JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Skin Disease Detection based on Indian Skin Tone

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Abstract : Skin is the largest organ of the body. In most developing countries, overcrowding and poor hygiene are responsible for the spreading of skin diseases. Some of the diseases look alike to the naked eye, whereas some diseases have the same texture, which leads to misinterpretation. The treatment of these diseases can be heavy on some people's pockets so they prefer not to take any treatment and opt for some household methods. If a disease is not detected early, the symptoms reach a severe state which might cause serious damages. Moreover, there is a need for more advancements concerning dermatological morbidities in a developing country like India. Thus, there is an alarming need to develop different methods to detect skin disease using techniques that are not only cost-effective but also flexible enough for anyone to access. This paper proposes a skin detection method based on Image processing and Machine learning. As accuracy is the most important factor in disease detection it is achieved using CNN algorithm. In this system, both CCN and Transfer Learning models like VGG19 and RESNET50 have been proposed to detect skin diseases. The performance metrics of these models are found out for comparison, to test them for different skin tones.This system promises the accuracy of 86% with very limited data.

***IndexTerms*—**Indian skin tone, Convolutional Neural Network, Transfer Learning, Visual Geometry Group, Residual Neural Networks,Disease Classification.

I.INTRODUCTION

Despite the fact that skin diseases rank the fourth most common cause of human illness, many people do not consult a physician.[1] There is a growing number of skin disorders in both developing and developed countries. According to the World Health Organization (WHO), skin diseases are among the most common noncommunicable diseases in India, indicating the severity of the problem. There are not enough dermatologists in India, further aggravating this situation. Presently, only about 6000 dermatologists cater to a population of over 121 crore.[2]

As mankind has begun exploiting the resources of planet earth, it has caused imbalances and consequently a rise in pollutants in the atmosphere. It is the part of the body that is most exposed to contaminated substances, which translates to a high probability of becoming infected. These contaminated substances attract harmful microorganisms like fungus, bacteria, etc.With the weather set to heat up in the coming years, autoimmune skin diseases such as lupus, fungal infections, allergies, sunburn, tanning, rashes and pigmentation will also be on the rise. Approximately 40 to 50 percent of OPD patients in Delhi's hospitals suffer from skin ailments, sunburn, fungal and bacterial infections[3].

An increase in temperature causes an increase in sebaceous gland activity and sebum production. Sebum overproduction combined with shed keratinocytes clog hair follicles and result in acne.[4] We often ignore symptoms that could later cause carcinogens to be produced inside skin cells. To diagnose skin diseases, it takes seasoned eyes since the symptoms are overlapping and difficult to determine their exact type.According to a study conducted to evaluate the epidemiology of sensitive skin in the Indian population found that subjects with sensitive or very sensitive skin were two to four times as likely to suffer from atopic dermatitis, acne, psoriasis, or vitiligo. They were much more sensitive to climatic factors, environmental factors, cosmetics, and food intake. Even though it is reported less often than in other countries, sensitive skin is a common condition in India, affecting about one third of the population.[5].

II. REVIEW OF LITERATURE

This paper [6] presents a computer aided skin disease diagnosis model that could prove more objective and reliable. Aim of this paper is to detect skin diseases using an image of skin and to analyze the image by using filters to remove noise, convert the image into grayscale so that the analysis is easier and the information obtained is more valuable. The proposed method uses enhancement, segmentation, feature extraction, and classification techniques. Segmentation is done in two ways: first applying the mask for separate skin, and second applying it to the diseased area of the skin. These images serve to illustrate any type of skin disease and to demonstrate emergency orientation. Using the results of the study, doctors can help in diagnosing early and knowing the type of disease so that side effects on the skin can be avoided. It is only a downside that the image may be erroneous because of the noise.

In [7] Jainesh Rathod, et al. have proposed an automated image-based system for detecting skin diseases using machine learning. The system uses computation to analyze, process, and label the image data based on a number of features in the images. In addition to removing unwanted noise, skin images are also further processed for enhancement. Feature extraction is performed using techniques such as Convolutional Neural Network (CNN), softmax classifier is used for classification, and diagnosis reports are returned as output of this solution. Using this method, dermatological diseases can be detected more accurately and faster than using traditional methods. In addition, this tool can also be used as a reliable real-time educational tool for medical students studying dermatology. With this algorithm, over 70% accuracy can be assured.

