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Skin Disease Detection using Machine Learning Techniques

Arjun Singh[1], Madhav Prasad[2], Sachin Singh[3], Piyush Rastogi[4], Bala Shiwangi[5] and Ranjeet Yadav[6]
[1,6]Greater Noida Institute of technology/Computer Science & Engineering, Greater Noida, India
Email: innovativearjunsingh@gmail.com, ranjeetme48@gmail.com
[2]IEC College of Engineering & Technology/Computer Science & Engineering, Greater Noida, India
Email: madhavpnamdev@gmail.com
[3]Moradabad Institute of Technology/Computer Science & Engineering, Moradabad, India
Email: Singh.sachin1986@gmail.com
[4]Moradabad Institute of Technology/Department of CSE-AIML, Moradabad, India
Email: Piyushrastogi786@gmail.com
[5]Galgotias University/Department of IT-SOB, Greater Noida, India
Email: Bala.shiwangi@galgotiasuniversity.edu.in

***Abstract*— Skin diseases are growing rapidly in the worldwide, and their proper diagnosis with accuracy is needed for effective treatment. As seen in the previous years the results of treatments related to skin diseases are not up to the mark as needed due to various reasons like manual examinations of skin lesions, techniques used are more time consuming and these treatments are hindered due to human errors also. After seeing these complications, new technologies are developed as boon to skin treatments. These machine learning techniques consists of preprocessing operations like removing noise, standardizing the input, improving quality of image data for better classification. The hybrid approach has many benefits in the development of classical image analysis and deep learning to enhance classification, accuracy, robustness and interpretability. The results on various datasets available publicly like as HAM10000 and ISIC illustrate that the model designed has a higher diagnostic performance as compared to previous traditional methods, this automated classification of skin diseases has more potential as per analysis.**

***Keywords*— Skin disease classification, Deep learning, Hybrid machine learning, Image processing, CNN, SVM, Random Forest.**

I. INTRODUCTION

Nowadays skin disease is common problem facing by a large amount of people over the world. It has adverse effects for all age groups people and different skin type. Due to these problems early detection and diagnosis of skin disease is necessarily required for correct treatment. The effective treatment to people suffering from various types of skin diseases is provided with the help of this hybrid machine learning model. Some of the skin disease like melanoma [3], is dangerous for anyone's life if not identified and cured within time. Traditional methods used in past years uses visual inspection and biopsy reports for the classification and identification of skin lesions, but this process is not proper because it consists of human error and manual classification method due to similar types of skin lesions.

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Hence, it is found that at some point traditional methods are not providing proper treatments, not able to perfectly identify, classify and treat different skin lesions. As compared to new techniques it also takes more time in proper diagnosis. Various new possibilities have opened for automated skin disease diagnosis. The development of image processing methods has done wonders in advancements, segmentation, and feature extraction of magnified, illuminated skin lesions that's subsurface structure cannot be seen by naked eyes. It also allows reduction of noise and artefacts [5,8]. The use of machine learning techniques in classification of skin diseases has led to proper treatment within time and made these treatments easily accessible without human interventions. In recent times, computer aided diagnostic (CAD) systems are more popular and has gained more attention in medical sector like dermatology.

Various systems are developed for the purpose of digital image processing and artificial intelligence to help in detecting, classifying different skin lesions [1]. Decision Tree are widely utilised for identification process and classification process of image features into different categories of skin problems [5]. As compared to traditional methods, these techniques lead to provide fast, interpretable, and reliable results when trained properly with extracted features [18].Various steps that are being followed in hybrid machine learning techniques for better classification of skin disease are:

Prevalence of skin diseases: Most common health issue worldwide, leading millions of people affected regardless of age or gender.

Requires Early and Accurate Diagnosis: Detection of disease within time plays a important role for effective and successful treatment preventing severe complications. Manual diagnosis takes more period of time then automated [2,17].

Image processing in medical diagnosis: Thermoscopic images are enhanced by image processing techniques like reduction of noise, contrast adjustment and segmentation.

ML for classification: SVM, RF, have been majorly used for skin disease classification.

