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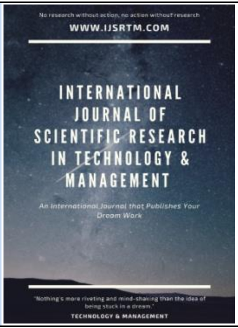

A Review on Automatic Skin Cancer Detection in the Field of Image Processing

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Abstract*— Skin cancer incidence is rising in several countries, particularly in India, making automatic skin cancer detection a critical and challenging task in medical image processing. Such detection systems typically involve two key steps: first, identifying skin anomalies, and second, classifying them as benign or malignant. Traditionally, skin cancer diagnosis has relied on invasive conventional techniques, although various commercial diagnostic tools and auxiliary methods are now available. This paper reviews the diverse approaches for skin cancer detection, encompassing stages like image preprocessing and classification. Preprocessing is essential for enhancing image quality by removing noise and irrelevant background elements. This comprehensive review critically examines existing literature in the field, highlighting recent advancements along with their respective advantages and limitations.

Keywords*— Automatic Skin Cancer Detection, Support Vector Machine, Convolutional Neural Network, Machine Learning, Image Processing, Melanoma.

I. INTRODUCTION

Skin cancer is a common form of cancer that arises from abnormal cell growth in the skin and can spread gradually. The three main types are basal cell carcinoma, squamous cell carcinoma, and melanoma. Skin cancer primarily develops on sun-exposed areas such as the scalp, face, ears, neck, chest, hands, and legs, but it can also rarely occur on the palms or under fingernails. It affects people of all skin tones, including those with darker skin, though the patterns may differ: in darker-skinned individuals, melanoma often appears on areas not typically exposed to the sun, such as the soles of the feet and palms, while squamous cell carcinoma can also develop on less sun-exposed areas. Basal cell carcinoma commonly occurs on the neck or face, and squamous cell carcinoma frequently appears on the face, ears, and hands. Melanoma may develop anywhere on the body, either on normal skin or from a pre-existing mole, often appearing on the face or torso in men and the lower legs in women, and can also occur on skin that has not been exposed to sunlight [1].

Fig. 1. Skin Cancer [1]

In recent times, skin cancer has been recognized as one of the most dangerous forms of cancer in humans, with types including melanoma, basal cell carcinoma, and squamous cell carcinoma, among which melanoma is the most unpredictable. Early detection of melanoma is crucial for effective treatment. Computer vision has proven valuable in medical image diagnosis, and this paper presents a computer-aided method for detecting melanoma using image processing techniques. The system takes a skin lesion image as input and applies novel image processing methods to assess the presence of skin cancer. The Lesion Image Analysis tool evaluates melanoma parameters such as asymmetry, border, color, and diameter (ABCD) by analyzing texture, shape, and size during image segmentation and feature extraction. The extracted features are then used to classify the image as either normal skin or a melanoma lesion. The paper also reviews various automatic skin cancer classification models, which differ in recognition accuracy and can classify lesions as benign or malignant.

Fig. 2. Types of Skin Cancer [2]

Of the three primary types of skin cancer—basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and melanoma—melanoma is the most dangerous, with significantly low survival rates. Early detection of melanoma can potentially improve survival outcomes. The detection process is generally divided into four key components: image preprocessing, which involves steps such as hair removal, noise reduction, enhancement, and resizing of the input skin image; and segmentation, which isolates the region of interest within the image for further analysis [3].

II. RELATED WORKS

Several studies have been conducted in the field of automatic skin cancer detection, and this paper aims to review these works and identify common challenges. Accurate recognition is critical, as correct classification and detection directly affect system performance. Nezhadian et al. [4] proposed a system using standard segmentation to extract cancer-affected skin areas, followed by classification with 2-D discrete wavelet transform, employing SVM and color-texture features for improved classification. However, the transformation model was relatively weak, sometimes sharpening the image in ways that reduced sensitivity to disease. The study focused on distinguishing between benign and malignant melanomas, emphasizing high-accuracy image segmentation. To enhance segmentation, an active contour model was used, with the initial region selected by the user. Texture-based features and RGB components were extracted, with TC features identified as the most efficient for wavelet transform approximations. Overall, studies on larger, more comprehensive databases are necessary to improve diagnostic performance and speed. Additionally, the general skin cancer detection process is broadly divided into four components: image preprocessing, which includes hair removal, noise reduction, enhancement, and resizing; segmentation to isolate the region of interest; feature extraction; and classification.

