International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 07 | July 2024 www.irjet.net p-ISSN: 2395-0072

Skin disease detection using deep learning and machine learning algorithms

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Abstract - *Human skin is an unpredictable and almost intricate landscape due to its irregular lesion patterns, moles, varying tone, presence of thick hair, and other confusing features. Identifying the infected skin area and identifying the type of skin disease helps in early awareness. This study deals with the detection system that allows users to detect and identify skin disease by providing an image of the affected area as input. In this study, there is one website on which there is a section called upload image inside which user can upload the image of his/her skin lesion, that input image can be taken from the database or by a user. Now, that image goes in backend where image undergoes preprocessing such as resizing and finally the array format of that specific image enter into convolutional neural network, which provides an output between zero to eleven. Each digit is affiliated to specific skin disease for instance Acne_Level_0 is for output digit 0, Acne_Level_1 is for output digit 1. Acne_Level_2 is for output digit 2, Blister is for output digit 3 and so no.*

Key Words: **Convolutional Neural Networks, Image pre-processing, max-pooling, fully-connected layer, data augmentation, deep learning.**

1.INTRODUCTION

Computer intervention has become inevitable in all fields in recent years. One sector that heavily relies on computers for diagnostic purposes is the medical field. Skin diseases account for the majority of all illnesses worldwide. Despite being widespread, diagnosing it is highly challenging and requires extensive domain knowledge. **[3]** Also dermatologists clinic fees are expensive therefore major patients decide to delay the treatment of any skin disease encountered as patient thinks that skin disease is avoidable. But it is necessary to grasp knowledge that if certain skin diseases treatment are not started on time then delay in diagnosing and treating of that specific skin disease might result in increase in its intensity and as a result it might turn chronic and later when patient decides to treat that specific skin disease then it takes years of ointment applications and years of medicinal consumptions to treat that skin disease as it might have turned chronic due to delay in visiting dermatologists. At last it gets more expensive to treat such skin disease which has turned chronic and requires higher intervention of dermatologist and long term of dermatologists bills hit and at the end it turns more and more suffering to the patient body due to not only long term consumption of medicines but also application of ointments for quite a long time. Therefore, it is necessary for the patient to at least diagnose the skin disease that patient is suffering from. So once if patient is aware about the skin disease that he/she is aching through then he/she can prioritise the duration in which he/she want to visit the dermatologists clinic to cure the skin disease. **[3]** Early detection is skin disease can help not only to reduce the cost of dermatologists clinic but also reduce the suffering duration of patient. As a result, if there is one system in which a user can upload his/her skin lesion image and can receive the name and certain information regarding the skin disease that patient might be suffering through which is detected through the skin lesion image uploaded by the user then this can accelerate the process for patient to have a blur knowledge regarding his/her affected skin condition. Moreover, it is well known fact that it takes ample amount of time investment in waiting area in dermatologists clinics. So, if such skin disease detection system is available in reception areas of dermatologists clinics then the receptionist could take the pictures of skin lesions of patients and form a report for the same and deliver it to the dermatologist to acknowledge him regarding number of patients with common skin disease issues and remaining with intense skin regarding issues. So that doctor could do time management in such manner that he/she could give appropriate time to each patient depending upon patient's skin disease intensity. To prepare such system the classifier used in the proposed work is convolutional neural network as they work efficiently in the case of images. **[5]** Also to train the model on large data sets of dermatological images, deep learning algorithms such as convolutional neural network is most efficient.

2. METHODOLOGY

2.1 Dataset

In this research, we used a custom dataset for skin disease classification. The dataset is divided into training and validation sets. Training dataset is within train folder and the model performance is assessed using validation dataset which is inside val directory.

Training Data Path: /content/drive/MyDrive/prectical model/train

Validation Data Path: /content/drive/MyDrive/prectical model/val

Each sub-directory within these paths represents a different class of skin diseases. There are exactly twelve folders in the train folder, each one named after a different type of skin condition. There are pictures of that particular skin disease in the folder under the same skin disease name. The complete train and val folders dataset is built in this way.

