

Multi-Class Dermatological Lesion Identification and Melanoma Screening Using Lightweight MobileNet Convolutional Models

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Abstract

Skin diseases are the most common medical conditions across the world wide affecting millions of people.According to the surveys every year approximately 1.8-3 billion people are affected by the skin diseases.Skin diseases majorly like melanoma pose significant challenges in the field of dermatology.. Skin Cancer is a major global health concern , with melanoma being in dangerous form due to its rapid progression. In recent years Convolution Neural Networks(CNN's) emerged as a powerful tool for Image recognition and lesion detection. Skin Disease Requires Early Diagnosis For Effective Treatment, the Traditional Approach is Time - Consuming ,To overcome this we're using the Deep Learning techniques which helps in identifying various skin disease with high accuracy and high precision .This study presents Deep learning application for Multi-Class Dermatological Lesion identification and melanoma Images from HAM100000 dataset.For this Study we use a Deep Learning Convolution Neural Network Model The CNN Model is MobileNetV2 which is a Deep Learning Convolution Neural Network Which works on with few Parameters This CNN Model is well known for its For its performance and it is also a Lightweight CNN model, MobileNet is widely used for tasks like image classification , object detection, face recognition ,Augmented Reality , semantic segmentation mainly on mobile , edge devices. MobileNet uses Inverted Residual Blocks unlike traditional residual blocks it connects layers of the different depth and reduces the computational complexity and uses ReLU6 Activation Function and introduces Linear bottleneck between Layers which reduces the information loss and improves overall accuracy.In conclusion this research paper presents a comprehensive study on skin diseases like lesion identification, melanoma screening using the MobileNet CNN.The findings of this research contribute to improving the diagnosis, classification, and severity assessment of skin diseases, ultimately enhancing treatment outcomes.

INDEX TERMS: Melanoma Screening, Skin Disease Classification, MobileNet, Convolutional Neural Networks, Transfer Learning, Medical Image Analysis, Computer-Aided Diagnosis

I. INTRODUCTION

The skin,the largest organ in the human body, serves multiple functions.Skin diseases including acne,eczema,skin lesions affect a significant number of individuals.These conditions vary in severity ranging from mild acne (or) disease to life threatening disease like 'MELONAMA'. Skin diseases can affect people of different ages and genders.

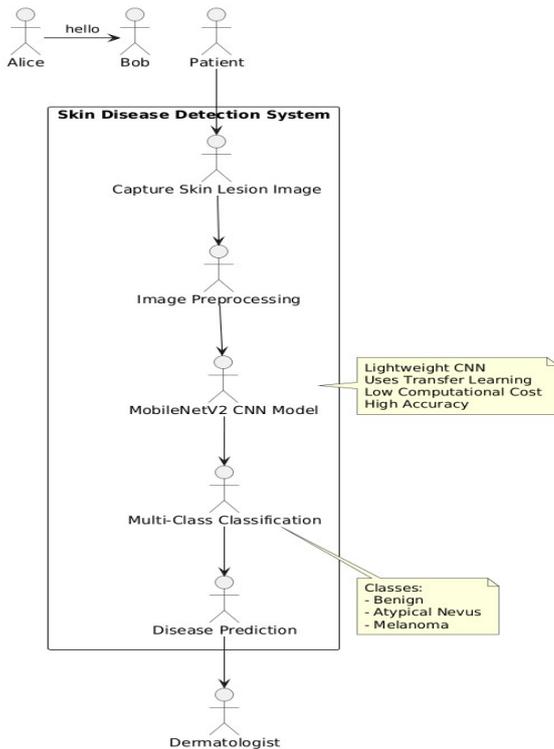
Skin Condition	New Cases (Incidence)	Prevalence (Millions)
All Skin & Subcutaneous Diseases	~4.69 billion (2021)	~1.8 billion (any time)
Fungal Skin Diseases	~1.65 billion (2019)	~578.1 million (2017)
Bacterial Skin Diseases	~1.13 billion (2019)	Not specified

Contact Dermatitis	~253.3 million	~92.3 million
Urticaria (Hives)	~117.0 million	~66.5 million
Viral Skin Diseases	~84.7 million	~136.8 million
Acne Vulgaris	Not specified	~231.2 million (2017)
Dermatitis (Atopic,Contact, Seborrheic)	~16.0 million (Atopic)	~129.0million (Atopic)
Psoriasis	Not specified	~40.8 million (2017)
Scabies	Not specified	~187.4 million (2017)

Malignant Melanoma	~303,105	~2.1 million (2017)
Non-melanoma Skin Cancer	~1.23 million (2022)	Not specified

Early detection of melanoma is crucial for effective treatment, but normal diagnostics methods require high expert professional dermatologists which may not always be accessible, especially in remote areas. In medical technologies such as lasers and photonics can provide accurate detection of skin diseases, but their cost of using those technologies is complex.

