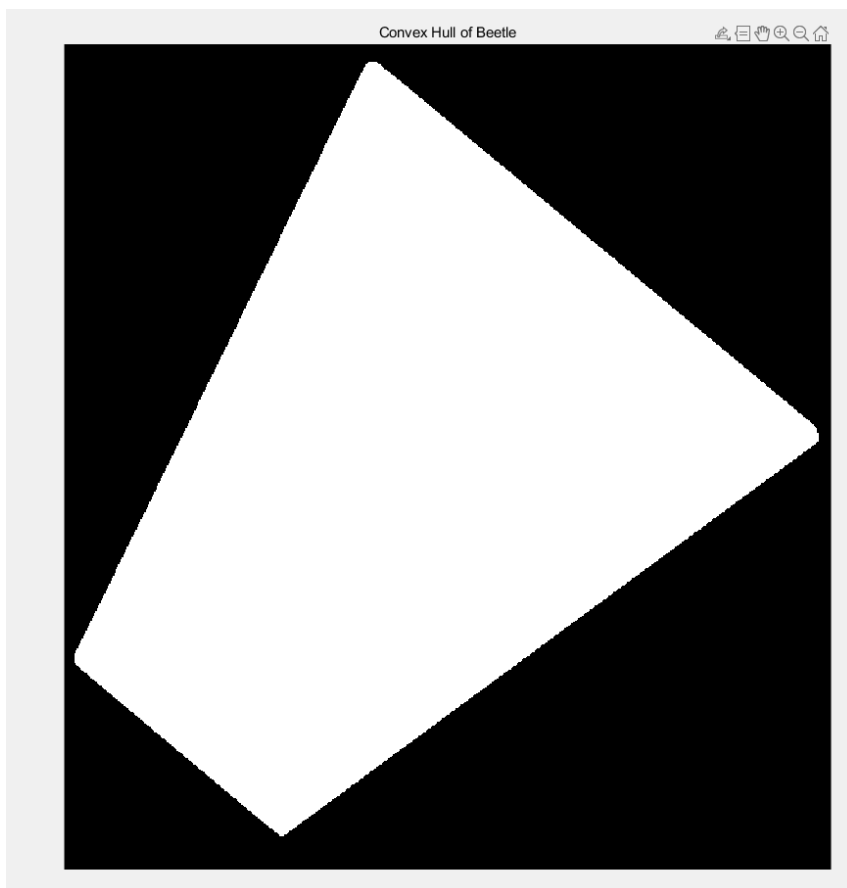
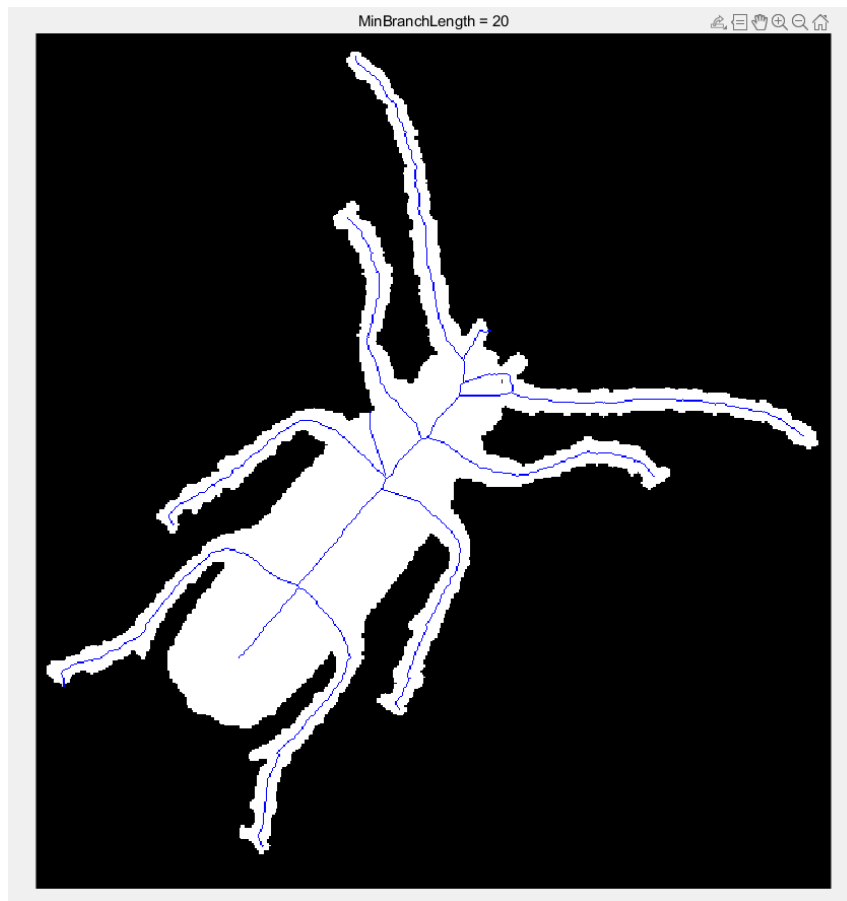




