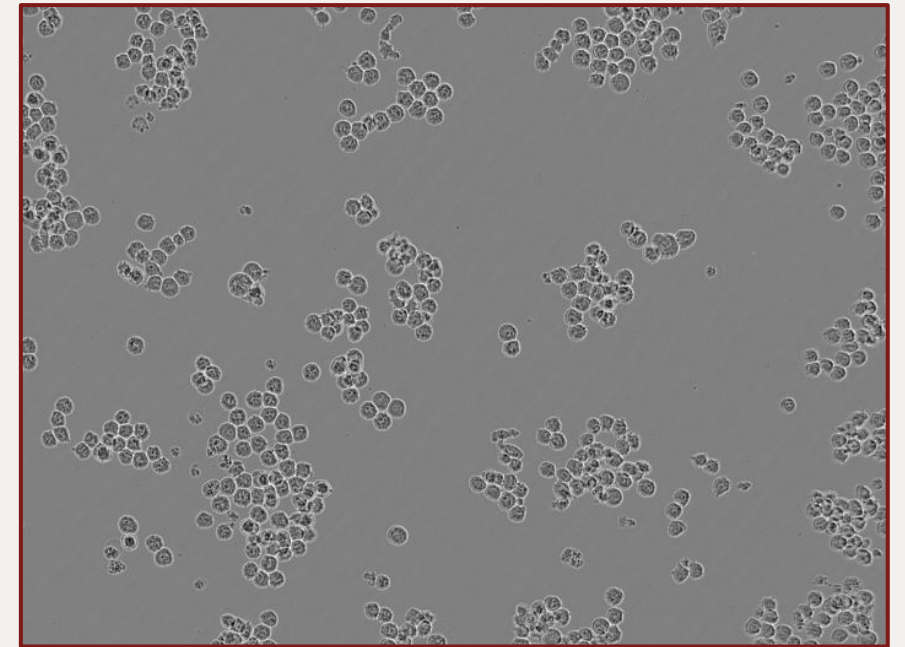# Ahmedabad University

Label-Free Cell Detection Using Traditional Image Processing on the LIVECell Dataset

Group 5 - NetraByte

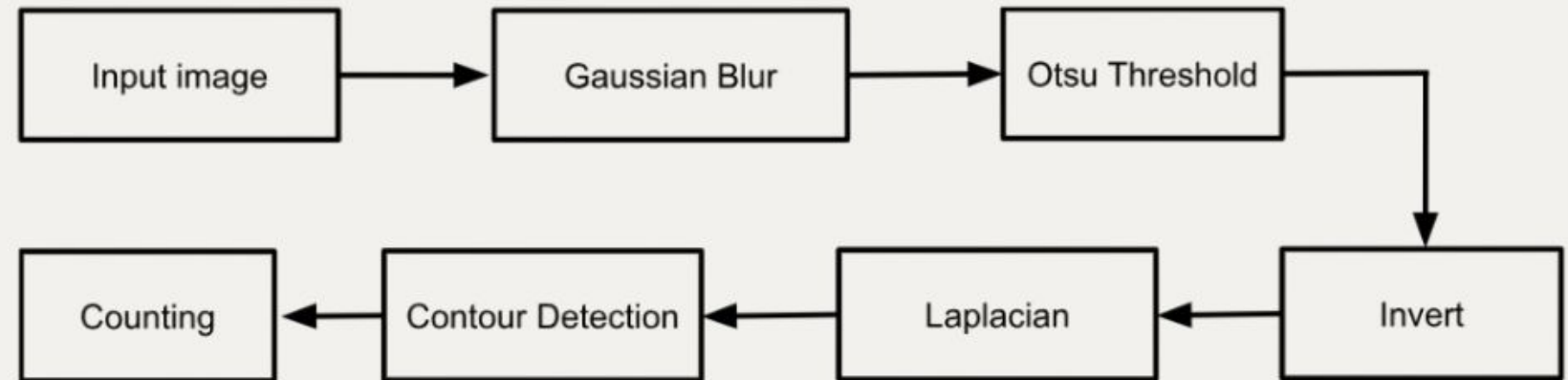|	
Nirjara Jain - AU2340010	Bansi Mahkana - AU2340191
Aashi Shah - AU2340043	Diya Patel - AU2340184

Introduction

- **Objective**: Perform cell detection and segmentation using traditional image processing techniques.

