Dermatological Disease Detection using Image Processing and Artificial Neural Network

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Abstract— **Skin diseases are among the most common health problems worldwide. In this article we proposed a method that uses computer vision based techniques to detect various kinds of dermatological skin diseases. We have used different types of image processing algorithms for feature extraction and feed forward artificial neural network for training and testing purpose. The system works on two phases- first pre-process the colour skin images to extract significant features and later identifies the diseases. The system successfully detects 9 different types of dermatological skin diseases with an accuracy rate of 90%.**

Index Terms— **Skin disease, artificial neural network, computer vision, clustering, dermatology.**

I. INTRODUCTION

Dermatology is the branch of medicine dealing with the hair, nails, skin and its diseases, It is a specialty with both medical and surgical aspects A dermatologist takes care of diseases, in the widest sense, and some cosmetic problems of the skin, scalp, hair, and nails. Human skin is one of the most unpredictable and difficult terrains to automatically synthesize and analyze due to its complexity of jaggedness, tone, presence of hair and other mitigating features. In a developing country like Bangladesh it is expensive for a large number of people to go to dermatologist for their skin disease problem. Every year a large number of populations in the developing countries like Bangladesh suffer due to different types of skin diseases. So, it is very necessary for both the patients and dermatologists to have an automated skin disease detection system especially in developing countries. Even though there have been several researches conducted to detect dermatological skin diseases using Computer Vision based techniques but almost every one worked for only 2-3 diseases. In our wok we have worked to detect 9 different types of skin diseases. They are Eczema, Acne, Leprosy, Psoriasis, Scabies, Foot Ulcer, Vitiligo, Tinea Corporis and Pityriasis Rosea. We have used 8 different types of algorithms for image pre-processing (YCbCr, grey image, sharpening filter, median filter, smooth filter, binary mask, histogram and sobel operator). Our system will take 10 different features from image pre-processing results and user inputs (liquid type, liquid colour, elevation, duration, feeling, gender, age). These features are used for training and testing purpose of our feed forward artificial neural networks (ANN). Using artificial neural networks (ANN) as knowledge base appears to be a promising method for diagnosis and possible treatment routines. In this article next we will discuss in brief about the related works regarding this topic, architecture, methodology, pre-processing algorithms and learning algorithm used in our proposed method. Then we will discuss about result and efficiency of our system.

II. RELATED WORK

Detecting different types of skin diseases from colour image is a very challenging task in computer vision. Finding out different features from the colour skin images of the infected area of different skin diseases and detecting them with a high accuracy rate is the primary purpose of this research.

Researchers are working on several algorithms that can be used to detect different types of skin diseases. Kabari et al [6] crated a artificial neural networks system that predict diagnosis and routine treatment for skin diseases patients and their accuracy rate is *90%.* M. SHAMSUL et al [11] proposed an automated dermatological diagnostic system. They have used different pre-processing algorithms like ours and used feed forward back propagation artificial neural networks for training and testing purpose. Shuzlina et al [12] elaborates a prototype with back propagation neural network (BPNN) to assist the dermatologist accuracy rate was *91.2%.* Nidhal et al [15] proposed a psoriais diseases detection system using feed forward artificial neural networks. Nasir et al [2], Shang et al [7] and Nibaran et al [13] compared between different features of different types of algorithms. Hashim et al [1] used different matlab tools for image processing and Wahab et al [3] presented a texture classification system. Gerald et al [4] have introduced an approach that produces accurate overlays of thermal and visual medical images. Chang et al [8] proposed an automatic facial skin defects detection and recognition system with an accuracy rate of *98.0%.*

In this research similar approach like [6],[11] is used in order to detect different types of skin diseases from colour image. The main difference between their system and our system is, they have considered region of interest (ROI) as image extracted feature but we have considered average colour code of infected area, shape, and area size and also some inputs from user as features like elevation of the infected area, liquid colour, liquid type etc.

