ISSN 2816-8089

RESEARCH ARTICLE

Facial Skin Disease Detection using Image Processing

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Abstract

Busy lifestyle, modernization, increasing pollution and unhealthy diets have led to problems which people are neglecting. The potential causes are not drinking enough water, stress, and hormonal changes or even genetics. Few skin conditions are minor while others can be life-threatening. The skin is the largest organ of the body and is composed of water, proteins, fats, and minerals. Problems appear on the outer layer of the skin that is epidermis. Skin diseases are considered to be the fourth most common cause of human illness. Skin diseases are observed to increase with age and are seen frequently in both men and women. Skin disorders can be temporary or permanent, which can have an impact on individual, family and social life caused by inadequate self-treatment which may also induce psychological problems. In recent years, the use of computer technologies is becoming practically universal for both personal and professional issues. Facial skin problem identification and recognition has evolved to a great extent over the years having its application in many domains. Detection of skin diseases is done using Convolution Neural Network (CNN) and image processing methods as CNN yields better performance in terms of accuracy, precision, and results than the existing conventional methods. Image processing uses a digital computer to process the images through an algorithm, which focuses on features like skin tone, skin texture and color. We present a brief review about various facial skin problems providing more insight into the effective models and algorithms used.

Key Words: *Skin diseases; Convolution Neural Network (CNN); Image processing*

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***Received Date**: December 19, 2022, **Accepted Date**: January 23, 2023, **Published Date**: January 28, 2023*

***Citation**: Lohith R, Niharika N Govinda, Pruthvi K, et al. Facial Skin Disease Detection using Image Processing. Int J Bioinfor Intell Comput. 2023;2(1):1-11.*

1. Introduction

Skin diseases account for 1.79% of the world's disease burden and learning to distinguish one condition from another can help us diagnose and treat the condition. In the medical field doctors make decisions swiftly with the help of Computer aided detection (CAD) or Computer aided diagnosis. Analyzing an image is the most crucial task as these Images provide information that doctors analyze and aid evaluate the problem in a short time. A convolution neural network (CNN) - based CAD model has been created with promising outcomes for recognizing single-sore skin issues like melanoma. Computer aided design models created for these infections are regularly structured with normalized pictures, for example, dermoscopy pictures to produce the desired accuracy.

Machine learning algorithms are used in data science when you want to make accurate inferences about a given data set (for example, when you need to predict whether a patient has a skin problem based on image processing results). increase. This can be achieved by giving the algorithm a large number of examples: patients with and without skin disease, and the results of each patient. The algorithm learns from these examples until it can accurately predict whether a patient has skin problems based on the results. This opens various applications such as Virtual personal assistants, predictions while commuting, videos surveillance, social media services, email spam and malware filtering, online customer support, search engine result refining, product recommendation and online fraud detection [1]. One of the more recently developed biologically-inspired optimization algorithms, the Artificial Algae Algorithm (AAA), was introduced inspired by the vital behavior of microalgae. In AAA, algal colony modification—exploration and development—is given a spiral motion. AAA can effectively search the feature space to find the ideal attribute combination that minimizes the designed objective function and features a meta-heuristic optimization algorithm inspired by nature, aiding to successfully solve various numerical optimization problems. It also helps in clustering analysis as this helps avoid local occurring at the initial stages.

2. Problem Statement

Facial skin problem identification and recognition has evolved to a great extent over the years. Detection of skin diseases is done using Convolution Neural Network (CNN) and image processing methods. CNN yields better performance in terms of accuracy, precision and results than the existing conventional methods. Image processing uses a digital computer to process the images through an algorithm. We focus on features like skin tone, skin texture and colour. We present a brief review about various facial skin problems providing more insight into the effective models and algorithms used.

3. Existing System

Numerous systems have been developed to assist in the diagnosis of skin conditions such skin cancer and tumors, facial detection, facial gesture recognition, and facial emotion or expression detection using Machine Learning techniques and algorithms. In the system works involving 2 phases - firstly pre-process the color skin images to extract features and then identification of diseases [2]. The pre-processed images are trained, and results are fed to an artificial neural network (ANN). The proposed system used 775 color skin images out

of 128 dermatological disease patients, and they achieved 90% accuracy by detecting 9 dermatological diseases. However, due to factors such as low contrast between lesions and skin, visual similarity between disease and non - disease part, and so on, correct disease recognition is highly difficult [3]. There are some limitations and drawbacks in CNN methods such as the position and orientation of objects are not encoded, they struggle to categorize photos with diverse positions, abundant of training data is required in order for the model to perform effectively, if the convolution neural network has numerous layers, the training procedure can be especially time-consuming if the computer's GPU is not up to grade, Convolutional neural networks will identify the picture as separate patterns made up of pixel clusters and not perceive them as elements that make up the picture [4]. To maximize the efficiency of the model, these limitations must be dealt with effectiveness.