- **Dataset used**: LIVECell (phase-contrast microscopy)

- **Motivation**: Phase-contrast images are challenging due to low contrast, halo artifacts, and overlapping cell structures.

- **Aim**: To achieve accurate, reliable segmentation without using any deep learning models.

- **Outcome**: Strong performance on scattered and overlapping cells with interpretable, efficient processing.
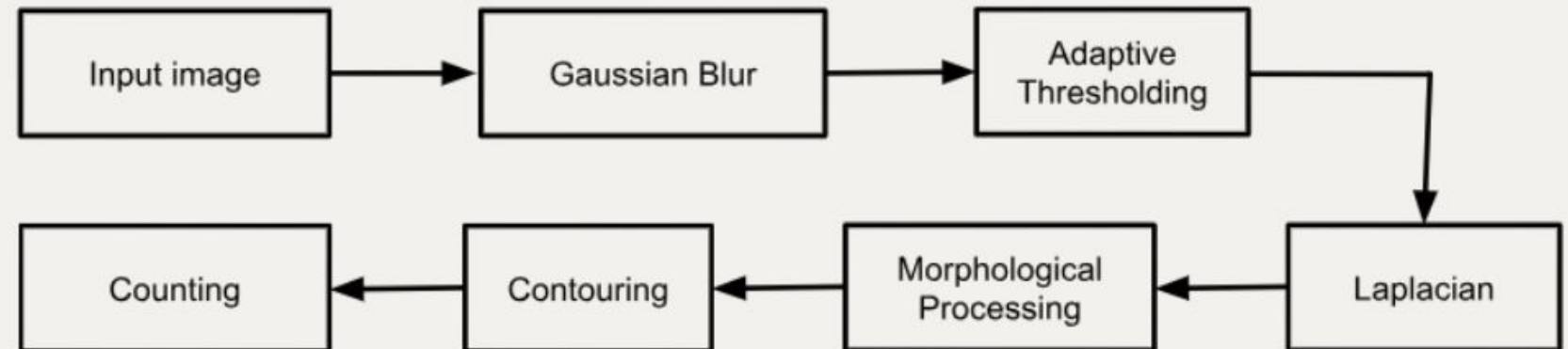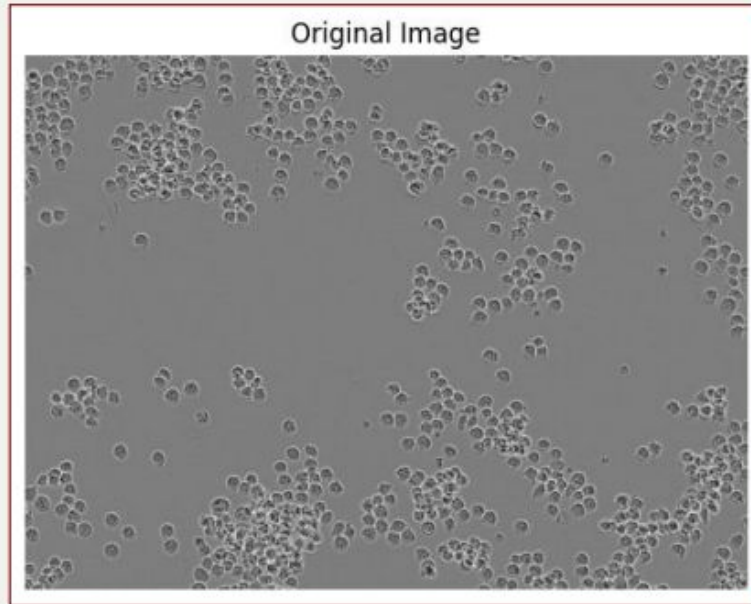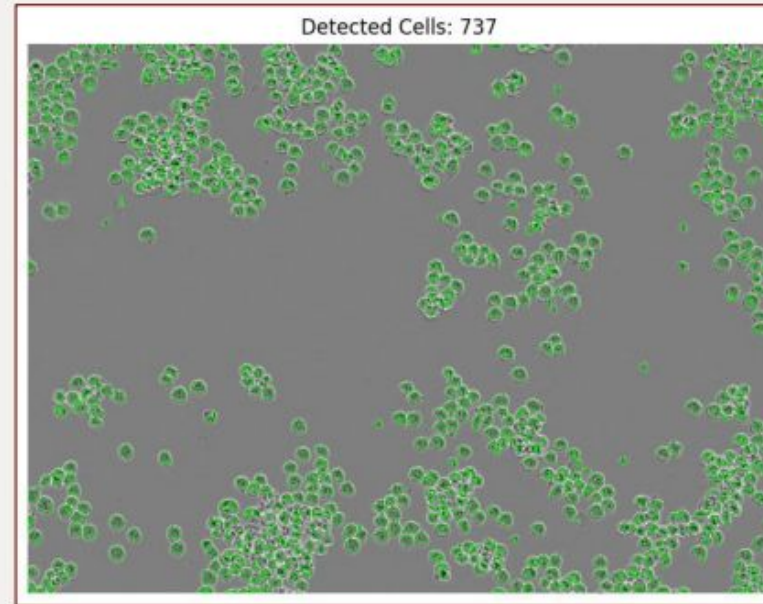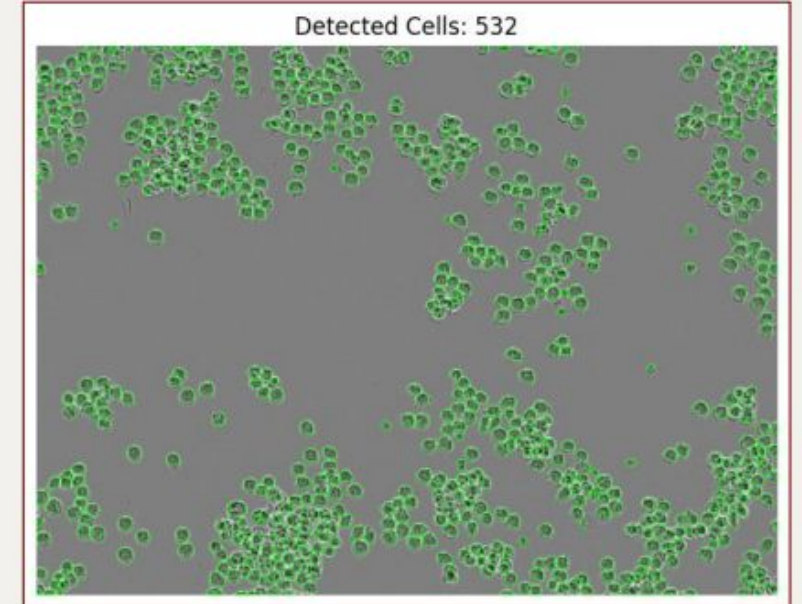
Before Midsem

