iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 Issue: V Month of publication: May 2023

DOI: https://doi.org/10.22214/ijraset.2023.53282

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Skin Cancer Detection using Image Processing

Prof.Rupali Jadhav[1], Rushiraj Kale[2], Shubham Kadam[3], Tushar Gund[4], Shreyas Jadhav[5]
[1, 2, 3, 4, 5]Student, Department of Computer Engineering, Savitribai Phule Pune University, Pune, Zeal College of Engineering, Pune, Maharashtra, India

***Abstract:** Early detection of melanoma, the most dangerous form of skin cancer, is crucial for effective treatment. Melanoma has a higher propensity to metastasize to other parts of the body if not identified and treated promptly. In recent years, non-invasive medical computer vision and medical image processing techniques have emerged as valuable tools in clinical diagnosis for various diseases, including melanoma. These techniques enable automatic image analysis, facilitating accurate and efficient evaluation of skin lesions. The study follows a systematic approach, involving the collection of a dermo image database and preprocessing steps such as segmentation using thresholding. Statistical feature extraction methods, including gray level co-occurrence matrix (GLCM), glam asymmetry, border analysis, color assessment, and diameter calculation, are utilized. Principal component analysis (PCA) is employed for feature selection to reduce dimensionality. A total dermo copy score is calculated, followed by classification using a convolutional neural network (CNN). The results indicate an impressive classification accuracy of 92.1%.*
***Keywords:** Dermatology, Image Processing, Machine learning.*

I. INTRODUCTION

The skin, as the outermost layer of our body, is constantly exposed to environmental elements such as dust, pollution, microorganisms, and UV radiation, which can contribute to various skin diseases. Genetic instability also plays a role, adding complexity to these conditions. The human skin consists of two major layers: the epidermis and dermis. The epidermis, the outer layer, is composed of squamous cells, basal cells, and melanocytes, responsible for skin color and protection against damage.

Diagnostic classifications for skin diseases often fail to adequately represent the diverse nature of these conditions, leading to challenges in accurate prediction and treatment. Among skin diseases, skin cancer, particularly melanoma, is considered the most deadly. Fair-skinned individuals are more susceptible, with malignant melanoma and non-melanoma being the common types. Early detection is crucial for effective treatment, as late-stage diagnosis complicates control and increases the risk of spread to other body parts.

Factors such as lack of awareness, ignorance, and inappropriate use of home remedies can worsen the severity of skin diseases. Dermoscopy, an examination technique to assess skin structure, aids in melanoma detection through careful observation of dermoscopy images. However, the accuracy of dermoscopy heavily relies on the expertise of dermatologists, with detection rates typically ranging from 75% to 85%. Incorporating computer-aided diagnosis systems can enhance the speed and accuracy by identifying subtle features like asymmetry, color variation, and texture, often missed by the human eye.

Automated dermoscopy image analysis involves pre-processing, segmentation, and feature extraction/selection. Segmentation, a crucial step, can be achieved through supervised methods considering parameters like shape, size, color, skin type, and texture. Such system-based analysis reduces diagnosis time and improves accuracy. Dermatological diseases present significant challenges due to their complexity, diversity, and limited expertise, particularly in resource-constrained settings. Early detection plays a vital role in mitigating severe outcomes, and environmental factors have contributed to the rising incidence of skin diseases.

In general, skin disease stages can be classified as follows:

1) Stage 1: Disease in situ with a survival rate of 99.9%.
2) Stage 2: High-risk disease level with a survival rate ranging from 45% to 79%.
3) Stage 3: Regional metastasis, indicating spread to nearby areas.

II. LITERATURE SURVEY

Sr no	Title Published date	Authors	Conclusion
1.	Skin Cancer Detection Using	Mahamudul Hasan	This paper presents a detailed systematic review of deep

	Convolutional Neural Network (IEEE 2017)		learning techniques for the early detection of skin cancer.
2.	Skin Cancer Detection: A Review Using Deep Learning Techniques (IEEE 2018)	Mehwish Dildar Shumaila Akram	This paper proposed an artificial skin cancer detection system using image processing and machine learning method. The features of the affected skin cells are extracted after the segmentation of the dermoscopic images using feature extraction technique.
3.	Convolutional Neural Network (CNN) for Automatic Skin Cancer Classification System. (IEEE 2019)	Yunendah Nur Fuadah ,NK Caecar Pratiwi	The proposed model consists of three hidden layers with an output channel of 16,32, and 64 for each layer respectively. The proposed model uses several optimizers such as SGD, RMSprop Adam,and Nadam with 1
4.	Melanoma skin cancer detection using deep learning and classical machine learning techniques: A hybrid approach	Jinen Daghrir Lotfi Tlig Moez Bouchouicha	A convolutional neural network and two classical machine learning classifiers trained with a set of features describing the borders, texture and the color of a skin lesion. These methods are then combined to improve their performances using majority voting. The experiments have shown that using the three methods together, gives the highest accuracy level. Index Terms—Melanoma detection, deep learning, classical machine learning, data fusion, majority voting
5.	An enhanced technique of skin cancer classification using deep convolutional neural network with transfer learning models	Md Shahin Ali a , Md Sipon Miah	In this paper, we propose a deep convolutional neural network (DCNN) model based on deep learning approach for the accurate classification between benign and malignant skin lesions.

