Enhancing Dermatological Diagnosis through Machine Learning: A Multi-Class Skin Disease Detection System with Convolutional Neural Network

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Abstract

This research paper proposes a novel approach to detecting skin diseases using machine learning techniques. The proposed system utilizes image processing techniques to extract features from skin lesion images and then applies machine learning algorithms to classify the lesion into different categories. The proposed system can be evaluated using a large dataset of skin lesion images and the machine can learn itself based on the provided data and predicted achieved high accuracy in detecting various skin diseases such as melanoma, eczema, and psoriasis. The proposed system has the potential to aid dermatologists in diagnosing skin diseases and improving patient outcomes.The algorithm that we propose to use is Convolutional Neural Network (CNN) as it is one of the most preferred algorithms for image classification.

1 Introduction

Skin diseases are a significant health concern that affects millions of people globally, leading to discomfort, morbidity, and even mortality in severe cases. Early and accurate detection of skin diseases is crucial for effective treatment and prevention of complications. In recent years, the use of machine learning (ML) algorithms have gained popularity in the automated diagnosis of skin diseases. These techniques have the potential to improve the speed and accuracy of diagnosis while reducing the workload on dermatologists. However, the development of reliable and effective ML models for skin disease detection requires addressing various challenges, including data imbalance, limited data availability, and the need for interpretability.

One recent study published in the Journal of Medical Systems in 2020 titled "Automated Detection and Classification of Skin Diseases Using Machine Learning: A Review" reviewed several studies that used machine learning algorithms for skin disease detection, including studies in Bangladesh. The review found that machine learning algorithms have shown promising results in detecting and classifying skin diseases accurately and can assist dermatologists in providing timely and accurate diagnoses.

Another study published in the International Journal of Computer Applications in 2018 titled "A Novel Machine Learning Framework for the Diagnosis of Skin Diseases" proposed a machine-learning framework for diagnosing various skin diseases, including psoriasis, eczema, and vitiligo, based on clinical images. The study was conducted in Bangladesh, and the framework showed promising results with high accuracy rates.

These are just a few examples of research studies that have used machine learning for the diagnosis of skin diseases in Bangladesh. However, it is important to note that the use of machine learning algorithms for skin disease diagnosis is still a developing area of research, and further studies and research are needed to validate and refine these approaches.

In this research paper, we present a comprehensive review of the recent advances in skin disease detection using machine learning techniques. Furthermore, we propose a novel approach for skin disease detection using a combination of deep learning and image processing techniques. Specifically, we use a convolutional neural network (CNN) to extract discriminative features from skin lesion images and Support Vector Machine (SVM) classifier to predict the disease category. Our main goal is to provide a promising direction for future research in this field.

2 Literature

The proposed research utilizes machine learning techniques to improve the detection of skin diseases. In the literature, many works have been done to improve the accuracy of skin disease detection using machine learning algorithms.

One related work is a study by Esteva et al. (2017)that used a convolutional neural network to classify skin lesions into various disease categories. They used the ISIC dataset to train their model and achieved a classification accuracy of 91%. Another related work is a study by Brinker et al. (2019) that developed a mobile app to classify skin lesions into different disease categories using a deep convolutional neural network. They achieved a classification accuracy of 90.3% using a dataset of 10,000 skin images. Another research by Shamsul Arifin et al. (2012) shows dermatological disease diagnosis using color-skin images by feedforward backpropagation artificial neural networks. In the test case, a diseased skin detection has an accuracy of 95.99% and a disease identification accuracy is 94.016%.

The proposed research differs from previous studies in several ways. First, the research utilizes a large and diverse dataset of skin disease images that represent different ethnicities, genders, and ages. This approach ensures that the dataset is representative of the population, accounting for variations in skin types and conditions. Second, the research uses image processing techniques to extract features from skin lesion images before applying machine learning algorithms. This preprocessing stage improves the accuracy of the model by ensuring data consistency. Third, the proposed research uses the AlexNet CNN architecture, which has been proven to be effective in image classification tasks, to classify skin lesions.

In summary, the proposed research builds on previous studies that have used machine learning algorithms for skin disease detection. However, it differs by utilizing a large and diverse dataset, performing preprocessing on the dataset, and utilizing the AlexNet CNN architecture. These differences could lead to improved accuracy in skin disease detection, which could aid dermatologists in diagnosing skin diseases and improving patient outcomes.

3 Methodology

3.1 Data collection

By collecting a large and diverse dataset of skin disease images we can ensure that the dataset is representative of different ethnicities, genders, and ages to account for variations in skin types and conditions. We can use publicly available datasets like ISIC or DermNet or collect data from hospitals, clinics, or dermatologists.

3.2 Data processing

This stage can also be called preprocessing of the provided image. We can perform pre-processing on the dataset to ensure data consistency and improve the accuracy of the model.

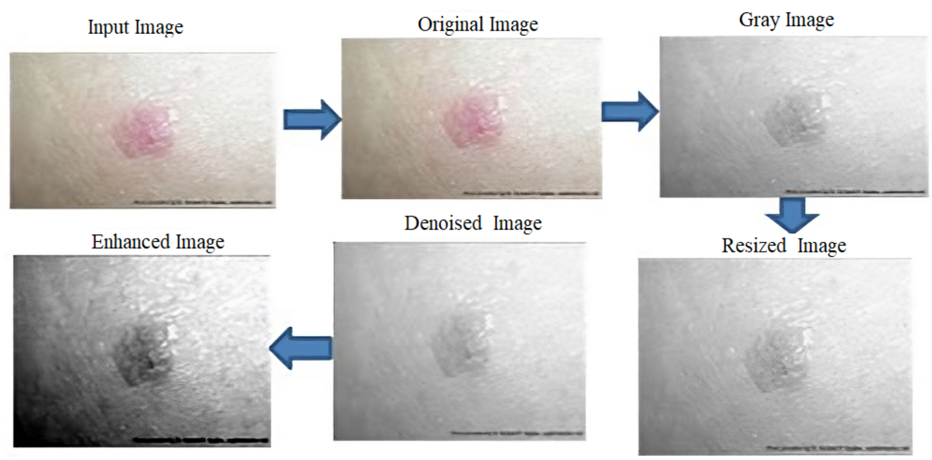

Fig.1.Preprocessing of the provided image.