Limitations of Traditional and deep learning methods: These methods are mostly depended on humans, which may not able to provide accurate classification of complex image patterns [7].

Need for Hybrid approach: As it combines the merits of both traditional image processing and modern techniques.

In summary, the development of an efficient, accurate, and productive hybrid classification model in which combination of traditional and modern practices is used for better image processing with help of machine learning techniques [19]. The overall aim is skin disease diagnosis and for advancement in medical sector.

II. Literature Review

A. Analysis of Existing Research

In past times, numerous studies and research has been conducted to enhance the traditional techniques and to develop enhanced, automated systems for betterment in detection and classification of different skin problems and diseases. The major focuses are on subjects like image processing, feature extraction and identification of various skin problems with the use of cutting-edge techniques in machine learning and deep learning algorithms [4,7].

B. Traditional Approaches in image processing and ML

Previously the classification of images is done manually and are mainly relied on classical methods of processing techniques. Various methods like edge detection, morphological operations, thresholding, and region-based segmentation were used to isolate lesions from surrounding skin. Different algorithms Decision Trees were used for the classification of diseases based on handcrafted features like color, structure, and shape [14].

C. Approaches based on Deep Learning

Deep learning models, such as CNNs, are majorly popular for image analysis in medical science. This CNNs automatically extract hierarchical features from raw images, without manual design, which leads to improvement in results accuracy within less time. The CNN models are trained with different datasets for acquiring remarkable accuracy in differentiating between skin lesions such as benign and malignant. CNN based models needs large annotated datasets and significant computational resources.

D. Hybrid Techniques

Integration of image processing in hybrid techniques, to overcome the limitations of previous methods and models. It consists od strengths of both approaches which makes this model better in diagnostic performance

with manual feature interpretability and deep feature representation. One of the best examples of hybrid combination can be found when texture and color features are integrated with deep features from pretrained CNN models like ResNet as shown in Table 1. This results in improving accuracy of classification and reduces time [16]. The following table shows various processes required for hybrid machine learning technique:

TABLE I. HYBRID MACHINE LEARNING TECHNIQUES

Research Theme	Techniques used	Major Contribution	Limitations
Image Preprocessing	Noise removal, segmentation	Better lesion visibility and extraction of accurate RQI	Variation in skin tone
Feature Extraction	Texture(GLCM,LBP), color, shape	Identify different visual properties of lesions	Handcrafted feature may fails to capture complex visual variations
Deep Learning models	CNN, ResNet	Automated feature learning and higher accuracy	Require large dataset and high computational cost
Hybrid Techniques	CNN+SVM+RF, Feature fusion	Improved accuracy and interpretability	Increased risk of overfitting remains
Classification algorithms	SVM, Random forest	Provided robust classification for fused feature	Performance depend on feature quality

Fig 1. Atopic Dermatitis

Fig 2. Melanoma

E. Insights from Literature Review

- Hybrid models are integration of classical image processing with modern deep learning techniques for better results in treatment.
- Feature fusion has importance in the betterment of accuracy and time.
- Segmentation quality is impactful to performance of classification.
- Recently a shift toward transfer learning and transformer-based hybrids for better generalisation.
- The goal of presented method is to enhance both accuracy and interpretability.

III. PROPOSED MODEL

The proposed model presents a hybrid skin disease classification framework which consists of various combination of image processing, feature extraction, deep learning methods, and machine learning techniques for better result with accuracy and reliable diagnosis of various skin lesions.

A. Architecture of Proposed Model

- Image gain: Input thermoscopic images are collected from various sources like public datasets such as ISIC. Variation in images can be shown in terms of quality, size and illumination of images [19,20].
- Preprocessing: For improving the quality of images and to prepare it for further feature extraction various algorithms like morphological filtering is used for hair removal, for reduction of noise Gaussian or median filter can be used. Similarly contrast enhancement and image resizing is done.
- Lesion segmentation: In this process, various methodologies like thresholding or U-Net based segmentation are done for focusing only on affected skin area and removing the background noise.
- Feature Extraction: In this hybrid model two types of features are extracted.
  - Handcrafted features: In this feature extraction the basic visual patterns are recognised such as texture, color, and shape feature.
  - Deep feature: It is extracted from a pretrained CNN model for example ResNet50, EfficientNet. The convolutional layers are present for proving edges, patterns and texture representations.

