CSE585/EE555: Digital Image Processing I

Computer Project # 1:

Mathematical Morphology: Hit-or-Miss Transform

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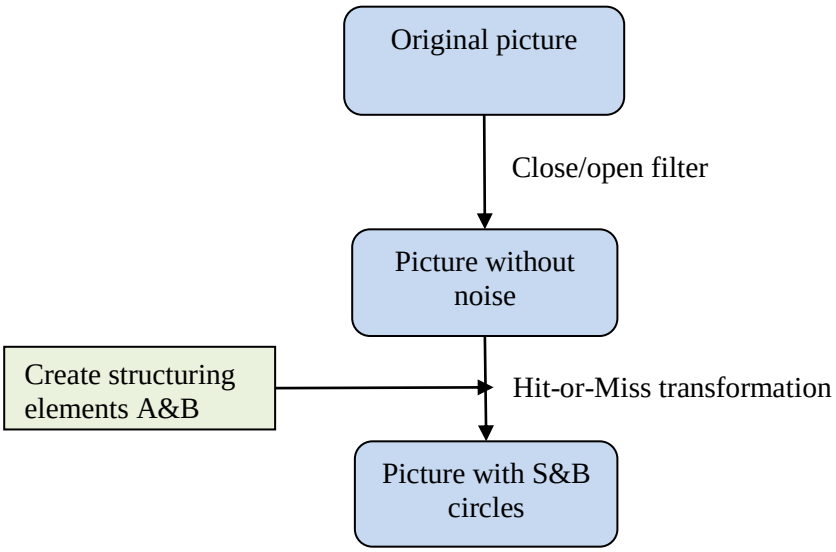
A. **Objectives**

In this project, we are going to do a Mathematical Morphology: Hit-or-Miss Transformation. To be specific, we try to select the smallest and biggest circles in a picture with five different sized circle and noise. In order to complete this task, we should first remove noise from the picture and then develop two structuring elements to do the Hit-or-Miss Transformation. Finally, we can get the smallest and biggest circles.

B. **Methods**

In the main function, it's really intuitional to show what we are doing. We have the original picture and then use a close/open filter to remove the noise. Finally, we use the Hit-or-Miss transformation to select the smallest and biggest circles in the picture.



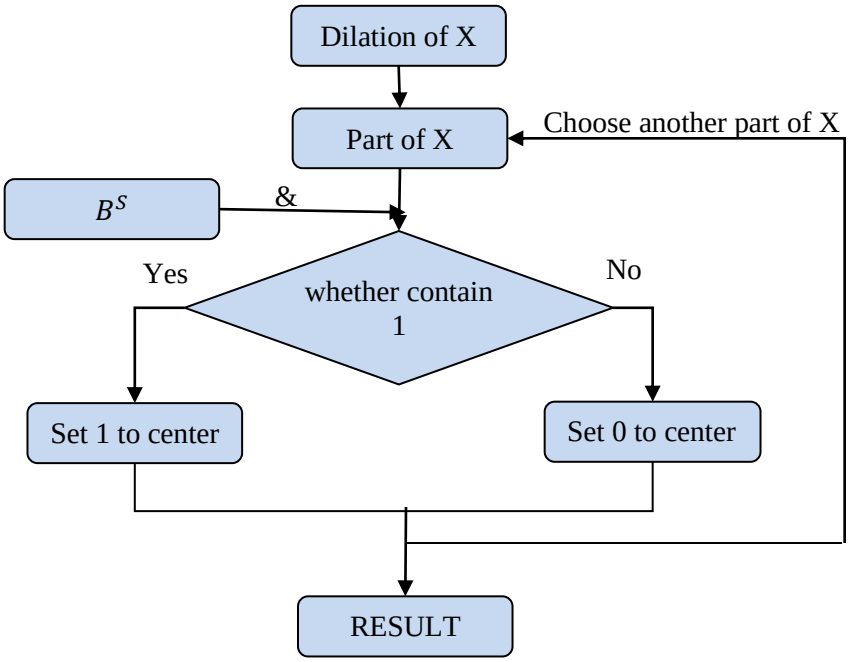
As we can see, in the main function, we get two subfunction. One is close/open filter and the other is Hit-or-Miss transformation.