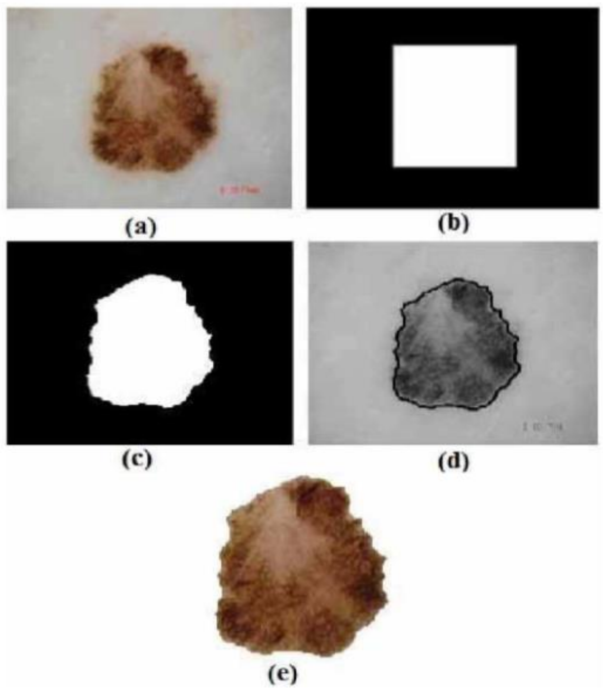

Fig. 3. Preprocessing steps for malignant lesion. original image (a), initial segmentation (b), active countor model segmentation (c), border of the sementation on gray scale image (d), colored ROI (e) [4]

Amulya P M et al. [5] proposed a melanoma detection system based on an SVM classifier, which relies on training samples and iterative machine learning processes. The detection process involves several stages, including preprocessing, segmentation, feature extraction, post-processing, and classification using advanced algorithms and software to achieve accurate results. Studies on ABCD rule–based classification highlight the importance of precise feature extraction for reliable classification. Among classifiers, SVM demonstrated higher accuracy compared to k-means clustering and decision tree classifiers, and overall, neural network–based techniques have shown superior performance. However, a key challenge is that achieving accurate identification often requires extensive training time, and optimizing robust algorithms can reduce computational time while maintaining detection accuracy.

Prachya Bumbrungkun proposed a system using a snake model, which reports skin cancer–related mortality in Thailand and processes input images by comparing them with template shapes such as curves, circles, rectangles, and ellipses. The snake model aids in extracting regions of interest while eliminating unwanted areas, but it is less effective for precise edge extraction from skin feature templates, which can impact recognition performance.

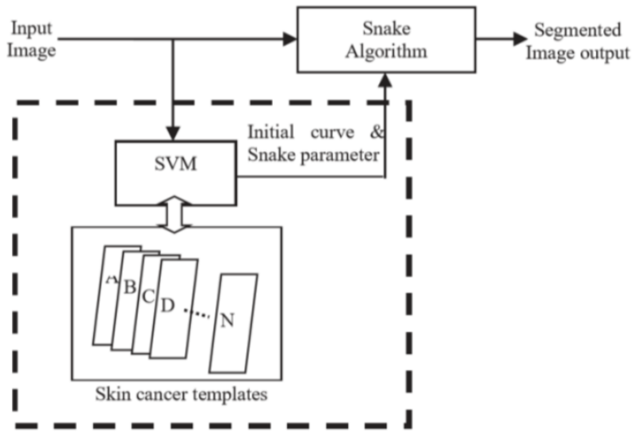

Fig. 4. System Process [6]

Soniya Mane et al. [7] proposed a skin cancer detection system based on preprocessing and classification techniques, utilizing threshold-based segmentation and an SVM classifier. Clustering, which groups similar data items together while maximizing dissimilarity between clusters, is also employed in the process. The system offers an efficient computer-aided diagnosis (CAD) approach to detect skin cancer, addressing the limitations of manual detection. Traditional methods, such as biopsy, are invasive, painful, and time-consuming, whereas CAD provides a non-invasive and faster alternative. In this system, the input skin image undergoes preprocessing, followed by segmentation to isolate the region of interest, feature extraction to derive relevant attributes, and classification of the lesion based on the extracted features.

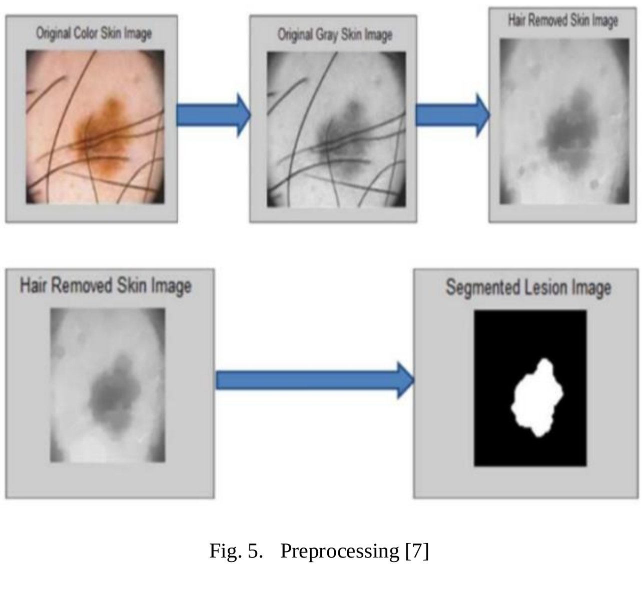

Fig. 5. Preprocessing [7]

