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Skin Disease Detection Using Image Processing and Neural Networks

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Abstract: - Dermatology is one of the diseases which is unpredictable and difficult to diagnose because of its complexity. Dermatology is very difficult to diagnose because of its complexity and expensive. In most developing countries, it is expensive for people to detect. According to world Health Organization (WHO), skin disease is the most common in India. The present use of smartphones in the developing countries like India has opened new avenues for diagnosis of disease inexpensively. In smartphones camera technology can be used to exploit the image processing capabilities of the device for disease diagnosis. The proposed system deals with the creation of the application that helps to diagnose the skin disease. This application uses machine learning and image processing technologies to detect the type of the skin disease. The system consists of 2 parts- machine learning and image processing. Image processing part deals with applying the filters to images to remove noise to make it uniform. Unwanted elements must be removed from the image before processing. If unwanted elements are not removed it will affect the output efficiency. The machine learning part deals with the processing of data from the image and generation of the result.

Key Words — disease detection, edge detection, hardware Resources image processing, k-means, MATLAB, neural networks, operating system, software resources.

I. INTRODUCTION

Dermatology is the most unpredictable disease due to its complexity and expensive. In the developing countries like India it is difficult to consult a dermatologist. There is a need for computational technique with the view to minimize the error in the detection and produce accurate results. The proposed system is the self-learning system which can detect the skin disease using the image processing and neural networks.

System has 2 parts image processing and machine learning.

In image processing the filters are applied to the image to increase the accuracy of the image. Machine learning is used to process the data collected from the image and detect the disease. Before image processing the unwanted noises from the image is removed to increase the accuracy of the result. To detect the affected part, the edges are detected. The image processing algorithms and machine learning algorithms are applied to detect the disease. Using these applications, it is easy to detect the type of the disease.

As detailed in the diagram, the first step in this process is image acquisition by an imaging sensor in conjunction with a digitizer to digitize the image. The next step is pre-processing.

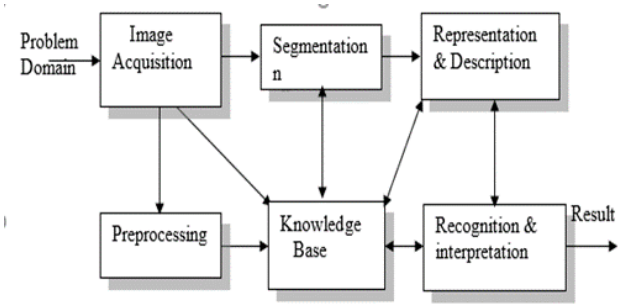

Fig.1.1. Block Diagram for fundamental sequence

Pre-processing deals with enhancing, noise removing, isolating regions etc. Segmentation partitions the image into its parts or objects. Usually Raw pixel data is the output of the segmentation which consist either boundary of the region or pixel of the region themselves. Representation is the process of transforming the raw pixel data into a form useful for subsequent processing by the computer.

Description deals with differentiating one class of objects from another. Recognition is the process of assigning label to an object based on the information provide by its descriptors. Interpretation is process of assigning meaning to an ensemble of recognized objects. The knowledge about the problem

domain is in the knowledge base. The knowledge base guides each processing module and controls the interaction between the modules.

II. PROPOSED SOLUTION

The proposed solution in this paper is a prototype with a database of 4 common skin diseases, using which patient can self-diagnose and get some prior knowledge of their skin disease before consulting the dermatologist. This prototype can be used in mobile hospitals in rural areas. Thus, this prototype can be accessed even in most remote areas of the country.

The proposed prototype provides an easiest and convenient method of skin disease detection where the patient provides a picture of the infected area as an input prototype and any further analysis is done on this input image. No pricking of the skin is required.

A. Block diagram

The proposed system consists of two phases: training and testing. Training process analyses and performs image processing on the training database whereas the testing process analyses the input image provided by the patient. Before any analysis on the input image is done, image pre-processing is done so that all images are consistent in desired characteristics.

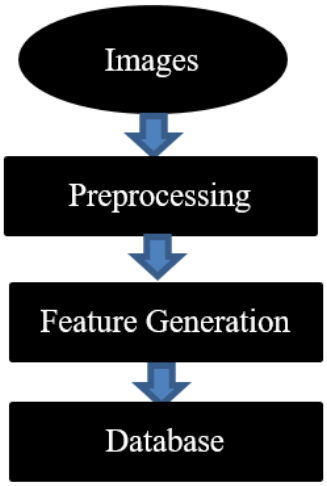

Fig.2.1. Block diagram for database creation

In the training process, the training database first undergoes pre-processing and then its features are generated/extracted.