2.2 Preprocessing

Preprocessing contains steps to make raw data ready for training and prediction. In this study preprocessing of raw images is carried out before feeding them into the model. Preprocessing of data is vital step in machine learning as it results not only in enhancement of the efficiency of the model but also increase in the speed of execution of the model. For image Augmentation of Training data preprocessing normalization technique is used such as normalizing the pixel values in range [0-1] to ensure that consistency of input data is preserved. Normalization technique assist model to learn in more efficient manner. Data Augmentation technique such as rotation up to 40 degrees, flipping such as horizontal flip, shifts are also used to increase the size of dataset. **[2]** Data Augmentation resist the model from overfitting to the training data. Resizing the images is another preprocessing technique which is computationally Efficient as small and uniform image sizes result in faster training and prediction. Also neural network needs each and every input image of same size. In this study image is resized to 150 X 150. Batch processing technique process images in batches rather than single image at a time which speeds up training process. In this study batch size is 32 so at a time 32 images are fed to the network. Conversion to Numerical Format is used for preprocessing to convert input image into an array format as arrays are easy to augment as compared to raw images.

2.3 Convolutional Neural Network

[5] One class of deep learning algorithms called Convolutional Neural Network is dedicated to processing and analyzing visual data. Convolutional Neural Network is widely used for image classification, Image recognition, Image segmentation tasks.

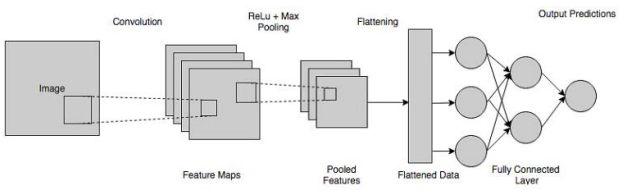

Fig -1: Convolutional neural network

Input Layer: This is where raw data is fed into the convolutional neural network. Without a doubt, an image's raw data comprises of its pixel values.

Convolutional layer: This layer is responsible for modifying the input data by applying kernels. **[5]** Through convolution, each filter extracts distinct features from the input data. Activation maps, another name for feature maps, are the outputs produced by this layer.

Activation function: An activation function called Rectified Linear Unit is applied after each convolutional layer. It is applied on each and every element. **[5]** This is implemented to introduce non-linearity in the network so that the network could discover more intricate patterns. Using this function any element with negative values are replaced with zero. **[5]** Another activation function is softmax activation function which is used in output layer for multi-class classifications.

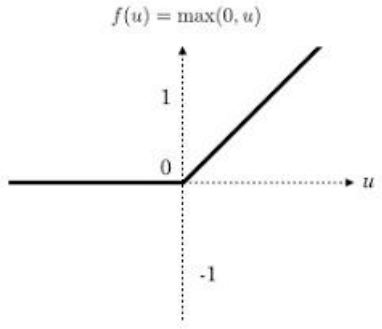

Fig -2: Rectified Linear Unit Activation Function

Max-pooling: A neural network can extract important features from the input with the help of max-pooling. **[5]** Max-pooling is responsible for dimensionality reduction of data. **[4]** This assist in focusing on vital parts of the data which actually has impact on target variable. In this study, the size of max-pooling is 2 X 2.

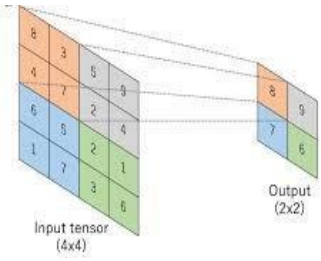

Fig -3: Max-pooling

Flattening: The output feature maps are flattened into one- dimensional vector following multiple convolutional and pooling layers.

Dropout: A layer that, during training, randomly sets a portion of the input units to zero on each update. It prevent model from overfitting.