Otsu's Thresholding

Input image → Gaussian Blur → Otsu Threshold → Invert → Laplacian → Contour Detection → Counting

Adaptive Thresholding

Input image → Gaussian Blur → Adaptive Thresholding → Laplacian → Morphological Processing → Contouring → Counting

Before Midsem

Original Image

Original

Detected Cells: 737

From Approach 1

Detected Cells: 532

From Approach 2

Ahmedabad University

Before Midsem

Original

From Approach 1

From Approach 2

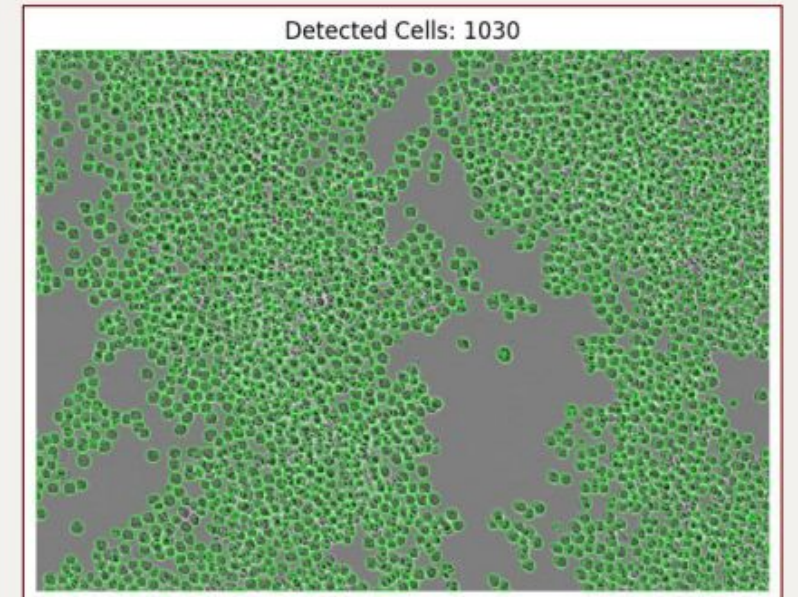Edlund, C., Jackson, T.R., Khalid, N. et al. LIVECell—A large-scale dataset for label-free live cell segmentation. Nat Methods 18, 1038–1045 (2021). https://doi.org/10.1038/s41592-021-01249-6