III. ARCHITECTURE AND METHODOLOGY

The system works on two phases- first pre-process the colour skin images to extract significant features and later identifies the diseases. At first we are using the colour skin images and then apply 8 different image processing algorithm on it to find some visual pattern and significant features like average colour code of infected area, infected area size in case of pixels and shape or edge detection of an infected area. Then we use user inputs like gender, age, duration, liquid type,

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liquid colour, elevation and feeling. We train user input values along with colour skin image extracted features to train and test into a feed forward back propagation artificial neural network to identify the dermatological disease. Here we have shown the complete architecture of the system through a diagram.

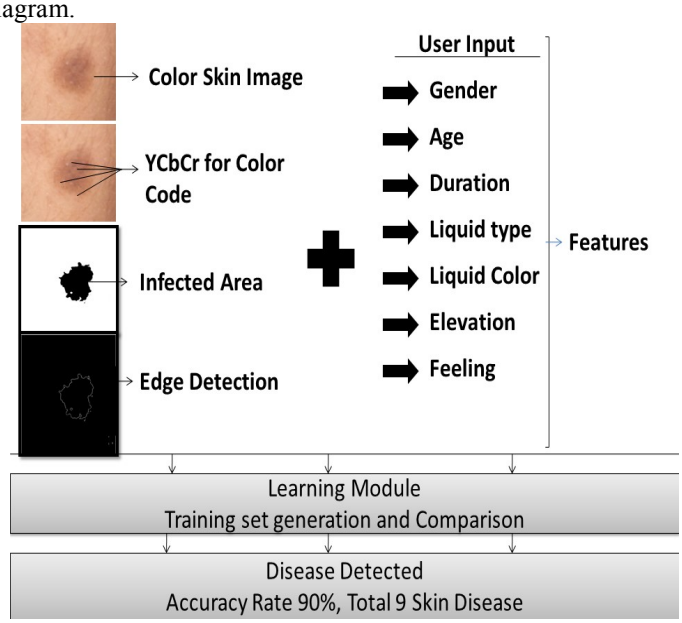

Figure 1: Complete Architecture of the system.

IV. Data Collection

Our first task was to collect necessary data's (image, information) of patients. For fulfilling this purpose we went to Sir Salimullah Medical College and Mitford Hospital, Dhaka, Bangladesh, Department of Dermatology. We took images of total 128 patients of 9 different diseases from the dermatology department.

Table 1: Data Collection Table

Disease Name	Number of Patients	Images taken
Eczema	7	28
Acne	25	152
Leprosy	5	24
Psoriasis	12	99
Scabies	40	277
Foot Ulcer	6	35
Vitiligo	15	62
Tinea Corporis	10	66
Pityriasis Rosea	8	32

A specialized doctor was present to validate and record the external data of the patients such as disease history, feeling in diseased part of body, elevation of the diseased region etc.

Table 2: Camera Specification

Camera	Sony Cyber shot DSC-W550
Focusing	The camera was focused manually to adjust the variable nature of natural light
Image Resolution	14.1 Megapixels
Shutter Speed	1/20 to 1/125 seconds (based on natural lighting)

V. Pre-processing Algorithms

We pre-processed the images and trained the resulted images in our feed forward back-propagation neural network. Eight different types of algorithms were used, they are grey image, sharpening filter, median filter, smooth filter, binary mask, histogram, YCbCr and sobel operator. The algorithms were implemented sequentially.

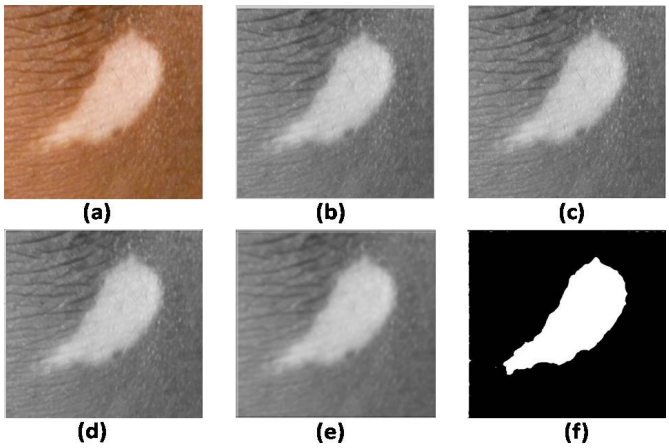

Figure 2: Result of Pre-processing algorithms. (a) Original Colour skin image, (b) Grey Scale image conversion, (c) sharpening filter, (d) Median filter, (e) Smooth Filter, (f) Binary Mask