Fully Connected Layer: It is also knowns as Dense layer. These Dense layers are formed by feeding the flattened vector into one or more fully connected layers. **[5]** This layer process on extracted features to reach the decision of prediction. Every single neuron in a fully connected layer is linked with every other neuron in the layer before it. The network can thus discover intricate relationships between diverse features.

2.4 Loss function

The role of Loss function is to give measure of how well model's predictions match true labels which implies that loss measures are the difference between the true labels and the predicted probabilities. Model look forward to minimize loss function and that is done using optimizer. In this study, Sparse Categorical Cross-entropy loss function is used as it works well for multi-class classification where target variable is an integer such as 0,1,2,3,4 and so on. In skin disease detection at the end we classify 12 diseases so we are performing multi-class classification so sparse categorical cross-entropy function is advisable to use.

2.5 Optimizer

The main goal of optimizer is to adjust weights of neural network to decrease the measure of loss function. Adam optimizer is used in this study with learning rate of 0.0001 in which Adam stands for Adaptive Moment Estimate. Parameter used in training phase called learning rate is such that it regulates how frequently the weights of the model are changed. Learning rate basically controls the size of steps that optimizer takes while updating weights. High learning rate results in large steps which helps in speeding up training of model but provides suboptimal result at the end. Whereas, in Low learning rate small steps are taken and takes comparatively more training time and reaches to more precise convergence. In this study, Adam optimizer has learning rate of 0.0001 which is considered as low learning rate.

2.6 Accuracy metric

It is used to measure the fraction of predictions that model predicted correctly. Accuracy is the ratio of number of correct predictions to the total number of predictions. Accuracy metric is used while training as well as during validation to measure of model's performance.

[2] Accuracy = Number of correct predictions/ Total number of predictions

3. PROPOSED WORK

3.1 Introduction

This section presents a through approach that makes use of convolutional neural network to classify diverse 12 skin conditions. Preprocessing the data, training the model and deploying it through online interface are all steps in this process. The workflow's primary objective is to take an input image of skin lesion from user, preprocess it, classify it using convolutional neural network model that has been trained, and then present the prediction results to the user through an intuitive interface.

3.2 Work Flow

User will open Uniform Resource Locator and reach to the landing page of the website where the user interface of skin detection system will be visible. User when scroll down to the upload file section to upload image of skin lesion and hits proceed button then one form is submitted with action='/predict' Which takes user to the new uniform resource locator having "/predict". Before user visit this "/predict" page. The uploaded image of skin lesion by user undergoes preprocessing where firstly image is resized in 150 X 150 format, later image is converted into array using "img_to_array" function of keras library. Image is needed to be converted into an array because performing augmentation on array is simpler compared to images. After image is transformed into an array, image is normalized in range [0 - 1]. Preprocessing step such as Normalization is helpful in enhancing efficiency of the model. Finally, such preprocessed image visits into the trained model. Model is loaded using 'load_model" function from keras library. So, this array form of image enters into the model. Now, in order to increase robustness of the model function from keras called "ImageDataGenerator" is used to augment images. Various augmentations are applied such as rescaling in range of [0-1], rotation up to 40 degrees, horizontal flip, width and height shifts for data augmentation of training dataset. Whereas, for data augmentation of validation dataset only rescaling in range of [0-1] is performed using same "ImageDataGenerator" function. At the end of preprocessing data enters into the Convolutional Neural Network model which is defined using "sequential" model with multiple "Conv2D", "MaxPooling2D"," Dropout", "Flatten" and "Dense" layers. The model is compiled using Adam Optimizer of learning rate 0.0001, Sparse categorical cross-entropy loss function and accuracy matrix. Using validation data, the model is verified after being trained on the training dataset. With the aid of function called "ModelCheckpoint" from keras library, the best model is preserved. Finally, when predicted result arrives which is in digits between zero to eleven that value is redirected to the function within which the loaded model was called passing array of input image as parameter. Now, each digit between zero to eleven is mapped with respective skin disease html page. So, after prediction whichever digit arrives, it is mapped to the corresponding html page and the html page for that specific skin disease is displayed on "/predict" uniform resource locator. At the end user gets to see the name of predicted disease followed by the same image which was provided by the user followed by the information regarding detected disease.

