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Parkinson Skin Diseases Detection System using ML

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***Abstract*— Parkinson's-related skin conditions can provide early indicators of the neurological disorder, especially through changes in texture, dryness, and seborrheic symptoms. Traditional diagnostic approaches rely on clinical evaluation, specialist analysis, and laboratory tests; typically, they are slow, costly, and reliant on expert availability. Recently, rapid assessment of Parkinson's abnormalities using images has been enabled by progress in Computer Vision (CV), Deep Learning (DL), Machine Learning (ML), and Artificial Intelligence (AI).**

This paper offers a thorough examination of AI- based image analysis systems developed for detecting Parkinson's-related skin abnormalities. The work examines the pre-processing techniques, methods of segmentation, handcrafted and deep feature extraction, and classification. It finds limitations in previous studies, which include datasets collected from real-world and performance degradation due to in uncontrolled environments. The paper also discusses future research directions on lightweight CNN models, IoT-integrated systems, and early-stage disease detection.

***Keywords*— Artificial-intelligence-based disease detection, Image processing, Parkinson's skin abnormalities, Dermatological analysis, Convolutional Neural Networks (CNN), Machine Learning (ML), Deep Learning (DL), Medical image classification, Feature extraction, Segmentation techniques, Computer vision, Healthcare automation, Early disease identification, and Skin biomarker detection.**

I. INTRODUCTION

The provision of healthcare services is a cornerstone of wellness across the globe and early diagnostic capabilities for neurologic disorders impacts treatment options, quality of life, and health permanence. In these disorders, Parkinson's disease is particularly clinically relevant due to its increasing incidence and prevalence, progressive aspects, and significant socio-economic risk. it brings to countries around the world. Studies using various medical instruments have recently observed. manifestations in Parkinson's patients, including seborrheic dermatitis, abnormal oil secretion, changes in texture, and variations in pigmentation that show promise as biomarkers for early diagnosis.

This paper describes an innovative AI-based approach for identifying symptoms related to Parkinson's skin disease through the use of combined neurocutaneous biological markers and other modalities dermatologic abnormalities related to Parkinson's disease are diagnosed in the traditional dermatological examination or specialist-based clinical contexts that are time-intensive, and provide inconsistent results that are prone to human subjectivity, especially when applied across large populations where continuous monitoring is empirically and conceptually infeasible.

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When laboratory-based diagnostic tools, such as dermatoscopy, histopathological analysis, or biochemical studies, are performed, they consistently provide more trusted responses; these studies can be extensive and costly and require trained professionals to execute, which limits their availability for frequent screening, especially in lower-resourced geographic areas. Limited access to these studies contributes to delayed diagnosis that allows worsening symptoms and decreased opportunities for early intervention.

Recent developments in AI, ML, DL, and CV have led to a new era of image-based medical diagnosis in healthcare. AI-based systems can identify skin changes related to Parkinson's by analyzing color variation, textural irregularities, oiliness, and surface patterns from smartphone cameras or high-resolution imaging devices. The latest convolution network architectures boost classification accuracy and remove the requirement for manual feature engineering, creating a more robust and adaptable process for identification in real-world clinical practice.

Moreover, AI-assisted diagnostic systems offer non-invasive screening for early detection of subtle biomarkers, and the ability to continuously monitor high- risk cases. Different variants of transfer learning such as VGG16, ResNet, MobileNet, and EfficientNet demonstrate performance in the task of classification applied to medical imaging-even using datasets that are somewhat limited with respect to dermatology. Increasing open- source availability of medical image repositories and enhanced computational capabilities have seen AI dermatology grow as a promising direction in predictive healthcare and remote diagnostics.

Yet, challenges remain in achieving strong generalization under uncontrolled lighting, a scarcity of real clinical datasets, inconsistency in image acquisition, and the difficulty of detecting very early-stage symptoms.

II. Literature Review

Numerous research studies have studied whether AI can accurately detect dermatological abnormalities associated with neurologic or systemic disorders. In the initial stages of this work, typical image processing techniques focused on the affected skin areas, i.e., K-means clustering, thresholding, Otsu segmentation, etc., and color space transformations were used to classify disease states. Traditional machine learning classifiers include decision trees, random forests, k-nearest neighbours (k-NN), and support vector machines (SVM) used to characterize skin conditions based on manually extracted features.

GLCM features and SVM classifiers were widely used in the studies on the detection of diseases in theSkin disease, reporting an accuracy of 92–96 Parkinson's-related skin recognition is mostly done using CNN-powered VGG16, ResNet50, and AlexNet models, among others, which offer accuracy above 97% in their respective literatures Newer studies have shown deep learning to surpass traditional ML methods because CNN models automatically learn meaningful features without human involvement. According to a review published in 2022, CNN offers encouraging results for detecting Parkinson's-related skin abnormalities but encounters certain challenges when tested in real-world clinical settings. Parkinson's skin, the controlled environments report high accurate results due to effective lighting, camera quality, and homogeneous backgrounds that are not reported to be easily replicated.