Ahmedabad University
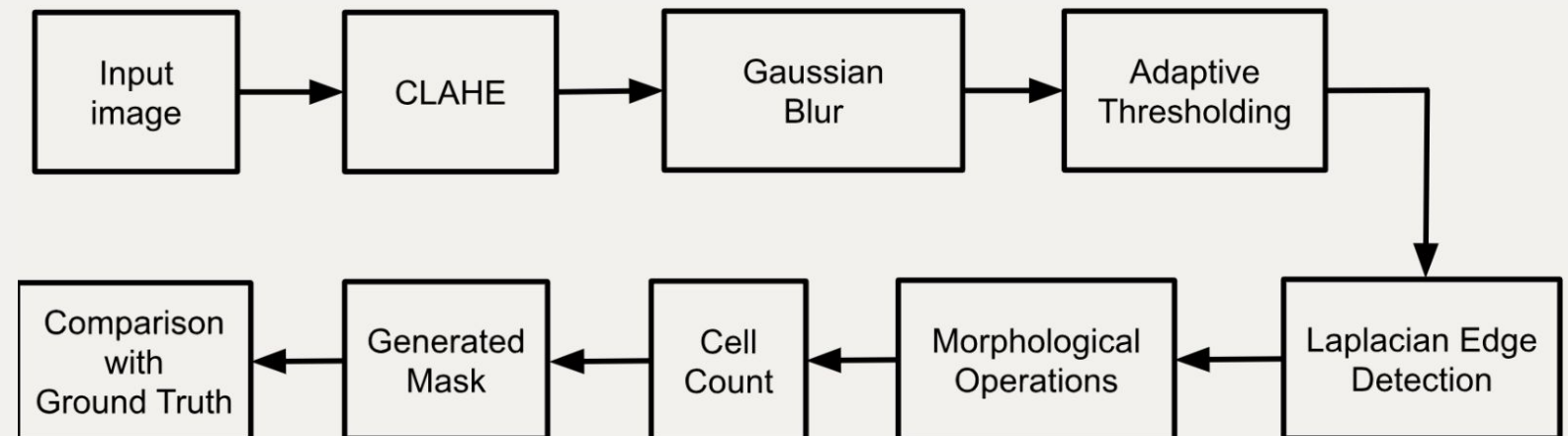
Updated Methodology

First Approach for Scattered/Distinct Cells
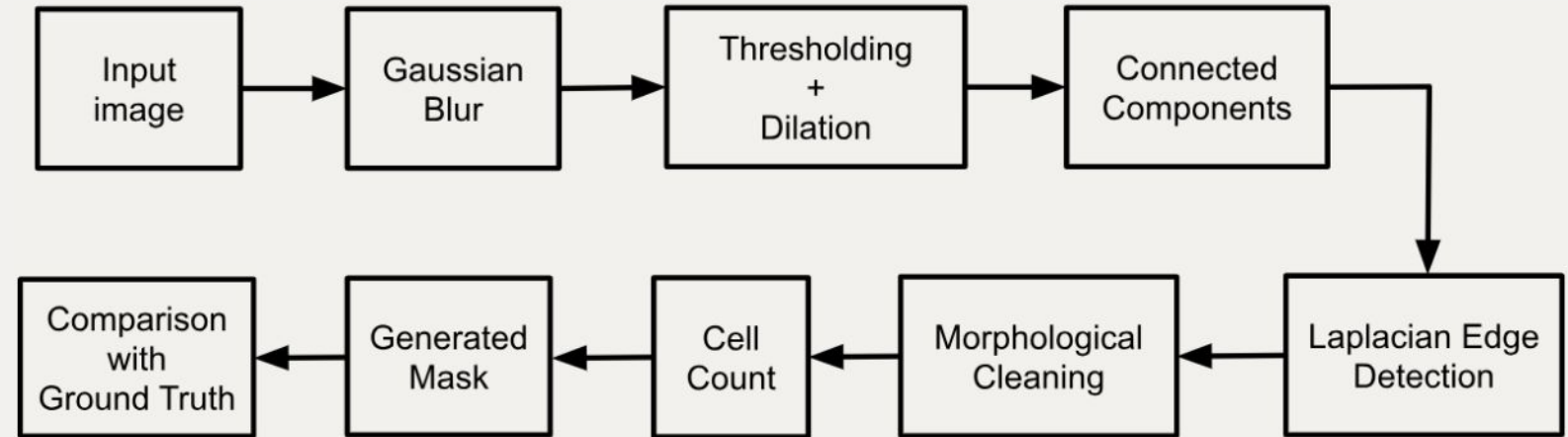
Second Approach for Overlapping cells