3.3 Detail on Layers

In this study, four Conv2D and four MaxPooling2D layers are there, one flatten layer is present, 3 Dropout layer and 3 Dense layers prevail. Initially the size of input preprocessed image is 150 X 150

1. The output shape after first Conv2D layer will be reduced to 148 X 148 with 32 filters each of size 3 X 3.

2. The output shape after first MaxPooling2D layer will be reduced to 74 X 74 retaining 32 channels.

3. The output shape after second Conv2D layer will be reduced to 72 X 72 with 64 filters each of size 3 X 3.

4. The output shape after second MaxPooling2D layer will be reduced to 36 X 36 retaining 64 channels.

5. The output shape after third Conv2D layer will be reduced to 34 X 34 with 128 filters each of size 3 X 3.

6. The output shape after third MaxPooling2D layer will be reduced to 17 X 17 retaining 128 channels.

7. The output shape after fourth Conv2D layer will be reduced to 15 X 15 with 256 filters each of size 3 X 3.

8. The output shape after fourth MaxPooling2D layer will be reduced to 7 X 7 retaining 256 channels.

9. The first Dropout rate is 0.5. So 50% of units are made zero to prevent overfitting.

10. Now, flatten layer flattens the input to 1D array of 12544 elements.

11. The first Dense layer comes up with 128 neurons and Rectified Linear Unit activation function.

12. The second Dropout rate is 0.1. So 10% of units are made zero to prevent overfitting.

13. The second Dense layer comes up with 256 neurons and Rectified Linear Unit activation function.

14. The third Dropout rate is 0.25. So 25% of units are made zero to prevent overfitting.

15. The third Dense layer comes up with 12 neurons and softmax activation function.

Table -1: Mapping of skin disease based on model output

Skin disease names	Output digit
Acne_Level_0	0
Acne_Level_1	1
Acne_Level_2	2
Blister	3
Cold sore	4
Normal	5
Eczema	6
Hives	7
Lupus	8
Ringworm	9
Rosacea	10
Scalp Infections	11

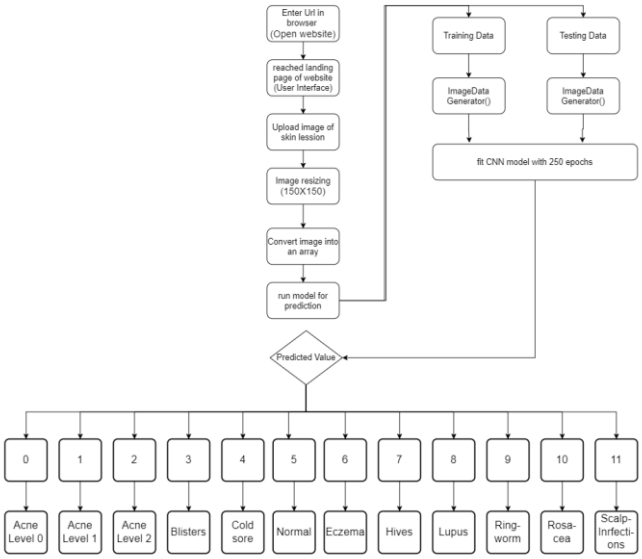

Fig -4: Flow chart of proposed work

4. OUTPUT

The suggested system's user interface (UI) is made to be simple to use and intuitive, allowing for smooth communication between the user and the Convolutional Neural Network (CNN) model. The main objective of the user interface is to make it simple and effective for users to upload pictures of skin lesions and get diagnostic results. This section describes the UI design, and workflow from picture upload to result display.

