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Prediction of Skin Diseases using Machine Learning Algorithms

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Abstract: *Skin diseases caused by fungi, bacteria, allergies, viruses and other infections are some of the common ailments that affect people. With the advent of cutting-edge medical technology, the diagnosis of skin diseases has been made possible and easy with the added benefits of the speed and accuracy. One of the challenges with diagnosis of skin diseases is that it is very expensive due to the high dermatologists' fees as well as the cost of the medical equipment used in screening. An image processing system used for the diagnosis of skin diseases is costly but it increases the speed at which diagnosis is done including increase in the number of accurate diagnoses per day. This paper proposes a skin disease diagnosis based on Machine Learning, particularly neural networks which are trained with a given dataset and later using images taken from screening medical equipment in digital, predict a particular skin disease with respect to a given dataset. Training involves the input of a dataset from which the minimum number of images after the sum of all classes in the dataset is obtained. The selected images are resized into uniform dimensions to avoid reduction of accuracy in prediction before feature collection is done. Matlab gives the best platform for implementing as it has high processing power which allows it to handle large amount of dataset and also the capability to debug the code easily.*

Keywords: Convoluted Neural Networks (CNN), Deep Neural Networks (DNN), Residual Neural Networks (RNN), MATLAB Resnet-50

I. INTRODUCTION

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Digital image processing is used in various fields and it helps in the automation of various processes that require a human's visual perception, which has effectively been side stepped by the inception of digital image processing. Digital image processing is very important because it involves the use of machines which are accurate every time they are running since they do not get tired despite the long time spent running. Another importance of digital image processing is the capability of using a high computation power obtained from advanced computers and computing concepts such quantum computing which can help in performing highly complex tasks within a small amount of time. Not only that, but also, application in a wide variety of areas which makes it very flexible.

Despite digital image processing gaining much of attention in technological advancements, it is also limited in terms of interoperability of a given system from one area of application to another. Usually this is the case because a digital image processing system is hard coded to only be effective and efficient in only one area of application. This in turn leads it to not performing well in another field. This problem is corrected by adding highly advanced digital image processing system with artificial intelligence, specifically neural networks which are capable of learning new tasks by specifying arguments in the algorithm.

Digital image processing has a lot algorithms which use different techniques but share common steps to achieve a given objective whether including image compression or image recognition. The fundamental steps in digital image processing are image acquisition, image enhancement, image restoration, color image processing, wavelets and multi resolution processing, compression, morphological processing, segmentation, representation and description, and object recognition.

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This paper argues for the usage of digital image processing together with neural networks in the recognition and identification of skin diseases.

II. RELATED WORKS

Medical diagnostics technologies are advancing specifically in terms of expert systems and application of artificial intelligence to achieve accurate prediction of diseases [1]. Intelligent systems that have been sufficiently trained in a particular domain of the diagnosis of specific illnesses have saved and helped a lot of people. Since the advent of machine learning and artificial intelligence, the medical industry has experienced exponential growth and a lot of attention in the scientific and technology sector by developing and conducting research in cutting- edge technology so as to improve medical diagnosis.

Expert systems were one of the necessary steps toward the automation of medical diagnosis however, they were not as accurate or as fast as those of neural networks [2]. Expert systems are rule-based where algorithm is based on conditions defined by a programmer or system engineer. In a field as complex as medicine, it is nearly impossible for a system developer to anticipate all possible conditions without missing out. This is one important reason why machine learning using neural networks is a solution to problems such as diagnosis and prediction of diseases.

In the paper [3] convoluted neural networks (CNN) are used as the basis for training a system. Deep neural networks (DNN) are the most basic but they have a disadvantage with vanishing gradients. This paper proposes residual neural networks (RNN) which jump certain layers in order to reduce vanishing gradients which negatively impact the overall training of neural networks as they are being used. RNN is also more important because the training is relatively faster than the DNN and CNN since some of the layers are jumped thereby making the training to be done faster without sacrificing the accuracy of the system.

