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Research Article

Skin Disease Detection with an Application to Psoriasis Images

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Abstract

Psoriasis is an incurable, long term skin condition that affects 125 million of the world's population. It can have a remarkable negative impact on the patient's physical, emotional, psychological state. There is no specific medical test exists for psoriasis. Only visual examination is done by looking at skin lesions. Psoriasis is distinguished from other skin diseases by the images taken via the camera. Hence, the image-based algorithm can be used to detect psoriasis. The computer-aided system can be used to automatically segregate psoriasis lesion and healthy skin from skin images using computer vision and machine learning techniques. Prepossessing the color skin images to extract significant features and classifying helps in detecting psoriasis. This can be achieved with the help of computer vision and machine learning techniques. The proposed system aims to achieve this using a median filter for noise removal, skin masking for segmentation and CNN as a classifier.

Keywords: *Dermatology, Psoriasis, Computer vision, Image processing, Machine learning, Computational Intelligence, Automated disease diagnosis.*

Introduction

Skin is the biggest organ of the human body. It acts as a shield against fungal infection, bacteria, allergies, viruses, and controls the temperature of the body. Situations that frustrate, change the texture of the skin or damage the skin can produce symptoms like swelling, burning, redness, and itching. Allergies, irritants, genetic structure, and particular diseases and immune system-related problems can produce dermatitis, hives, and other skin problems. Many of the skin diseases, such as acne, ringworm, eczema, psoriasis also affect the appearance. Skin can also produce many types of cancers. Skin disease is a particular kind of illness caused by bacteria or an Infection and common reasons for skin diseases are climate changes and lifestyle. It can have a huge impact on a person's day to day life, restrict their movements, lead to depression and some diseases can even cause deaths. Tough skin diseases are common it is very difficult to identify most skin disease at an early stage. It becomes important to identify these diseases at their initial stage to control it from spreading.

Psoriasis is a common, chronic and immune-mediated skin disease [1]. It affects 125 million people worldwide [2]. Around 30 percent of psoriasis patients attempt suicide due to its embarrassing appearance, which makes it equally dangerous to depression, heart disease, and diabetes. Generally, psoriasis appears on scalp, elbow, knees and lower back but it may spread further to all parts of the body. The cause of psoriasis is still unidentified. There is no permanent cure for psoriasis reported till date but it can be controlled by prolonged treatment.

There is no specific medical test exists for psoriasis. A dermatologist usually makes visual examination by looking at the skin lesion and sense of touch. The current diagnostic method leads to subjectivity in decision making and is unreliable and laborious. Hence, a computer-aided diagnosis system could be useful.

Based on the above mention, it motivates to develop a computer-aided system for psoriasis detection. The detection method is divided into two stages accurate segmentation of skin lesion and extracts significant features, classifying images into healthy skin images and psoriatic lesion. The first stage involves preprocessing the color skin images to extract the significant features automatically from it using computer vision techniques and in the second stage, based on those extracted features images are classified into healthy skin image or psoriatic lesion using machine learning techniques. This system does not replace the dermatologist rather assist them in getting precise results, keeping track of treatment development.

A. Techniques used to detect psoriasis

1) Visual exam and medical history: Doctor usually diagnose psoriasis by taking your medical history and examining your skin, scalp and nails.

2) Skin biopsy: Rarely, Doctor may take a small sample of skin (biopsy). He or she will likely first apply a local anesthetic. The sample is examined under a microscope to determine the exact type of psoriasis and to rule out other disorders.

B. Clinical features for detection of psoriasis

1) Erythema: Red patches of skin covered with thick, silvery scales.
2) Area: Area affected by psoriasis.
3) Desquamation: Is the shedding of the outermost membrane or layer of a skin tissue.
4) Induration: An increase in the fibrous elements in tissue commonly associated with inflammation and marked by loss of elasticity and pliability.

Review of Literature

A significant development has been seen in computeraided diagnostic system for disease detection. This section reviews the related work based on various techniques used for skin disease detection detection.

