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Diagnosis of skin diseases using Convolutional Neural Networks

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Abstract—Dermatology is one of the most unpredictable and difficult terrains to diagnose due its complexity. In the field of dermatology, many a times extensive tests are to be carried out so as to decide upon the skin condition the patient may be facing. The time may vary from practitioner to practitioner. This is also based on the experience of that person too. So, there is a need of a system which can diagnose the skin diseases without any of these constraints. We propose an automated image based system for recognition of skin diseases using machine learning classification. This system will utilize computational technique to analyze, process, and relegate the image data predicated on various features of the images. Skin images are filtered to remove unwanted noise and also process it for enhancement of the image. Feature extraction using complex techniques such as Convolutional Neural Network (CNN), classify the image based on the algorithm of softmax classifier and obtain the diagnosis report as an output. This system will give more accuracy and will generate results faster than the traditional method, making this application an efficient and dependable system for dermatological disease detection. Furthermore, this can also be used as a reliable real time teaching tool for medical students in the dermatology stream.

Keywords—Dermatology, Image Processing, Computer Vision, Machine Learning, Artificial Intelligence, Neural Network, Deep Learning, Computational Intelligence, Automated Disease Diagnosis, Convolutional Neural Network

I. INTRODUCTION

Dermatological diseases are the most prevalent diseases worldwide. Despite being prevalent, its diagnosis is profoundly arduous and requires extensive experience in the domain. Around to a study, 24 percentage of the population consult their general practitioner (GP) with a skin quandary in a period of one year. There is an inconsistent (and generally inhibited) schooling in dermatology at undergraduate level which denotes that the trainees should reassess their present skills and knowledge in this particular area. Currently about 90 percentage of diseases of the skin are managed exclusively by the Primary Care. This implicatively insinuates that most of the skin disease quandaries can be solved if care is taken at an early stage. Skin disease can impact significantly on quality of life for patients [6]. Skin disease rates are increasing and outcomes depend on early diagnosis. GPs have an important role in early diagnosis of the skin ailments [1]. There have been many endeavors to implement traditional medicine across the different parts of the globe especially in the countries which are not technologically advanced, but the efforts have been met with challenges such as huge cost of medical tools and equipments and also lack of medical expertise. Skin disease typically results from environmental factors along with other causes. The necessary tools required for early detection of these diseases are still not readily available in most populations globally. Here the proposed paper provides an approach to detect various kinds of these diseases. The user gives input of the skin disease image, which then the system processes, does feature extraction using CNN algorithm and use softmax image classifier to diagnose diseases. If no disease is found, the system provides a negative result. Thus in this paper, a novel dermoscopy detection and classification method based on Convolutional Neural network (CNN) is proposed.

II. ARCHITECTURE

The system can be broadly categorized into following major phases:

1. Image Acquisition:

The images are acquired either through camera or through locally stored device.Whatever might the source, it is very essential that the input image is clear and precise. For this, a high quality image is required.

2. Image Pre-Processing:

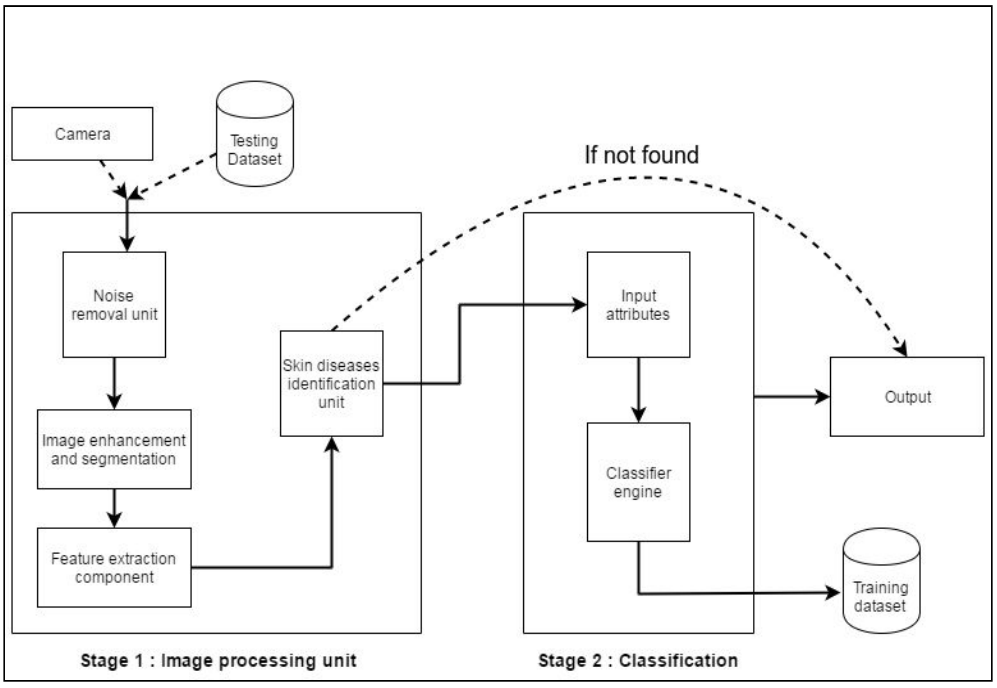
The image is standardized in this phase by removing noise like hair and skin pigments, as it can confuse the analysis. Also,the image which is given as the input maybe not be of standard size as required by the algorithm, so it is necessary that required image size is obtained.

