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Leveraging SCNN for Enhanced Skin Cancer Detection Using Deep Learning Approaches

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ABSTRACT

This paper presents the establishment of a skin disease identification system exploiting the deep learning strategies, uniquely called Sequential Convolutional Neural Networks (SCNNs), to automate the detection and classification of various skin conditions based on image data. By applying the SCNN proposed model on a varied collection of skin pictures, the system discover to realize the configurations and features reflective of different skin diseases, including melanoma, eczema, and psoriasis. Through feature extraction and classification, the model can accurately diagnose skin diseases. The proposed model produce a non-invasive and cost-effective approach to skin disease diagnosis, facilitating early intervention and timely treatment. Additionally, a user-friendly interface is created to host the system, allowing users to create accounts, upload skin images, and receive reports containing the identified disease along with preventative and precautionary measures. This implementation of deep learning for skin disease identification has the promising potential to enhance healthcare consequences by granting more efficient and more faultless diagnosis, ultimately improving patient care and quality of life. The proposed model gave the highest accuracy of prediction compare to the existing works.

Keywords: *Sequential Convolutional Neural Networks, melanoma, eczema, psoriasis, feature extraction*

1. INTRODUCTION

The people are facing different bacteria and virus that may cause diseases in their daily lives. From that the very normal one is skin disease. It maybe comes about any kind of fungal infection, susceptibility, viruses and any bacteria. We can identify the skin problem by the changes happening in our skin like changing the color and texture of the skin. In many cases the skin diseases are constantly occurring and sometimes it's became spreadable. Unfortunately for many people's it develops into skin cancer. Everything because of late discover. As a consequence, we have to pinpoint the skin diseases before it create any complications. For that, we can go for the advanced prediction techniques which are more popular in nowadays. This paper has developed the combined model with ANN and CNN. In recent days distinguishing the skin disease was taking larger time to analyze the level of infection as well as it causes higher financial and also have to spent too much physical cost of the sufferer. Some kind of diseases including skin disease the prevention was applicable in numerous cases only, but in many cases the prevention also not working well due to its genetic condition and some illness problem. To avoid those unsatisfied type of prevention this model is going to be the best solution.

In this paper, an improved SCNN model has been developed to identify the skin diseases in prior. Automated categorization of skin diseases where using image data set is a very challenging assignment. To avoid the complications of above problem in this paper found one of the best improvised models for identifying the skin problem. For create the model this paper taken HAM1000 dataset from kaggle. The dataset contains many classes which include Melanoma, basal cell carcinoma, vascular lesions and dermatome fibroma. In machine learning and deep learning variances of techniques are available to predict with the image dataset. But in this work select CNN because of its dual character. Primarily it can identify all the related features from the given image dataset. And it can exterminate the values which are used to complete manual attributes evocation.

2. LITERATURE REVIEW

Nawal Soliman et. al. [1], addresses the pressing need for efficient and accessible methods of diagnosing skin diseases. Despite advancements in medical technology, the affordability and accessibility of skin disease diagnostics remain limited. Leveraging image processing techniques, the study proposes a cost-effective and accurate approach to automate the detection process. By utilizing readily available tools like digital cameras and standard computing equipment, the method involves acquiring digital images of affected skin areas, preprocessing them to enhance clarity, extracting features applying a pre-trained convolutional based neural network, and classifying these features by accepting a Multiclass hyper-plane classifier. Results demonstrate a superior reliability rate for identifying the different kinds of skin diseases, providing valuable information on disease type, spread, and severity to users. This innovative approach not only ensures reliable diagnosis but also minimizes the reliance on specialized equipment and expertise, holding promise for improving dermatological healthcare delivery, particularly in resource-constrained settings.

N. D. Chowdary et. al. [2], have created deep learning model and also the recommendation system which is mainly give the suggestions to the patients. They are used CNN with GAN(generative adversarial network. The model gave the highest accuracy level in prediction.

K. A. Olatunji et. al. [3], have developed the unique model to analyze the peoples skin problems with CNN model. But the model has very low accuracy level.

