APPLIED PHYSICS 186
DR. MARICOR SORIANO

Activity 10

blob Analysis

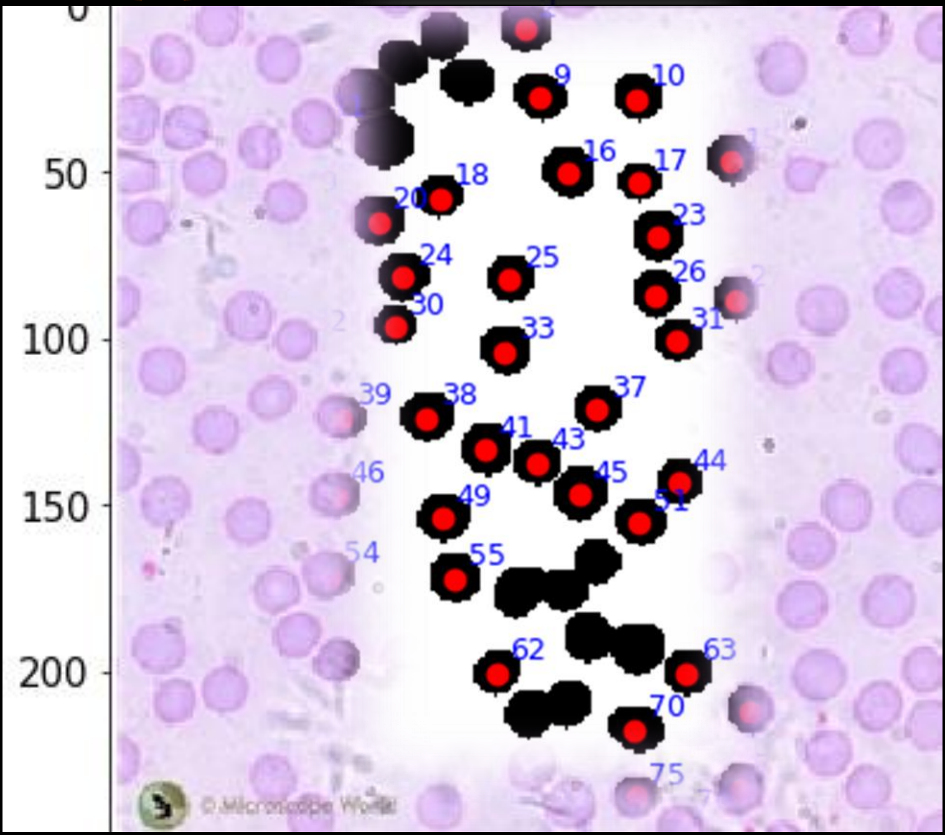

Figure 1. Blood Cells under a microscope. Superimposed is a preview of the implemented blob detection.
(from: https://www.microscopeworld.com/p-3468-microscope-resolution-explained-using-blood-cells.aspx)

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2015-04622

In this report, I integrated all the concepts that I learned so far to exploit as much information possible from a microscopic image of blood cells in Figure 1. First, I wanted to segment the image where the taking a cell as my Region of Interest (ROI). I employed the parametric and non-parametric segmentation algorithms I used in the previous activities and the results were shown in Fig. 2. Non-parametric method returned a more visually appealing segmentation hence, I used this results for further processing.