3. Data storage component to maintain testing and training data images:

In case of supervised learning, as the case here, training dataset is required. Testing dataset is the images acquired during image acquisition [2].

4. Classifier to identify the type of skin disease:

Softmax classifier used here is the last layer of the network that yields actual probability of each label.



The architecture contains two major parts Image processing unit and classification unit.

Image processing unit will enhance the image by removing noise and unwanted parts of the skin and then the image will be segmented into different segments to differentiate from normal skin after that features of the image will be extracted to find out whether skin is infected or not.

• Noise removal unit: Removes the unwanted pigments and hair from the image.

• Image enhancement unit and segmentation: Brings the affected part into focus by enhancing the area and also segmenting the area into various segments so as to differentiate it from the normal skin [4].

• Feature Extraction Component: Feature extraction is one of the major step in any classification oriented problems. Features are the key for both training and testing purposes. This features contains the important information about the image which will be used to identify the disease [4].

• Skin Disease Identification unit: Finds out whether the skin is benign or malignant.

• Input Attributes: All the important attributes such as asymmetry, border, color, diameter, evolution etc which were extracted from image are now given as a input to Part II that is the classifier part [5].

• Classifier engine: Classifies the images into one of the pre-defined diseases through classification algorithm(here softmax classifier is used) [4,5].

III.ALGORITHM USED:

Convolutional Neural Networks:

Convolutional Neural Networks (which are also called CNN/ConvNets) are a type of Artificial Neural Networks that are known to be immensely potent in the field of identification as well as image classification.

We take an example to explain the same :

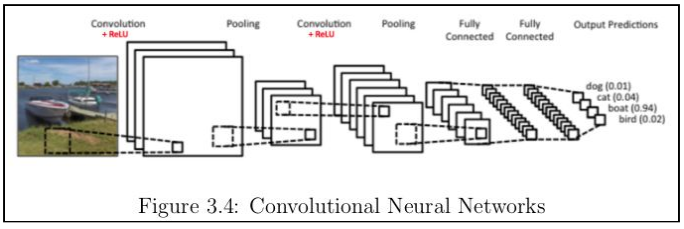


Figure 3.4: Convolutional Neural Networks

Four main operations in the Convolutional Neural Networks are shown as follows:

(i) Convolution: The main use of the Convolution operation in case of a CNN is to identify appropriate features from the image which acts as an input to the first layer. Convolution maintains the spatial interrelation of the pixels.

This is done by attainment of image features using miniscule squares of the image.

Convolution formula

$$I\_new(x,y) = \sum_{j=-1}^{1}\sum_{i=-1}^{1} \alpha_{ij} I\_old(x-i, y-j)$$

:

Every image is viewed as a matrix of pixels, each having its own value. Pixel is the smallest unit in this image matrix. Let us take a 5 by 5(5*5) matrix whose values are only in binary (i.e. 0 or 1), for better understanding. It is to be noted that images are generally RGB with values of the pixels ranging from 0 - 255 i.e 256 pixels.

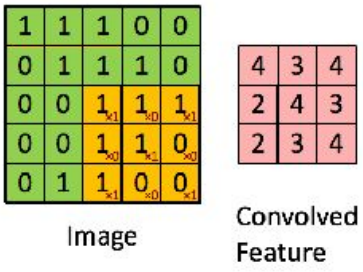
Below is the image that is to be convoluted

1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

Now let us take a case of another 3 by 3 matrix as represented as:

1	0	1
0	1	0
1	0	1

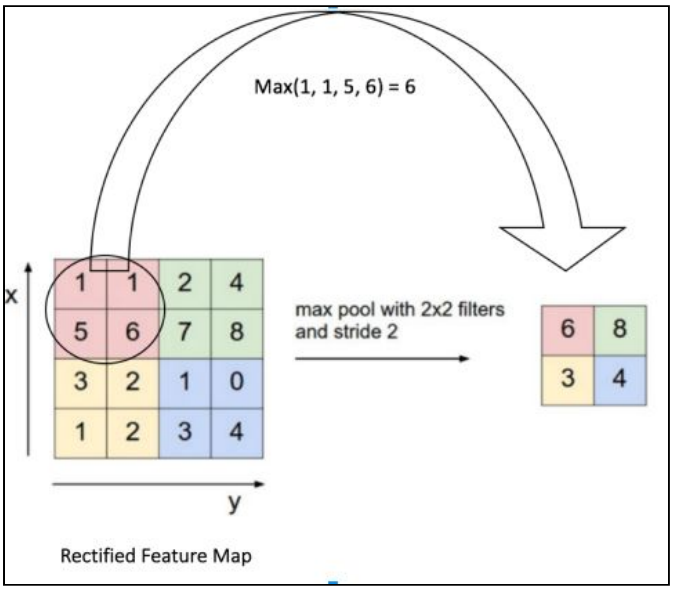
So the convoluted image matrix would be



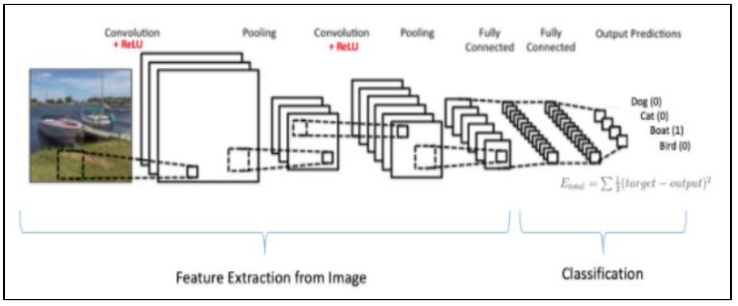
(ii). Non-linearity: ReLU or Rectified Linear Unit is a non-linear operation. ReLU acts on an elementary level. In other words, it is an operation which is applied per pixel and supersedes all the non-positive values of each pixel in the feature map by zero. It is basically a smooth approximation

Equation : $f(x) = ln(1+e^x)$

(iii). Pooling or sub-sampling : Spatial Pooling which is also called subsampling or downsampling helps in reducing the dimensions of each feature map but even while doing so, retains the most consequential information of the map. After pooling is done, eventually our 3D feature map is converted to one dimensional feature vector



4. Classification (Fully Connected layer) :The output from the convolution and pooling operations provides prominent features which are extracted from the image. These features are then utilized by Fully Connected layer for relegating the input image into different classes predicated on the training dataset.



III. IMPLEMENTATION:

The implementation of Convolutional Neural Networks can as such be done on any platform. But python (Python 3.5 here) is preferred here as it provides the developer with a large range of neural network and machine learning libraries

A. Some Major Libraries used for implementation

(a)OpenCV : OpenCV is an Open Source Computer Vision library with Python interface along with Java, C and C++ interfaces too. It is supported on multiple platforms and is used for real-time image processing and computer vision.

(b)Scikit learn : A free machine learning library with various algorithms for tasks such as classification and regression.

(c). Keras : It is a deep learning library, capable on running on top of Tensorflow.

(d). Tensorflow : Developed by Google, it is an open-source library.Here it is used as a backend for Keras as it is useful for numerical computations and calculations.

Also libraries such as numpy, pandas, etc are used.

B. Dataset:

Images available online along with images from Dermnet (dermnet.com) are used

C. Explanation:

Initially the images are preprocessed and converted to a standard size (120X120). In order to have a large number of images in the dataset, the images are rotated in all the directions(each differing by 90 degrees) and also flipped. Then the image is given as an input to the first layer of the network. Then as shown above, Convolutional Neural Network is applied onto it until high-level features such as border, edge and colour are obtained from it. This is done with the help of the different operations of the ConvNet such as Convolution, Max Pooling,etc till the image flattens out into a image vector. These are the vectors with which classification can be done as these vectors contain the information leading to the determination of high level features. The initial batch size is taken to be 20 while epoch size is taken to be 25. After feature extraction model is saved into the dataset. This data gets updated after each epoch. After the model is trained, test images are used in order to check the results.

IV. RESULT:

An initial training gives the output accuracy of 70% approximately. This can be definitely increased by increasing the training data set in the deep learning model. Five diseases were initial tested, which can be further increased in the future. A large data set can increase the accuracy to more than 90 percent.

V. CONCLUSION:

Thus we have learned about Convolutional Neural Networks and how it is used for image classification. Hence skin diseases can be diagnosed using this technique and also be classified using the same**.** Using advanced computational techniques and large dataset, the system can match the results of a dermatologist thus improving the quality standards in the area of medicine and research.

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