Pre-processing tasks include image resizing, normalization, and augmentation, such as flipping or rotating images, adjusting brightness, and adding noise. Unifying the image size will help speed up the process Ambad and Shirsat (2016).

3.3 Model selection

Convolutional Neural Network (CNN) is a neural network architecture commonly used for image classification, object detection, and other computer vision tasks. The main building blocks of a CNN are convolutional layers, pooling layers, and fully connected layers. Convolutional layers perform feature extraction by applying filters to the input image, while pooling layers reduce the spatial dimensionality of the feature maps. Fully connected layers are used to classify the input based on the extracted features. Several variants of CNN architecture have been proposed, such as VGGNet, AlexNEt, ResNet, and InceptionNet, which differ in the number and arrangement of layers. These architectures have achieved state-of-the-art performance on various benchmark datasets and have contributed to significant advances in computer vision research. But in this research, we are more concerned with a specific CNN architecture named AlexNet.

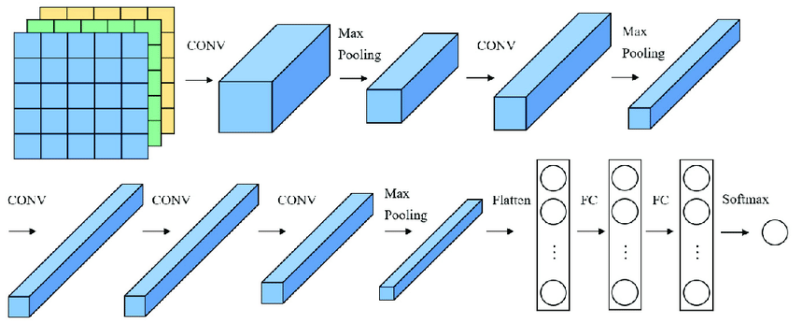

Fig.2. Schematic diagram of the AlexNet structure.

AlexNet is a deep CNN model. AlexNet architecture consists of 5 convolutional layers, 3 max-pooling layers, 2 normalization layers, 2 fully connected layers, and 1 softmax layer. Each convolutional layer consists of convolutional filters and a nonlinear activation function ReLU.The pooling layers are used to perform max pooling. Dividing the dataset into training, validation, and testing sets. We can train this CNN model on the training set using backpropagation to minimize the loss function. Hence, monitoring the model's performance on the validation set and adjusting the hyperparameters like learning rate, batch size, and a number of epochs accordingly Chu et al. (2019).

3.4 Feature extraction

Passing the skin disease image through the AlexNet model we can extract the features such as texture, color, and pattern of the skin disease.

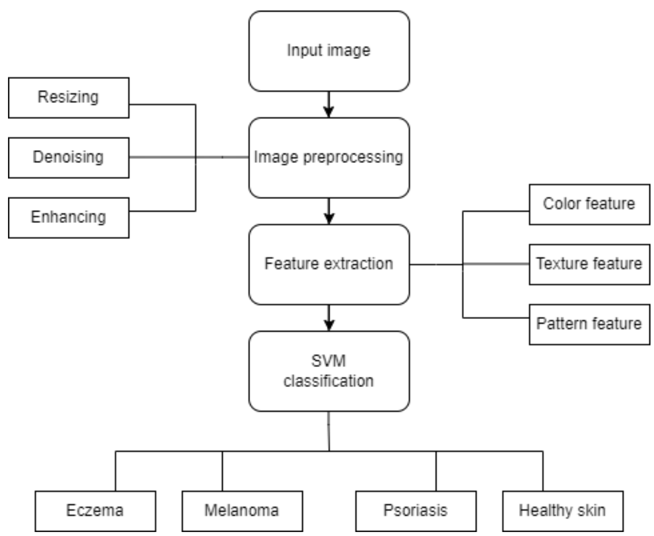

Fig.3.Proposed system block diagram.

3.5 Classification

Support Vector Machine (SVM) is a powerful machine-learning algorithm that can be used to classify skin diseases based on extracted features from skin images. After preprocessing the data, we can train the SVM model using the training set.Cristianini et al. (2000)

3.6 Interpretation and analysis

Analyzing the trained model's predictions to interpret its behavior and identify its strengths and weaknesses, we can conduct a sensitivity analysis to examine how the model's performance varies with respect to different features like age, gender, or disease severity.

4 Conclusion and future work

Skin disease detection using machine learning has shown great potential in improving the accuracy and speed of diagnosing skin diseases. With the increasing prevalence of skin diseases and the limited availability of dermatologists, machine-learning algorithms can assist in early detection and treatment, leading to better patient outcomes. If we can come up with a high accuracy and reliable trained CNN model assuring the maximum chance of detecting the disease correctly, it could be of great use in remote areas. We can create a web application or a mobile app that takes skin images as input and outputs the corresponding diagnosis based on the trained model.

Many enhancements can be made in this research, gathering a wide variety of data. Thus, we can train this model to detect all sorts of skin diseases more accurately. Moreover, we have high hopes that this research being used in the majority of dermatology. We plan to elevate this research by making a dermoscopic device embedded with a pre-trained CNN model. It would help the dermatologist give assurance with the diagnosis.

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