The normal image of the infected area is converted into a greyscale image at first. Sharpening filter is applied to the greyscale image to get shaper details of the infected area. Median filter is used after sharpening filter to remove noise. We used 5*5 matrix here for median filter. Smoothing filter is applied after media filter. The idea of mean (smoothing) filtering is simply to replace each pixel value in an image with the mean ('average') value of its neighbours, including itself. Binary image was generated from the mean filtered image and distribution of colour of binary image was showed by histogram. YCbCr was used to extract average colour code of the infected area from the binary image. Sobel operator was applied to binary image to detect edge of the infected area.

Figure-2 shows the original colour skin image and results of implementing different algorithms.

VI. Feature Extraction

Two types of features were extracted are given below:

1. Features extracted from images (colour, area, edge)
2. Features extracted from user input (liquid type, liquid colour, elevation, duration, feeling, gender, age)

1. Features Extracted from Images

The first feature extracted from colour image is the colour code of the infected area of the skin. We used YCbCr algorithm to find out the colour code of the infected area from the binary image. The area or size of the infected skin is important to classify the disease. It is done by first getting the histogram graph of the binary image. After we get the histogram of the binary image we get to know the pixel of the whole area. Then we multiplied the area in pixel with the ratio of pixel to finally get the area or size of the infected skin in mm^2.

Detecting the edge of the infected area gives us the shape, as it is very important to detect the diseases. To detect the edge we have used sobel operator here. Binary mask splits the main infected area from the whole image and applying sobel

operator in the binary image gives us the shape of the area by detecting the edge.

2. Features Extracted from User Input:

The features we collected from patient's history are liquid type, liquid colour, elevation, duration, feeling, gender, age. Three different types of liquid type (blood, pus, watery) are considered. Liquid colour parameters for blood, pus and watery are red, yellowish/white and transparent respectively.

During data collection we measured elevation of the infected area for different diseases. The average approximate sizes of elevation for all diseases are 0.1cm-7cm depending on the situation expect leprosy patients because the elevation of infected area is very high for leprosy. We saw different types of feeling of patients for different diseases like itching, pain, burning sensation, numbness, headache, fever etc. Gender, age, duration these features are collected from normal patient's survey. A specialized dermatologist helped us to validate the survey we conducted on the patients.

VII. Learning Algorithm

We have used feed-forward back-propagation neural network training to perform this step. We validated and tested our system using the tenfold cross validation process. The virtue of using a cross validation technique is that there are no overlapping of the test data and training data, making the system testing results viable and dependable. We have trained our feed forward back-propagation neural network with 10 different features, 3 of them are extracted from the image pre-processing algorithms and 7 of them are from user inputs. In this system we have used 100 neurons in our hidden layer to get the best result from the system. Some sample feature values are given below that we have used in our input layer.