Results (Approach 1)
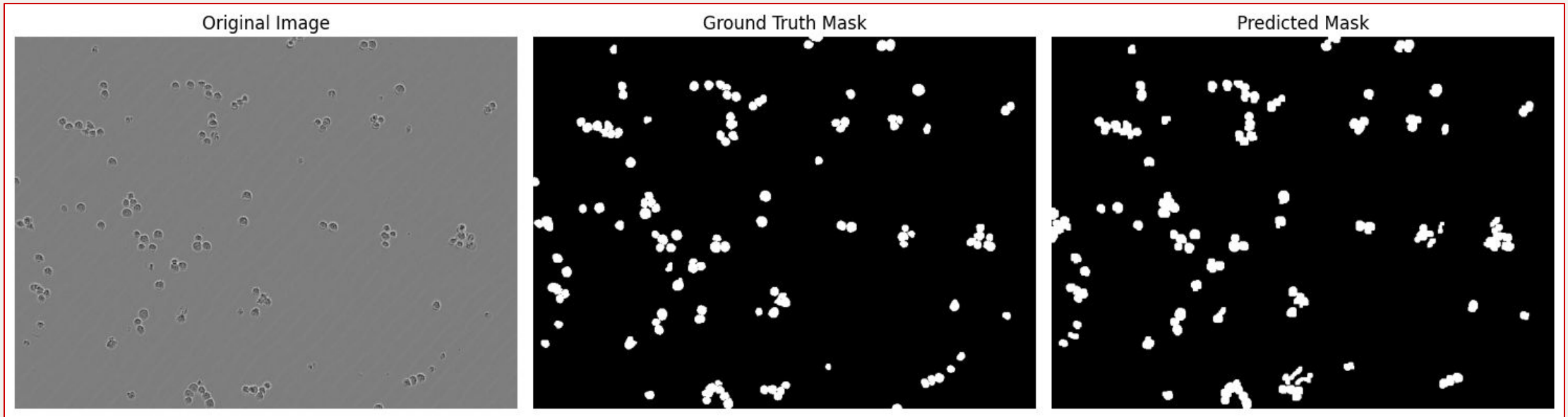
Accuracy	98.55 %
Precision	79.39 %
F1-score	84.31 %

Results (Approach 2)

| | Original Image | Ground Truth Mask | Predicted Mask |
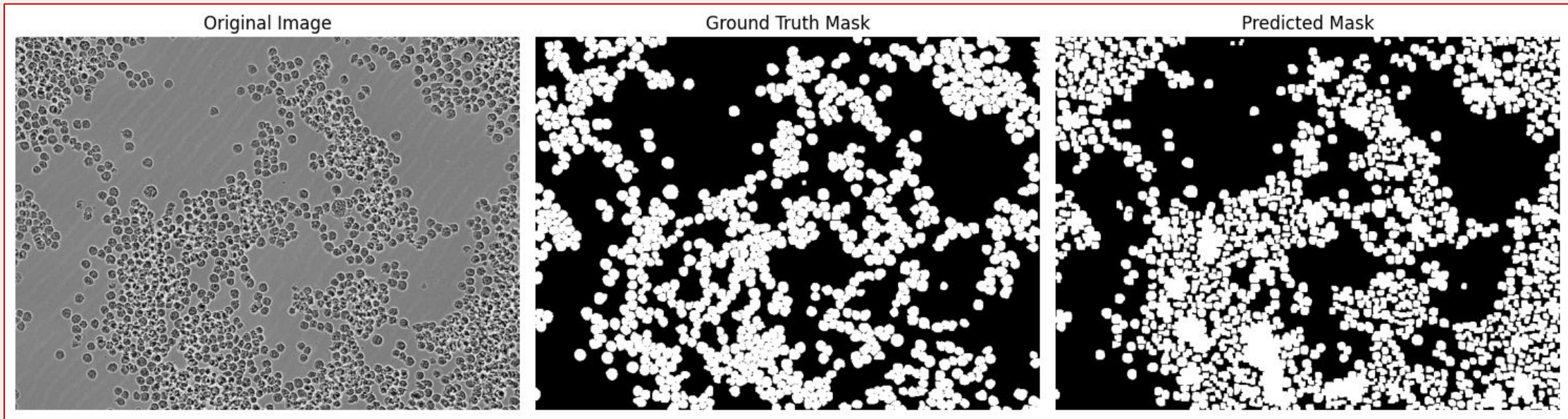
Accuracy	81.01 %
Precision	71.59 %
F1-score	75.07 %