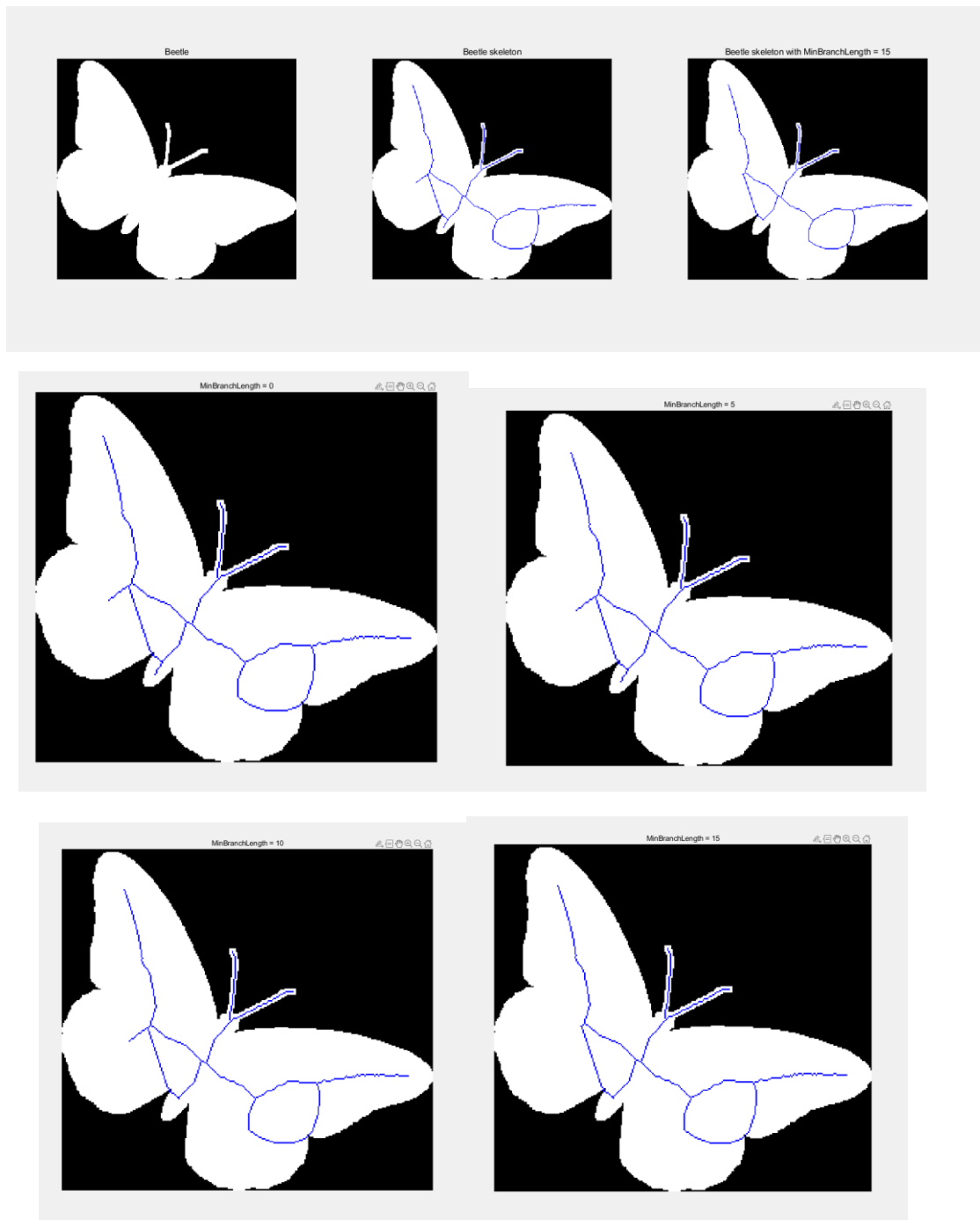
Q3.