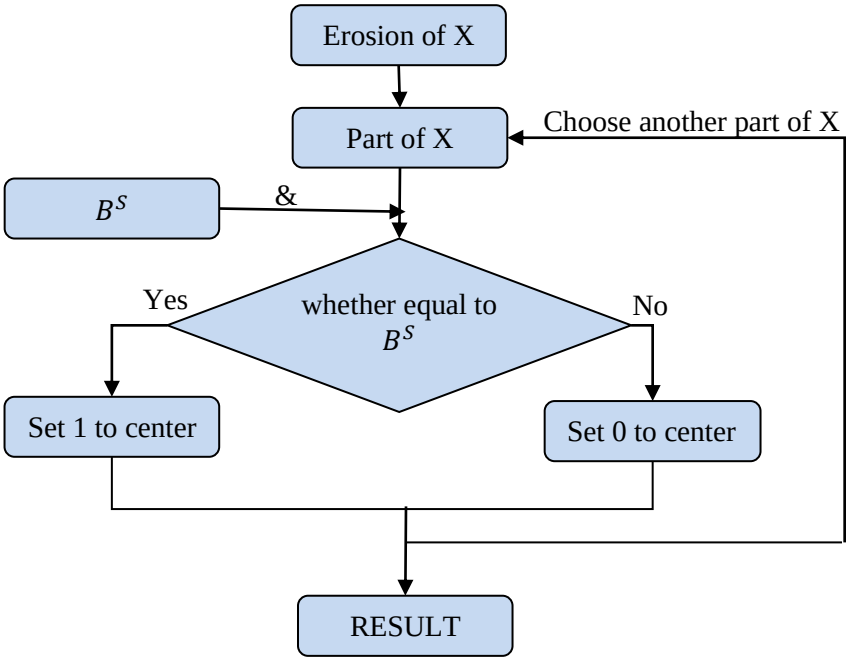
At the very beginning, because we cannot use the "imdilate" and "imerode" function in MATLAB directly, we need to find out how these function work. From theory, we know

$$X \oplus B^S = \{z \in E : B_z \uparrow X\}$$

$$X \ominus B^S = \{z \in E : B_z \subset X\}$$

So we can do "&" operation between B^S and every part of$X$. For dilation, if the result contains 1, we can judge that $B_z \uparrow X$, thus we can get a 1 at the center of this part. If not, we get 0. And for erosion, if the result equal toB^S, we know that$B_z \subset X$, so we get a 1 at the center of this part. If not, we get 0 at this position. Thus, when we do this operation to all part of X, we obtain a new matrix with 0 and 1 and that is the result of dilation or erosion.





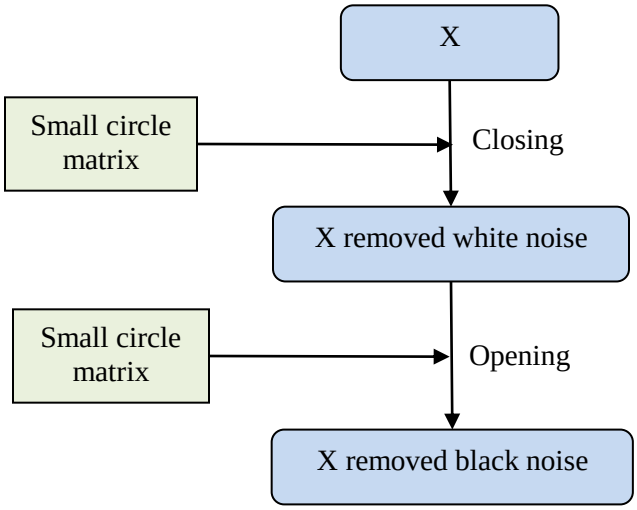
After we get the function of dilation and erosion, in the close/open subfunction, we use the close/open filter to fill holes in regions. First, we should create a small circle matrix and use it do a "closing" mathematical morphology operation with original picture.

$$X \cdot B = (X \oplus B^S) \ominus B$$

As we know, “Closing” operation is like “Roll ball B outside X”. This is using to remove the white noise, which is inside or at outer border of the black circles. Then we use the small circle matrix to a “opening” mathematical morphology operation with the picture we got just now.

