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Skin disease detection using Image Processing and Machine Learning

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Abstract: Dermatological diseases are the most prevalent diseases worldwide. Despite being common, its diagnosis is extremely difficult and requires extensive experience in the domain. In this research paper, we provide an approach to detect various kinds of these diseases. We use a dual stage approach which effectively combines Computer Vision and Machine Learning on clinically evaluated histopathological attributes to accurately identify the disease. In the first stage, the image of the skin disease is subject to various kinds of pre-processing techniques followed by feature extraction. The second stage involves the use of Machine learning algorithms to identify diseases based on the histopathological attributes observed on analyzing of the skin. Upon training and testing for the six diseases, the system produced an accuracy of up to 95 percent. This paper proposes a skin disease detection method based on image processing techniques. This method is mobile based and hence very accessible even in remote areas and it is completely non-invasive to patient's skin. The patient provides an image of the infected area of the skin as an input to the prototype. Image processing techniques are performed on this image and the detected disease is displayed at the output. The proposed system is highly beneficial in rural areas where access to dermatologists is limited.

Keywords: Dermatology, Image Processing, Computer Vision, Machine Learning, Data Mining, Computational Intelligence, Automated Disease Diagnosis

I. INTRODUCTION

Dermatology is one of the most unpredictable and difficult terrains to diagnose due its complexity. In most developing countries, it is expensive for a large number of people to consult a dermatologist. The ubiquitous use of smart phones in a developing country has opened up new avenues for inexpensive diagnosis of diseases. We can use the camera technology present in every smartphone and exploit the image processing capabilities of the device for diagnosis. We have developed an application that utilizes a two staged approach in order to tackle the problem. The first stage involves Image Processing for identification and the second stage involves Machine Learning for a near fool proof solution. Difficulty for the differential diagnosis is that a disease may show the features of one disease in the initial stage and may have the characteristic features of another in the following stages.

Usually a biopsy is necessary for the diagnosis but these diseases share many histopathological features as well. This issue is solved by using machine learning models on the clinically evaluated features which are determined by an analysis of the skin samples under the microscope. Owing to the subjective nature of diagnosis, medical students find it difficult to verify their diagnosis. This system acts as an effective learning tool, aiding verification of their results as they have access to clinical data. We have achieved higher accuracies using an ensemble of Computer Vision and Machine Learning algorithms. Skin disease is an abnormal condition of the skin. Skin plays an important role in protecting the body from harmful bacterial, fungal and parasitic infections. Hence the correct diagnosis of skin disease is crucial. Various factors causing skin diseases and affecting skin disorder pattern are genetics, occupation, nutrition, habits, etc. Geographical factors like season and climate also affect. In developing countries, overcrowding and poor hygiene are responsible for spreading of skin diseases. The pattern of skin diseases varies from country to country. Moreover, remote areas are severely affected.

II. PROPOSED SYSTEM

This system acts as an effective learning tool, aiding verification of their results as they have access to clinical data. We have achieved higher accuracies using an ensemble of Computer Vision and Machine Learning algorithms. The system is capable of detecting three of the most commonly occurring diseases, namely – Psoriasis, Lichen Planus, Pityriasis Rosea.

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III. COMPUTER VISION

The system uses Computer Vision as the first stage in Identification of the type of skin disease based on the Numerous features extracted from the image using various image processing techniques. The computer vision stage itself consists of two phases. In the first phase, we pre-process the image taken through the camera of the smart phone in order to extract the necessary features. The second phase involves using the features extracted in order to identify the disease using various algorithms like Neural Networks.

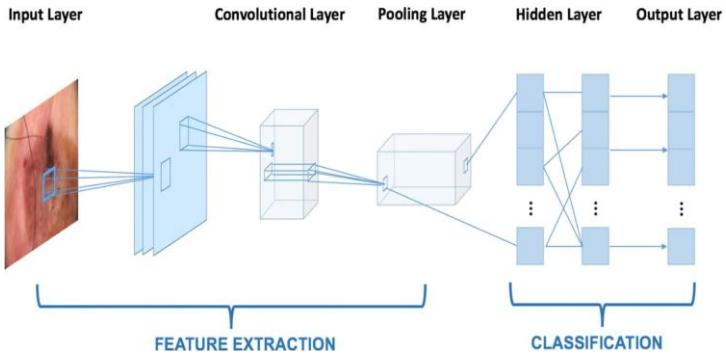
IV. MACHINE LEARNING

The system uses various Machine Learning techniques (CNN) in the second stage in order to refine the classification of the image.

Convolutional Neural Network:-
A neural network is a system of interconnected artificial "neurons" that exchange messages between each other. The connections have numeric weights that are tuned during the training process, so that a properly trained network will respond correctly when presented with an image or pattern to recognize. The network consists of multiple layers of feature-detecting "neurons". Each layer has many neurons that respond to different combinations of inputs from the previous layers. Typical CNNs use 5 to 25 distinct layers of pattern recognition. Training is performed using a "labelled" dataset of inputs in a wide assortment of representative input patterns that are tagged with their intended output response. Training uses general-purpose methods to iteratively determine the weights for intermediate and final feature neurons. Neural networks are inspired by biological neural systems. The basic computational unit of the brain is a neuron and they are connected with synapses.