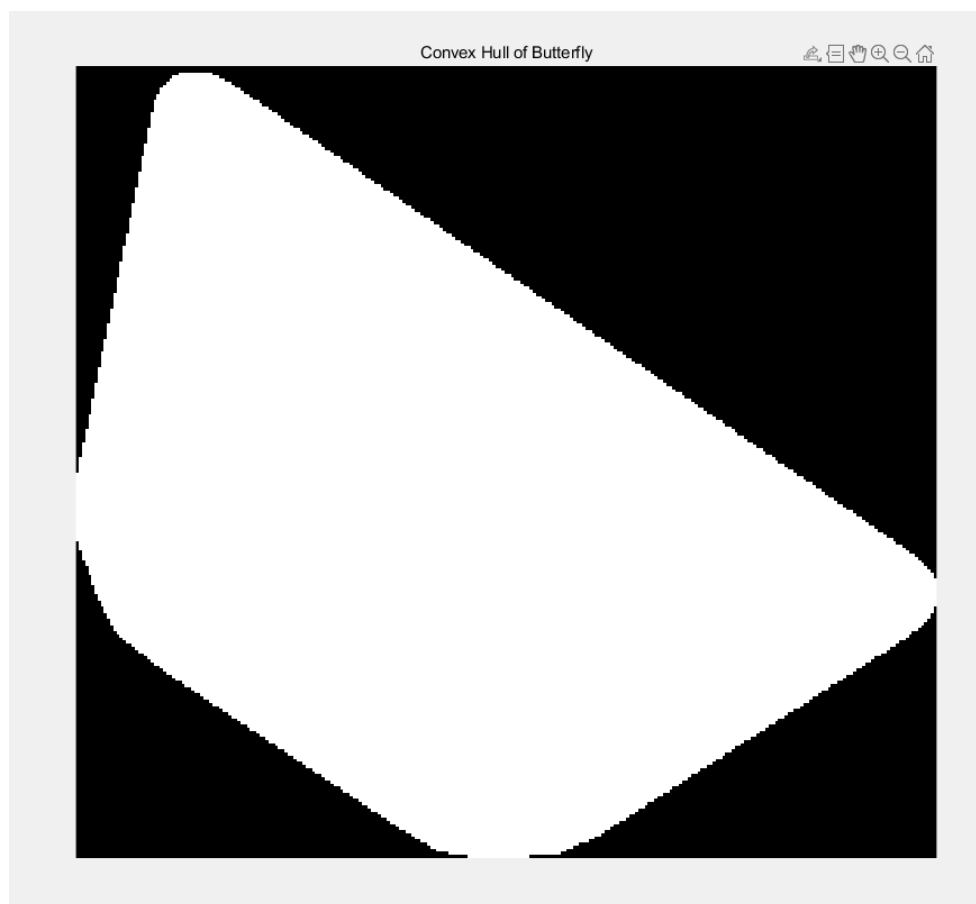
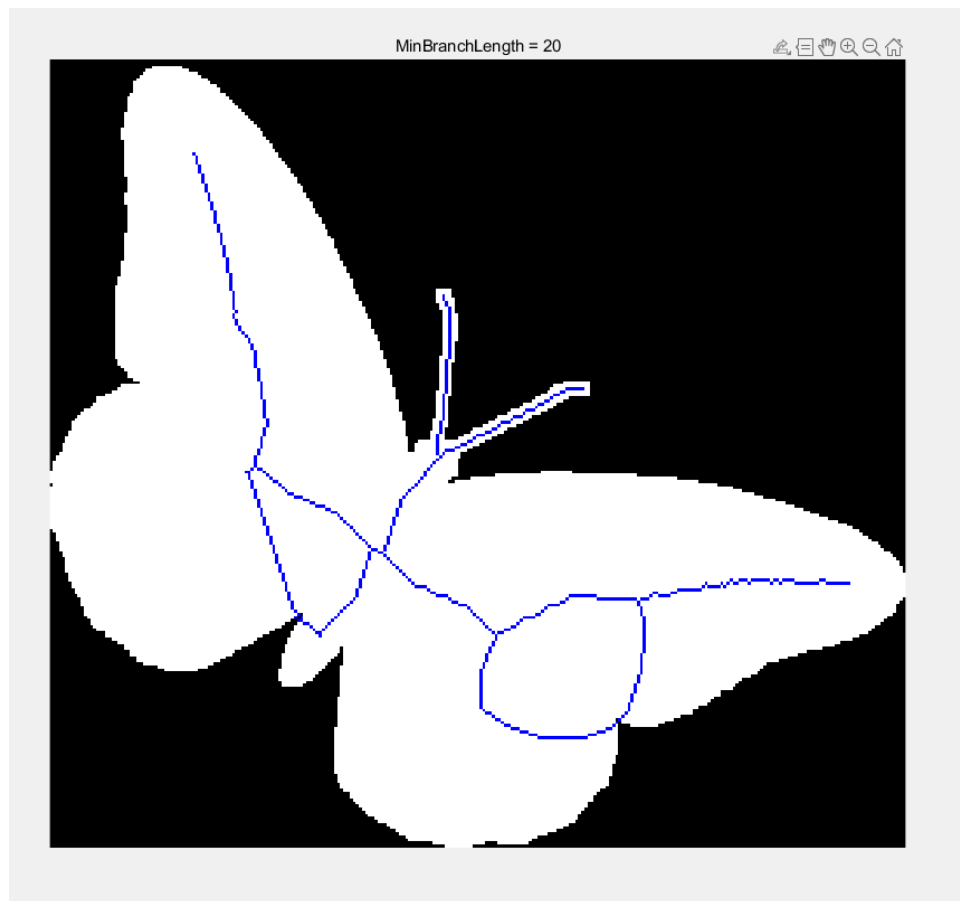
- a. **Beetle:** When I was searching for help from Matlab Mathwork, I noticed there are two functions to do skeleton. The first one is without parameter, the second one is with parameter `MinBranchLength = 15`. I think `MinBranchLength` is 10 is the best.



