

Conference Abstracts

Mitigating Diagnostic Disparities in Melanoma Screening: A Robust 3D Spatial-Spectral Deep Learning Framework for Resource-Limited Settings

Mohamed Nabil Agha, Bachelor of Science in Computer Science and Artificial Intelligence^{1a}

¹ Cairo University

Corresponding author

^a Mohamed Nabil Agha, Bachelor of Science in Computer Science and Artificial Intelligence, Cairo University, Email: mohamednabilagha@gmail.com

Keywords: Hyperspectral Imaging, 3D CNN, Diagnostic Disparity, Randomized SVD (RSVD)

<https://doi.org/10.53876/001aa.129649>

International Journal of Cancer Care and Delivery

Vol. 6, Issue Supplement 1, 2026

Background

Melanoma is the most fatal skin cancer, yet early diagnosis is severely hampered by **diagnostic health disparities**. In resource-constrained settings, reliance on subjective visual inspection and limited access to specialized pathology often leads to high rates of missed malignancies (False Negatives), contributing significantly to health inequities in cancer care. Hyperspectral Imaging (HSI) offers detailed biochemical data that can mitigate this subjectivity.

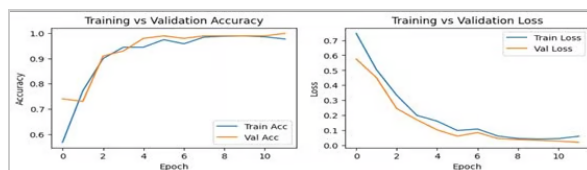
Methods

We developed an integrated deep learning framework for Melanoma (MEL) versus Nevus (NEV) differentiation using HSI data. The methodology involves a robust preprocessing pipeline, including data augmentation for sample size mitigation. The key innovation is the use of **Randomized Singular Value Decomposition (RSVD)** for efficient spectral feature extraction, feeding a customized **3D Convolutional Neural Network (3D CNN)** architecture to synchronously analyze the spatial-spectral data. The model was evaluated on a balanced test set (n=100: 50 MEL, 50 NEV) from the histology-verified Hyperspectral Dermoscopy dataset.

Results

The RSVD-3D CNN model demonstrated exceptional diagnostic performance on the test

set, achieving an overall **Test Accuracy of 99.00%**. Critically, the model achieved a perfect **1.00 Sensitivity (Recall)** for the Melanoma class, resulting in **zero False Negative** predictions. The training and validation loss curves converged stably at a low value (Val Loss \$approx 0.03\$), confirming model robustness and generalizability.



Class	Precision	Recall (Sensitivity)	F1-Score
NEV	1.00	0.98	0.99
MEL	0.98	1.00	0.99
Weighted Average	0.99	0.99	0.99

Table 1. Classification Performance Metrics (Test Set, n=100)

Conclusion

This deep learning framework sets a new benchmark for HSI-based melanoma diagnosis by achieving clinical-grade reliability. The ability to eliminate False Negatives directly addresses a critical **diagnostic disparity** in resource-limited settings. The model serves as an essential, non-invasive **Implementation Science tool** that can be deployed to provide objective triage, significantly improving health equity and

ensuring timely access to life-saving care for underserved populations.

Keywords

Melanoma; Hyperspectral Imaging; 3D CNN; Health Equity; Diagnostic Disparity; Implementation Science; Randomized SVD (RSVD)

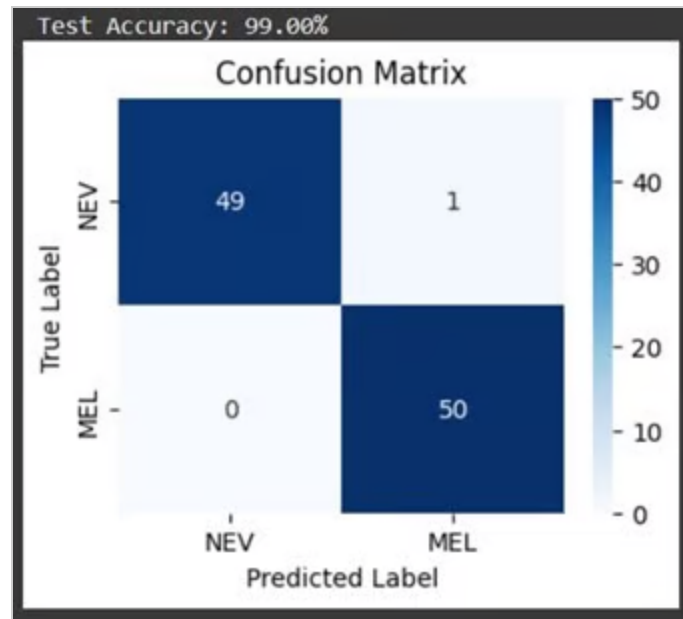


Figure 1. Confusion Matrix