[8]This system is developed for diagnosing skin diseases which allow user to identify diseases of the human skin to provide advises or medical treatments in a very short time period. The system uses technologies such as image processing and data mining for the diagnosis of the disease of the skin. The image of skin disease is taken and it must be subjected to various processing for noise eliminating and enhancement of image. This image is immediately segmentation of images using threshold values. Finally data mining techniques are used to identify the skin disease and to suggest medical treatments or advice for users.

A system enables the user recognize skin diseases confronted of children through the Internet and make user for advice or Treatments in the shortest period of time. This is based on law and the ahead was used a sequence heuristics engine for development from the system. With this system, to assist and allows the user to Recognition of Paediatric. Dermatology through [10].

In this research paper [6], the input images obtained from the user is processed to predict skin disease presence or absence from a new input image. The input image of a user would be obtained using android application. In this system, the application would ask the user with many questions and disease type is predicted using the end user answers. At last the proposed system, suggests medicinal descriptions, surgery and medicinal drug based on the skin disease trained model. Skin diseases like Eczema, Fungal infection and Urticarial are been analysed in this project. This question and answer based application doesn't provide promising results every time.

III. SYSTEM IMPLEMENTATION

3.1 Proposed Work

This paper aims to show how a system of prediction of skin disease works from the perspective of all mathematical constructs and techniques including an explicit and a full account of algorithms used to include factors affecting the performance of the system. Acquisition and image processing is conventionally handled by a digital image processing algorithm while the training of the system involves the use of a convoluted neural network. MATLAB uses resnet-50 as one of convoluted neural networks which is known as residual neural network with 50 layers. Residual neural network resembles the constructs of a cerebral cortex's pyramid cells. It is an artificial neural network that skips several connections to traverse over various layers. Due to the capability of skipping several connections, the speed at which the network is trained is increased without sacrificing the efficiency and effectiveness of the network. Furthermore, it is

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used to avoid vanishing gradients during the obtaining of weights and partial derivative of error function. This paper provides a full account of how the training is done based on formal mathematical formulation of neural networks.

3.2 System Design

A. Forward Propagation:

A neural network given the weight of $W^{l-1,l}$ for connection from layer *l-1* to layer *l* and the weight $W^{l-21,l}$ for connection from *l-2* to *l*. This makes the forward propagation to be as shown below:

$$\boldsymbol{a^l} \coloneqq \boldsymbol{g}(\boldsymbol{W^{l-1,l}}.\boldsymbol{a^{l-1}} + \boldsymbol{b^l} + \boldsymbol{W^{l-2,l}}.\boldsymbol{a^{l-2}})$$
$$\boldsymbol{g}(\boldsymbol{Z^l} + \boldsymbol{W^{l-2,l}}.\boldsymbol{a^{l-2}})$$

Whereby the variables are:

$\boldsymbol{a^l}$ the activations of neurons in a layer *l*

$\boldsymbol{g}$ the activation function of layer *l*

$$\boldsymbol{Z^l} = \boldsymbol{W^{l-1,l}}.\boldsymbol{a^{l-1}} + \boldsymbol{b^l}.$$

This is the forward propagation of the system of a residual neural network. A general case of layers more than three, the equation for the neuron activation is represented as follows:

$$\boldsymbol{a^l} \coloneqq \boldsymbol{g}(\sum_{\boldsymbol{k-2}}^{\boldsymbol{k}} \boldsymbol{W^{l-k,l}}.\boldsymbol{a^{l-k}})$$

Whereby $\boldsymbol{k}$ is the number of layers within a given neural network.

Below is a diagram that shows a neural network in forward propagation with three layers:

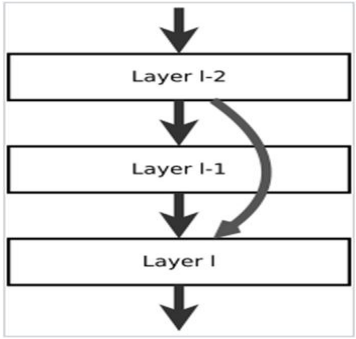

Figure 3.2: Neural network with three layers

B. Image Acquisition

Digital images are acquired manually by users using either the user interface during the process to classify the skin disease within an image and images are also acquired in a bulk in the form of a dataset intrinsically. Acquisition conveys images to the image enhancement.