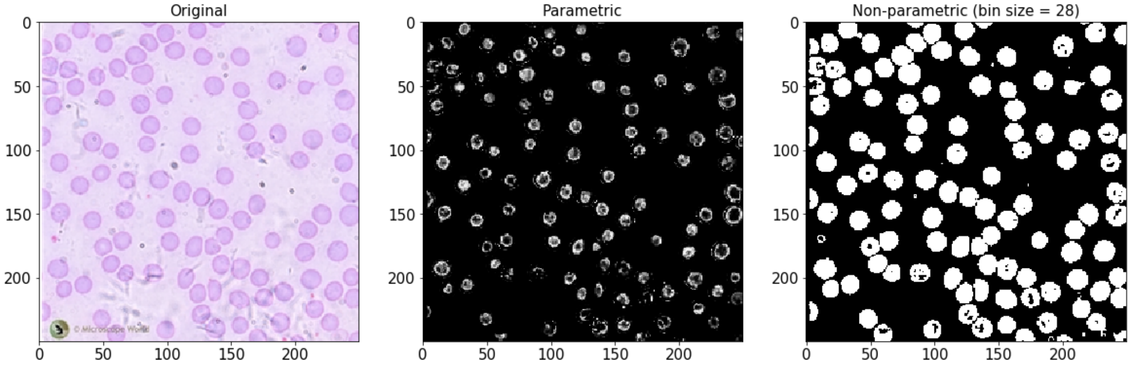

Figure 2. Segmentation algorithms were employed to the colored microscopic cell image. The non-parametric segmentation retained more visual information.

Upon application of morphological "cleaning" as shown in Fig. 3, some cells were lost. I also tried employing the erosion and dilation operators however, unwanted artifacts can still be observed. Nevertheless, I decided to test both the segmented image and morphologically cleaned image on *Skimage*'s blob detection algorithm. Luckily, the *measure* package does the data extraction altogether. I was able to extract the centroid coordinates, area, major and minor axis lengths, angle of rotation, and from there, calculated for the eccentricity and the perimeter.

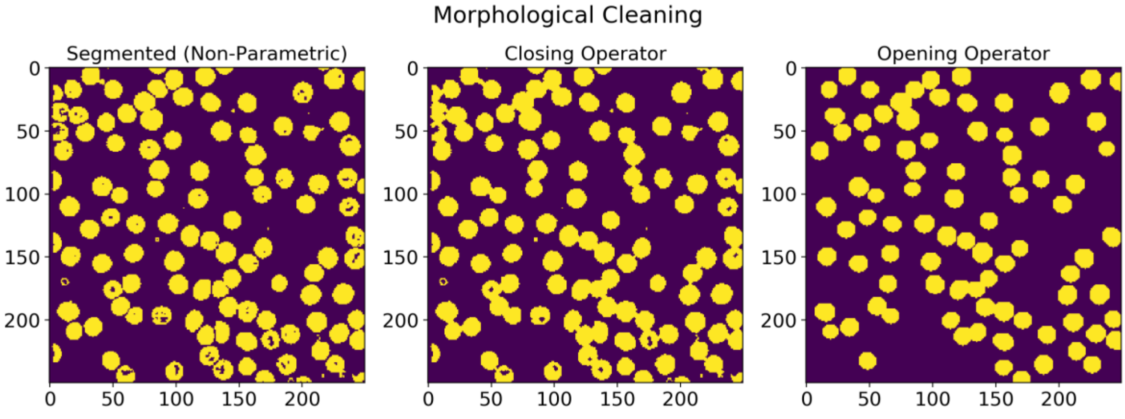

Figure 3. Further morphological processes were employed to "clean" the segmented image and isolate cells from each other. However, some segmented cells were lost upon further processing. Here I used Open-CV's opening ang closing operator.

Here, 82 useful blobs were detected on the segmented cell image alone as shown in Fig 4., way more than the 69 useful blobs in the segmented + cleaned image as shown in Fig 5. For both cases, blob detection fails at cells which are coinciding with each other. More blobs can be detected if I employ better segmentation & cleaning which can remove these artifacts. Nevertheless, we got a majority number of blobs detected. Now, we can proceed to analyze the blob features using the result in Fig. 4.