This paper [8] presents a method of representing the shape, color, and texture of skin diseases in digital images and classification of the results of image analysis based on the type of skin disease. The method used is a combination of Local Binary Pattern (LBP) and Convolutional Neural Network (CNN) which can later be used as sensors or vision for skin diseases automatically. The result of this study can help in the early identification of skin diseases. The level of accuracy found by combining LBP with CNN is quite high with an average value of 92% .

A CNN-based [9] architecture for skin lesion segmentation based on convolutional neural networks is proposed here, along with a method for skin lesion segmentation based on that algorithm. Using this method, diagnosis imaging systems can assess the skin lesion's features and classify it based on its characteristics. The proposed method requires fewer resources than existing methods, and it can be applied to systems without powerful GPUs, yet training accuracy remains high (over 95%). The model was trained on the ISIC dataset, a common dermoscopic image dataset. Using the model, training and segmentation tasks become more accurate.

In this work [10] by R. Remigius Lourdhu, et. al, melanoma cancer can be detected automatically using image processing techniques. The analysis begins with collecting images of various skin diseases from patients. These images are then given as input to the diagnostic tool for further processing and are classified into benign and malignant tumors. It is essential to detect early malignancies on skin lesions. In doing so, a more rapid diagnosis can be made. In the first step, noise and hair are removed from the input image. The disease area is then segmented from the input image. Afterward, features are extracted from the image. To further categorize images, 16 features are obtained and used. In the future, this work could be implemented in hardware using hardware description language (HDL) Coder, which generates synthesizable Verilog or VHDL code from Simulink or MATLAB. This work can also be hardware implemented in a FPGA or ASIC Board.

This paper [11] proposes a framework to monitor changes on the skin over time. These spatial changes are captured via the magnitude and direction of the vectors in the resultant displacement field. The proposed framework is developed and validated with skin samples of melanoma. The framework in this paper monitors the changes and predicts the severity of change over time. It is planned to be implemented as part of a diagnostic system for real-time analysis. With a dedicated server, analysis of advanced images, detection of changes and prediction of changes could be carried out.

III. PROPOSED METHODOLOGY

The proposed solution is an automated approach to skin disease identification that can be put to regular scrutiny by checking the performance of a new set of test images. It lends users the ability to perform a preliminary diagnosis of skin inflammation or deformation which can be useful when a dermatologist is consulted. As a result of this solution, the system is able to minimize the amount of time spent on the preliminary examination of patients to identify the disease.

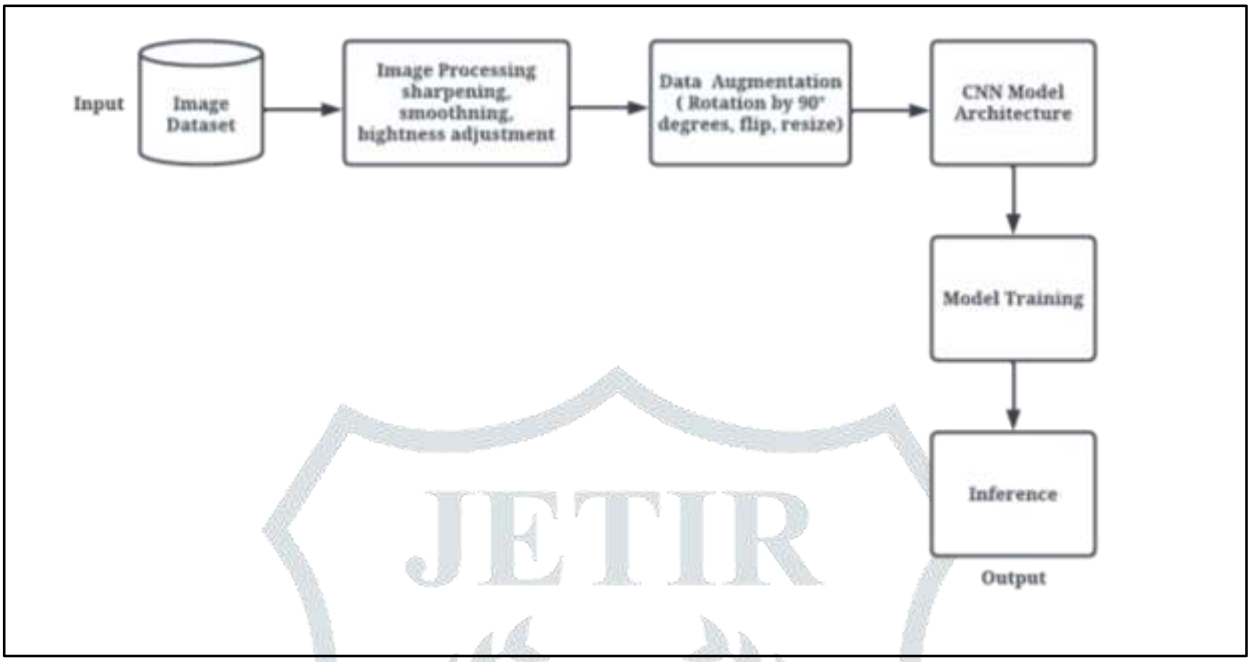

Fig 1: Block diagram of proposed system

Figure 1. shows the block diagram that can be simplified into following processes:

3.1 Database Creation

The input images belong to diseases which are prevalent in India and are of Indian skin tone. A directed search has been done regarding these images. The sparsity in this dataset is dealt through Data Augmentation. This is neat jargon for the process of leveraging various image transformation techniques to create variations in terms of position, orientation, resolution and extent of zoom of Region of Interest in the images. The diseases in this database are Acne, Lentigines, Leprosy, Melasma, Periorbital hyperpigmentation and Postinflammatory hyperpigmentation. Furthermore, these images were clinically verified, which helped in sorting out the images with better authenticity.

Table 1: Count of images for each diseases in database

Disease	Total images per disease
Acne	22
Lentineges	15
Leprosy	24
Melasma	26
Periorbital Hyperpigmentation	19
Postinflammatory Hyperpigmentation	18
Vitiligo	38
Others	21

3.2 Pre-Processing

Once the database is ready, the next process is pre-processing which ensures a clean and noise free database. Image processing routine is used to extract out the skin from images calibrated for asian skin tones.In these routines we have implemented image smoothing for noise reduction, Image sharpening to increases interpixel gradients to make edges crisp and clear, dynamic range adjustment to controls the brightness of the image , Rotation and flip image on spatial axis.

Data Augmentation is used to eliminate scarcity of data which has been fulfilled by morphing the small subset of image data based on image processing routines to have a variety of data points on which the model can train effectively.

3.3 Model Architecture

The Convolutional Neural Networks are used for inferencing due to their ability to capture spatial dependencies with translation and orientation invariant.

CNNs are regularized versions of multilayer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. The "full connectivity" of these networks make them prone to overfitting data. CNNs take a different approach towards regularization: they take advantage of the hierarchical pattern in data and assemble patterns of increasing complexity using smaller and simpler patterns embossed in their filters.[12]

3.3.1 Transfer learning techniques

Convolutional neural networks usually require a large amount of training data in order to avoid overfitting. A common technique is to train the network on a larger data set from a related domain. Once the network parameters have converged an additional training step is performed using the in-domain data to fine-tune the network weights, this is known as transfer learning. Furthermore, this technique allows convolutional network architectures to successfully be applied to problems with tiny training sets[12].

3.1.1.1 VGG19

VGG-19 is a convolutional neural network that is 19 layers deep. VGG19 is a variant of VGG model which in short consists of 19 layers (16 convolution layers, 3 Fully connected layer, 5 MaxPool layers and 1 SoftMax layer).It is version of the network trained on more than a million images from the ImageNet database. The pretrained network can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals. As a result, the network has learned rich feature representations for a wide range of images. [13]

3.3.1.2 ResNet50

The ResNet-50 model is a convolutional neural network (CNN) that is 50 layers deep. ResNet50 is a variant of ResNet model which has 48 Convolution layers along with 1 MaxPool and 1 Average Pool layer.A Residual Neural Network (ResNet) is an Artificial Neural Network (ANN) of a kind that stacks residual blocks on top of each other to form a network.[14].The Resnet50 made the use of 3-layer bottleneck blocks to ensure improved accuracy and lesser training time.

IV. RESULTS

4.1 Comparison of accuracy of models for each disease in Indian dataset by proposed method

Table 2: Disease-wise accuracy for all three models by proposed method

Model Architecture	Acne	Lentigines	Leprosy	Melasma	Periorbital Hyperpigmentation	Postinflammatory Hyperpigmentation	Vitiligo	Other
ResNet50	74%	67%	0	46%	21%	54%	100%	37%
VGG19	74%	67%	0	46%	21%	54%	100%	37%
CNN	60%	67%	100%	46%	21%	54%	0	37%

For Leprosy, CNN is giving best accuracy unlike VGG19 and ResNet50 which are not able to detect it. Whereas for Vitiligo, ResNet50 and VGG19 are giving best accuracy and CNN is not able to detect it.