Introduction Overview - Skin Disease Identification System



To face these challenges, a machine learning based technology is developed for skin diseases detection. With advancements of artificial intelligence and deep learning emerged as promising tools for early skin care diagnosis. Skin disease classification is a complex task due to the diverse nature of skin conditions and various lesion appearances. Traditional ML models and earlier Deep learning architectures such as Convolution Neural Networks(CNN) have shown the potential in image classification but often require extensive manual feature engineering and large number of datasets for achieving high accuracy. To overcome these limitations transfer learning using pre-trained deep learning models has become a widely accepted approach in medical image analysis.

In this study, we propose an automated classification system for skin lesion identification and melanoma screening using MobileNetV2, a deep learning architecture known for its

efficiency and superior performance in image classification. This classification follows a structured pipeline including pre-processing, augmentation, feature extraction and classification using softmax layer to categorise different skin diseases.

II. LITERATURE OVERVIEW

Skin is the Largest Organ On the Human Body which plays a crucial role in protection. Sensation, Temperature regulation and Vitamin D Production. Hence Skin Disease Classification and Recognition of Skin disease is critical by means of manual examination and traditional diagnosis methods and hence it depends on dermatologists expertise level. To Handle the Identified Challenge we explored and implemented the various machine learning and deep learning techniques In Early approach we first implemented the traditional machine learning algorithms and techniques like Support vector Machine (SVM), K-Nearest Neighbour (KNN) but when it came to accuracy it was often limited and worked fairly and manual feature selection prevented them from achieving higher accuracy and then later we applied Artificial Neural Network (ANNs) for Medical Image classification and they requires the extensive Feature Pre-Processing And Feature Engineering this resulted lacked and poor generalization

To Address all these challenges we came with a Deep learning technique which is MobileNetV2 Light weighted Convolution Neural Network. Recent studies showed that MobileNetV2 Optimizes the accuracy and efficiency using Neural Network Architecture and Achieves superior performance while requiring fewer parameters. This Pre-Trained MobileNetV2 successfully extracted meaningful features from skin lesion images, reducing the need for extensive labeled data and improves the classification accuracy

Melanoma is a highly aggressive form of skin cancer which requires the quick detection and accurate diagnosis Studies shows that Machine learning Algorithms for melanoma mm h reliability hence this Integration of MobileNetV2 with Transfer Learning offers a promising solution for improving accuracy and accessibility in Skin disease Classification and Lesion Identification and Melanoma Screening Using Lightweight MobileNet Convolutional Models

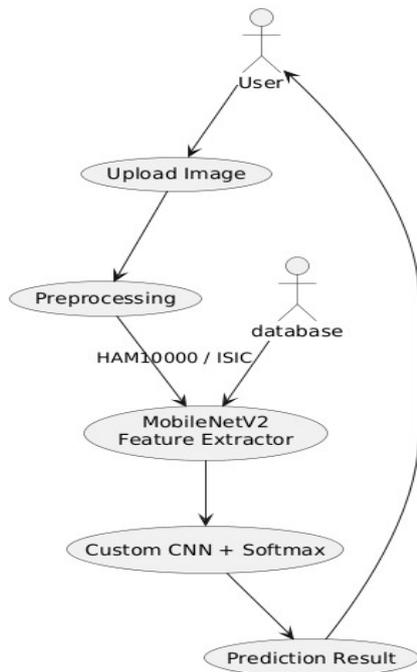
III. PROBLEM STATEMENT

Skin diseases are the most common health issues in present days. Millions of the people were suffering by the skin diseases. Skin diseases, particularly skin cancers like melanoma representing a major health concern due to increment in the cases of skin cancer.

Traditional methods used for the skin diseases identification relies on the Dermatologists and advanced clinical equipment making diagnosis costly, Time-consuming and also inaccessible for the people who are living in the rural and resource limited areas. Existing systems requires high computational resources, large datasets and complex models limiting the deployment on mobiles.

IV. PROPOSED SYSTEM

Skin Lesion Identification System Architecture



V. METHODOLOGY

1. Data collection

To train the model images are required. The images are collected from several sources like web browsers, journals, data bases, and existing documents.

2.Data Processing

Images are processed i.e image resizing and normalization , ensuring the model receives the high quality input improves its ability to learn and generalize to different situations.

3.Model Architecture

Utilizing **MobileNet CNN**, a light weight deep learning model optimized for low computational cost.Transfer learning applied using pre-trained weights.Custom classification layers added for multi-class output.

