Cross-modal explainable AI for melanoma diagnosis

Junwen Zheng[1], Xinran Xu[2], Xiuyi Fan[3], Chang Cai[3]

[1]College of Information and Intelligence Engineering, Zhejiang Wanli University, 315100, Ningbo, Zhejiang, China, [2]College of Computing and Data Science, Nanyang Technological University 639798, Singapore, Singapore, Singapore, [3]Lee Kong Chian School of Medicine, Nanyang Technological University, 639798, Singapore, Singapore, Singapore

Track: Research
Theme: Screening and Diagnosis

ABSTRACT

The opacity of current deep learning-based melanoma classification systems remains a critical barrier to clinical adoption, despite their diagnostic accuracy approaching expert levels. To address this trust gap, we propose an interpretable framework that integrates multimodal clinical reasoning with explainable artificial intelligence (XAI) techniques. Our approach introduces a dual-stage segmentation pipeline that combines UltraLight-VM-UNet pseudolabel generation with SAM2's boundary-aware segmentation. From these segmentations, we extract three clinically validated dermoscopic features—"Asymmetry," "Border," and "Color"—aligned with the "ABCDE" rule commonly used in melanoma diagnosis. A cross-modal contrastive learning architecture then fuses VIT-derived image embeddings with the extracted clinical features, enhancing interpretability by aligning visual patterns with established biomarkers. To further support clinician understanding, we incorporate a hybrid explanation system that leverages CLIP-mediated medical concept activation and large language models (LLMs) to generate interpretable diagnostic reports. Trained and evaluated on the ISIC 2018 and 2020 datasets, our cross-modal XAI framework achieves expert-level diagnostic accuracy (92.30%, AUC 0.9689) while significantly improving clinician trust through transparent decision pathways. Our results demonstrate that multimodal explainability can be effectively integrated into melanoma classification without compromising diagnostic rigor, outperforming traditional black-box AI systems.

Keywords: Melanoma classification, explainable AI (XAI), dual-stage segmentation, contrastive learning, clinician trust