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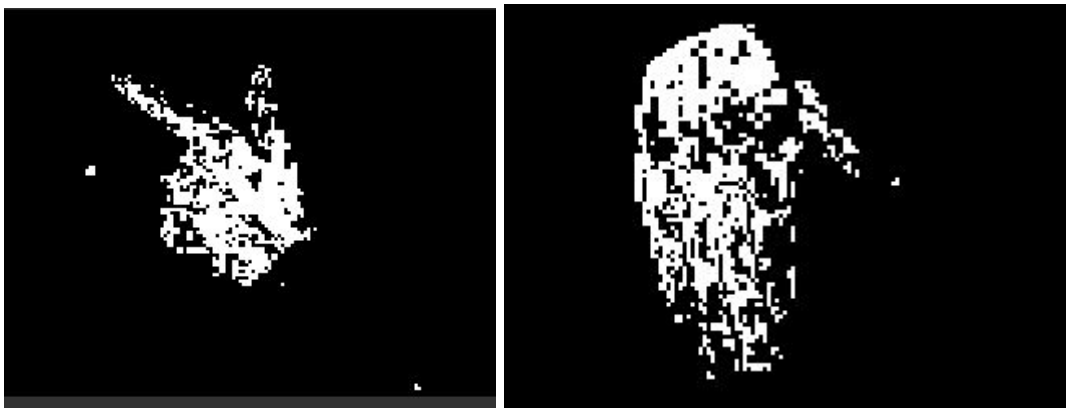
Morphological Operators

In this project we worked with a series of basic morphological operators:

- Erosion
- Dilation
- Opening
- Closing
- Boundary

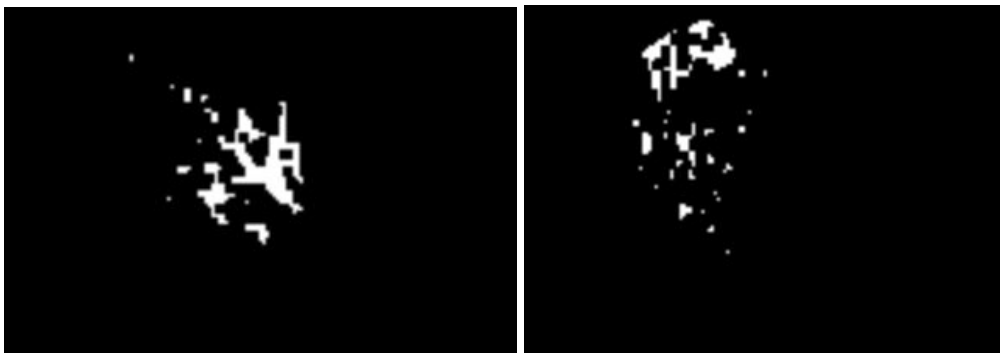
We used these operators to reduce noise and create boundaries for the following images:



left: gun, right: palm

Algorithm and Results

Erosion: For Erosion we took a structural element as an arbitrary shape of white pixels. For each white pixel in the gun or palm image we would then see if the mapped structural element at that point would be a subset of the image's white pixels. If it was, we would then include the selected white pixel in the final result. Here are the results with a [3x3] structural element for gun (left) and palm (right):



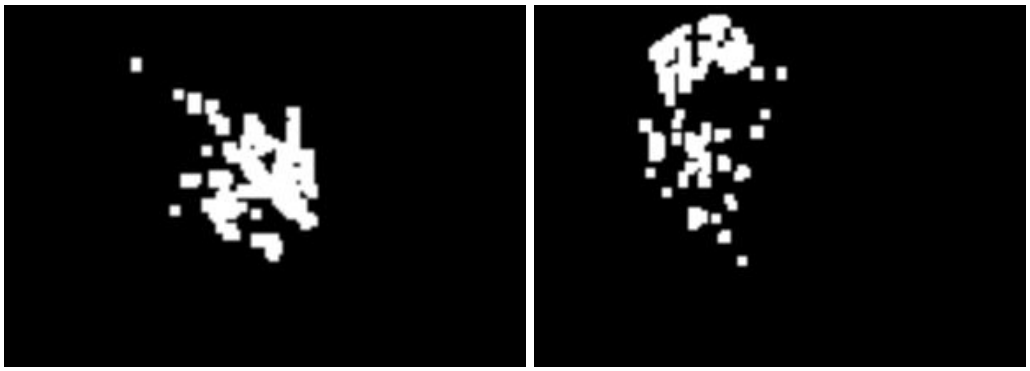
As you can see these don't really make our images any clearer, but Erosion will be very useful for some of our later morphological operations, as well as for finding the boundary.