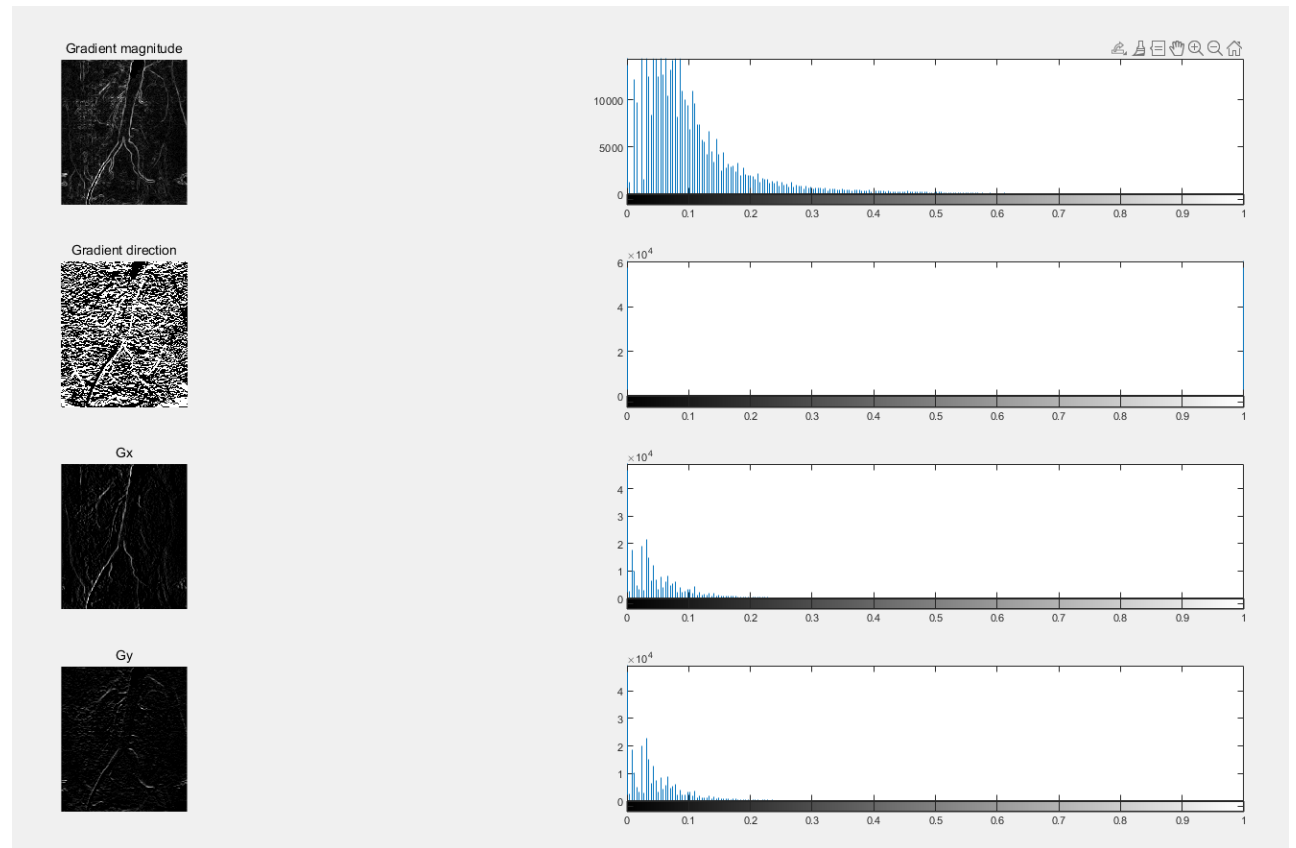


- b. The first one is without parameter, the second one is with parameter $\text{MinBranchLength} = 15$. I think when MinBranchLength is 10 is the best solution.





Q4. I used `imgradient` to get the gradient value of magnitude and direction, the histogram of magnitude illustrated most of them are closing to 0, which means they are dark. So, I changed the value of threshold from 0 to 0.09 with 0.01 as the increasing rate. With T increasing, blood vessel at the center of the image becomes clearer.