4. Module Description

Modules:

- Data collection and pre-processing
- Training, testing and validation split
- Training process methodology
- Prediction methodology
- Data visualization

4.1. Data collection and preprocessing

The raw data collected must undergo a series of modifications before it can be used as input for predictive models. All types of processing that prepare data for the next step are simple declarations of data pre-processing. A major challenge in creating accurate models for prediction is making it easy for algorithms to interpret the properties of the data. One of the steps involves data cleansing where the missing values are added, noisy data are reduced, and inconsistencies are corrected. Transformation of the data is done after cleaning so that the data can be integrated into different forms by changing the format. The data set is obtained from the Kaggle online website and uploaded into data frames such as NumPy, Scikit-Learn, TensorFlow, Keras, SciPy. The data which is processed is used for further stages in the model.

4.2. Training, testing and validation split

The entire dataset is divided into training and testing with 85% of the dataset for training and 15% for testing. The training set is utilized to train the model by analyzing the features and patterns present in the data. The testing set is used to evaluate the trained model after the model is trained with enough data to form a logical pattern or analyze the features. Its final model performance is provided in terms of accuracy, precision, and graphs. The training data is further split into training and validation sets. The validation set of data is used to validate the model's performance during the training phase. This progression provides information that aids us to tune the hyper parameters of the model which can help make accurate groupings of the data samples.

4.3. Training process methodology

All predictions depend on how the model was trained. Machine learning algorithms provide training data for models to learn features and understand requirements. A target attribute of an algorithm must find patterns that map input data attributes to target and output a machine learning model [5]. The training data set with labels is given to several Machine Learning techniques like Inception-ResNet-v2, VGG-16, Xception, ResNet50, all which are convolutional neural network architecture to extractfeatures from the data and keep the data prepared for prediction. We must specify a lot of functions like: The training data source, the data attributes containing the target to be predicted, the transformation instructions, and finally the parameters that control the learning algorithm. Here, the model automatically selects an appropriate algorithm based on the specified goal.

4.4. Prediction methodology

No predictive model is specified. They are reviewed and revised periodically to reflect changes in the underlying data. Predictive models make assumptions based on what happened in the past and what is happening now [6]. If new incoming data indicates a change in the current situation, the impact on expected future results should also be recalculated. Our model uses classification and clustering methods to segregate based on shared attributes or to group large groups of things with common characteristics. Random forest algorithms combined with decision trees classify large amounts of data, and the most popular and fast K-Means algorithms group data points by similarity. In short, predictive analytics saves time, effort, and money, and improves model quality.

4.5. Data visualization

By putting data in a visual context and attempting to comprehend it, data visualization seeks to reveal patterns, trends, and connections that might not otherwise be visible [7]. Without visualization it is challenging to communicate the data findings and identify patterns to gain insights and manipulate vast amounts of data. These techniques reinforce the message that we are trying to retrieve or convey to our audience. It comprehends big data with just a glance at displayed data thereby revealing the errors and inaccuracies quickly. This technique employs the Pandas python utility, matplotlib, to generate simple graphs from training and test data, such as line charts, bar charts, and histograms [8]. These scrutinized data help alter the parameters and analyze deviation to improve the efficacy.

5. Methodology

5.1. Resource collection

The initial step is the collection of data. By gathering and storing data, evaluating critical information becomes possible. The data set created was a collection of images from Kaggle, an online website that focuses on different facial skin illnesses among which 5 classes of images were downloaded and some from other sources on google. The data set includes a total of 1000 images, which are divided into five different classes - Acne, Melisma, Milia, Rosacea, and Sebaceous Hyperplasia, each class containing 200 images. The images in the

data set are usually in the JPG, JPEG or PNG format. The dermoscopy images collected from a wide variety of populations were acquired using different modalities. With a wide range of diversity many cleaning methods need to be used. This data set is used for the training, testing and validation processes. The dataset sample images were collected from below link: https://www.kaggle.com/code/yuningalexliu/dermatology-image-classification

5.2. Data pre-processing

Pre-processing of data is done in order to maximize the performance of the Facial skin disease detection system by the early processing of data to look for missing values, data, and other abnormalities in the data set. One of the techniques implemented for data preprocessing is the unifying image dimension or image resizing. Image scaling changes the image size without changing the data in the provided input. Here the number of pixels remains the same, but the image is resized. Resampling is physically changing the number of pixels. These act as dimensional changes of objects in a graphical environment. We used TensorFlow to help implement model tracking, performance monitoring, and model retraining best practices to resize images. It contains special features for image recognition, which are stored and trained as the input increases. The 'tf.image.resize()' function can be used for image scaling. First, a sample image will be sent. This image is decoded and resized according to specifications such as Max Min and Aspect Ratio.