Dilation: For Dilation we took a structural element as an arbitrary shape of white pixels. For each white pixel in the gun or palm image we would map the structural element in its place. I did have to add a check for boundary conditions so that we don't add any white pixels to the opposite side of the image when we

are close to the edge of the image. Here are the results with a [3x3] structural element for gun (left) and palm (right):

As you can see from the results, we have reduced a lot of the holes within the images.

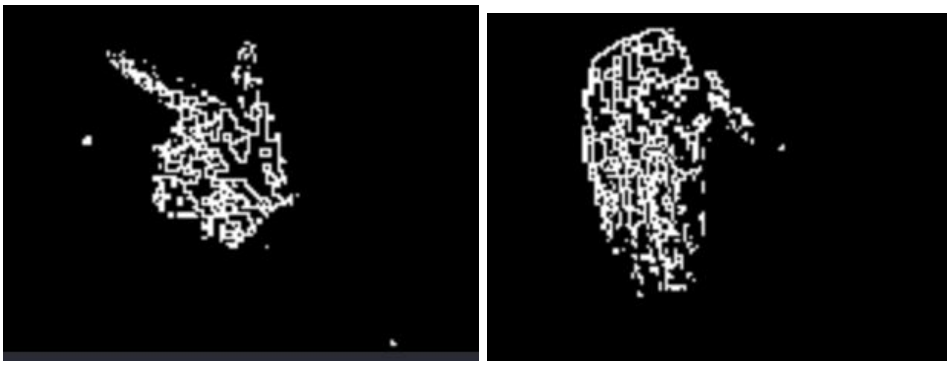
Opening and Closing: For opening we first use erosion on an image, then we use dilation. For closing, we first use dilution on the image, then we use erosion. These produce different results as the order affects the shape produced. Opening will remove narrow bridges and paths, while closing will fill in holes. Here are the results for Opening with a [3x3] structural element for gun (left) and palm (right):



Here are the results for Closing with a [3x3] structural element for gun (left) and palm (right):

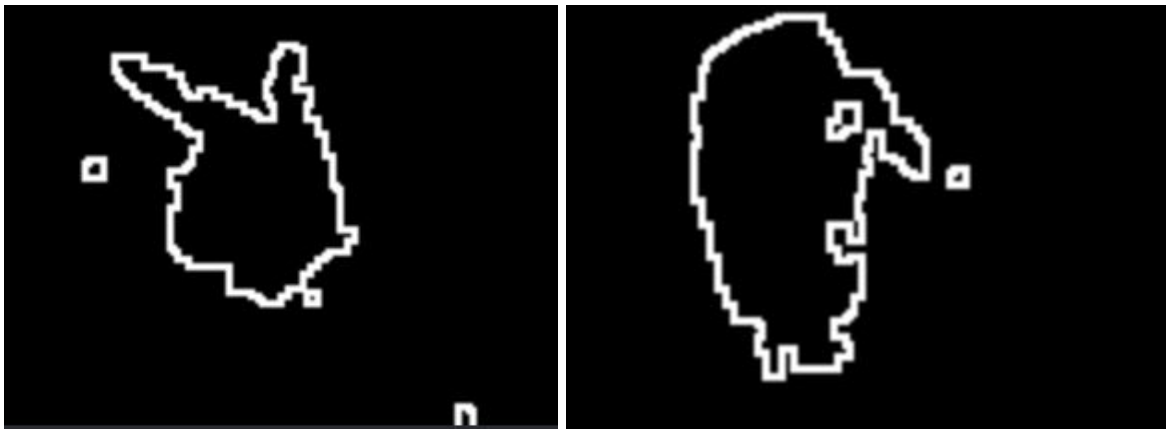
As you can see, the Opening operator ends up removing much of the fingers for both gun and palm, this is mostly due to the fact that there are so many holes in both images— so many narrow bridges/areas end up getting deleted. The Closing operator has much more success, closing many of the holes that were originally present in the image.

Boundary: To find the boundary of the image we simply first do an Erosion using an arbitrary SE and then find the difference between the original image and the Erosion. Here is the result with a [3x3] structural element for gun (left) and palm (right):



From the results we can see that we do not get a very clean boundary at all. This is due to our Erosion, visible from our Erosion result images on the first page, being so sparse in data points. Our images already had too many holes in them, so using Erosion only expands these holes.

Clean Boundary: To develop a clean boundary for both images, I first used a Dilation with a [5x5] structural element, then performed the Boundary operation. Here are the results with first a Dilation with a [5x5] structural element then a Boundary operation:.



The results are not perfect but they are much better than before! The reasoning behind using Dilation first is because we know that the Boundary operation will use Erosion, which greatly expands on holes. To remove some of these holes that are causing issues from our Erosion we perform a Dilution— which will expand the area of the image and fill in many of the holes present. This gives us a much cleaner boundary.