The authors Azia Hameed et. al. [4] from their report in the world 1.79% of the population have the skin problem in different kinds. They has developed the MCML classification algorithm to predict the skin diseases. And they had a comparison between the MCML with MCSL, Multi class with single level. Accuracy of their model also high compare to the MCSL.

Nawal Soliman et. al. [5], used different methods to find out the skin problems clearly. Behind the skin issues there is many reasons are there. To analyze all the reasons clearly they used image processing techniques to diagnose. This model gave the maximum accuracy level compare to many existing models.

The principle aim of the study [6] is to develop Deep learning model. The authors used Naïve Bayes Classifier to identify the skin disease detection by applying the dynamic cut graph methodology.

In Artificial neural network, strategy which is used to investigating the visual representation [7] is CNN. CNN is the well admired methodology due to its advanced feature mapping process. Generally every CNN has three layers in default [8]. The primary layer is used for giving input and second one is used as hidden layers and final layer for output. The considerable part of the entry unit is data input matrix. The next layer which can perform all the process CNN is hidden layer [9]. It consists of the layers which is filter the entry and exit later concealing them by the neural response method. The intermediate layers are made up of kernel layers [10], Subsampling layers, Standardization layers, vectorization layers and feed forward layers. In the model with the above layers it also made up of the neural response procedure in the internal layers is generally uses ReLU activation function. Final layer is composed of the end categorization matrix.

3. PROBLEM STATEMENT

In this synchronic fraternity, the skin diseases are prevailing. Majorly skin problems manifest as smaller circles or arbitrarily formed patches on the sufferer’s skin [11]. Skin diseases represent one of the most prevalent human malignancies, often diagnosed visually through clinical screening, dermoscopic analysis, biopsies, and histopathological examination. In existing, many research papers are there to identify the skin problems. Despite the inaccuracies of the existing samples in prediction, this model goal to progress a robust solution for skin disease prediction by exploiting the deep learning algorithm. In some scenario, these conditions can steer to critical situation, even consequent in skin cancer [12]. By investigating an open source datasets about skin disease, this model directs to pinpoint the possible skin scrapes and epidemic. Through clear challenging with the datasets, the most qualified match for the sufferer’s condition is resolved.

However, the manual classification of skin lesions is labor-intensive and prone to human error. To address this challenge, proposed work is developed for skin disease identification system leveraging cognitive computing techniques, notably Convolutional Neural Architecture (CNAs), to systematize the observation and classification of various skin conditions based on image data.

4. PROPOSED METHODOLOGY

In recent years exploration of skin diseases are objective task. In this recommendation system the CNN model was encouraged to identify five types of skin problems in addition to well-conditioned skin. The suggested model receives an image from the user and detects the issue based on the provided image. Initially, it transforms the color image into a grayscale version to enhance the image's clarity. In a second step the region of the image has been identified by applying the feature extraction technique. And also Hyper-parameter tuning is used to perform spontaneous feature extraction.

This model contribute the best confirmation of the infection compare to exiting methodologies which taken more time and less accuracy and more memory needs.

The key goal of this model is referred as to control the cost and work effectively and this model overcomes that.

As equated with some existing model this model can predict more number of skin illness incorporating Pigmented skin lesions, cutaneous Melanoma, Non-cancerous keratosis, Basal cell tumor, Actinic keratosis, Vascular birthmarks, and Dermal fibroma.

A new model is proposed by using VGG25 and achieved 89.75% testing Accuracy which is highest to compare with the existing methodologies. It is also act as a user friendly GUI to access.

4.1 Data collection

The proposed model employs the publicly accessible HAM10000 dataset, which incorporates 10,015 microscopic skin scanned copy of stained skin layer lesions accumulated from different types of sources. The set of data contains different view of pictures in the file format of JPEG, with a difference of 600 × 450 pixels.