Original kidney



Filtered kidney



$T = 0$



$T = 0.01$



$T = 0.02$



$T = 0.03$



$T = 0.04$



$T = 0.05$



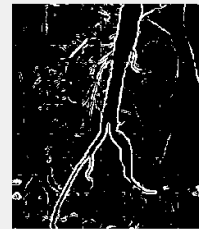
$T = 0.06$



$T = 0.07$



$T = 0.08$

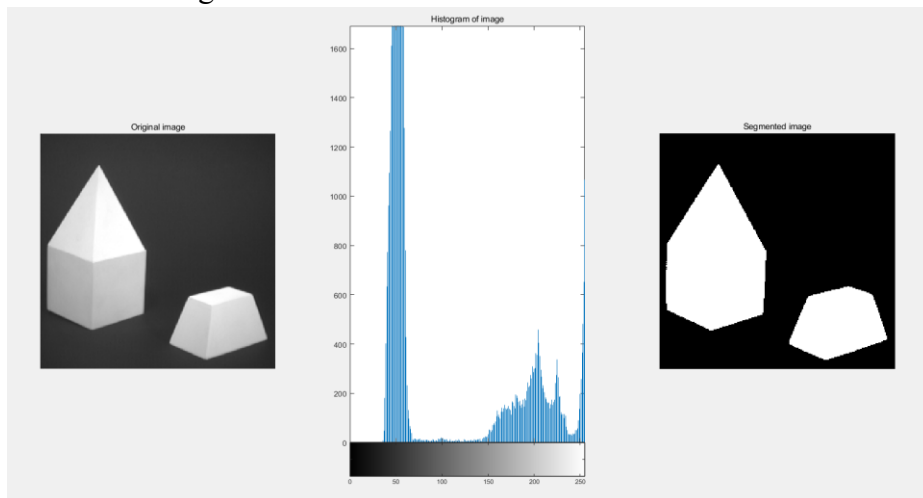


$T = 0.09$

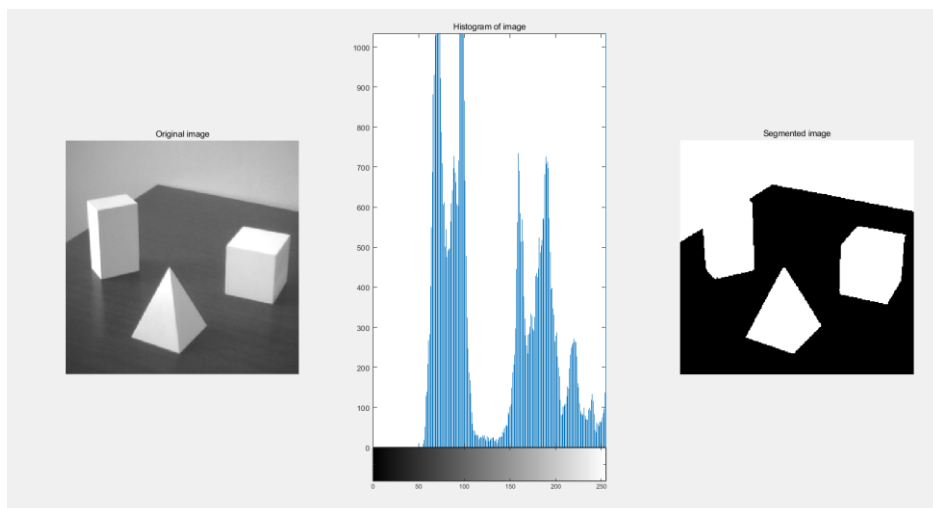


Q5.

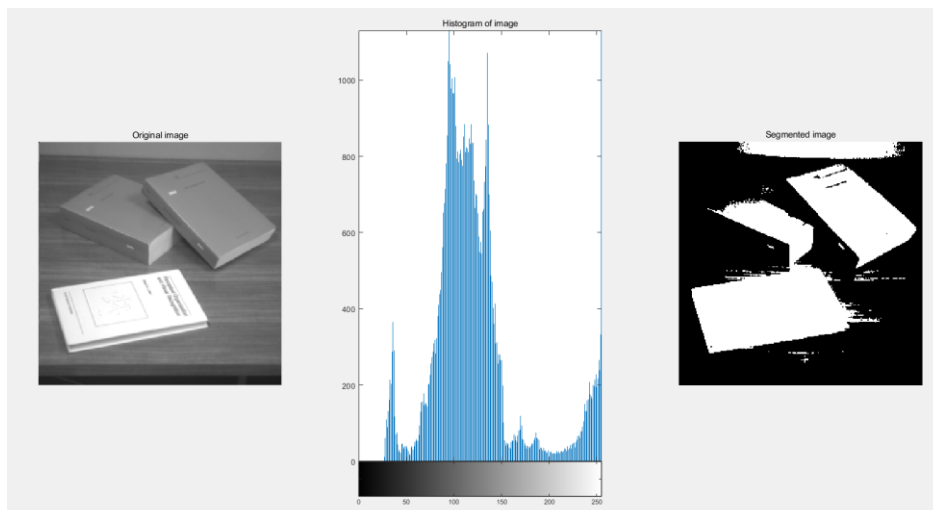
- a. `geometric_shapes_1.pgm`: There are 2 peaks at the histogram, at 50 and 200, but based on the algorithm it set it to 97.



- b. `geometric_shapes_2.pgm`: There are two peaks at 50 to 100 and 150-200.

