Homework 3

Hengtao Guo

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https://github.com/Tonight1121/Biology-Image-Analysis

1 Solution

To improve the hough circle detection in the red-blood-cells.png, I offered some modifications in image pre-processing and adjustments in cv2.HoughCircles parameters.

1.1 Original Detection

The original circle detection using the source code in lecture would look like the following Fig. 1.

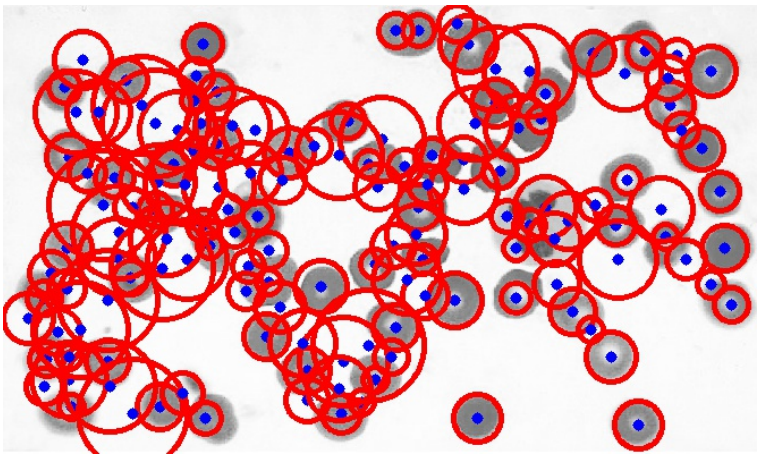

Figure 1: Original Detection

1.2 Gaussian Blur

By using OpenCV function cv2.GaussianBlur with a 5*5 kernel, the noise within the image got reduced. Thus, it reduces more wrongly detected circles with variational sizes. The circle detection after applying Gaussian bluring would appear like Fig. 2

At this moment, we can see that although we have got rid of many false positive detections, the size of each cell may not correspond to the original cells very well. In order to further improve the detection accuracy, we have to dive into parameters adjustments.

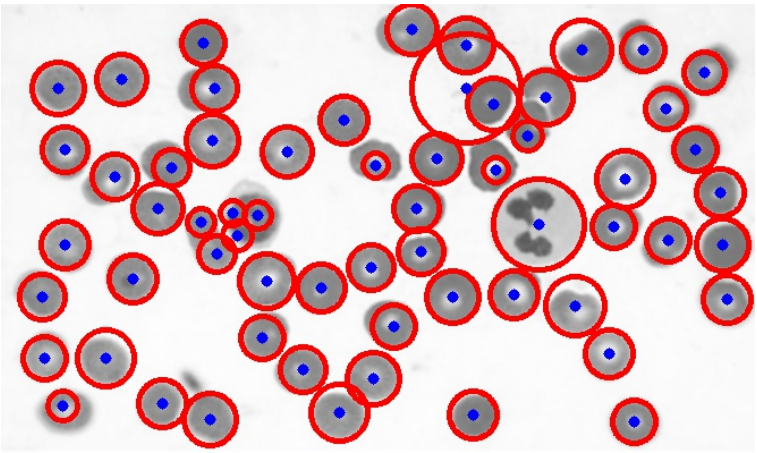

Figure 2: Detection with Gaussian blur

1.3 Parameters Ajustments

First, let us revisit the parameters in cv2.HoughCircles:

cv2.HoughCircles(image, method, dp, minDist, circles=None, param1=None, param2=None, minRadius=None, maxRadius=None)

Image means the input image. Method means the method used for circle detection and our only option is cv2.HOUGH_GRADIENT. 'dp' means the inverse ratio of resolution. 'minDist' means the minimum distance between two detected centers. 'param1' is the upper threshold for the internal Canny edge detection. 'param2' is the threshold for center detection, the lower this value is, the more circles we can get. 'minRadius' and 'maxRadius' are the minimum and maximum circle radius counted through pixels, repectively.

As the cells in the image have similar sizes, it is reasonable to limit the radius boundary. After several attempts, I set the minRadius=15 and maxRadius=2. By doing so, the circles are forced to form around the cells more tightly.

We also can see that in the original image there are no cells overlapping, so I set the minimum distance between each pair of cells to be (minRadius + maxRadius) / 2 = 20. By doing so, we force the circles to form without overlapping. The results are shown in Fig. 3.