Each piece of data in the collection, including images and patient details, contains seven unique attributes: The patient's age, gender, image ID, lexicon ID, DX type (employed for technical validation), the geographical coordinates of the skin lesion, and the diagnostic classification of the lesion are also taken into account. These features are utilized for labelling and diagnostic targets.

To efficiently assemble the set of data, each image is sorted into its corresponding folder based on the seven distinct types of diseases. In this process, the primary criterion which is utilized for dividing the pictures are the 'Picture ID' and the 'dx' (disease) classifications.

4.2 Pre-Processing

- To secure constant transformation in statistical learning schemes, all included the loaded pictures in the collection of data were resized to a specific size of 220x220 pixels.
- For the SCNN model, in the early stages pictures were downscaled to 96x96 pixels to accelerate training. These images were then converted into NumPy arrays, allowing pixel-level access. To normalize the pixel values between 0 and 1, a common preprocessing step, the model was able to learn more efficiently.

In Pre-processing below steps are followed

- Label Encoding
- Checking class count imbalance
- Scaling image amount of values
- Partitioning the data into developing, assessing, and justifying sets

4.3 Image Classification

A SCNN model was utilized to train and evaluate the image dataset. The framework functionality was examined by applying difference of assessment indicators, including F1-measure, true positive rate, exactness and true rate. These parameters were mainly used to determine the proposed model effectiveness and reliability of the developed method in categorizing and analyzing the image dataset.

4.4 Proposed Model

To accurately classify skin diseases, feature extraction is a critical component of computational learning and data-driven learning models. This proposed system employs a robust Sequential Convolutional Neural Network system (SCNN) architecture to employ all the relevant factors and classify skin diseases effectively.

The CNN architecture consists of nine convolutional layers, next by a flattening network layer to transform the 2D feature maps into a 1D array. Subsequently, two fully connected layers are used for classification. The detailed flow structure of the developed SCNN is illustrated in Figure 1, and Algorithm 1 provides a step-by-step explanation of its operation.

The process starts with uploading optimized images into the Sequential Convolutional Neural Network (SCNN). A small 3x3 kernel is then used for convolution to create a feature map. To introduce non-linearity, the ReLU activation function is applied. This convolution and activation step is repeated twice. Following this, Max Pooling is performed to downsample the feature representation. After pooling, the process of convolution and ReLU activation is executed twice again. Next, three additional convolution and ReLU iterations are carried out. This sequence is repeated three times, followed by another Max Pooling operation. The resulting 2D feature map is then flattened into a 1D vector. This vector is passed through a fully connected (FC) layer with 1024 units, using ReLU activation to extract relevant features. The extracted features are then fed into another FC layer that utilizes the Softmax activation function for classification. At the final stage, loss is computed, and gradients are accumulated for all trainable layers and parameters. Backpropagation is performed to refine the model by minimizing errors. Finally, the network parameters are updated using an appropriate learning rate, and the entire process is repeated iteratively until the error rate reaches its lowest possible value.

From the experiment we conclude that the model utilizes a learning rate of 0.001 and a mini-batch gradient descent with a momentum of 0.9 as key hyperparameters.

4.5 Approach (1) the stages of Image identification based on the SCNN

Step 1: Uploading the optimized picture(s) to the SCNN

Step 2: Perform convolution using a small kernel (3x3) to construct a feature map.

Step 3: To convert the linear data into non-linear data apply the ReLU activation function.

Step 4: Reiterate Steps 2 and 3 twice.

Step 5: Down sample the representation map by conducting Max Pooling.

Step 6: Revisit Step 4 next in sequence of Point 5 twice.

Step 7: Execute Steps 2 and 3 three times.

Step 8: Repeat Step 7 next in sequence of Point 5 three times.

Step 9: Transform the 2D representation map into a 1D vector by applying the Flatten layer.

Step 10: Insert the feature vector with the help of a completely interconnected layer with 1024 channels for attribute retrieval, by examining the ReLU activation method.

Step 11: Insert the identified factors into another FC layer with a Softmax activation methods for categorization.

