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MP2 Report
Computer Vision
April 13, 2023

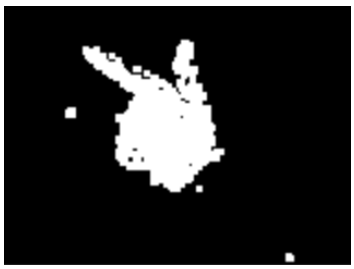
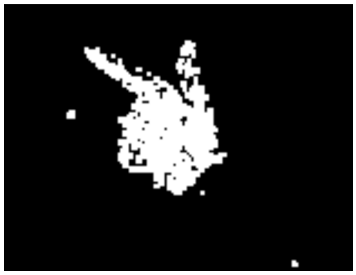
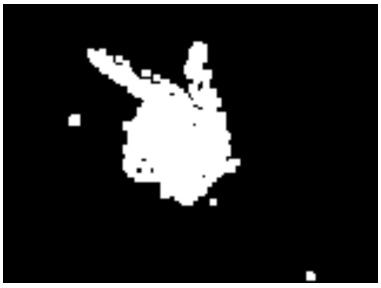
Task

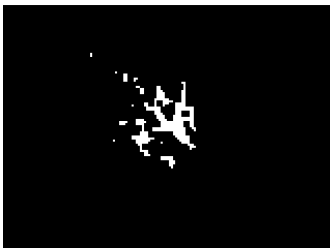
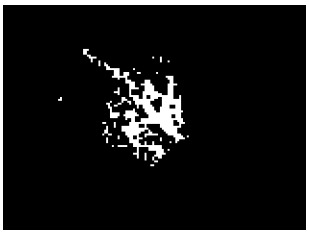
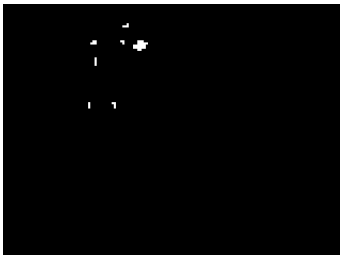
The Task for this MP was to make a few morphological operators as we discussed in class. Specifically, we were to make functions that carry out erosion, dilation, opening, closing, and boundary delineation. Erosion and dilation are the foundation for the following three algorithms. How it works is that we start with an input image and a structuring element (SE), which is a parameter that can be changed in size leading to different results. For dilation, the goal is to inflate the image. There are two ways to do this, in both we move the SE across all of the pixels in the input image. You can either think about it as (1) if the SE is in a position where any of it's pixels is overlapping a foreground pixel (here this is white), then the center pixel is made to be in the foreground in the output image, or (2) you iterate over each pixel in the input image, and if a given pixel is in the foreground, then you center the SE over this point and all points in the SE are added to the foreground. I used method 2. For erosion, the goal is to deflate the image, and like dilation you also work with an SE and move the SE across all pixels in the image. At any point that the SE does not completely overlap with foreground pixels, all pixels covered by the SE in that moment will become background in the output image. Building on these two, opening is when you subject an image to erosion and then dilation, and closing is when you subject an image to dilation and then erosion. Boundary delineation is done by performing erosion on the input image and then subtracting the eroded image from the input image.

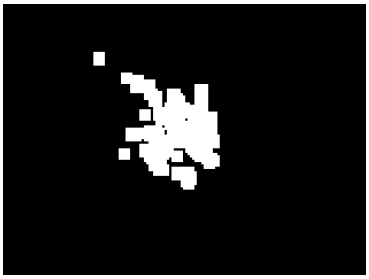
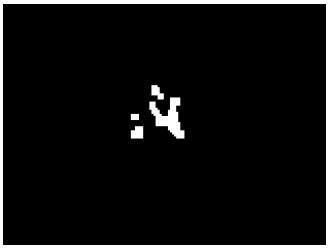
Algorithm Descriptions