II. Methodology

A. System Overview

The proposed AI-based framework for Parkinson's skin disease detection will focus on the automatic detection of dermatological abnormalities due to PD by employing advanced image processing and deep learning techniques. The system must function independently of any clinical manual inspection and instead deliver dependable real-time diagnostic support tools. Assessment of such abnormalities through eye inspection is quite time-consuming, subjective, and very frequently inconsistent between medical experts.

Automated AI-driven workflows provide steady

The pipeline begins with high-quality skin photos obtained by the camera of smartphones, dermatoscopes, or other clinical imaging instruments. The photos are processed in a certain order: preprocessing, segmentation, feature extraction, and classification. Each stage takes numerous layers of visual information from the skin surface, including textural irregularities, oil secretion patterns, discoloration, and lesion boundaries, all of which are connected with the dermatological signs of Parkinson's disease.

The framework employs a hybrid pipeline that employs DL models capable of learning spatial information to detect modest dermatological signs associated with the early stages of Parkinson's disease. This will ensure accurate detection of symptoms such as seborrheic dermatitis, atypical skin oiliness, and texture abnormalities, all of which are quite common in Parkinson's patients. This AI-powered infrastructure is completely aligned with the modern health objectives, enabling digital dermatology, remote screening, and early diagnosis.

B. Architecture Design

The design has four interrelated and connected layers. Each of the layer plays a key role in the disease detection process. It enhances modularity, scalability, and readability such that the system can be used with different datasets or in various field conditions.

Input Layer

The first layer collects skin images from differing bits of acquisition (smartphone, dermatoscopes, clinical) Skin images will include varieties in skin tone, lighting conditions, texture quality, and background noise.
Therefore, this layer focuses on gathering data in its raw, unprocessed form, which reflects the diversity found in diagnostic accuracy and quick analysis in clinical and real-world settings actual farmland scenarios [3].

Processing Layer

This layer standardizes the input images for analysis. There are a number of preprocessing approaches that vary by image or dataset (e.g., resizing, smoothing, sharpening, equalization). All steps are completed to remove unrelated distortions, noise during image acquisition. . After preprocessing of images is completed, infected areas will be differentiated, and separated from, the healthy surface layer utilizing segmentation techniques such as K-means clustering, or region- growning approaches. Segmentation directs the system to focus only on the, reducing computational overhead and improving the accuracy of recognition.

Cognitive Layer

This acts asthe core intelligence layer for high-level learning and prediction. A combination of CNNs, MobileNet-V4, and ViT blocks are used to extract high- dimensional features that describe disease-specific characteristics [1], [2].
Deep learning models learn fine details such as:

- Irregular or inflamed patches
- Excessive sebum accumulation
- Symmetric or asymmetric distribution of affected region

This layer also performs the function of intermediate feature fusion, merging shallow features with classification across diverse skin types and imaging environments.

Output Layer

Finally, the processed data is turned into useful results. The system predicts disease class and severity scores. If integrated, it suggests management strategies. The output is generated in real time and can be used on mobile devices for immediate use [2].

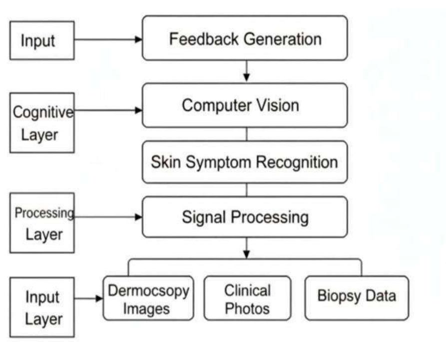

Fig. 1. System Architecture of the Parkinson’s Skin disease detection System

C. Functional Modules

The system is divided into several interrelated functional modules for proper processing from input to output.

Image Acquisition Module

Gathers skin images in and under different conditions, including indoor light, sunlight and under clinical scenarios. This module mayalso contain smartwatch data, enabling the usage of the system in a remote healthcare environment.

Preprocessing Module
This module enhances image quality by:

- Noise removal by Gaussian Blur Adjusting Brightness and Contrast Normalizing Color Intensities
- RGB to HSV/LAB spaces conversion

These steps reduce the effects of environmental variations such as shadows, reflections, or background clutter [3].

Dataset Description
This module have a dataset This dataset is composed of a range of biomedical voice measurements from 31 people, 23 with Parkinson's disease (PD). Each column in the table is a particular voice measure, and each row corresponds to one of 195 voice recordings from these individuals ("name" column). The dataset was split into 80% training and 20% testing.
We Performend the various ML Algo on the dataset and having the different Accuracy:
SVM: Accuracy =0.97 Decision Tree: Accuracy =0.87 KNN: Accuracy = 0.89

TABLE I: MODEL COMPARISON

Model	DataSet	Accuracy
SVM Algo	195 voice recording	97%
Decision Tree	195 voice recording	0.87
KNN	195 voice recording	0.89

Segmentation Module
This module isolates diseased regions using:

- K-means clustering
- Otsu thresholding
- Contour-based region extraction
- Correct segmentating, diseased region ensures the classifier only classifies skin irregularities related to Parkinson's disease and minimizes misclassification of healthy skin regions.