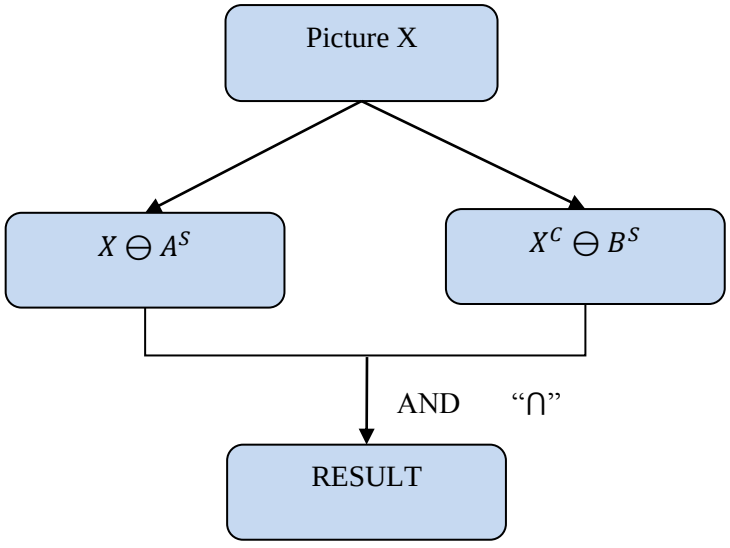
$$X \circ B = (X \ominus B^S) \oplus B$$

“Opening” operation is like “Roll ball B inside X”. This is using to remove the black noise.



What’s more, in the Hit-or Miss transformation subfunction, we apply equation

$$X \circledast (A, B) = (X \ominus A^S) \cap (X^C \ominus B^S)$$



In this equation, we should solve a problem that is how to select A^S&B^S.

Actually, we try some different radius to the Hit-or-Miss transformation, then we find the right radius to select the largest and smallest circles. And when we get the circle A^S, B^S is just the complement of A^S.

C. **Results**

In this project, we get some pictures, and we will show you what we get below. First one is the original image.

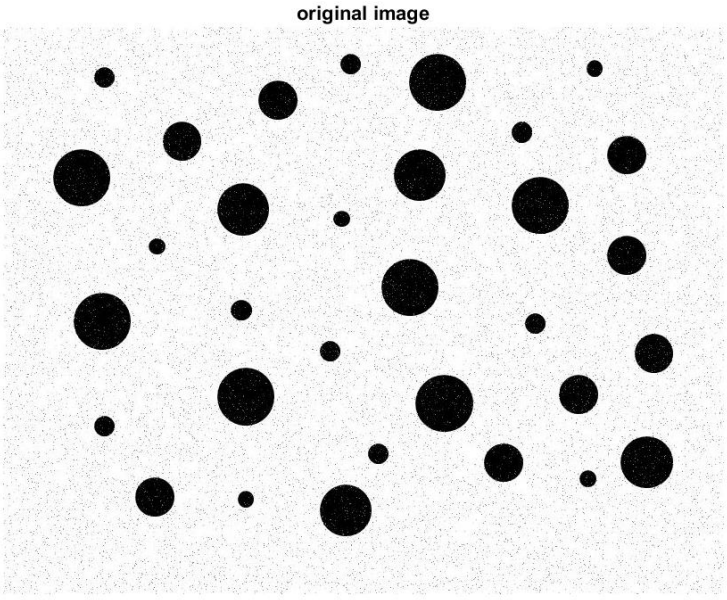


Figure1. Original “disks” image

For the first step, we should change this image to a binary image. We change all the grey points(grey scale between 1~254) in to a white or black points. As we can see in figure(2), all the points become white or black.