Ahmedabad University

Results (Both Approach)

| | Original Image | Ground Truth Mask | Predicted Mask | Predicted Mask |
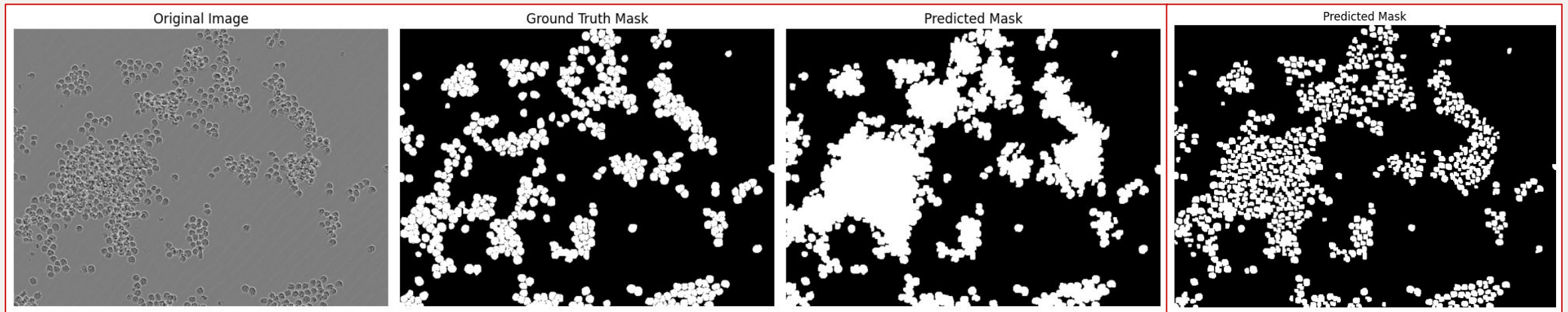
Accuracy	86.94 %	88.65 %
Precision	62.54 %	74.73 %
F1-score	75.49 %	72.27 %

Conclusion

- Worked on a classical pipeline for detection of LIVECell (BV-2) cells.

- Achieved high accuracy for distinct cells with thresholding and morphology.

- Enhanced overlapping-cell separation through CLAHE+Adaptive thresholding.

- Classical methods were efficient, lightweight, and interpretable.

- Detected several cells missed in ground truth, showing strong boundary sensitivity.

- Limitations still exist with respect to highly overlapping or irregular cells.

Ahmedabad
University

References

- Edlund, C., Jackson, T.R., Khalid, N. et al. LIVECell—A large-scale dataset for label-free live cell segmentation. Nat Methods 18, 1038–1045 (2021). https://doi.org/10.1038/s41592-021-01249-6

- Senthilkumaran, N., & Vaithegi, S. (2016). Image segmentation by using thresholding techniques for medical images. *Computer Science & Engineering: An International Journal*, 6(1), 1-13. https://d1wqtxts1xzle7.cloudfront.net/43439997/Image_segmentation_by_using_thresholding_techniques_for_medical_images

- Zhang, F., Wu, Y., Xu, M., Liu, S., Peng, C., & Gao, Z. (2021, October 26). *A morphological image segmentation algorithm for circular overlapping cells*. Tech Science Press. https://www.techscience.com/iasc/v32n1/45302/html

- Plaksyvyi , A., Paszkowska, M., & Powroźnik, P. (n.d.). (PDF) a comparative analysis of image segmentation using classical and deep learning approach. https://www.researchgate.net/publication/376127494_A_Comparative_Analysis_of_Image_Segmentation_Using_Classical_and_Deep_Learning_Approach

Ahmedabad University