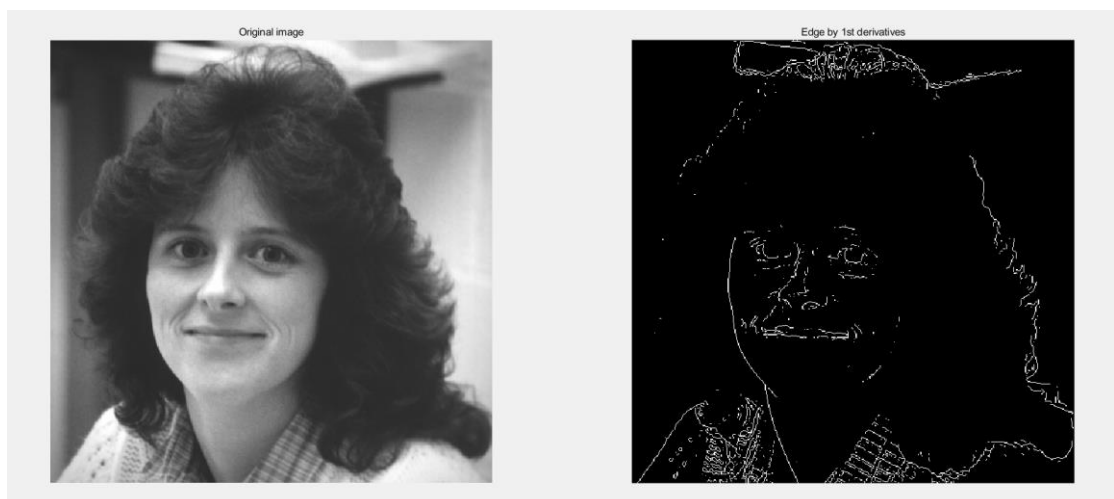


- c. `books.pgm`: There is only one peak from 75 to 150. However, a weird thing is that the upper two books are distinguished. Their grey level is pretty close to background, but still segmented.

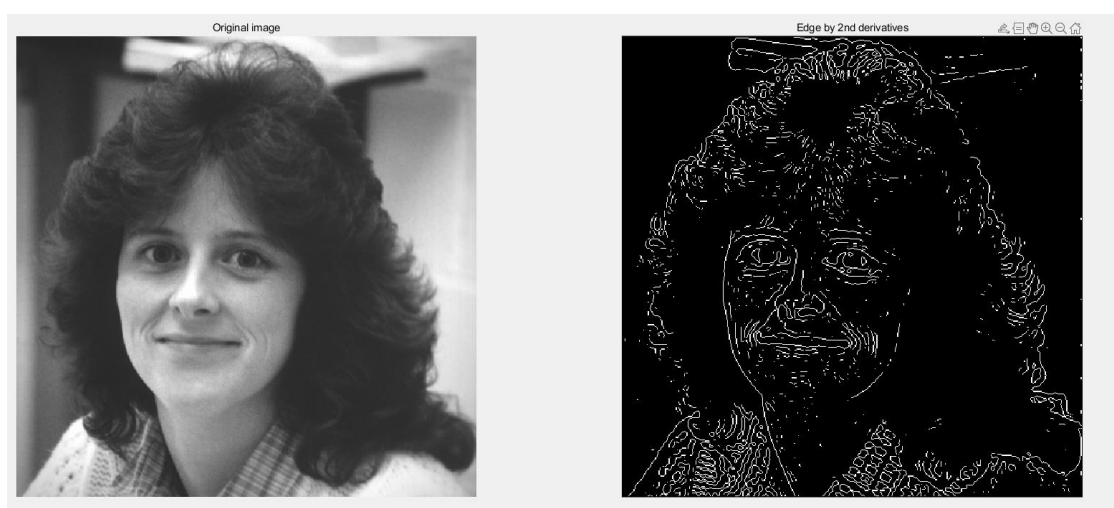