Step 12: Analyze the loss at the end layer and cumulate gradients for all trainable layers and parameters.

Step 13: Accomplish back propagation to fine-tune specifications by propagating the exception.

Step 14: Upgrade the variables by applying learning rate factors, revisiting the Steps 2–13 until it securing the lowest error rate.

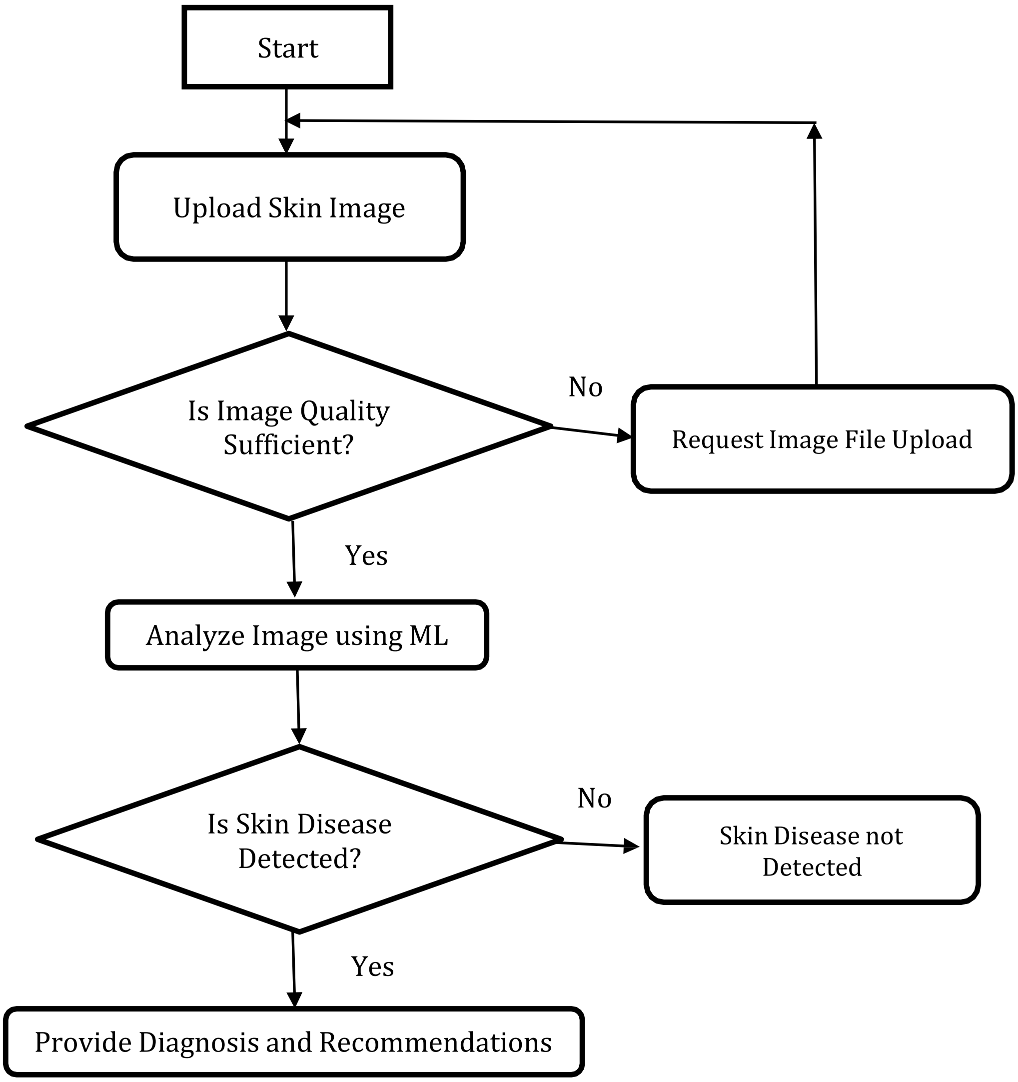

Figure 1: Flow structure of SCNN

The CNN was instructed from the basics on the particular picture following the Steps outlined in Algorithm 1. The resulting weights of the proposed network were then saved for use in future testing.