A. SVM based approaches

Shrivastava et al. worked on 540 images of Indian origin taken from psoriatreat, Pune. A computerized system for the detection of psoriasis is implemented using the machine learning paradigm. the dataset is prepared by manual cropping of the healthy skin from psoriatic lesion further Support vector machine is used for classification [2][3]. Higher-order spectra (HOS), texture and color features and their seven combinations for better accuracy. PCA is used for feature extraction[2]. The system with HOS, color, texture features outperforms the system with a simple machine learning paradigm. Another researcher group Mohammad et al. also used SVM in their work, they demonstrated automatic detection of erythemato-squamous diseases using PSO-SVM. UCI erythemato-squamous diseases dataset was used. There are 366 samples in this dataset which has 34 features. Association rule is applied to eliminate redundant features and then PSO-SVM is trained to classify the obtained dataset. This system achieves the optimized accuracy for SVM using AR. This system gives an accuracy of 94% for SVM and 98% for PSO-SVM[4].

B. ANN based approaches

Some researchers used Artificial neural networks in their work for the classification of various dermatological diseases. Syu et al. in their paper, psoriasis detection based on the deep neural network was proposed. Several convolution layers are used for feature extraction and these feature maps are feed into two fully connected layers. Relu and softmax are used as an activation function. To train DNN, loss function binary cross-entropy and adam are used. 5700 image samples are used. The accuracy for the proposed method can achieve 91% [5]. Yasir et al. in their work, proposed a computer vision-based techniques to detect various kinds of dermatological diseases. They used images processing algorithms for feature extraction and feed-forward artificial neural network for training and testing purpose. 775 images of 9 different skin diseases are used collected from Sir Salimullah Medical College and Mitford Hospital, Dhaka, Bangladesh. The system successfully detects 9 types of dermatological disease with an accuracy of 90%. A limitation with this is, it requires user input [6]. Kumar et al. in their paper, they provided an approach to detect various kinds of skin diseases. They used a dual-stage approach which combines image processing and machine learning algorithm. This system extracts color, size, shape features and for the prediction Decision tree, KNN, ANN machine learning algorithms are used. Images were collected from MS Ramaiah Medical College, Bangalore. The system successfully detects 6 types of dermatological disease with an accuracy of 95% [7].

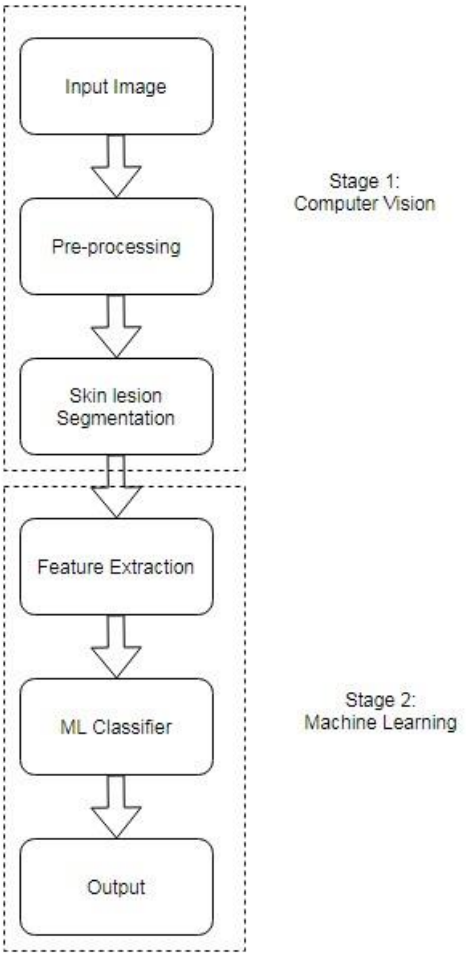

Fig. 1. Overview of System

System Overview

Steps shown in Fig.1 are illustrated as follows:

1) User uploads the image of the affected skin region.
2) Computer vision module will receive an image given by the user and the following operations are performed: a) Preprocessing of image

b) Segmentation of image.