Q6.

- a. 1st derivatives: The 1st derivative told us where the edge is.



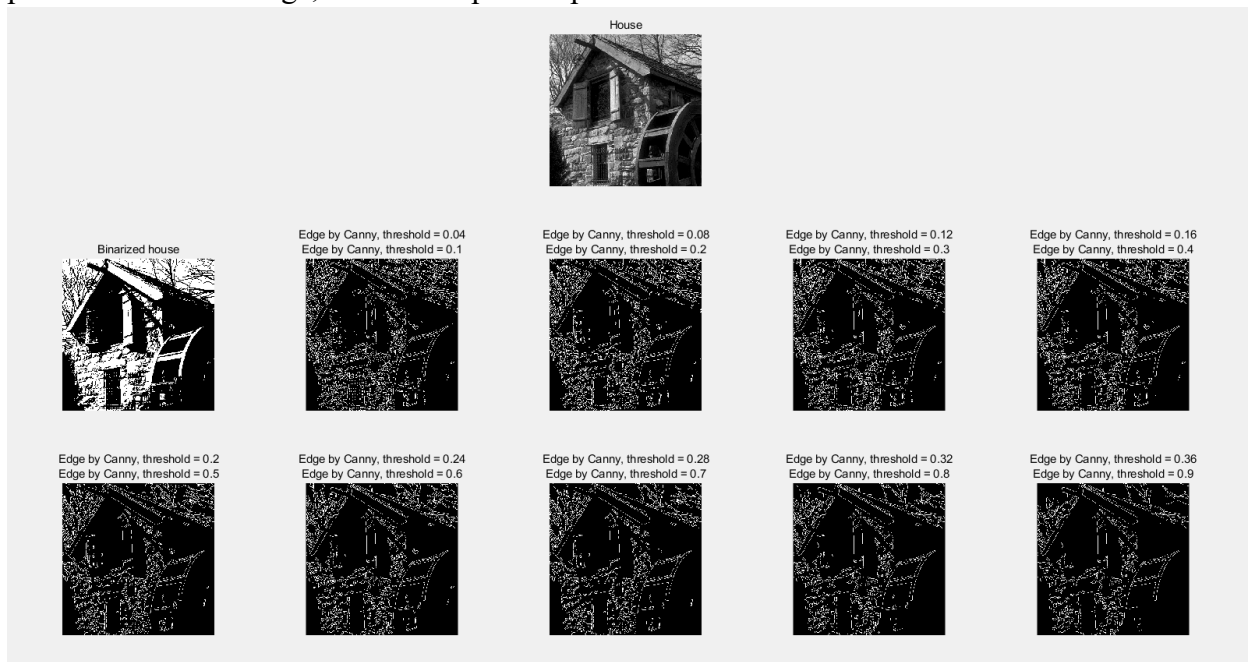
- b. 2nd derivatives: 2nd derivative show edge direction of images, and we can see each edge were double sketches. It can show us edge much clearer.