5.3. Data labeling

During this process, the raw data was categorized into 5 classes manually and provided appropriate labels to the classes, giving context that the Machine Learning model utilizes for learning. This process is known as data labeling. As we knew that, the data set is divided into five different classes, these classes are provided with a suitable data label, which is used for the classification purpose. The five classes included in the data set are: Acne, Melisma, Milia, Rosacea, and Sebaceous Hyperplasia. During the detection of facial skin problems, the classification of the skin disease takes place amongst these five-labeled classes.

5.4. Data splitting

The data set is divided into three groups for processing the data. The first subset, referred to as the training data, is a part of our data set that is used to train a Machine Learning model [9]. The second subset, referred to as the testing data, is used to test and evaluate the trained model. The last subset, referred to as the validation data, is used to validate the Machine Learning model's performance. From the data set, 70% is used for training the model. The size of training data is greater than the testing data because the more data we provide for training, the better the model analyzes the data, creating a structured model that classifies with clearer patterns. After data is being provided to the Machine Learning Algorithm, it extracts features, discovers patterns and classifies the data. Due to the usage of labeled datasets for classification, we obtained supervised training data for the Machine Learning model. From the data set, 15% of the data is used for validation purposes: the trained model's predictions and the actual results are examined to assess the model's performance. The remaining 15% of the data set is used as testing data that determines the overall performance of the algorithm. It is a sample of data withheld from the training model, which is used to measure model performance [1]. The Training data set is utilized to weigh the

model's fit while validation data set is used to adjust the model's hyper parameters to improve accuracy.

5.5. Model selection

Initially, VGG–16, Xception, Inception- ResNet-v2 and Resnet50 of Convolutional Neural Network (CNN) architecture was used as the Machine Learning model for processing, identification, and classification of facial skin problems. These models were selected based on its merits and demerits in comparison with other Convolutional neural network models. By running these models to analyze the real time performance and effectiveness, it was observed that the other models performed inferior compared to our implementation model Inception- ResNet-v2 with respect to accuracy, time taken to process and compatibility with the systems specifications. Convolutional neural network (CNN) based Inception- ResNet-v2 architecture was developed using training data from the ImageNet collection. The 164-layer deep network has the ability to classify images into different categories with higher precision. The Inception ResNet-v2 model is used as the base model for processing and classification of the data set, which categorizes and identifies the detected facial skin problem. To improve the performance further, the pre–trained weights are not used in the model for implementation because building a model by training it using our data set and tuning the hyper parameters to alter the structure to effectively analyze patterns aided in increasing the accuracy by 5-7%. Additional layers are added to the InceptionResNet-v2 base model, which makes the implementation model customized and well trained.

5.6. Model training

Machine Learning architecture is built using the training model. It consists of the groups of germane input data that has an effect on the output as well as the sample output data. The input data given is first classified as skin or non-skin so that the model can decide whether to process further. During training, we have provided 1027 images out of which 1021 images were correctly classified as skin or not skin and gained an accuracy of 99.41%. This is depicted through a confusion matrix in Figure 1.