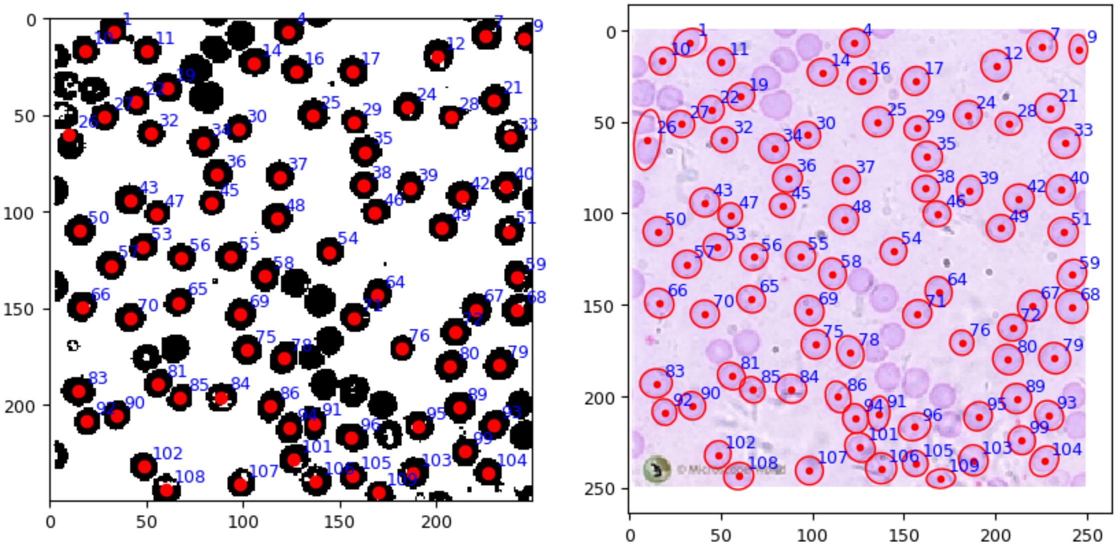

Figure 4. *Skimage's* blob detection on the non-parametrically segmented cell image. 109 blobs were detected, but I only considered 82 blobs which falls within 100 to 300 square pixels range.

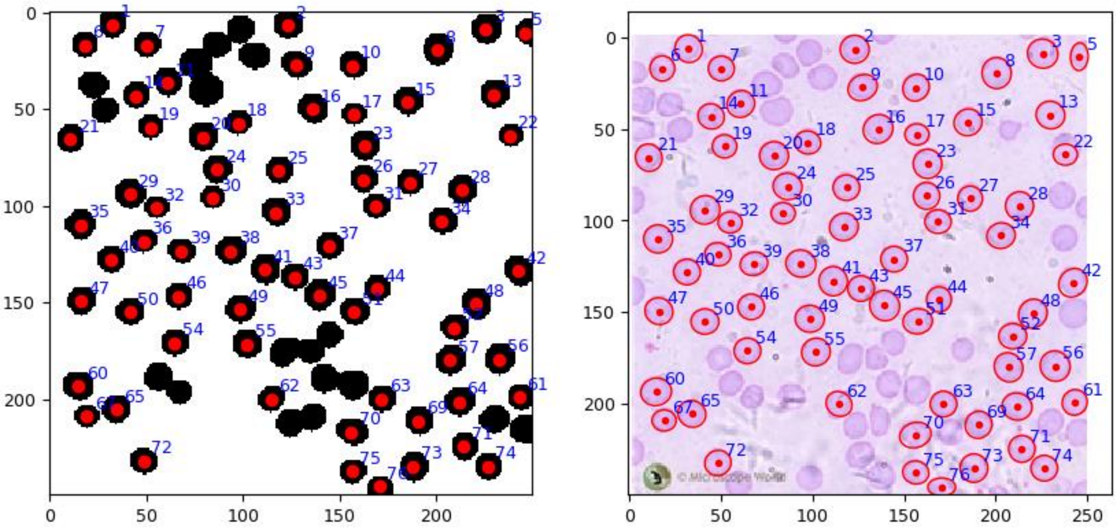

Figure 5. *Skimage's* blob detection on the non-parametrically segmented + morphologically cleaned cell image. 76 blobs were detected, but I only considered 69 blobs which falls within 100 to 300 square pixels range.