Layers of CNN:-

1) Convolution Layers
2) Pooling/subsampling Layers
3) Non-Linear Layers
4) Fully connected Layers



System Diagram of CNN

CNN is used due to following reasons:-

1) Ruggedness to shifts and distortion in the image.
2) Fewer memory requirements.
3) Easier and better training.

Identification of Disease from the features:-

1) Psoriasis: It can be identified based on the occurrence of plaques on the face, torso, knees and elbows. The special feature of this disease is that it occurs near the nail beds as well.
2) Lichen Planus: Being present on the face, it is harder to differentiate from other diseases, but it exhibits purple coloured patches which turns on its respective feature function.
3) Pityriasis Rosea: This condition affects mainly the knees and elbows. The number of components Becomes a distinguishing feature as the number of Rashes is high.

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V. MATHEMATICAL MODEL

Mathematical Model:
S={s, e, i, o, functions, DD, NDD, Success, Failure}
Where,
S = System
s = initial state = Give input Images and training data
e = end state = Skin detection
i = Input = image, Training data
o = output= Area of detection

Functions = {f1, f2, f3}

f1 = Taking image
f2 = Give inputs Image, Training data
f3= Gary scale conversion
f4= Using CNN It will detect the Detection
Deterministic data = same output from a given condition and return the same result every time

Non deterministic data = result will vary every time for given input
NP Complete: Set of I/O are limited.
Success condition = According to proper inputs
Failure condition = Wrong inputs and blur image

VI. COMBINED RESULTS

The mobile application developed on the principles as described above produce better results than any application in this space owing to the two stage refinement in detection. Though each stage in itself produces fairly accurate results, combining the two stages increases the accuracy, making this application an efficient and dependable system for dermatological disease detection. Furthermore, this can be used as a reliable real time teaching tool for medical students in the dermatology stream. As an added advantage, this application can also be used by the common user as we have been able to achieve fairly accurate detection rate by Computer Vision techniques alone.

VII. SCREENSHOTS

This are the screenshot of our system GUI:

1. This is user SIGN UP page. You have to first create your account.

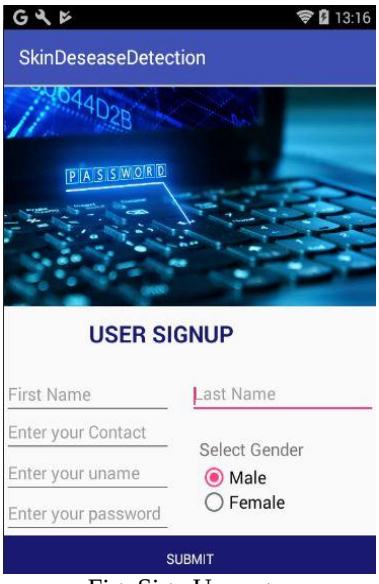

Fig: Sign Up page

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2. This is LOG IN page of our system:

Fig: Log In page

3. After Log In you have to upload the image of affected part which you have to predict.

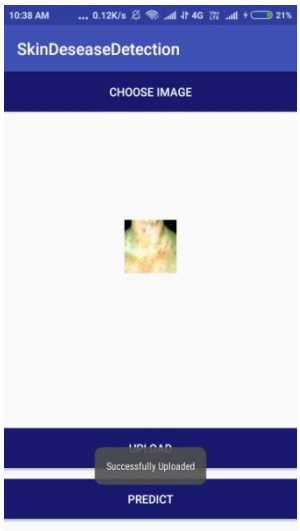

Fig: Upload image

4. After uploading image you will get the predicted disease as in fig:

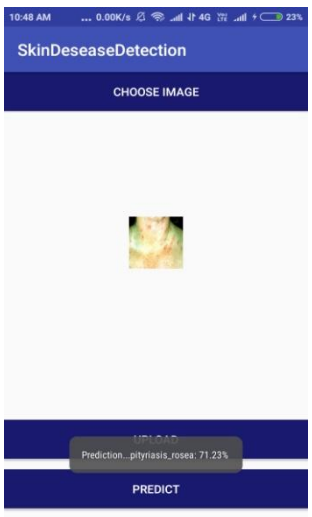

Fig: Disease Prediction

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VIII. FUTURE WORK

The system suffers from inaccuracies when it is tasked with detection of diseases on varying skin colors. As part of our future work, we would like to make the system develop immunity to the varying skin colors. Our focus in this system has been on the six of the most common dermatological diseases. We intend to continue working with the doctors to come up with better feature functions in order to broaden the number of diseases that the system can detect.

IX. CONCLUSION

By using image processing from which researcher can get an idea for an efficient techniques. There are future scopes of improvements in present methodologies as no model guarantee hundred precent accuracy and is also limited to few number of skin diseases. In future present methodologies can be expanded for the detection of skin diseases in animals. A common model should be implemented for identification of all types of skin disease. Comparison of our work with related works in this domain has revealed stark differences in the implementation and performance. The novel method of using a dual stage system has given very promising results in identification of skin diseases with accuracies of up to 95%.

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