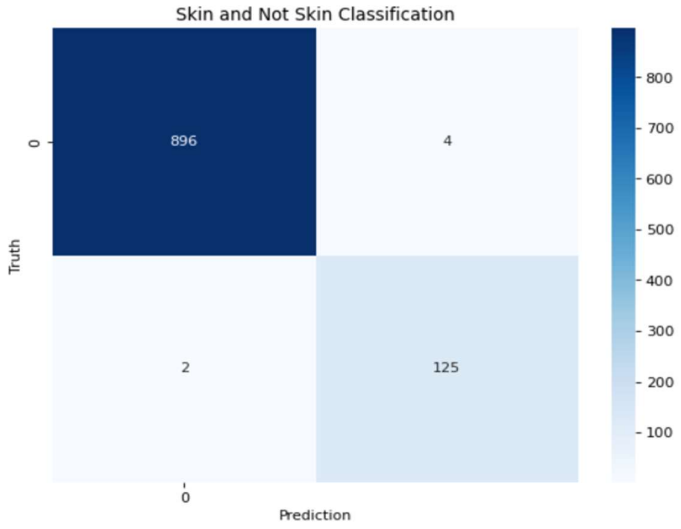

Figure 1: *Confusion matrix of skin and not skin classification.*

Once the model detects the image as skin, another model runs in a hierarchical structure to detect and classify into 5 different classes. To identify the similarities between the processed output and the sample output, the model architecture utilizes the training model to run the input data [10]. The relations are analyzed from the outcome which is utilized to improvise the model. This iterative process explained above is called Model fitting. Training and validation accuracy is very vital for the model to be built with maximum precision. When the input and output values are included in the training data, supervised learning is feasible. The model is trained using the base Inception- ResNet-v2 model along with the additional customized layers mentioned in the previous section with the usage of the testing data set. The model is trained and made to learn the features from the training dataset, so that the prediction analysis can be done effectively during the model testing.

5.7. Model testing

Model testing is the procedure through which the effectiveness of a fully trained model is assessed on a testing set of data [11]. The model testing provides the prediction analysis of the predicted value from the model validation and displays the result. The model is trained by providing disease-specific images for each of the five classes and ensuring the prediction results are correct when tested. Figure 2 shows the confusion matrix for disease classification when the model was trained.

Figure 2: *Confusion matrix of disease classification.*

The result is classified based on which class out of the five classes have more similarity with the imputed testing data to the testing model for evaluation. If the testing data cannot be classified within the five classes, then an error message is displayed. The result to the user is displayed on the website after uploading the image. This is done using a Flask framework, which is a web-based application. HTML is used in the front end and Python code is used in the back end. The Flask framework provides connectivity between the front end and the backend, which allows the user to view the result on the website.

6. Result and Conclusion

The implemented model is made accessible with the home page through a web interface, where the image can be uploaded through the hard drive storage or camera which is depicted in Figure 3 and Figure 4 respectively. The result provides information about the detected skin problem by displaying the predicted skin problem and explanation to understand it. The web page also provides useful and effective links for explaining that issue in detail by an expert and home care remedies to the user through YouTube links, so that the user can comprehend the issue and depending on their convenience and feasibility, they can take basic remedial step to prevent the facial skin problem which is illustrated in Figure 5. The accuracy of Inception-ResNet-v2 to detect each class is shown in Figure 6.