- Feature Fusion: It provides best results and balances performance and interpretability.In summary, the proposed model is combination of various steps like feature fusion, and classification. Each stage is developed to reduce noise, capture discriminative patterns and improve overall performance of the system. This model is very helpful in medical sector for skin diseases classification and effective treatment.

IV. Result and Discussion

The proposed hybrid skin disease classification model has been evaluated using dermoscopic image datasets and the performance of the system has been checked through various parameters [20].

A. Overall Performance

After the combination of both traditional methods and deep learning techniques, the development of hybrid model has been done. Consisting of strengths of both models, hybrid system has demonstrated as better performance compared to individual methods. Overall system accuracy has been improved and advancement in skin disease classification has been seen as shown in figure 4. The system can achieve high precision for most classes, improved sensitivity toward malignant classes, and a balanced F1 score across all categories. The hybrid system is capable of differentiating between different skin disease categories.

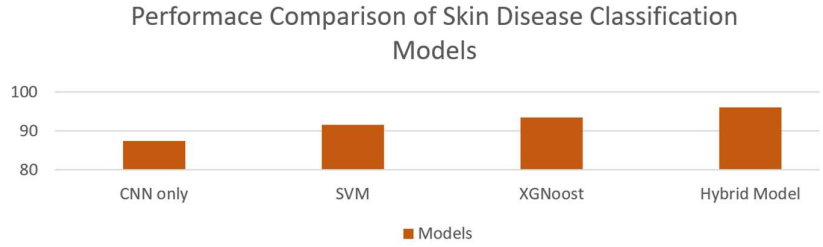

Figure 3. A bar chart for the performance comparison of skin disease classification models

B. Benefits of Feature Fusion

There are various advantages of feature fusion as Handcrafted feature captured color, texture, and shape patterns in all different types of skin lesions. Deep CNN features are encoded with high level semantic patterns. And when both are combined the model produced higher and more discriminative results, leading to better classification with higher accuracy and increased performances [3,12]. Here is a Table 2 is shown for the comparisons of different skin disease classification over the years.

Table II: Comparison Between Various Models and its Accuracy within the Years

Year	Technique/Model used	Key methods	Accuracy/Findings
2017	Deep CNN	ML algorithms for skin lesions classification	Dermatologist level accuracy(~91%)
2018	CNN with transfer learning	Multiclass skin lesion classification using pretrained CNN	Overall accuracy 86.9%
2020	GLCM +CNN hybrid	Texture and deep feature fusion for classification	90.3% accuracy achieved
2022	CNN + LBP hybrid model	Combined local binary pattern with deep CNN outputs	90.5% classification accuracy
2023	Hybrid CNN+ SVM+ Image processing	Fusion of handcrafted and deep features	94.2% accuracy effective for multiclass skin lesion classification

V. Conclusion

The presented hybrid skin disease classification model successfully combines various processes such as image preprocessing, lesion segmentation, handcrafted an deep CNN feature extraction, and machine learning based classification into a single framework. This model has the fusion of both feature extraction process(handcrafted and deep features) which makes this model to capture both low and high level characteristics of skin lesions that leads to more reliability than standalone CNN or machine learning techniques[11].Overall, it can be concluded that the results obtained from Hybrid methods are more enhanced, improved for better treatment results, making the system more accurate. This hybrid model will increase diagnostic performances and can severe as an effective tool for computer aided skin disease detection.

FUTURE SCOPE

The presented model can consists of more opportunities in future for more advancement.

- Diverse and larger dataset: By the use of more extensive and wide range of data from various age groups, different skin tones and regions this model can be more improvised and specifically trained for best results in less time.
- Advanced segmentation methods can be used such as Mask R-CNN which can help extract lesions more accurately.
- It can be used by the integration with Electronic medical records for improve personalized predictions.
- 3D skin imaging and multimodal data: After the integration of dermoscopic images with thermal imaging, patient meta data may be easily daigonsed with higher rate of accuracy and speed.[16].

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