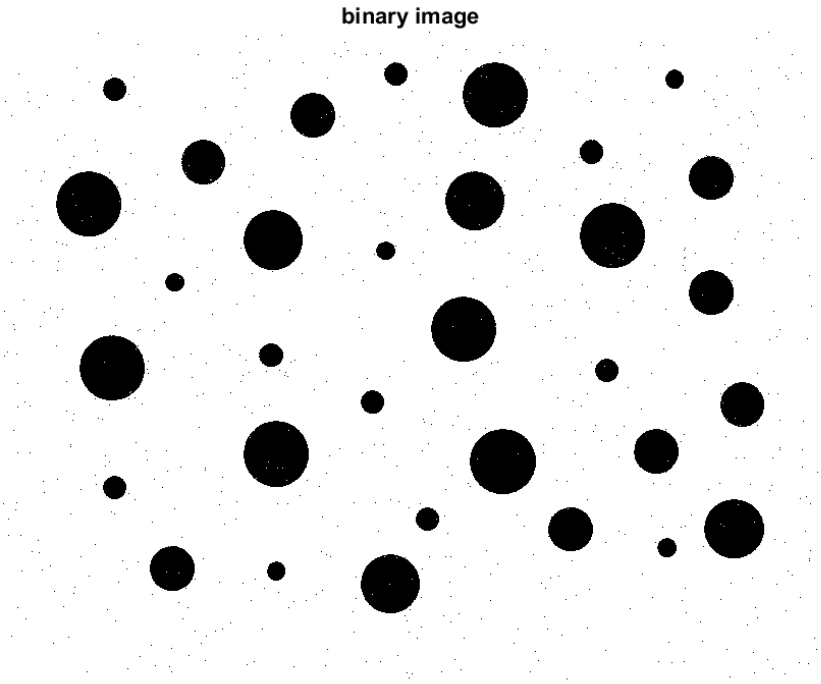


Figure2. Binary image

Then, we use the close/open filter to eliminate the salt-and-pepper noise. In figure(3), the small black points and small white points are all gone.

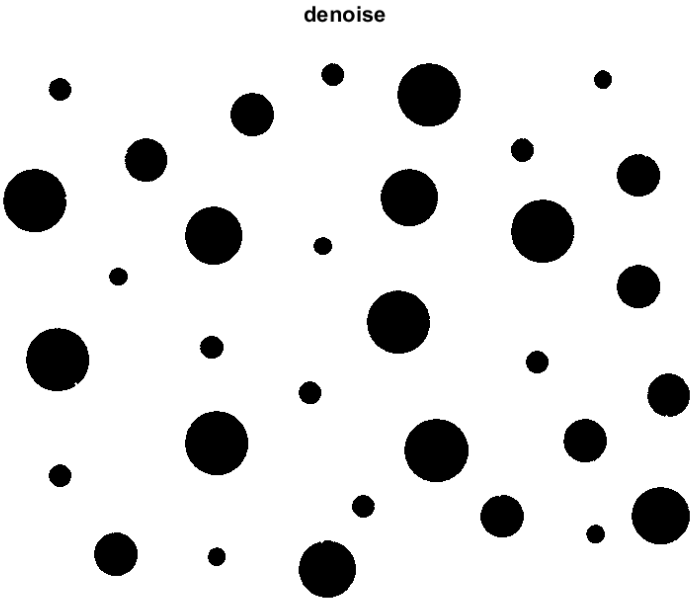


Figure3. Denoise image

Now we can start to do the Hit-or-Miss transformation. We pick the largest circles firstly. As we expected, only the largest circles left.

