

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)

- During this week, we continued our work on improving the segmentation results obtained from the adaptive thresholding method.
- After analyzing these results, we noticed that our current approach works better for some datasets as compared to the results of last week. In some cell types, the quality of segmentation improved a bit while the overall accuracy remained low as compared to expectations.
- One of the major reasons for the low accuracy is that the dataset contains overlapping, non-round cells, which are very hard for the current segmentation pipeline to effectively deal with.
- We discussed these issues with the course instructor. Based on feedback from the discussion, the main focus for now should be specifically on round-shaped cells, such as BV2 and SkBr3 types. Hence, we did not experiment further on other complex cell shapes this week.
- We also tried histogram-based enhancement approaches to improve the contrast before the segmentation, and it gradually improved the accuracy for overlapping cells.
- Subsequently, we refined the existing adaptive thresholding method by tuning its parameters and combined it with morphological noise reduction in order to enhance the quality of segmentation. And we are getting better results for distinct and well-separated cells.
- Further, several parameters were also modified. The Accuracy, Precision, and Recall showed some minor fluctuation, but the change was too minor to account for an appreciable gain in performance.

Results

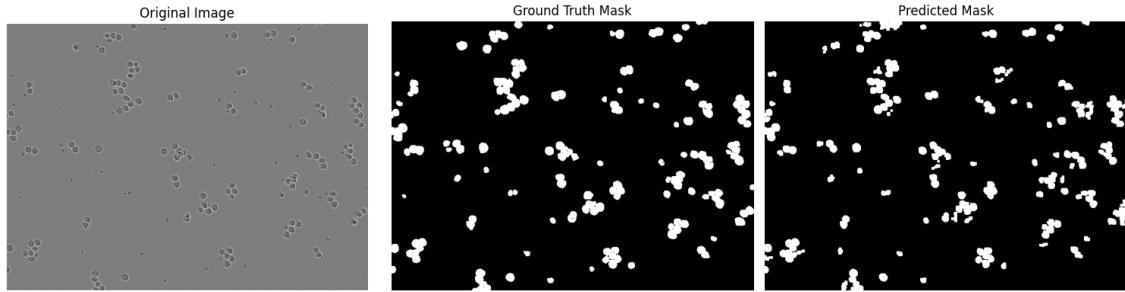


Figure 1: First Image is the original image for the dataset of BV2 and the second image is the Ground Truth for the original image and the third image is the Predicted output for the original image

Performance Metric	Value (%)
Accuracy	97.55
Precision	84.63
Recall	82.95
F1-score	83.78

Table 1: Performance Metrics for Fig 1

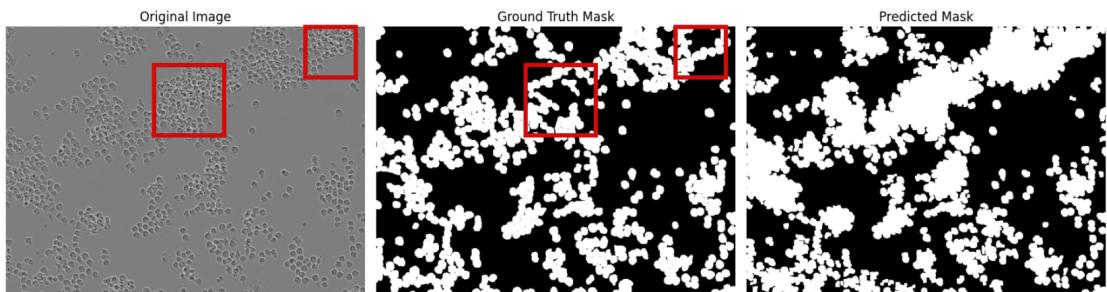


Figure 2: First Image is the original image for the dataset of BV2 and the second image is the Ground Truth for the original image and the third image is the Predicted output for the original image

Performance Metric	Value (%)
Accuracy	87.72
Precision	76.45
Recall	92.22
F1-score	83.60

Table 2: Performance Metrics for Fig 2

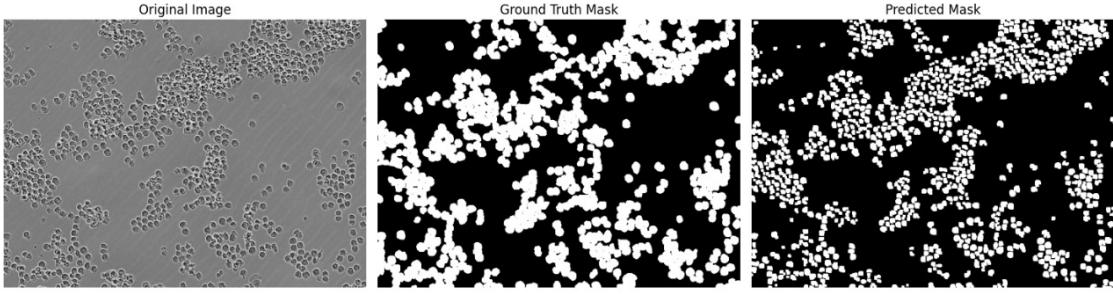


Figure 3: We worked upon on the same image and included CLAHE into the pre-processing methods. We are not getting the best results but it is better than the before one for overlapping cells. The change is clearly visible in the predicted mask. We will try to improve this result.

Performance Metric	Value (%)
Accuracy	82.89
Precision	86.84
Recall	58.41
F1-Score	69.85

Table 3: Performance Metrics for Fig 3

II. What is planned for next week

1. To perform systematic variation and tuning of all function parameters used in the segmentation pipeline, to yield improved performance metrics in terms of accuracy, precision, recall, and F1-score.
2. Observe how each parameter affects the output masks and document the optimal combination that gives the most balanced results.
3. Re-analyzing the Round Cell datasets (BV2 and SkBr3) after optimization of parameters and comparing the performance with previous results.
4. We will also study research papers and previous works based on the same dataset and compare our current results with theirs to understand possible improvements and techniques we can adopt.
5. Explore other image preprocessing techniques, if time allows, which may lead to better quality segmentation prior to thresholding.

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] A. K. Jain, S. Bhattacharjee, and S. Chatterjee, “Automated Counting and Classification of Cells from Microscopic Images Using Classical Image Processing Techniques,” *Biomedical Signal Processing and Control*, vol. 45, pp. 220–233, 2018. [Online]. Available: https://www.researchgate.net/publication/374381260_Automated_Cell_Counting_using_Image_Processing