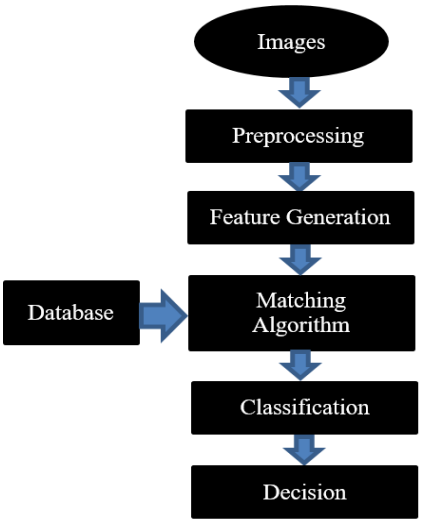

Fig 2.2 Block diagram for testing process

From fig 2.2, the testing process consists of an image provided by the patient which undergoes preprocessing and its features are generated.

Since this is an object query recognition application, the feature vectors of the two processes are compared and are classified by matching machine learning algorithms.

B. Diseases being considered

According to dermatologists, most common skin diseases are eczema, impetigo, melanoma, psoriasis, acne, warts, hives and shingles. Out of these, we have considered 3 skin diseases along with one normal skin for creating database are: Eczema, impetigo, melanoma and unaffected skin.

Fig 2.3 eczema

Fig 2.4 impetigo

Fig 2.4 melanoma

Fig 2.5 normal skin

80 percent of people have had some skin related issues in their lifetime. Eczema being a long-term skin disease needs early diagnosis and constant care. Global warming, pollution and ultraviolet rays contribute to the increase of skin diseases.

III. METHODOLOGY

The Disease Detection System involves three phases: 1. Image Pre-Processing; 2. Feature Extraction; and 3. Classification.

A. Image Processing

Once the user inputs the image, the image will be pre-processed and the model will be trained to classify the disease. The pre-processed steps involve image acquisition, grey image, image filtering, smoothening and sharpening image, image segmentation, enhance contrast of image etc.,

1. *RGB to Greyscale conversion*:

In grayscale morphology, images are functions mapping a Euclidean space or grid E into, where is the set of reals, is an element larger than any real number, and is an element smaller than any real number.

2. *Image Enhancement*:

Image enhancement operations improve the qualities of an image like improving the image's contrast and brightness characteristics, reducing its noise content, or sharpen the details.

This just enhances the image and reveals the same information in more understandable image. It does not add any information to it.

3. *Image Filtering:*

Median filtering is used specially to reduce impulsive, salt-pepper noise. In this, each pixel value in an image is replaced with the median value of its neighboring pixels including itself.

4. *Image Segmentation:*

Image segmentation is performed to separate suspicious lesion from normal skin. This is implemented through MATLAB. multilevel threshold method is performed where image is segmented into 3 levels. The Segmented image is converted into a color image using label2rgb ().

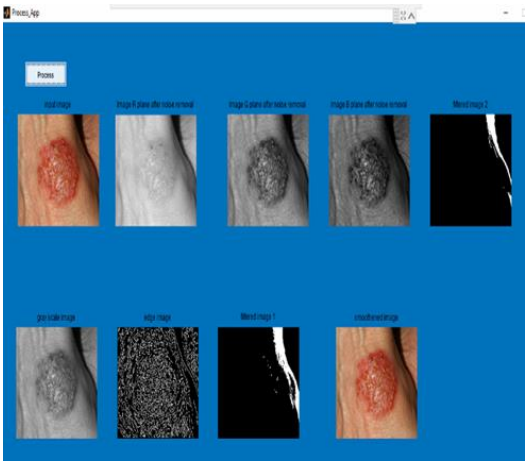

Fig. 3.1. Image Pre-processing steps.

B. Feature Extraction

We mainly use texture feature extraction, Gray Level Co-occurrence Matrix (GLCM) texture considers the relation between two neighboring pixels in one offset, as the second order texture. The gray value relationships in a target are transformed into the co-occurrence matrix space by a given kernel mask. In the transformation from the image space into the co-occurrence matrix space. It contains information about the positions of the pixels having similar gray level values.

The following features are extracted: Energy, Entropy, Contrast, Inverse Difference Moment (IDM), Homogeneity, Correlation, Variance, RMS, S.D, Mean, Skewness, Smoothness, Kurtosis.