C. Image Enhancement

Image enhancement transforms the scale of an image or images to a uniform scale in order to minimize errors during classification and to avoid feeding a lot of errors to a given neural network. The process is not complicated because the acceptable scale of both horizontal and vertical axis is defined initially in the code.

D. Feature Extraction

In as much as forward propagation is concerned, feature extraction is solely a result of the neural network's forward propagation. The system uses activation of neurons where each layer has its own feature to extract. Since this system uses RESNET-50 which has 50 layers where by on each and every layer a feature is extracted and weighted probabilities are deduced. The results are stored within the network for future reference during classification.

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E. Classification

Classification is the assigning of a meaningful label to a given image by mapping a selected image feature weighted probabilities and comparing them to each of the feature weighted probabilities by the datasets. If there is congruency within the values a corresponding label is assigned to the selected image during classification.

3.3 System Development

A. Introduction

The skin detection system was made using the bottom-up technique where modules or units were developed first and tested separately before integrating them together. This was a prerequisite for the purpose of making debugging undemanding while speeding up the process of system development with minimal errors using MATLAB. System development discusses about modules in the system, flow diagram of the system and details of the algorithms used.

B. Module Description

Training System

This module is activated by clicking the train button on the system's user interface and a specified path within the code extracts a dataset and the system extracts features and there their corresponding labels and stores them in neurons.

Selecting Image

This is a user interface functionality as much as it is a module. It gives the user the ability to select an image from any directory within the system then the image is acquired into the neural network so as to predict the skin disease prevalent on the digital image.

Predicting or Classifying Image

The classification is done by feature extraction and extrapolate weighted probability values. These values are compared with for each trained probabilities and when corresponding values are identified an appropriate label to the selected image is assigned hence giving the system the capability to predict skin diseases.

Cancelling the System

In order to give a user, the privilege ability to exit the system of exiting from the system the cancel module is used to abort the system program running by closing the user interface. Below is a diagram that shows how the modules explained above are interconnected together

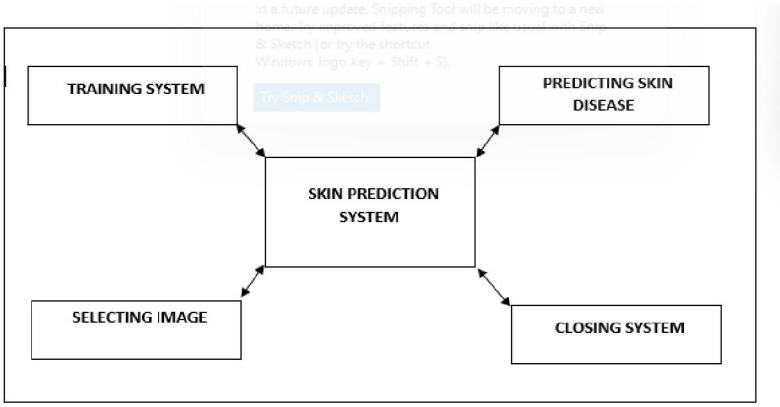

Figure 3.3.2: Module description figure

C. Architecture of The Proposed Solution

The system shows a process that begins with acquisition of images either intrinsically within the program for training purpose of the residual neural network or for prediction of skin disease after the user selects images.

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After acquiring the images, their sizes or dimensions are checked and converted into an acceptable size (scale) then the images are accepted into the system. The images contained in each and every folder are counted and the minimum number of images is obtained such that when selecting images for training only a uniform number of images are used per folder. This is done in order to avoid a skewed feature extraction which could make the neural network to be biased to one or more skin disease since it over trained in a specific class of a skin disease.