Histogram analysis was carried out to visualize the distribution of blob's area, perimeter, major axis length, and eccentricity as shown in Figs. 6,7,8 & 9 respectively. The blobs, on average, has an area of 182.20 ± 25.70 square pixels, perimeter length of 97.83 ± 9.21 pixels, and has a longer diameter of 16.33 ± 2.15 pixels. Eccentricity of each blob on average turns out to be 0.39 ± 0.16, implying the elliptical degree of the blobs. For reference, a circle has an eccentricity of 0.5.

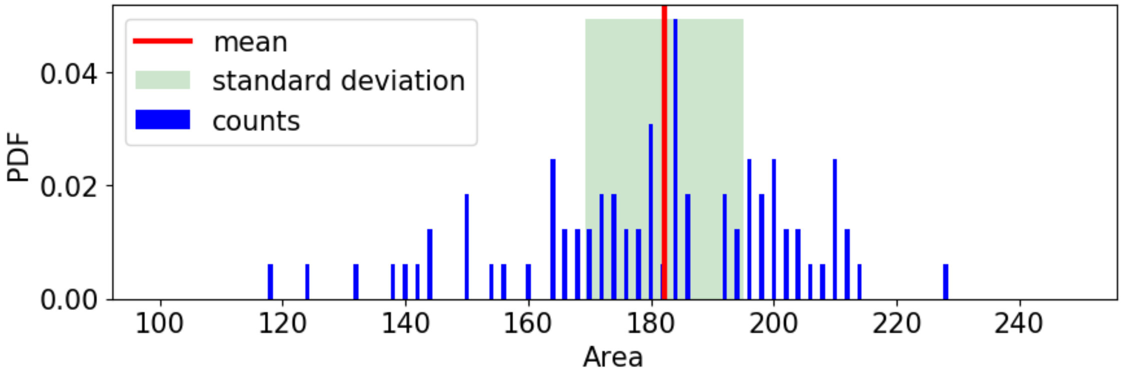

Figure 6. Probability distribution function and statistical properties of the blob areas.

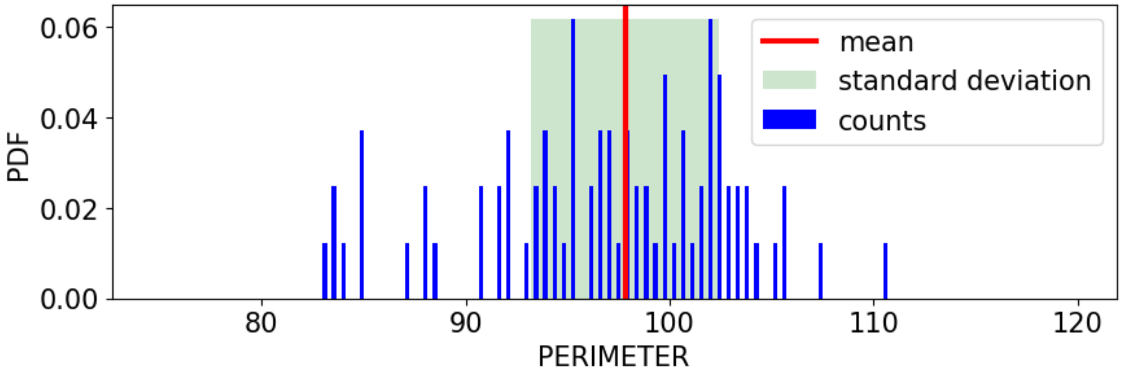

Figure 7. Probability distribution function and statistical properties of the blob perimeters.