4.6 Model hyper parameters:

To optimize the SCNN model, specific hyper parameters were carefully selected.

The Adam optimizer: was selected due to its performance and capability in manipulating with the massive datasets. It is a popular choice for its simplicity and ability to adapt to different learning rates for each parameter.

For the loss function: Total entropy of discrete classes was identified, which is well-defined for different-class of categorization issues. This kind of loss process determines the distinction of the estimated likelihood and the original class attributes.

Epochs: The proposed method was coached for 50 epochs, with the number of epochs carefully determined to prevent overfitting.

Batch Size: Experimental results indicated with the batch size of 64 provided one of the improved performance for the proposed model.

Learning factor: A training speed 0.001 was chosen, as it regulates the step size during gradient updates. An adaptive rate is inferior in size means it will give the outputs in smaller steps, while a greater one takes bigger steps.

By thoughtfully tuning these kind of hyper-parameters, the SCNN model was upgraded to offer superior performance in the recommended model.

5. RESULTS AND DISCUSSIONS

The application is designed to be user-friendly, catering to individuals with varying levels of technological expertise. Additionally, the project provides information about diseases, including possible causes or reasons for their occurrence. It also offers educational insights into various diseases, enabling users to gain a basic understanding of them.

Currently, the model predicts diseases such as Melanoma, basal cell carcinoma, vascular lesions and dermatome fibroma with an accuracy of 94% which are committed to further enhancing performance by amplifying the image collection in the dataset to maximize accuracy.

Skin image uploaded is depicted in Figure 2, analysis of skin image is shown in Figure 3, and Prediction report is described in Figure 4.