Step 1: Open Uniform Resource Locator

Fig -5: Skin disease detection landing page

Step 2: Scroll down to see upload image section

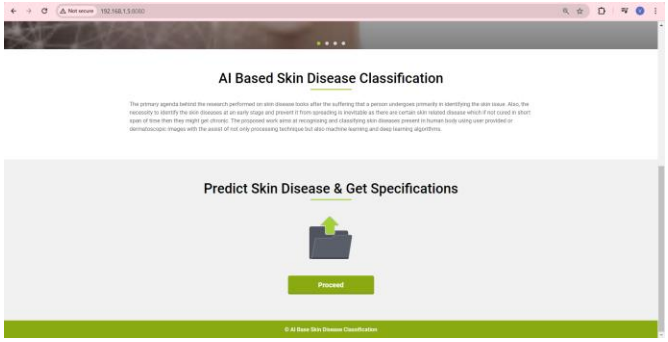

Fig -6: File upload section

Step 3: Browse through images and upload skin lesion image and click "proceed" button.

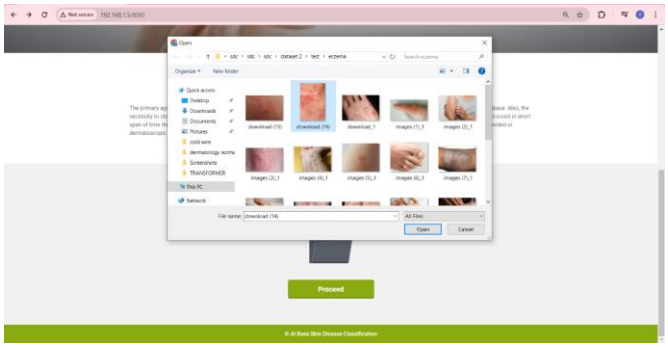

Fig -7: Upload image

Step 4: This will take you to the new page which not only contains the name of predicted skin disease on basis of uploaded image but also certain basic information related to predicted skin disease along with uploaded image.

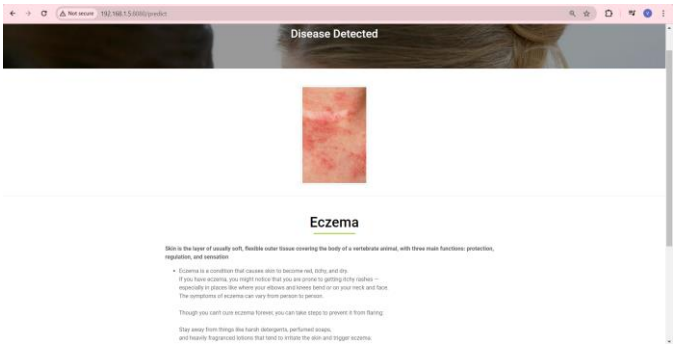

Fig -8: Skin disease predicted

5. CONCLUSIONS

In this research, there is use of Convolutional Neural Network (CNN) to create a complete system for the automatic classification of skin conditions. The proposed methodology encompasses number of phases, such as model training, data preprocessing, and deployment through a user-friendly web interface. Considerable augmentation techniques were used in the data preprocessing to improve the model's robustness. With numerous convolutional, pooling, and dropout layers, the CNN architecture was meticulously built to efficiently learn and extract information from the input images. The model was trained using a well-structured training and validation process, ensuring optimal performance and accuracy. During the deployment phase, a Flask-based web application was configured to enable users to upload photographs of their skin lesion, which the trained CNN model subsequently preprocesses and classifies. The predictions are mapped to specific skin diseases and the corresponding information is displayed to the user, providing informative experience. The automated method helps patient to diagnose their skin condition in early phase as well as aids medical professionals in lightening their burden. For 250 epochs the accuracy achieved is 64%. This can be increased by increasing number of epochs.

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