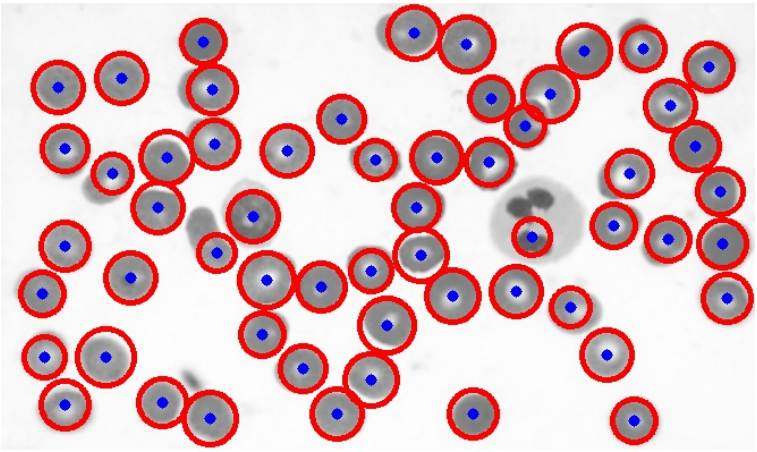

Figure 3: Detection with adjusting parameters

1.4 Other Experiments

If Gaussian blurring can be one method to tackle this problem, then enhancing the contrast of image may also help to improve circle detection. The first thing comes to mind is segmentation. The histogram of image is shown as Fig. 4

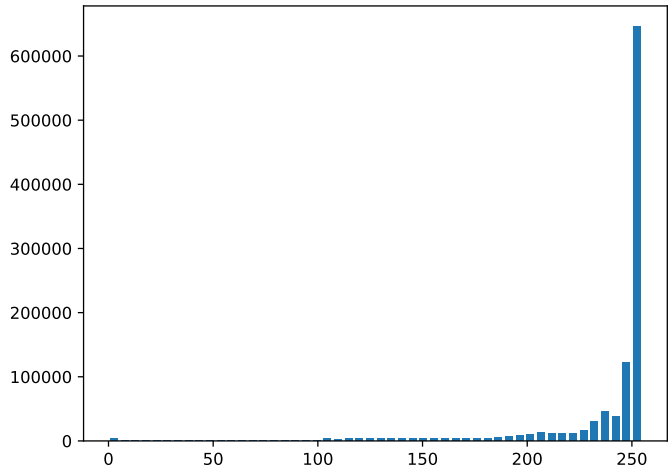

Figure 4: Histogram of original image

According to the histogram, I set a threshold with 220 and using 3*3 corrosion kernel. The segmentation mask is shown as Fig. 5.

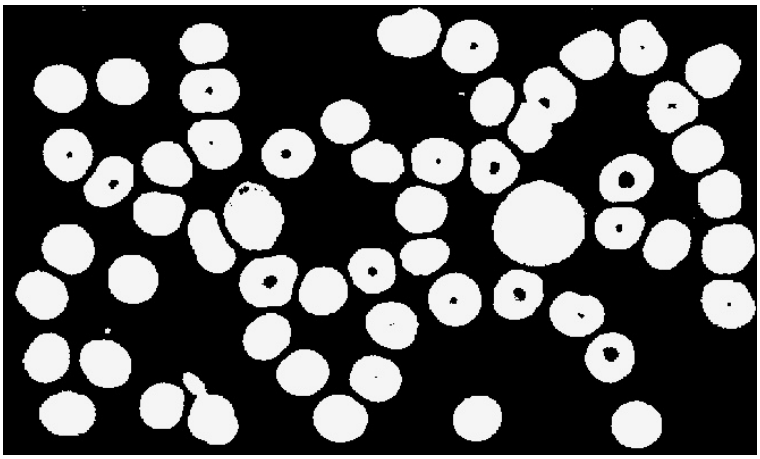

Figure 5: Mask of segmentation

This time we do not have much noise to be afraid of, so we can set a relatively large radius upper bound (40 for example). Applying hough circle detection on the mask image, then draw circles on the original image. The results can be seen in Fig. 6. This time the largest cell (actually I am not sure what that is) got included.

2 Final Result

The overall result of hough circle detection in cell image can be seen in Fig. 6.

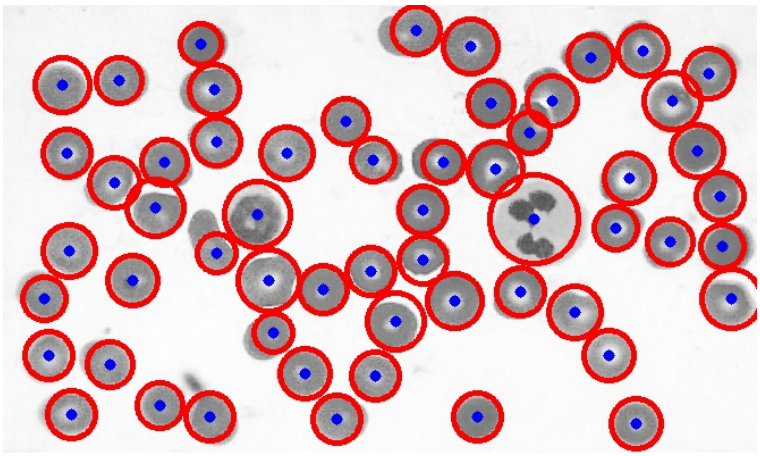

Figure 6: Hough circle detection on mask