The SVM classifier has been widely applied for melanoma detection, and it has been observed that the linear SVM function outperforms both the radial basis function and the Bayesnet classifier, providing the highest accuracy in distinguishing melanoma from benign lesions. This approach requires only a skin image, making the system non-invasive, eliminating the need for laboratory testing, and reducing both time and cost, as only a camera is needed for image acquisition [7]. Shalu et al. [8] proposed a system using Naïve Bayes, Decision Tree, and KNN classifiers for melanoma detection. Their method involves preprocessing and segmentation to enhance the image and extract the region of interest, followed by feature extraction from HSV and YCbCr color spaces. Among the tested classifiers, the Decision Tree achieved the best performance with an accuracy of 82.35%. The system exhibited higher specificity than sensitivity, indicating better identification of benign cases. To improve sensitivity, additional features such as border, shape, and texture characteristics compatible with HSV and YCbCr features can be incorporated.

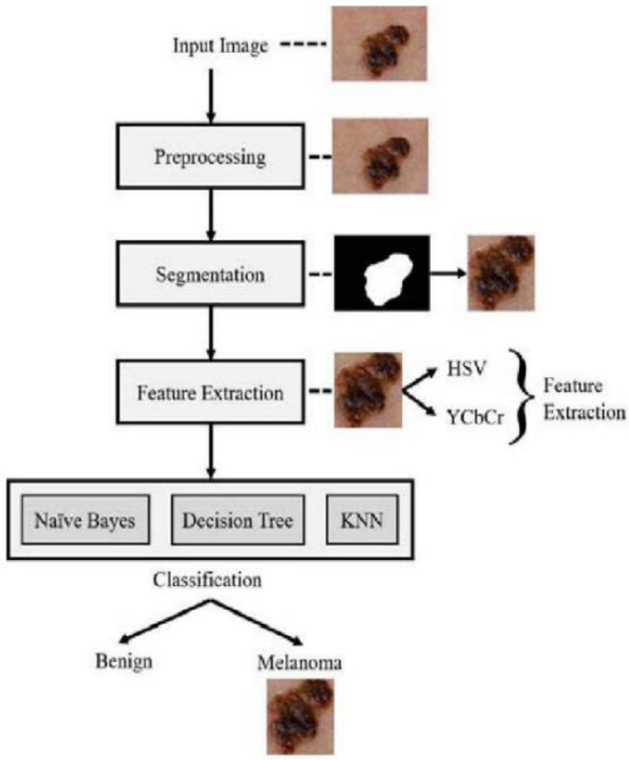

Fig. 6. Work Flow [8]

Noel B. Linsangan et al. [9] proposed a skin lesion analysis system based on the k-Nearest Neighbors (k-NN) classifier, implemented on a single-board computer using image processing techniques. The system analyzes geometric features of skin lesions to classify them as malignant, benign, or unknown. Performance tests were conducted to evaluate the system's accuracy; however, some images were not properly processed, often resulting in errors during feature extraction, which affected overall classification performance.

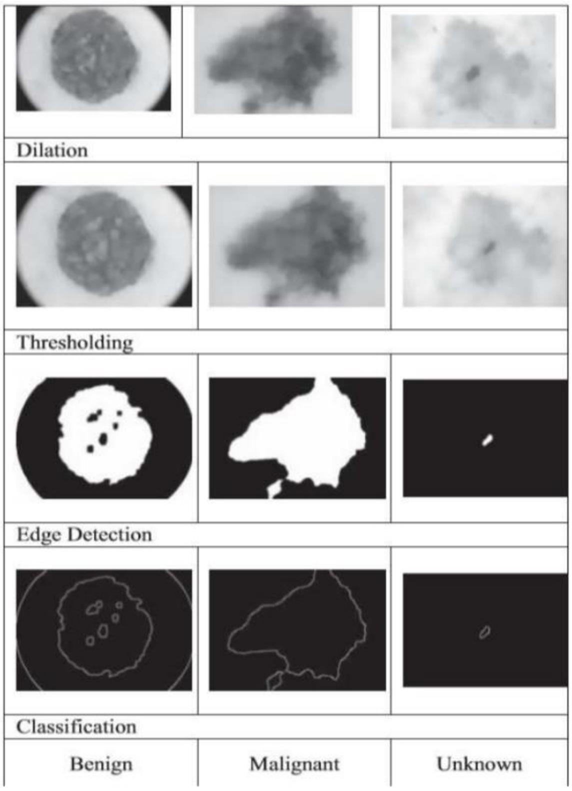

Fig. 7. Resulting Image [9]