When the images are resized, feature extraction and classification is done and this involves saving weighted probabilities in the system within the neural network. The weighted probabilities are tied or stored together with a particular class of skin disease in a form of a label.

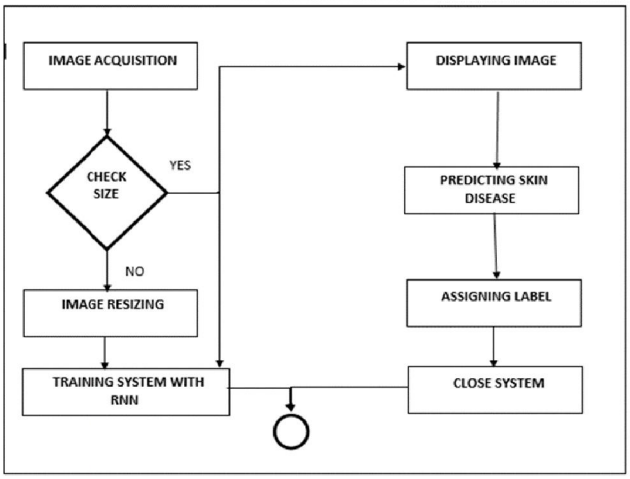

Figure 3.3.3: Skin disease prediction architecture diagram

D. Screenshots

Figure 3.3.3: Skin disease prediction select image diagram

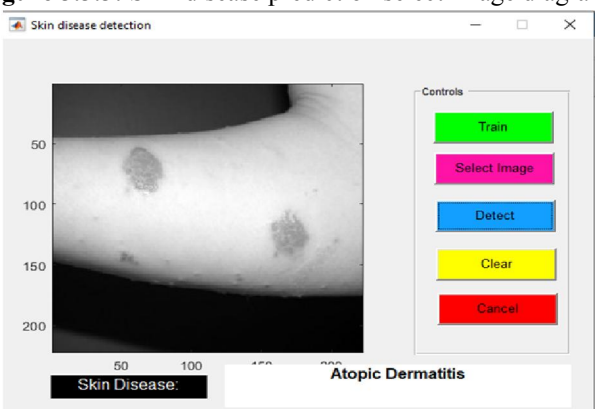

Figure 3.3.3: Skin disease prediction detect diagram

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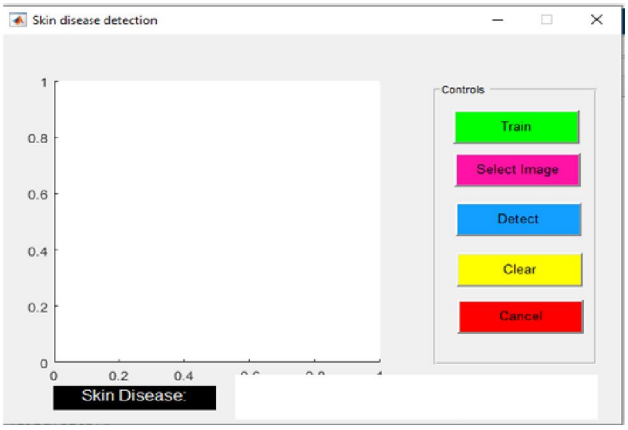

Figure 3.3.4: Skin disease prediction training diagram

IV. RESULT AND DISCUSSION

Using MATLAB, quantitative results were collected with the help of high-end performance computers with the aim of having a detailed account of how the residual neural network algorithm works and performs compared to other types of neural network algorithms.

Figure 4.1 shows that the residual neural network performs better when dealing with accuracy compared to the deep neural network. This is so because the deep neural networks have vanishing gradients which make it difficult for change to be observed by the system from one layer to the other. This also applies to the other factors including sensitivity, specificity and the F-measure.

