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Abstract

Skin cancer continues to represent a major global healthcare concern due to its increasing incidence, diagnostic complexity, and high mortality associated with delayed detection of malignant lesions. Early and accurate diagnosis plays a vital role in improving patient survival rates and reducing clinical burden, creating a strong demand for intelligent and automated diagnostic systems capable of supporting dermatological analysis. Recent advancements in computer vision and deep learning have significantly transformed medical image analysis by enabling automated lesion detection, segmentation, feature extraction, and classification using dermoscopic images. This book chapter presents a comprehensive overview of skin cancer recognition using advanced computer vision and deep learning methodologies, with particular emphasis on dermoscopic image acquisition, preprocessing techniques, image standardization, lesion segmentation, hybrid feature extraction approaches, convolutional neural networks, transformer-based architectures, and hybrid CNN–Transformer frameworks for precise lesion analysis and multiclass skin cancer classification. The chapter also examines the role of explainable artificial intelligence techniques in improving interpretability, diagnostic transparency, and clinical trust within automated healthcare systems. Critical challenges including dataset imbalance, image variability, computational complexity, limited generalization capability, and ethical concerns associated with medical AI deployment receive detailed analysis to highlight existing research limitations and future opportunities. Emerging technologies such as federated learning, self-supervised learning, multimodal medical imaging, lightweight deep learning frameworks, and real-time mobile healthcare systems further demonstrate the evolving potential of intelligent dermatological applications. Integration of computer vision with advanced deep learning architectures provides substantial capability for achieving scalable, robust, and clinically reliable skin cancer recognition systems that support accurate medical decision-making and accessible healthcare delivery across diverse populations.

Keywords: Skin Cancer Recognition, Computer Vision, Deep Learning, Dermoscopic Image Analysis, Hybrid CNN–Transformer Models, Explainable Artificial Intelligence

Introduction

Skin cancer has become one of the most rapidly growing health concerns across the world due to increasing exposure to environmental pollutants, ultraviolet radiation, and changing lifestyle patterns. The disease originates through uncontrolled proliferation of abnormal skin cells caused by genetic mutations and long-term exposure to harmful ultraviolet rays emitted from sunlight and artificial tanning devices [1]. Rapid growth in the global incidence of melanoma and non-melanoma skin cancers has created substantial pressure on healthcare systems and dermatological services. Melanoma, regarded as the most aggressive form of skin cancer, contributes significantly toward cancer-related mortality because of its capability to metastasize into deeper tissues and distant organs during advanced stages [2]. Basal cell carcinoma and squamous cell carcinoma account for a major proportion of non-melanoma skin cancer cases and frequently affect sun-exposed body regions such as the face, neck, arms, and scalp. Delayed diagnosis often results in severe complications, higher treatment expenses, and reduced survival rates among affected patients [3]. Early identification of malignant lesions therefore remains a critical clinical requirement for effective treatment planning and improved patient outcomes. Traditional diagnostic procedures rely heavily on visual inspection, dermoscopic examination, and histopathological assessment performed by dermatologists possessing specialized clinical expertise [4]. Such procedures demand extensive experience and often involve subjective interpretation, creating inconsistencies in diagnosis and limitations in large-scale screening programs. Increasing patient volume and shortage of trained dermatologists across several healthcare regions have further intensified the necessity for intelligent automated diagnostic frameworks capable of supporting efficient skin lesion analysis and early cancer recognition [5].

Advancements in medical imaging technologies have significantly transformed dermatological diagnosis through the introduction of dermoscopic imaging systems capable of revealing subsurface lesion structures invisible to the naked eye. Dermoscopy provides magnified visualization of pigment networks, vascular structures, globules, streaks, and asymmetrical lesion characteristics associated with malignant transformation [6]. High-resolution dermoscopic images facilitate detailed clinical examination and support accurate differentiation between benign and malignant skin abnormalities. Large-scale dermoscopic image repositories such as ISIC, HAM10000, PH2, and Derm7pt have accelerated computational dermatology research by providing annotated datasets suitable for machine learning and deep learning applications [7]. Variations in image acquisition conditions, lighting environments, lesion morphology, skin pigmentation, and imaging equipment frequently introduce substantial challenges during automated analysis. Hair artifacts, low contrast regions, air bubbles, ruler markings, and uneven illumination conditions reduce lesion visibility and influence segmentation and classification performance [8]. Standardized image preprocessing techniques therefore play a crucial role in improving image quality and enhancing the reliability of computer vision-based diagnostic systems. Image normalization, artifact removal, color correction, contrast enhancement, and image resizing procedures contribute toward consistent lesion representation and stable feature extraction during deep learning model training [9]. Integration of advanced imaging techniques with artificial intelligence has consequently created new opportunities for accurate, rapid, and scalable skin cancer detection capable of supporting modern precision healthcare systems [10].