School of Engineering and Applied Science (SEAS), Ahmedabad University

ECE501: Digital Image Processing

Group Name: NetraByte

Project: 11. Automated Object Counting

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I. What has been done so far (Progress)

- Till now, cell segmentation was done by comparing Otsu's thresholding and Adaptive thresholding. Considering the outputs, we finalized the Adaptive thresholding method as it provided better detection and handled varying lighting conditions with better results.
- This week, we improved the pre-processing step to enhance image contrast by applying Histogram Equalization and CLAHE (Contrast Limited Adaptive Histogram Equalization), considering local details.
- Then, we applied a CLAHE-enhanced image as an input for Adaptive thresholding, which brought out better cell boundary detection quality.

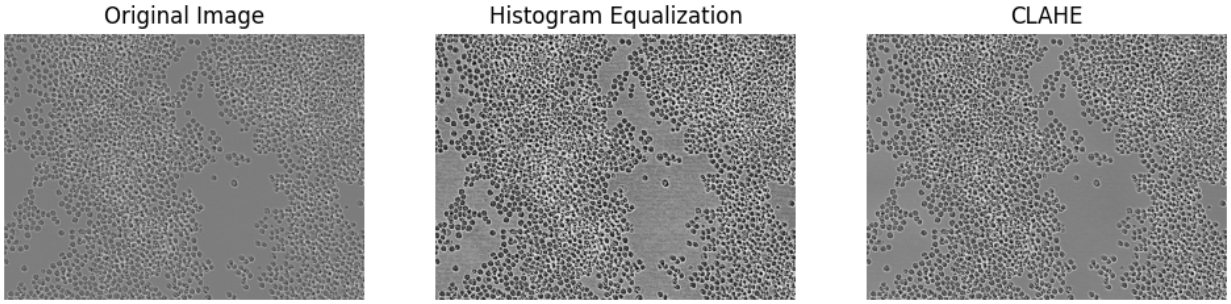

Figure 1: Original Image

A. Histogram Analysis

First, we analyzed the distribution of intensity of images before and after applying techniques for contrast enhancement in order to enhance image segmentation.

- Histogram 1: Original image histogram where the pixel intensities are closely packed around the middle range indicating low contrast and hence poor cell-background differentiation.

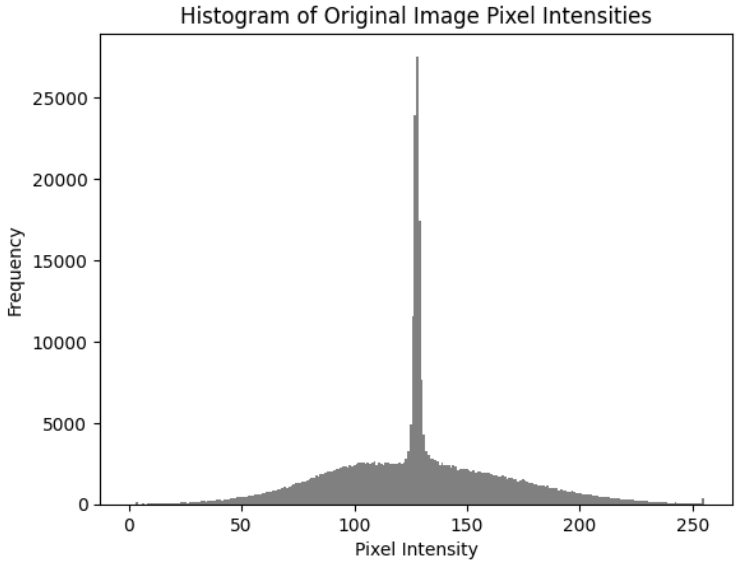

Figure 2: Original Image

- Histogram 2: Intensity distribution of pixels within segmented cells - there is a more natural spread, yet still limited dynamic range.