4.2 Comparison of accuracy of models for each disease in Indian dataset by doctor's opinion

Table 3: Disease-wise accuracy for all three models by doctor's opinion

Model Architecture	Acne	Lentigines	Leprosy	Melasma	Periorbital Hyperpigmentation	Post inflammatory Hyperpigmentation	Vitiligo	Other
ResNet50	73%	89%	0	46%	22%	77%	100%	44%
VGG19	67%	89%	0	46%	22%	77%	100%	50%
CNN	60%	79%	0	46%	22%	77%	100%	25%

All the three models give better and same accuracy for PIH and Vitiligo. For Lentigines, ResNet50 and VGG19 give the same accuracy. For "Other" diseases VGG19 is giving comparatively better accuracy than other two models

4.3. Performance metrics of dataset by proposed method

Table 4: Performance metrics of overall disease for all three models by proposed method

Dataset	Model	Accuracy
Indian dataset	CNN	75.25%
	ResNet50	82.43%
	VGG19	86.4%

Table 5: Performance metrics of overall disease for all three models by doctor's opinion

Dataset	Model	Accuracy
Doctor verified indian dataset	CNN	74.28%
	ResNet50	82.72%
	VGG19	82.40%

From Table 4 and Table 5, it can be observed that after sorting the images as per the doctor's opinion, the overall accuracy of VGG19 decreases but disease-wise accuracy increases significantly for Lentigines, Post Inflammatory Hyperpigmentation and Vitiligo. This also means that all the three models are working fine, since for CNN and ResNet50 the accuracies are almost same.

V. CONCLUSION

The accuracy obtained using the proposed method using the Indian dataset is 86.4% (VGG19) whereas when the same model was tested for the HAM10000 dataset, the accuracy of the model came to 93% (ResNet50). By this, it can be concluded that due to the sparse dataset of Indian skin tone, the accuracy is less. This can be overcome if there is sufficient image in the dataset. By proposed method, ResNet and VGG19 show best results for Acne, Lentigines and Vitiligo while CNN gives excellent accuracy for Leprosy.On the other hand, when compared with doctor's opinion method, all the three models (CNN, ResNet50,VGG19) shows the same accuracy for Post-inflammatory hyperpigmentation and Vitiligo.

VI. FUTURE SCOPE

Since the dataset is very less and is also not available easily, one way of increasing the dataset is by converting the available images into their RGB corresponds.

VII. ACKNOWLEDGMENT

We thank Dr. Pradnya Poharkar (B.A.M.S, CSD, Reg.No 1-55904-A) for verifying images from our database that helped us organize images of each disease more effectively.

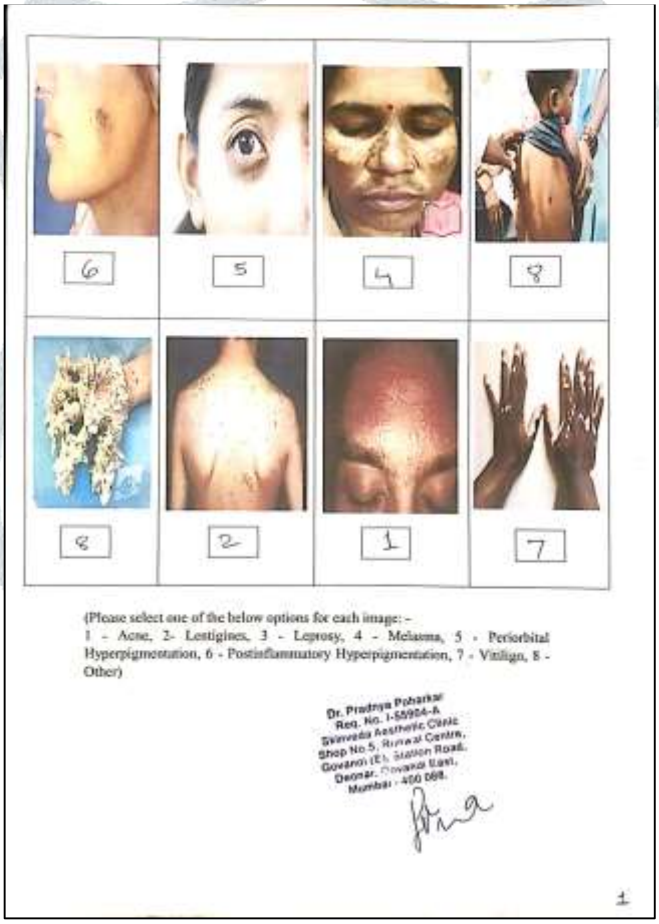

Fig.2: Database verification

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