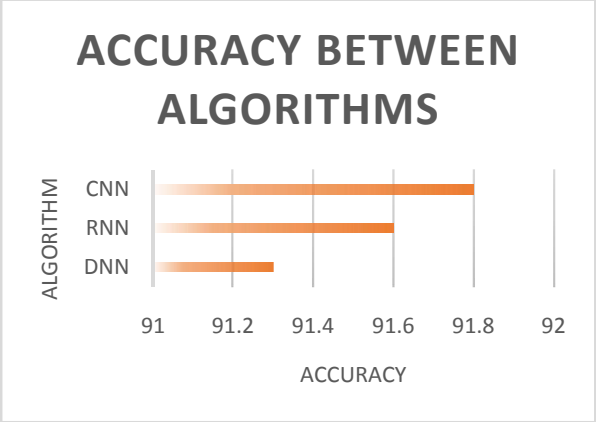

Figure 4.1: Accuracy between algorithms

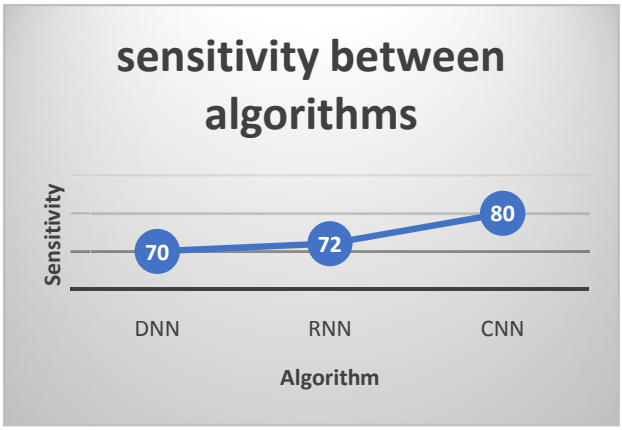

Figure 4.2: Sensitivity between algorithms

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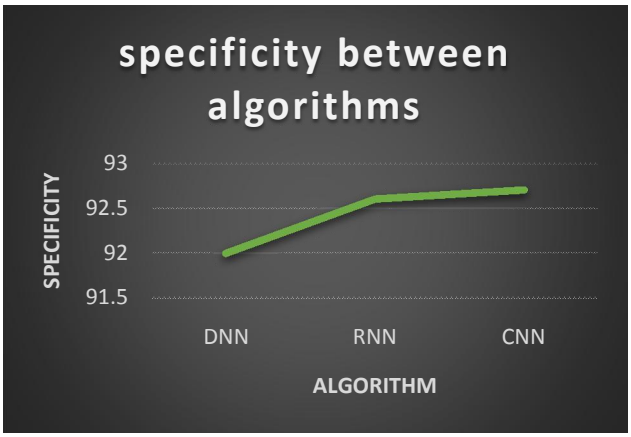

Figure 4.3: Specificity between algorithms

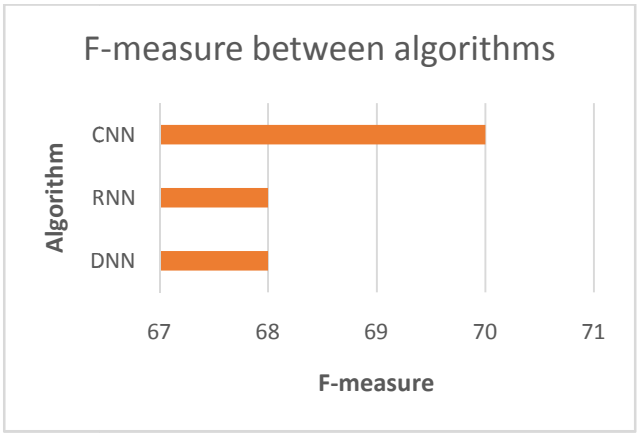

Figure 4.4: F-measure between algorithms

V. CONCLUSION

The system using RNN (residual neural network) was designed and developed using MATLAB Resnet-50 and it successfully predicted skin diseases after training it with a given dataset. The RNN algorithm is proven to be better than the DNN algorithm and it is a little less than the CNN algorithm.

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