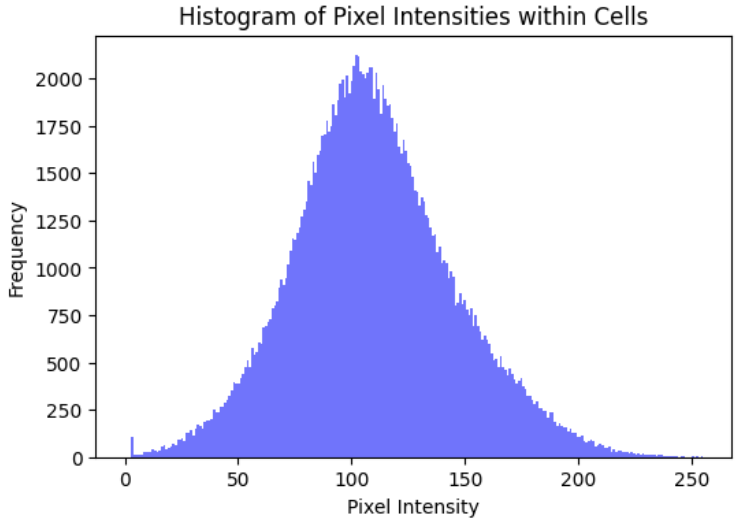

Figure 3: Original Image

- Histogram 3: This is the result after applying CLAHE, which redistributes the pixel intensities within the full range of 0-255 more uniformly. This enhances local contrast and allows for the revelation of finer cellular details.

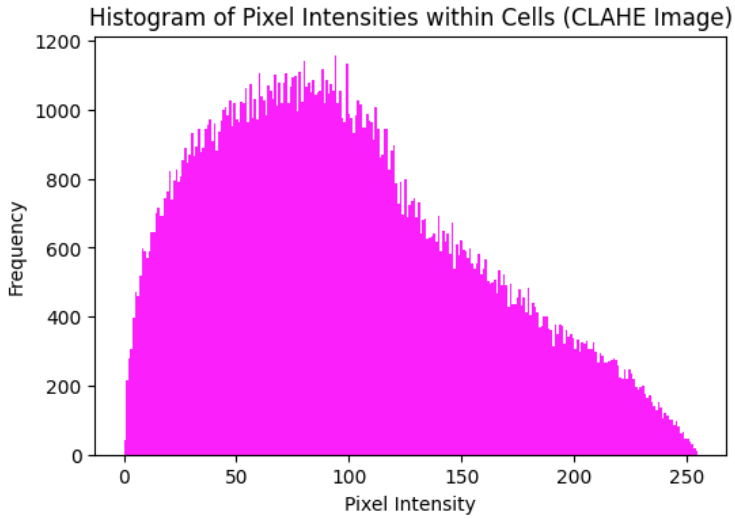

Figure 4: Original Image

It gives better visibility by applying Histogram Equalization followed by CLAHE, and also helps in Adaptive Thresholding by providing better distinction between cell and background regions.

II. Challenges faced

1. Our dataset consists of images divided into 8 different types, with 8 different folders. Because of this division, we failed to extract its annotations from the provided JSON file. When we tried to convert it from JSON to images for annotations, we got all black images. This might be because they are not mapped properly. Then we merged all the different types of cells into a single folder and again tried to convert annotations. We thought we would now be able to map them properly, but it is still not successful. They are still not mapped properly.

2. Initially, we had taken one type of cell data set (out of 8) for the formation of a pipeline for cell detection in the image. But when we moved that pipeline to all 8 types of cells, we got unexpected results. It was unable to detect cells in the image with varying cell types. We started changing parameters in the pipeline, but it is still not ready.

III. What is planned for next week

1. Automate the entire preprocessing, segmentation, and detection pipeline for other cell subsets in the data.

2. Incorporate JSON-to-mask conversion for testing the correctness of segmentation and detection outputs.

3. To study connected components analysis in detail and add it in our pipeline.

References

[1] C. Edlund, T. R. Jackson, N. Khalid, N. Bevan, T. Dale, A. Dengel, S. Ahmed, J. Trygg, and R. Sjögren, "LIVECell—A large-scale dataset for label-free live cell segmentation," *Nature Methods*, vol. 18, no. 9, pp. 1038–1045, 2021. [Online]. Available: https://www.nature.com/articles/s41592-021-01249-6

[2] J. A. Stark, "Adaptive image contrast enhancement using generalizations of histogram equalization," in IEEE Transactions on Image Processing, vol. 9, no. 5, pp. 889-896, May 2000, doi: 10.1109/83.841534. keywords: Histograms;Adaptive equalizers;Image enhancement;Signal processing;Fourier series;Differential equations [Online]. Available: https://ieeexplore.ieee.org/abstract/document/841534?casa_token=0wReGQrJaikAAAAA:jFq30LnzHLT18Qyms0z4-H4XWqkpUtI4uWRGaevo9Ve4REUA_Qg4hq0i95FRUksYQWF4I0Ent0U