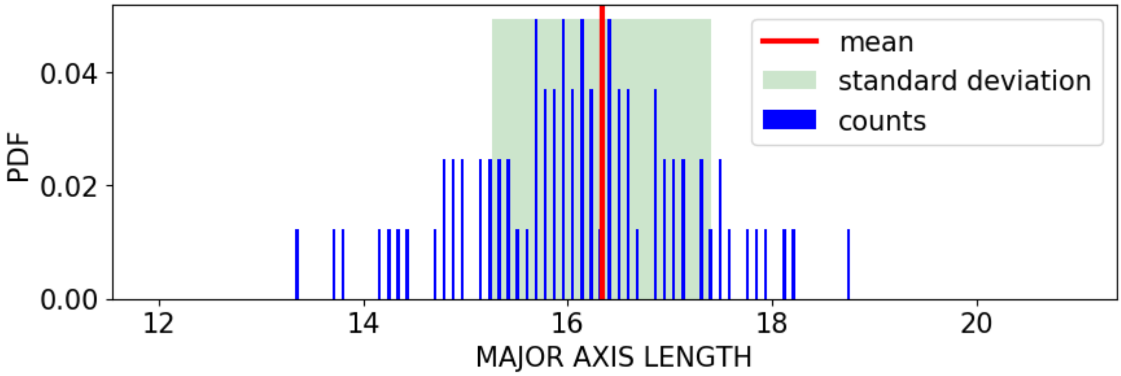

Figure 8. Probability distribution function and statistical properties of the blob's major axis lengths.

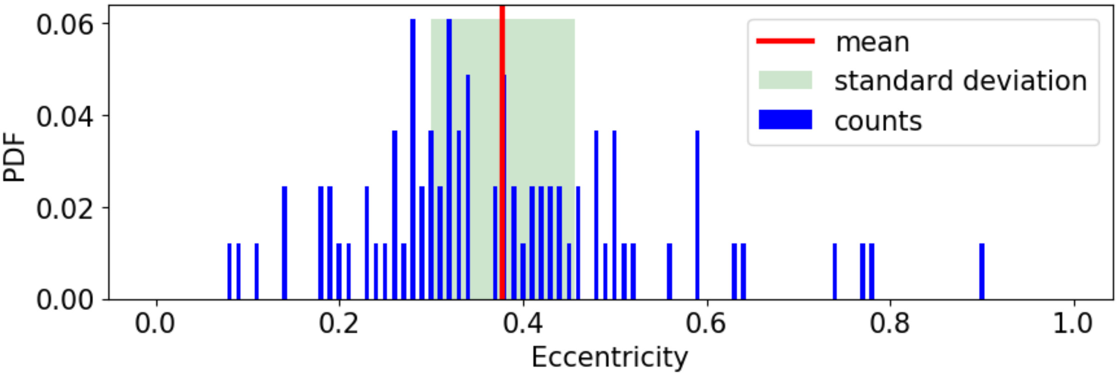

Figure 9. Probability distribution function and statistical properties of the blob eccentricity.

To sum up, I was able to apply segmentation and morphological cleaning on the cellular image and compared their effect on blob detection algorithms. Statistical analysis was also carried out to get an estimate of the blob's features and the probability distribution function for each feature was plotted for visualization. I wanted to compare the calculated feature measurements to the actual cell's feature measurements however, a scale isn't present in the test image.

Nevertheless, blob analysis was successfully carried out using image processing techniques and for this, I give myself a 10.

I want to thank Kenneth Domingo for helping me understand the step sequence in this activity, and for recommending that I should try out *Skimage*'s blob detection algorithm

References:

[1] M. Soriano, "Blob Analysis," 2019

Perimeter formula: https://www.mathsisfun.com/geometry/ellipse-perimeter.html

Skimage Labelling: https://scikit-image.org/docs/dev/api/skimage.measure.html

Morphological Opening and Closing: https://docs.opencv.org/trunk/d9/d61/tutorial_py_morphological_ops.html

Cell Image: https://www.microscopeworld.com/p-3468-microscope-resolution-explained-using-blood-cells.aspx