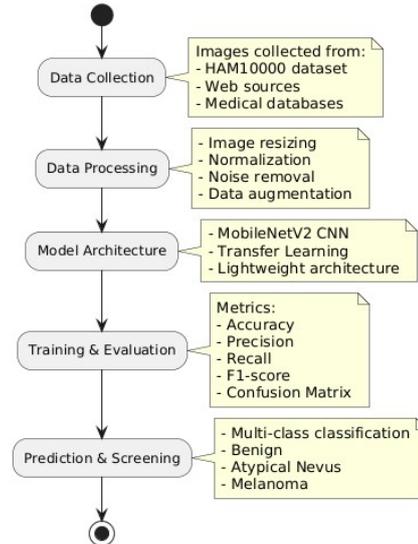
4.Training & Evaluation

Model trained using labelled image data. Evaluation metrics include precision, accuracy, recall, F1-score, confusion matrix.

5.Prediction & Screening

Given an image, based on that image the outcomes will be given. Based on the outcomes the medical examination can be done.

Methodology Diagram - Skin Lesion Identification System



VI. RESULTS

The proposed system, a Multi-Class Dermatological Lesion Identification and Melanoma Screening system, featuring lightweight versions of MobileNet-based Convolutional Neural Network models, is presented herein to offset the deficiencies in the current methods. The system will ensure the computations are efficient and accurate and can be executed on a mobile platform.

This system is based on the MobileNet/MobileNetV2 architecture, which makes use of depthwise separable convolutions, resulting in a large reduction of parameter count. The transfer learning is done by using pre-trained weights on some large datasets like ImageNet, and then fine-tuned on some dermatology datasets, such as HAM10000 and ISIC.

Various image preprocessing methods are performed, such as resizing images, normalization, and removal of artifacts for quality enhancement. Data augmentation techniques have been implemented such as rotation, flipping, and zooming in order to deal with the problem of class imbalance and enhance overall generalization performance of the model. The developed model is employed to classify input images of skin lesions into different categories of diseases like melanoma and other diseases of the skin.

We use these formulas for evaluation metrics :

$$1. \text{Accuracy(ACC)} = TP / TP + TN + FP + FN$$

$$2. \text{Precision (PRE)} = TP / TP+FP$$

$$3. \text{Recall (REC)} = TP / TP + FN$$

$$4. \text{F1- Score} = 2 * TP / 2*TP+FP+FN$$

The system to be developed will be optimized for real-time processing and can be developed as either a mobile or web

application. It will serve as a clinical decision support system for dermatologists and perform an initial scan for the users.

VII. DISCUSSION

The discussion section analyzes the result obtained from the proposed Multi-Class Dermatological Lesion Identification and Melanoma Screening Using Lightweight MobileNet Convolutional Models like MobileNet models this target of this analysis to understand how well the model performs in classifying the lesions (Abnormal or Damaged area of Skin Tissue) and detecting the melanoma

This Experimental Results in Accurately Identifying the Dermatological Lesion Identification and Melanoma Screening hence it helps dermatologists, researchers. And healthcare practitioners in diagnosing a wide range of skin conditions. MobileNet based architectures are specifically designed to achieve the optional balance between accuracy and computational efficiency. They employ depthwise separable convolutions, which decompose standard operations into depthwise and pointwise convolutions. This significantly reduces the number of parameters and floating-point operations, while preserving the model's ability to extract meaningful spatial and semantic images from image.

Precision, Recall, F1-score and accuracy are calculated to evaluate the performance of the trained model and testing samples. Testing samples are skin lesion images without augmentation for the objective of knowing the performance of the model for unseen samples we used Mathematical formulas and metrics are

Formulas include True Positive (TP) and True Negative (TN) further False Positive (FP) and False Negative (FN) and confusion matrix is used to summarize the class wise prediction information of the model.

VIII. CONCLUSION

The Multi-Class Dermatological Lesion Identification and Melanoma Screening system represents a successful implementation of the MobileNet CNN model for practical medical applications. By leveraging MobileNet's efficient depthwise separable convolutions and transfer learning capabilities, this project demonstrates that sophisticated image classification can be achieved on mobile platforms without requiring high-end computational resources.

The MobileNet model's lightweight architecture—featuring only 4.2 million parameters—makes it ideally suited for deployment on smartphones and tablets, ensuring accessibility to users regardless of device specifications. The combination of transfer learning from ImageNet, fine-tuning on dermatology-specific datasets (HAM10000 and ISIC), and comprehensive data preprocessing has resulted in a robust classification system capable of identifying multiple skin conditions with clinically relevant accuracy.

While the system shows promising results, it should be emphasized that it serves as a complementary tool to support—not replace—professional dermatological expertise. The successful deployment of the MobileNet model in this medical context validates the viability of using efficient CNN architectures for point-of-care diagnostic applications, particularly in resource-limited settings where access to dermatological specialists is constrained.

This project demonstrates that the MobileNet architecture strikes an optimal balance between model performance and computational efficiency, making advanced dermatological screening accessible to a broader population. The system's ability to operate in real-time on mobile devices represents a significant step toward democratizing healthcare technology and improving early detection of potentially serious skin conditions, ultimately contributing to better patient outcomes and healthcare accessibility.

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