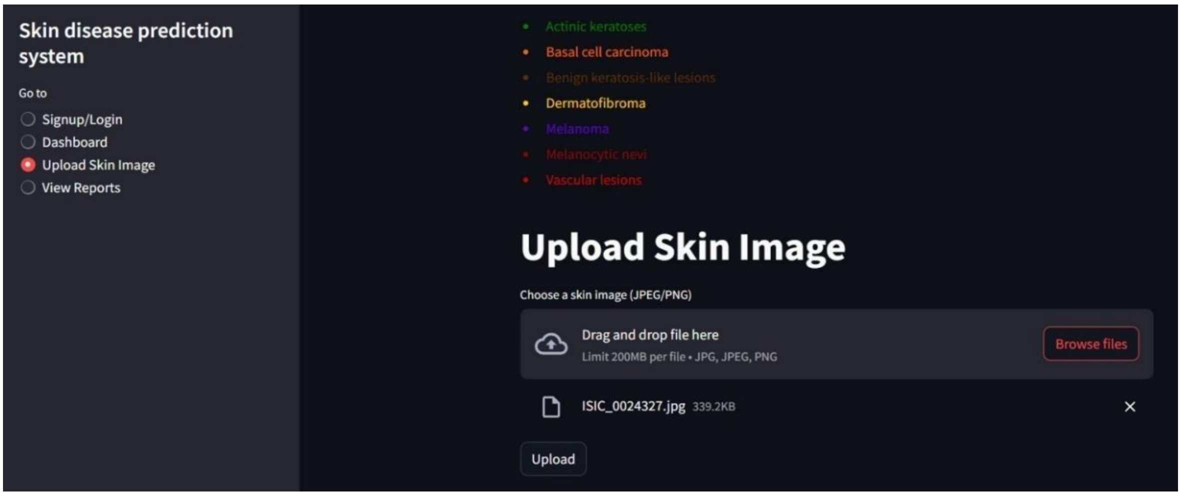

Figure 2: Upload Images

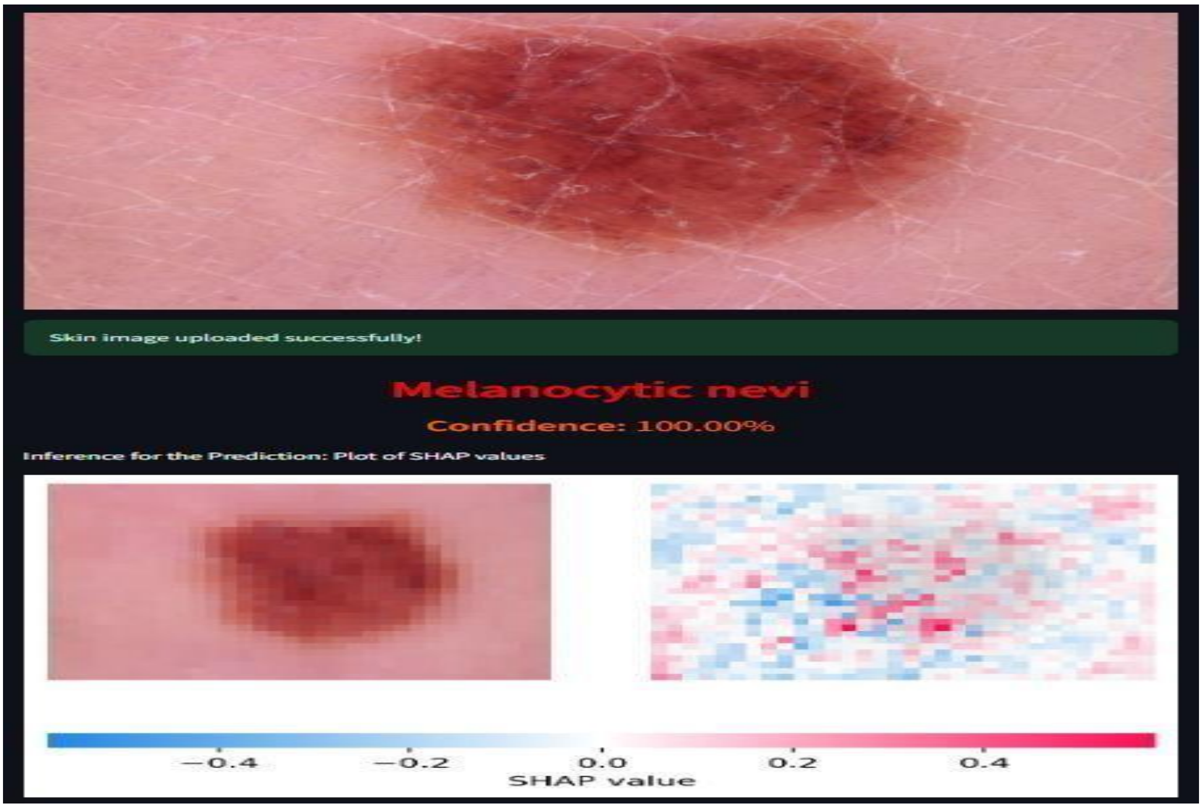

Figure 3: Analyzing Images

Figure 4: Generating Report

6. CONCLUSION

The development and implementation of a deep learning-based system for detecting skin problem mark a notable breakthrough in healthcare. By leveraging artificial intelligence and data analytics, this cutting-edge approach provides a more accurate and efficient method for diagnosing and managing various skin conditions.

By analyzing extensive medical data and images, the system can detect patterns and markers linked to specific skin diseases, enabling healthcare professionals to deliver timely and precise interventions. This not only simplifies the diagnostic process but also improves the overall quality of care for patients.

Moreover, the use of deep learning algorithms allows the system to continuously learn and enhance its accuracy over time. This technological advancement enables healthcare providers to offer more tailored and effective treatments, eventually resulting in better patient results and improved the quality of life. As technology evolves, the potential for deep learning in skin disease detection promises to revolutionize healthcare and advance medical practices. After through hyper-parameter tuning, the 4th attempt yielded the highest accuracy, with 89.75% on the testing data. Consequently, a Sequential CNN model was built based on the parameters of the 4th attempt to predict skin diseases accurately.

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