Figure 3: *Homepage – facial skin disease detection.*

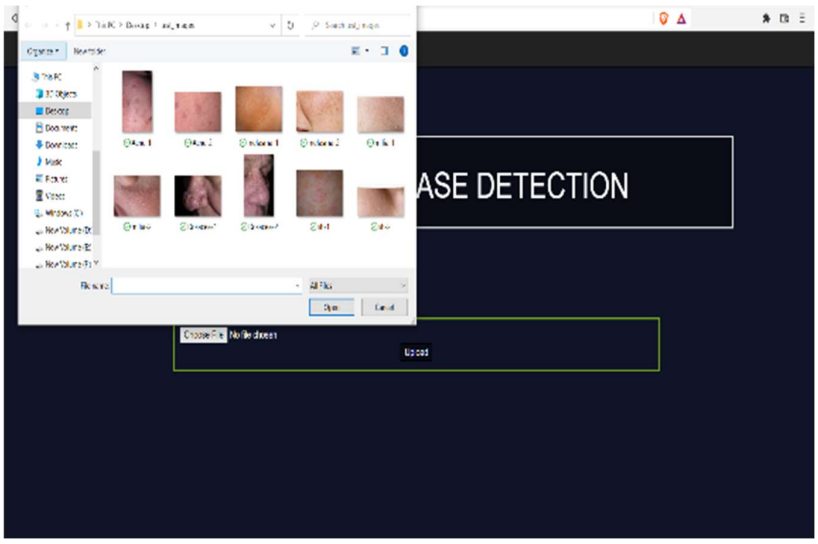

Figure 4: *Choosing file to upload image.*

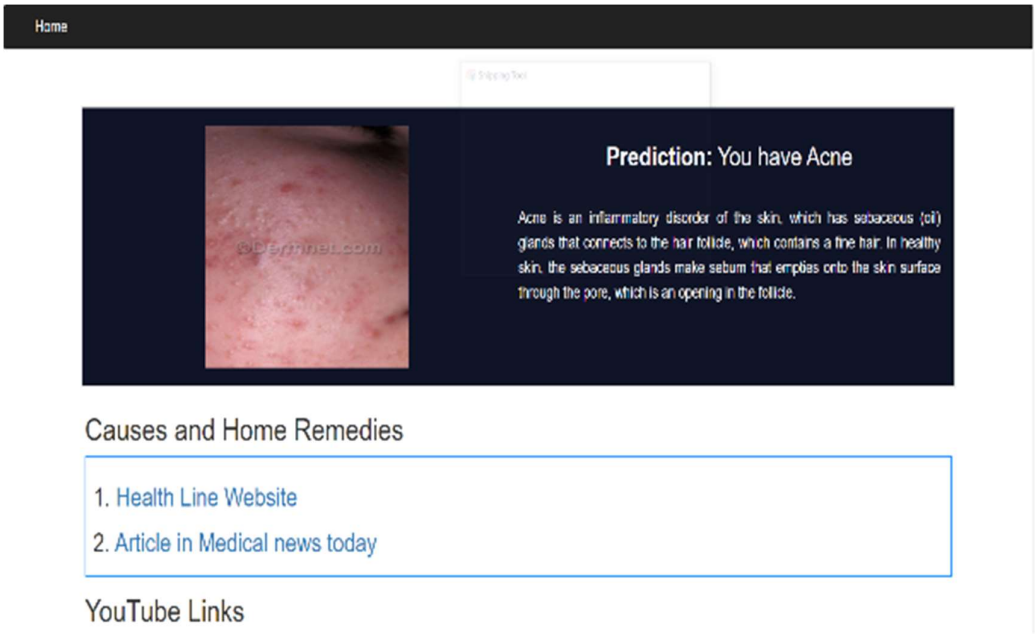

Figure 5: *Snapshot of result.*

```
1 from sklearn.metrics import classification_report
2
3 print(classification_report(y_real, all_pred))
```

	precision	recall	f1-score	support
1	0.81	0.98	0.89	114
2	1.00	0.60	0.75	20
3	0.60	0.75	0.67	8
4	0.97	0.73	0.84	83
5	0.80	1.00	0.89	8
accuracy			0.85	233
macro avg	0.84	0.81	0.81	233
weighted avg	0.88	0.85	0.85	233

Figure 6: *Training result.*

In this project, the proposed system detects facial skin problems, gives information about the detected skin disease and provides remedial measures to the users. The training accuracy rate of the designed methodology is 94.27% and the testing accuracy is 85.2%. The majority of human illnesses are caused by skin conditions on the face. When facial skin problems are treated early, they are less painful, traumatic, more beneficial and less expensive to treat. In today's society, early disease detection is crucial since outbreaks result in significant human suffering. Thus, here in the project, detection is accomplished via a Machine Learning – based approach, since multifaceted and diverse data can be handled well by the Neural Network model. A Convolutional Neural Network (CNN) based, Inception-ResNet-v2 architecture is used in the detection of facial skin problems. The model is trained in such a

way that it can detect five classes of diseases and provides prediction accuracy of the detected facial disease. This system examines the image that the user uploads to determine whether it is healthy or not; if not, it is classed as having Acne, Melasma, Milia, Rosacea, or Sebaceous Hyperplasia. The Machine Learning technique used, tends to improve the estimation performance i.e., accuracy of the model. With the help of technology, this could be made much more feasible aiding patients gain valuable diagnosis and care.

7. Future Work

Facial recognition is a very applicable device as many industries are improvising their technology by utilizing facial recognition to help users access their needs and wants including high-end technologies. The results of facial recognition are predicted to be utilized in 2.1 billion devices by 2024. The Inception-ResNet-v2 model can be improvised for real time application through iterative process of learning by the images uploaded while using the application. This will enhance the performance from time-to-time with larger data sets provided, helping extrapolate meaningful insights and patterns leading to better outcomes. Also, the website may be modified to an application with many modern features like capturing images, creating user accounts by storing data in the database, user history, symptoms of other common problems which creates awareness among users and give suggestions about daily skin care routines. The feature of redirecting the users to YouTube and websites may be upgraded to showing nearby dermatological centers or pharmaceuticals by noting the geological location of the user which enhances user experience. Finally, providing all these necessities to a user makes it a much easier task, reducing time and effort. With people understanding and worrying about the various problems related to facial skin diseases, there is a growing demand for skincare products such as sunscreens, face creams, body lotions and creams are expected to fulfill the growing demand. Digitalizing things and moving towards advanced methods has some demerits as much as it has some amazing changes it could bring to people's life. Utilizing these evolutionary techniques in a way which shortens the bridge in terms of money, effective results, and good experience, it is always a boon to society.

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