Feature Extraction Module The extracted features include:

- Hand-crafted features: GLCM texture, variance, entropy, color histograms
- Deep features (from CNN / ViT layers)
- Recent studies recommend using CNN–ViT-based hybrid feature extraction for identifying differences in skin texture Parkinson's illness due to their higher accuracy and adaptability [1]

Classification Module

- This module predicts the disease class using: Traditional ML models: SVM, Random forest
- Deeplearning models: MobileNet-V4, EfficientNet, CNN–ViT [2]
- DL models do better than traditional ML because they learn hierarchical disease features.

Module Output Generation The final module generates:

- Predicted abnormality label, confidence percentage, optional visual overlays.
- Recommendations for further action

The system is useful for making agricultural decisions in reality.

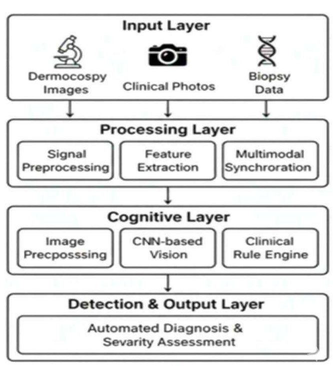

Fig.2. Multimodal Data Processing Flow of the Proposed System

Adaptive Psychological Modeling

Skin characteristics in Parkinson's vary in texture, oil secretion, pigmentation, and lighting conditions. Therefore, the system includes various techniques that help address this variability.

Transfer Learning: This involves improving previously trained models like ResNet50 and MobileNet-V4 with dermatological datasets. Transfer learning greatly increases accuracy and reduces training time.

Attention Mechanisms: Attention mechanisms included in ViT blocks improve the detection of skin abnormalities by selectively focusing on areas that show Parkinson's related symptoms.

Data Enhancement: Rotation, flipping, and changing brightness are some methods used to mimic real-world variations. This type of improvement will prevent overfitting and help the model generalize better.

Model Optimization: The models are designed for mobile devices to enable real-time diagnosis in the field. With MobileNet-V4, the inference can happen in just some milliseconds.

D. Workflow

The entire workflow of the proposed system is organized this wa-09y:

- Image Acquisition: A user acquires a skin image through a smartphone, dermatoscope, or other imaging devices.
- Preprocessing: The image is processed by enhancing the image to remove noise, adapt to lighting variations, and improve visibility.
- Segmentation: Automatic segmentation algorithms separate skin regionsrelevanttothe Disease region.
- Feature Extraction: The CNN–ViT blocks extract detailed features describing disease symptoms.

Classification: The system examines the type of disease based on patterns learned from the DL model.

The suggested diagnosis includes a confidence score and some more recommendations. This workflow allows for quick, precise, and quite easy disease detection in the large-scale farming.

III. Result and Conclusion

AI-based image analysis has considerably enhanced the identification of skin manifestations linked with Parkinson's disease, with a method that is painless, cheap, and convenient for early detection of disease. The literature detail outlines how CNNs, MobileNet-V4, and hybrid CNNs-Vision Transformer formulations routinely showed better accuracy, robustness and ability to identify subtle skin manifestations compared to conventional ML approaches. AI-based approaches provide batch and rapid options to traditional clinical examinations which limit relying on dermatologists, but can assist in early screening within a clinical or remote setting.

We performed different different Algorithms on it and the SVM performed based on the given DataSet

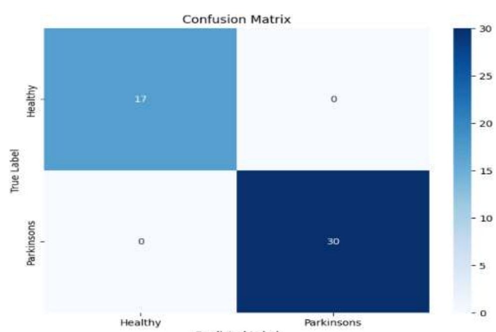

Fig 2

This is the best accuracy model for the Parkinson having the accuracy of the 97.

Future work should give priority to:

- Creation of large-scale, real-world Parkinson’s dermatological datasets
- Lightweight mobile-friendlymodels (MobileNet-V5, EfficientNet-Lite) for real-time prediction
- Integration with IoT and drone systems for large farm monitoring
- Early-stage disease detection by hyperspectral and multispectral imaging
- Hybrid CNN–Transformer models for more accurate feature extraction
- Disease severity estimation and yield impact forecasting

AI-driven Parkinson’s disease detection will keep evolving. This will improve digital healthcare and make a big difference in patient outcomes in future.

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