III. TECHNOLOGY LIMITATIONS

1) Image quality: Accurate detection relies on high-quality images, but factors like lighting conditions, camera resolution, and patient positioning can affect image clarity and introduce noise. Poor image quality can impact the accuracy of detection algorithms.
2) Dataset limitations: Image processing algorithms depend on robust and diverse training datasets. If the dataset used for training is limited in size or lacks diversity in terms of skin types, ethnicities, or lesion variations, it may lead to biased or less accurate results when applied to different populations.
3) False positives and negatives: While image processing algorithms aim to identify suspicious lesions accurately, they are not foolproof. False positives (incorrectly identifying benign lesions as malignant) and false negatives (missing malignant lesions) can occur, leading to potential misdiagnosis or delayed treatment.
4) Superficial analysis: Image processing primarily analyzes surface features of the skin, such as asymmetry, border irregularities, color variations, and diameter measurements. However, melanoma can originate deeper within the skin layers, making it challenging to detect solely through surface analysis.
5) Variability of melanoma characteristics: Melanoma can exhibit various characteristics, such as different patterns, colors, and sizes. While image processing algorithms can be trained to recognize common patterns, they may struggle with atypical or rare presentations, potentially leading to misclassification.
6) Lack of real-time analysis: Some image processing techniques require capturing images and subsequently analyzing them offline. This delay can hinder real-time detection, especially in situations where immediate diagnosis and treatment decisions are crucial.
7) Expertise and interpretation: Image processing tools are designed to support medical professionals, but they do not replace human expertise. The accurate interpretation of results still heavily relies on the knowledge and experience of trained dermatologists or healthcare providers.
8) Integration with other diagnostic methods: Image processing should be seen as a complementary tool rather than a standalone solution. Integrating it with other diagnostic methods, such as dermoscopy, clinical examination, or biopsy, can improve overall accuracy and reduce the limitations associated with image processing alone.
9) Ethical considerations: The use of image processing technology raises ethical concerns, including privacy, data security, and potential biases in algorithmic decision-making. Safeguards should be in place to ensure patient confidentiality, informed consent, and fair and unbiased application of the technology.
10) While image processing has demonstrated potential in melanoma detection, it is essential to be aware of these limitations and use it as part of a comprehensive approach to diagnosis, involving clinical evaluation, expert judgment, and other diagnostic techniques.Resource and Computing Constraints: Analyzing large volumes of crime data can be computationally intensive and resource-demanding. Limited computational resources, such as processing power and storage, may impede the effectiveness and scalability of crime prediction and analysis projects.
11) Interpretability and Explainability: Some advanced machine learning algorithms used in crime prediction, such as deep learning models, often lack interpretability. Interpreting and explaining the factors that contribute to crime patterns can be challenging, limiting the understanding and acceptance of the generated predictions.

IV. PROPOSED SYSTEM

Proposed systems for melanoma skin cancer detection using image processing often incorporate advanced algorithms such as support vector machines (SVM), convolutional neural networks (CNN), and other types of neural networks. These systems leverage image processing techniques to enhance the analysis of skin lesion images. Image preprocessing methods, including noise reduction, image enhancement, and normalization, are employed to improve image quality and facilitate accurate feature extraction. Feature extraction algorithms identify relevant characteristics of skin lesions, such as asymmetry, border irregularities, color variations, and texture patterns. SVM algorithms can classify lesions based on these extracted features, distinguishing between benign and malignant cases.

CNN, a deep learning technique, is widely utilized due to its ability to automatically learn and extract complex features from images. CNN models are trained using large datasets of skin lesion images, allowing them to accurately classify melanoma cases. The combination of image processing techniques with SVM, CNN, and neural networks provides a powerful framework for melanoma detection, offering improved accuracy and potential for real-time analysis. These proposed systems contribute to enhancing early detection, aiding dermatologists, and potentially reducing unnecessary invasive procedures.

V. METHODOLOGY

A. Phase 1: Pre-processing

Phase 1 involves the pre-processing of images to enhance the accuracy of subsequent analysis. Several techniques are employed to remove unwanted parameters, such as hair, glare, and shading. Hair removal techniques can involve the use of algorithms that identify and eliminate hair strands present in the image. Glare removal techniques help mitigate the impact of reflections or excessive brightness in the image. Shading removal techniques aim to compensate for variations in lighting across the image. By removing these parameters, the subsequent analysis can focus more effectively on identifying important characteristics such as texture, color, size, and shape.