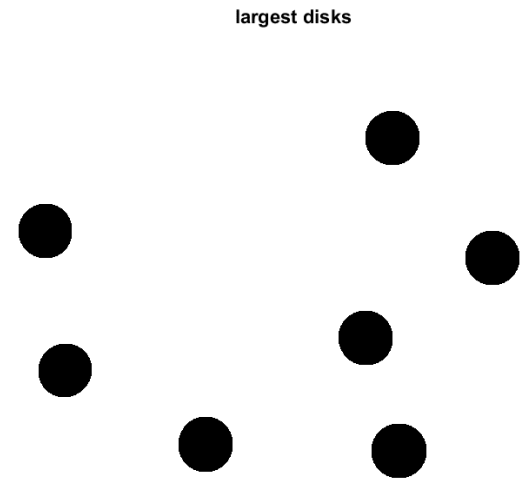


Figure4. Largest disks

Then we pick the smallest disks.

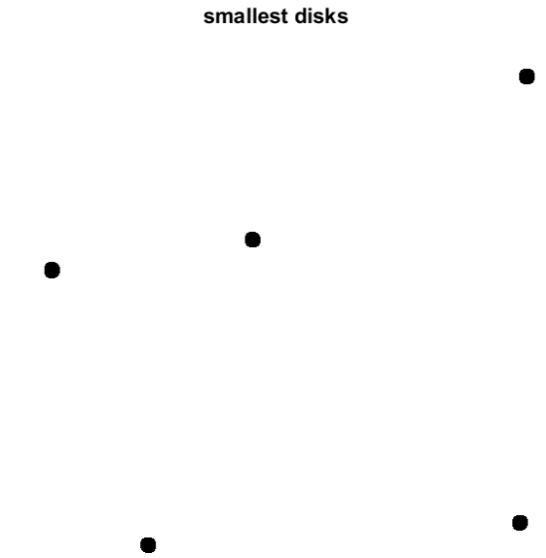


Figure5. Smallest disks

Finally, we combine the smallest and largest disks.

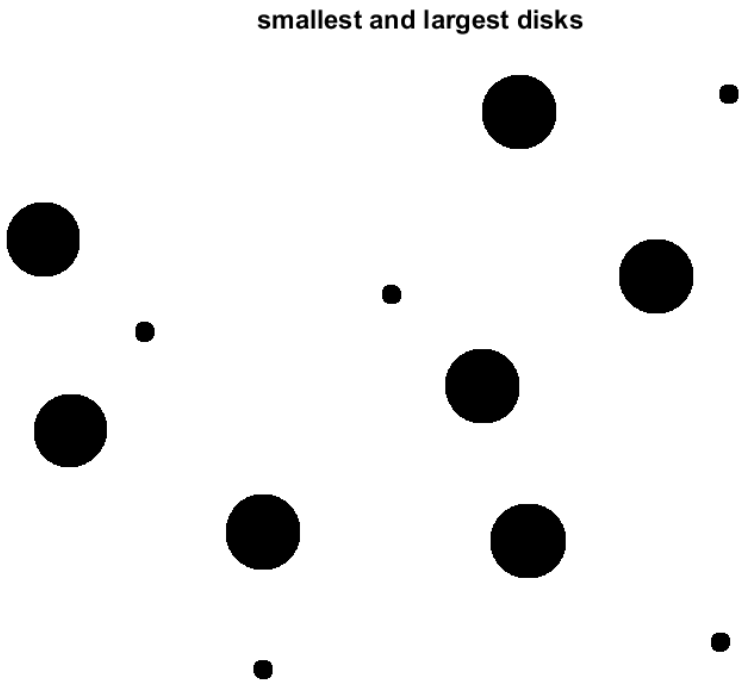


Figure6. Smallest and largest disks

In addition, we do the Hit-or-Miss transformation without using the close/open filter at the beginning. In the result, we cannot pick the largest disks and we can only pick 4 smallest disks(total number is 5). The reason is that disks we don't pick have some white noise inside them, so they are not equal to the structuring element we put. Thus, we cannot pick them.

D. **Conclusions**

From the result above, we know that the close/open filter really can help us to remove the salt-and-pepper noise. What's more, the Hit-or-Miss transformation is very useful in selecting the aimed image.