3) Segmented image is feed to a machine learning module.
which will perform the following operations: a) Feature Extraction
b) Classification.
4) Results are displayed to the user

Proposed Methodology

This proposed system works on two stage approach: *1) Computer Vision Stage:*

- Image Acquisition: Images are taken using a digital camera.
- Preprocessing of Image: Morphological operations are performed to enhance an image. Here, erosion is performed to remove extra pixels and dilation adds pixels to the boundries to fill gaps and gaussian blur is a low pass filter which removes high frequency elments is applied for noise removal.
- Image segmentation: Image segmentation is done to move out diseased skin patches from overall skin. Segmentation is carried out by applying a mask on an image.

2) Machine Learning Stage:

- Feature Extraction: The CNN model has the capability to extract features automatically. CNN will be used for unique feature extraction.Those features are further feed to the network for classification.
- Classification: Classification of skin images is performed based on the output layer of CNN[1]. CNN is ideal for 2D image classification.

The whole proposed system is expressed mathematically as below:

1) S= be the system for psoriasis detection.
2) Identify input to the system as i Where, i= clinical images.
3) Identify O as a output of the system. Where, o= classified image result 4) Identify F as a set of functions.

f= {f1,f2,f3,f4} f1= pre-process images f2=segment images f3= feature extraction f4= classification.

5) Identify C as a constraint. Where, c= image should taken from fixed distance
6) So,the complete system for psoriasis detection, S= {I,O,F,C}

Overview on Convolutional Neural Network

In Proposed System, the detection of psoriasis is carried out using Convolutional Neural Network (CNN). CNN consists of an input and output layer along with multiple hidden layers. The multile layers include Convolutiona layer, Pooling layer, Activation layer, Fully connected layer, the detail descriptions of these layers are discussed below:

Input image

Take the input image and pre-process it to get the required size.

Convolutional Layer

The first layers that receive an input signal are called convolution filters.Convolution may be a method wherever the network tries to label the signal by relating what it's learned within the past.The sign strength isn't hooked in to wherever the options square measure situated, but simply whether the features are present.

Pooling layer

Inputs from the convolution layer can be smoothened to reduce the sensitivity of the filters to noise and variations. This smoothing process is called sub-sampling and can be achieved by taking averages or taking the maximum over a sample of the signal.

Activation Layer

The activation layer controls how the signal flows from one layer to the next, emulating how neurons are fired in our brain. Output signals powerfully related to past references would activate additional neurons, enabling signals to be propagated more efficiently for identification.

Fully connected layer

The last layers in the network are fully connected, meaning that neurons of preceding layers are connected to every neuron in the subsequent layers.

Dataset

The psoriasis image data is collected from Trimbake hospital, Karad, Maharashtra, India. And Sushrut clinic, Akola, Maharashtra, India. All the images are of Indian origin patients, of various sizes taken from a digital camera and processed in JPEG format.

Experimental Intermediate Results and Discussion

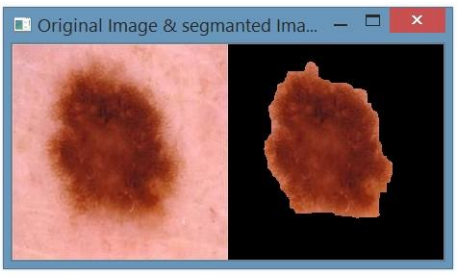

Fig. 2. original image and segmented image

The proposed system works on the detection of psoriasis disease. Segmentation of skin lesions is a challenging task. Some key challenges are listed below:

- Lack of publicly available psoriasis image set.
- Image may contain artifacts such as mole, hair, patches, noise.
- Presence of low contrast between background and skin lesion in images.

In the proposed system, using the masking technique over preprocessed image accurate segmentation of skin lesion is achieved. Fig 2. shows the segmented lesion from the original skin image.

Conclusion and Future Work

It is important to tackle this disease through early detection.The proposed computer-aided detection system will diagnose skin images into psoriasis lesions or healthy skin. Morphological operations are used for noise removal. Segmentation of images is done by using skin masking. CNN is used as a classifier.Future work can be extended to multiclass classification for classifying images into various types of psoriasis.

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