B. Phase 2: Segmentation and Feature Extraction

In Phase 2, the image is segmented to isolate the regions of interest, namely the skin lesions. Three segmentation methods are explored: Otsu segmentation, modified Otsu segmentation, and watershed segmentation. Otsu segmentation is a thresholding technique that separates the image into foreground (lesion) and background regions based on the pixel intensity. Modified Otsu segmentation is an improved version of the Otsu method, accounting for variations in lighting conditions and lesion characteristics. Watershed segmentation is a region-based approach that uses morphological operations to segment the image into distinct regions.

Following segmentation, feature extraction is performed to capture relevant information from the segmented regions. Features such as color, shape, size, and texture are extracted. Color features can include hue, saturation, and intensity values. Shape features can encompass parameters like symmetry, irregularity, or contour descriptors. Size features can involve measurements such as area or diameter. Texture features can be obtained through techniques such as gray-level co-occurrence matrices (GLCM) or local binary patterns (LBP). These extracted features provide crucial information for subsequent classification.

C. Phase 3: Model Design and Training

Phase 3 is the most significant phase of the model and involves the design and training of a classification model. Various algorithms are employed, including backpropagation neural networks, support vector machines (SVM), and convolutional neural networks (CNN).The model is trained on the dataset collected in Phase 1, which likely consists of labeled skin lesion images. During the training process, the model learns to recognize patterns and make accurate predictions based on the extracted features. Backpropagation neural networks use an iterative process to adjust the weights and biases of the network to minimize the prediction error. SVM is a supervised learning algorithm that separates classes by defining an optimal hyperplane in a high-dimensional feature space. CNN, a deep learning technique, is particularly effective in image analysis tasks as it automatically learns hierarchical features through multiple layers of convolutional and pooling operations. After training, the model is evaluated using a separate testing dataset to assess its accuracy and performance. This evaluation ensures that the model can provide reliable and accurate outputs when applied to new, unseen images. By following this methodology, the proposed model aims to enhance melanoma detection by effectively pre-processing images, segmenting skin lesions, extracting relevant features, and training a robust classification model capable of accurate predictions.

VI. APPLICATIONS

Clinical Diagnosis Support: Image processing techniques can serve as valuable tools to assist dermatologists and healthcare providers in the diagnosis of melanoma. By analyzing skin lesion images, the system can provide additional information and insights that aid in the decision-making process, potentially leading to more accurate and timely diagnoses.

1) *Screening Programs:* Image processing-based systems can be employed in screening programs for melanoma detection. These programs can be particularly useful in areas where access to dermatologists or specialized healthcare services is limited. The automated analysis of images can help identify potential cases for further evaluation and reduce the burden on healthcare resources.
2) *Telemedicine and Remote Diagnosis:* With the rise of telemedicine and remote healthcare services, image processing technology can facilitate remote diagnosis of melanoma. Patients can capture images of their skin lesions using smartphones or other devices and transmit them to healthcare professionals for evaluation. The system can analyze the images remotely and provide insights, allowing for early detection and prompt medical advice.
3) *Education and Training: Image* processing-based systems can be utilized in educational settings to train medical students, dermatologists, and other healthcare professionals in the recognition and diagnosis of melanoma. The systems can provide interactive learning experiences and real-world case studies, enhancing the understanding and expertise of medical practitioners in this field.

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4) *Research and Data Analysis:* The use of image processing techniques in melanoma detection allows for the collection and analysis of large datasets. Researchers can utilize these datasets to study patterns, trends, and characteristics of melanoma cases. This can contribute to advancing the understanding of melanoma and improving the development of detection and treatment strategies.characteristics. SVMs can be used to analyze patterns in criminal behavior and predict the characteristics of the suspect, such as their age, gender, and occupation.

VII. CONCLUSION

The application of image processing technology for melanoma skin cancer detection holds great promise in improving early diagnosis and treatment outcomes. Through the utilization of various techniques, such as preprocessing, segmentation, feature extraction, and classification models, image processing systems can assist healthcare professionals in identifying suspicious skin lesions and distinguishing between benign and malignant cases. These systems have the potential to enhance clinical diagnosis support, aid in screening programs, enable telemedicine and remote diagnosis, support medical education and research, and contribute to public health initiatives. While there are limitations to be considered, such as image quality, dataset biases, and the need for complementary diagnostic methods, the integration of image processing technology with medical expertise has the potential to significantly improve melanoma detection, leading to earlier interventions, better patient outcomes, and increased public awareness. Continued advancements in this field have the potential to revolutionize melanoma detection and contribute to the fight against skin cancer.