Entropy:

Entropy is the measure of randomness that is used to characterize the texture of the input image. Its value will be maximum when all the elements of the co-occurrence matrix are the same.

$$Entropy = -\sum_{i=0}^{G-1}\sum_{j=0}^{G-1} P(i,j) * \log(p(i,j))$$

Energy:

Energy can be defined as the measure of the extent of pixel pair repetitions. It measures the uniformity of an image. When pixels are very similar, the energy value will be large.

$$Energy = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} M^2(i,j)$$

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Contrast:

The contrast is defined in Equation, is a measure of intensity of a pixel and its neighbor over the image. contrast is determined by the difference in the color and brightness of the object and other objects within the same field of view.

$$Contrast = -\sum_{i=0}^{N-1}\sum_{j=0}^{N-1}(\mathrm{i}-\mathrm{j})^2\mathrm{M}(\mathrm{i},\mathrm{j})$$

Inverse Difference Moment:

Inverse Difference Moment (IDM) is a measure of image texture as defined in Equation. IDM is usually called homogeneity that measures the local homogeneity of an image. IDM feature obtains the measures of the closeness of the distribution of the GLCM elements to the GLCM diagonal.

$$IDM = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1}\frac{1}{1+(i-j)^2}M(i,j)$$

Skewness:

Skewness is usually described as a measure of a dataset's symmetry – or lack of symmetry. A perfectly symmetrical data set will have a skewness of 0. The normal distribution has a skewness of 0.

$$\text{Skewness} = \frac{\mathrm{Q1}+\mathrm{Q3}-2\mathrm{Q2}}{\mathrm{Q3}-\mathrm{Q1}}$$

Kurtosis:

The kurtosis parameter is a measure of the combined weight of the tails relative to the rest of the distribution.

$$Kurtosis = \left\{\frac{n(n+1)}{(n-1)(n-2)(n-3)}\sum\frac{(X_i-\bar{X})^4}{s^4}\right\}-\frac{3(n-1)^2}{(n-2)(n-3)}$$

C. Classification:

For classification, Support Vector Machine (SVM), Convolutional Neural Network (CNN) and Probabilistic Neural Network (PNN) classifier is used.

1. *SVM*

It is one of the common classification algorithms, which use a decision plane to separate a data set having different classes. The principal used in SVM is statistical and structural risk minimization. The SVM is already a ready-to-use available classifier in MATLAB.

Extracted features are directly fed into the SVM classifier. This process involves Training and Testing phases.

SVM is used to identify three different skin diseases. Firstly, the sample number and training number are selected from the extracted features like: color feature, and texture feature, then by using the rational kernel function of support vector machine, the classification model can be established.

2. *Neural network*:

CNN classifier is a layered architecture where multiple layers perform various operations to train and test the image data.

The Fully Connected Layer multiplies an input with weight matrix, adds bias vector and it is responsible for creating a model for classification layer by applying SoftMax Layer. SoftMax Layer is a logistic activation function which is used for multiclass classification.

PNN (Probabilistic Neural Network) from a list of classified samples. The samples are given in the format of a matrix containing a single sample per row. Comparison of both the classifiers based on accuracy and with the help of confusion matrix and displays the name of disease.

The confusion matrix shows the percentage of error and accuracy in classification.

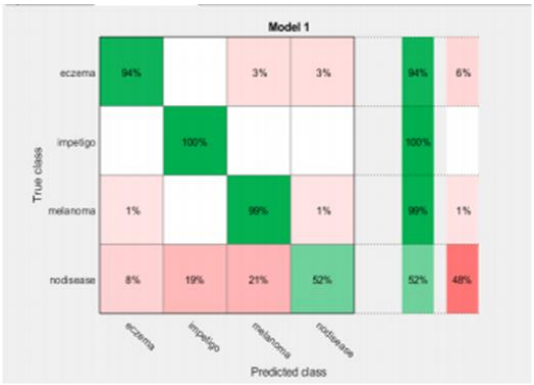

Fig.3.2. Disease name classification using confusion Matrix

IV. CONCLUSION

The system was implemented using MATLAB on windows operating system. Nowadays skin diseases are extremely common and must be detected as early as possible. The proposed system in this paper provides a feasible solution for the detection of skin diseases with the maximum accuracy rate. Accuracy may vary with image quality, quantity, and features. The project was developed using matlab code and a user interface was designed so that this application can be

used even by a novice user, so that anyone can use this app to detect skin diseases. Further to this an email notification is added so that the report can be sent as an email to the concerned user for further treatments. The proposed system is able to detect many types of distributed diseases with many distributed regions closed together and unable to detect the diseases that have distributed regions separately by distance.

V. FUTURE ENHANCEMENT

This proposed prototype consists of three diseases, that is melanoma, eczema, impetigo and normal skin using image processing with SVM classifier and CNN classifier. For commercial viability, the prototype must have a database that includes most skin diseases with pictures of all skin tones and types. This would lead to efficient and accurate detection.

As this system advances, dermatologists will need to understanding of hoe neural networks works, along with when and how it should be appropriately used in an open environment.

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