- c. The Marr-Hildreth edge detector: By using LoG and Zero crossing, gaussian noises were removed by sobel filter. And it makes easier to show the edge.



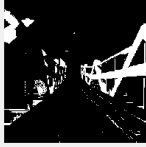
- d. Canny edge detector: I used different rate of threshold for upper bound and lower bound. The lower bound is from 0.04 to 0.36, 0.04 is the increasing rate. The upper bound is 0.1 to 0.9, 0.1 is the increasing rate. As we can see, more important parts show in the image, and less important parts were removed.



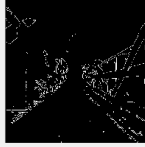
Bridge



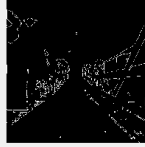
Binarized house



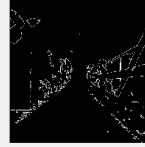
Edge by Canny, threshold = 0.04
Edge by Canny, threshold = 0.1



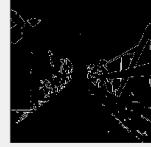
Edge by Canny, threshold = 0.08
Edge by Canny, threshold = 0.2



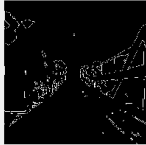
Edge by Canny, threshold = 0.12
Edge by Canny, threshold = 0.3



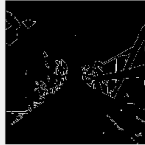
Edge by Canny, threshold = 0.16
Edge by Canny, threshold = 0.4



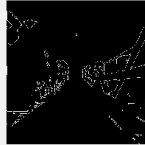
Edge by Canny, threshold = 0.2
Edge by Canny, threshold = 0.5



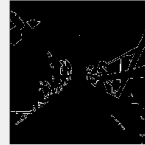
Edge by Canny, threshold = 0.24
Edge by Canny, threshold = 0.6



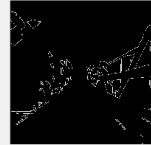
Edge by Canny, threshold = 0.28
Edge by Canny, threshold = 0.7



Edge by Canny, threshold = 0.32
Edge by Canny, threshold = 0.8



Edge by Canny, threshold = 0.36
Edge by Canny, threshold = 0.9



Woman dark hair



Binarized Woman dark hair



Edge by Canny, threshold = 0.04
Edge by Canny, threshold = 0.1



Edge by Canny, threshold = 0.08
Edge by Canny, threshold = 0.2



Edge by Canny, threshold = 0.12
Edge by Canny, threshold = 0.3



Edge by Canny, threshold = 0.16
Edge by Canny, threshold = 0.4



Edge by Canny, threshold = 0.2
Edge by Canny, threshold = 0.5



Edge by Canny, threshold = 0.24
Edge by Canny, threshold = 0.6



Edge by Canny, threshold = 0.28
Edge by Canny, threshold = 0.7



Edge by Canny, threshold = 0.32
Edge by Canny, threshold = 0.8



Edge by Canny, threshold = 0.36
Edge by Canny, threshold = 0.9