Giulia Mansutti et al. [10] proposed a skin cancer detection system using substrate integrated waveguide (SIW) technology. The study presents a novel millimeter-wave probe designed to detect skin cancer, which was evaluated through full-wave numerical simulations in CST. The probe achieves a lateral resolution of 0.2 mm and a depth of 0.4 mm, making it suitable for identifying early-stage skin tumors. Leveraging SIW technology with microstrip feeds, the probe is cost-effective and easy to implement, offering potential as a practical diagnostic tool for skin cancer. Future work involves fabricating the probe and testing it on a skin phantom to validate the simulation results.

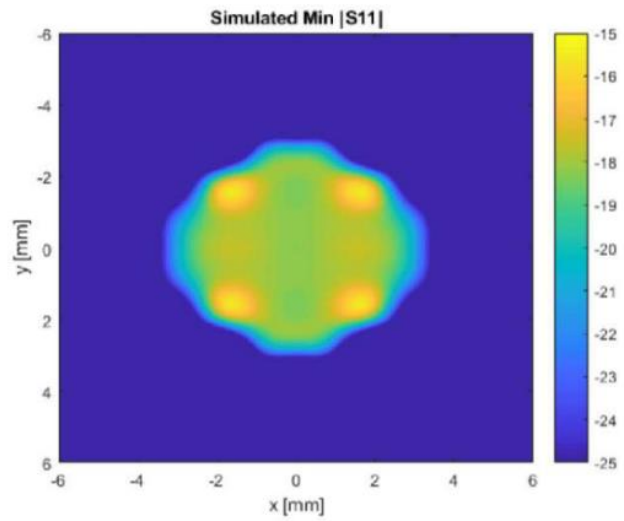

Fig. 8. Scan of an elliptical cancer target [10]

Md. Zahid Hasan et al. [11] proposed a skin disease classification system using an Artificial Neural Network (ANN) to identify cancerous regions from infected skin areas. The system employs machine learning to train on datasets containing various skin disease samples, erodes non-cancerous areas based on skin color, and highlights potential cancerous regions. However, supervised training limits the ANN's ability to handle irregular or undefined cancer cases, as prediction accuracy depends on the quality and variety of the samples. The system achieved an overall accuracy of 95%, which could be further improved. The study also examined the effects of dimensionality reduction using Rough Set theory within skin cancer decision support systems, comparing multiple classifiers including ANN, Support Vector Machine (SVM), and Random Forest (RF). Results demonstrated that the ANN performed effectively for three types of at-risk skin conditions—common nevus, atypical nevus, and melanoma—showing potential for improved decision support with limited datasets.

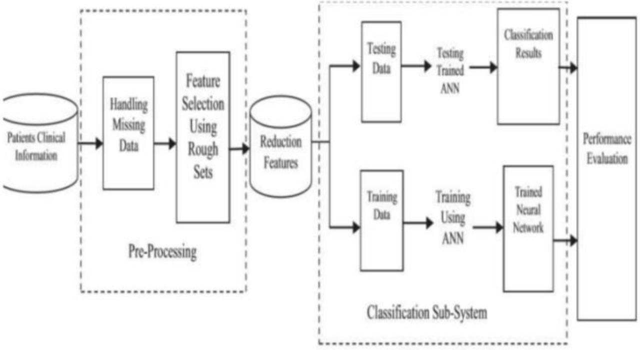

Fig. 9. Architecture [11]

III. Conclusion & Future Scope

This paper reviews several existing skin cancer detection systems, highlighting their limitations. Most current systems rely on machine learning methods trained on various datasets, but large datasets can consume significant memory and increase execution time, which is critical for timely and accurate diagnosis. The paper emphasizes melanoma detection using image processing tools, where computer-aided quantitative medical analysis supports efficient diagnosis. Feature extraction depends on the region of interest, making an appropriate segmentation algorithm essential to accurately identify melanoma pixels in the image. Preprocessing of dermoscopic images involves multiple stages, including hair and artifact removal using filters, grayscale conversion, noise reduction, and segmentation techniques such as thresholding, hybrid thresholding, multilevel thresholding, and automatic thresholding. Future systems could achieve higher accuracy with fewer false positives while reducing processing time, enhancing the overall efficiency of melanoma detection.

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