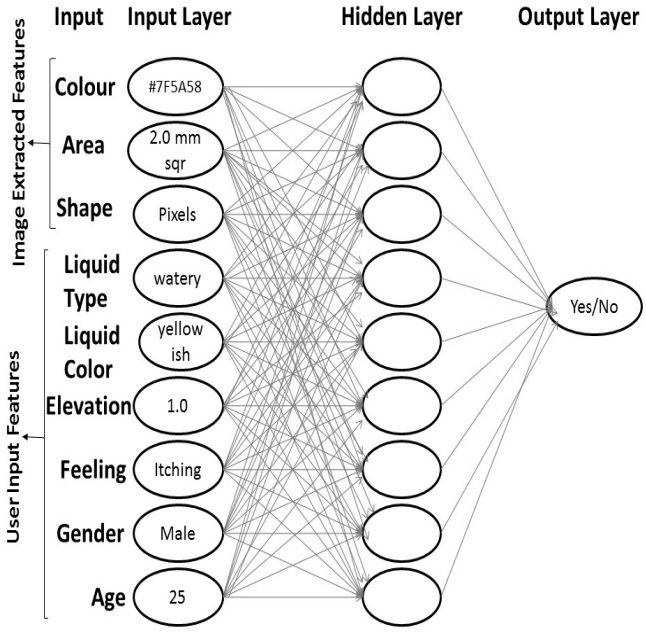

Figure 5: Feed forward back propagation artificial neural network diagram

In the figure-5 we can see that we have trained our feed-forward back-propagation neural network by 10 features. Features like colour, area, edge/shape are extracted from colour skin images and rest of the features like liquid type, liquid colour, elevation, feeling, gender, age are extracted from user input.

VIII. Result

In this research 775 colour skin images were used of 128 dermatological disease patients. The proposed system can successfully detect 9 different dermatological diseases with an accuracy of 90%. We have used 15 % of our colour skin images for testing purpose, 10% of images for validation purpose and 75% of images for training purpose. The supervised system works well than semi-supervised and unsupervised system. Detection rate of our supervised system is 90% where the detection rate of semi-supervised system is 88% and 85% for unsupervised system.

In the figure-6 we can see different detection rate for 9 different diseases. Detection rate of diseases that has low elevation in the infected area like foot ulcer, vitiligo and psoriasis are very high like 97%, 97% and 91%. Where the detection rate of diseases that has low elevation in the infected area are comparatively low which is between 85-88%. The whole processes of this proposed system starts with taking a colour skin image and pre-process the image by applying 8 different algorithms. Applying pre-processing algorithms we get three image extracted features which we use in our feed forward back-propagation neural network along with seven other user input features. Out of 9 dermatological diseases our system shows best accuracy rate for foot ulcer and vitiligo and our system did not perform according to our expectation for acne and tinea corporis.

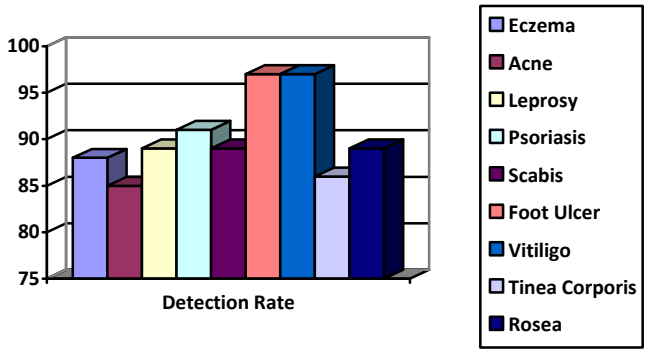

Figure 6: Detection rate of different skin diseases

In the Table- 3, we provided sample colour skin images of nine dermatological diseases, approximate elevation rate of each dermatological disease, total image used to train and test our system, successfully disease detected images and accuracy rate for each dermatological disease.

We can see that our system performed well for diseases that has low elevation in the infected area. For this type of disease images, system can generate binary image accurately and sobel operator can detect the shape of the infected area more precisely.

Table 3: Disease detection rate

Disease Name	Sample image	Elevation (cm)	Total image	Disease detected	Detection rate %
Eczema		0.1-0.3	28	23	88%

Acne		0.2-0.4	152	140	85%
Leprosy		1-7	24	20	89%
Psoriasis		0.1-0.2	99	90	91%
Scabies		0.15-0.25	277	246	89%
Foot Ulcer		NO	35	33	97%
Vitiligo		NO	62	60	97%
Tinea Corporis		0.1-0.2	66	52	86%
Rosea		NO	32	23	89%

IX. Conclusion

In this article we presented an automated system for detecting various kinds of skin diseases. At first it was not easy for us as we were trying to analyse human skin characteristics since human skin is one of the most difficult surface to analyse. It is unique and novel since our dataset was not acquired from secondary sources; rather it was a work of months of toil in an actual hospital of Bangladesh making the dataset a standard dataset which is completely new in perspective of Bangladesh. The system examines an image of infected human skin and detects the disease with an accuracy rate of 90%. We have tested a total number of 775 skin images for 9 diseases.

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