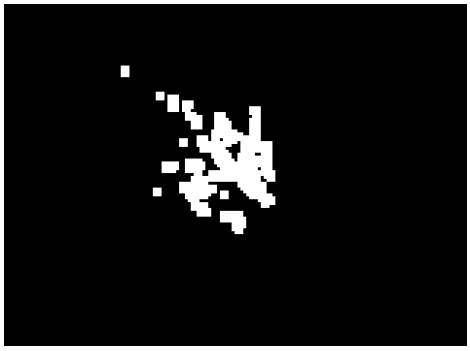
- Dilation
    - Iterated across each pixel and when it reaches a pixel that is part of the foreground, it includes all pixels that are part of the SE when centered on the current pixel as part of the foreground in the dilated image
- Erosion
    - Moved the SE across each point in the input image, every time the SE does not completely overlap with foreground, all pixels in the SE are part of the background in the eroded image
- Opening
    - Erode the initial image and then dilate it
- Closing
    - Dilate the initial image and the erode it
- Boundary delineation
    - Erode the input image and subtract the erosion from the original

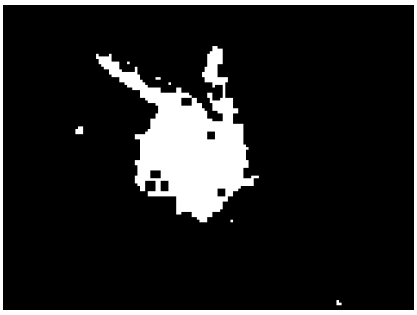
Results

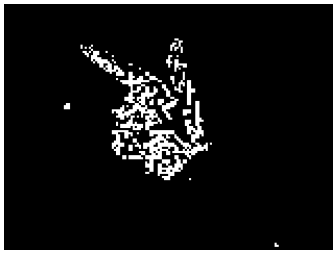
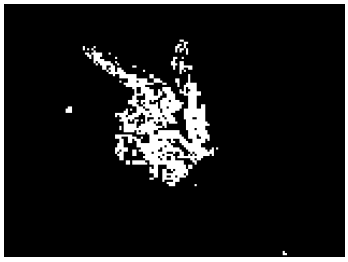
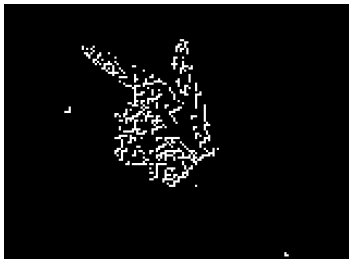
- Dilation: I found the dilation results to perform the best in terms of making the intended image more visible. I tried a few SE's for both the palm and gun images.
    - SE of all ones, 3x3 matrix 
    - SE of all ones, 2x2 matrix 
    - SE 3x3 with two columns of zeros and the right column of ones, you can see that the uneven SE slightly distorts the shape 
    - SE of all ones, 3x3 matrix 
    - SE of all ones, 5x5 matrix 
- Erosion: I found that erosion alone did not clear up the images

- SE of all ones, 3x3 matrix 
- SE of all ones, 2x2 matrix 
- SE of all ones, 3x3 matrix 
- SE of all ones, 5x5 matrix 

- Opening: based on the results of dilation and erosion, I figured that this would this would distort the image as they lose their shape from erosion and expand on it from there. I felt like the results echoed this
  - SE_e of all ones, 3x3, and SE_d of all ones, 5x5 
  - SE_e of all ones, 5x5, and SE_d of all ones, 3x3 

- SE_e and SE_d of all ones, 3x3 
- SE_e of all ones, 2x2, SE_d of all ones, 3x3 

- Closing: in contrast, I expected closing to maintain shape more accurately
  - SE_e of all ones, 3x3, SE_d of all ones, 5x5 
  - SE_e of all ones, 3x3, SE_d of all ones, 3x3 
  - SE_e of all ones, 2x2, SE_d of all ones, 3x3 
- Boundary: I was expecting that a smaller SE would lead to better results here, and that is what I found. However, I was surprised at how poorly it created a boundary.

- SE of all ones, 3x3 
- SE of all ones, 5x5 
- SE of all ones, 2x2 
- SE of all ones, 2x2 
- SE of all ones, 5x5 

Analysis

Overall, I found that dilation and closing worked best for making the images clearer. The results for my boundary images made me wonder if it would be better to use dilation and subtract the original image from the dilation to get a clearer (though less accurate) boundary.