Web-based System for Skin Anomaly Classification using Deep Learning Techniques

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Introduction

Ignoring new skin developments that may be cancerous is a primary cause of cancer worldwide. To address this issue, a user-friendly system is proposed, enabling users to receive a preliminary diagnosis with statistics about the anomaly, allowing them to make informed decisions about seeking professional medical attention, ultimately saving time and reducing waiting room hours.

Motivation

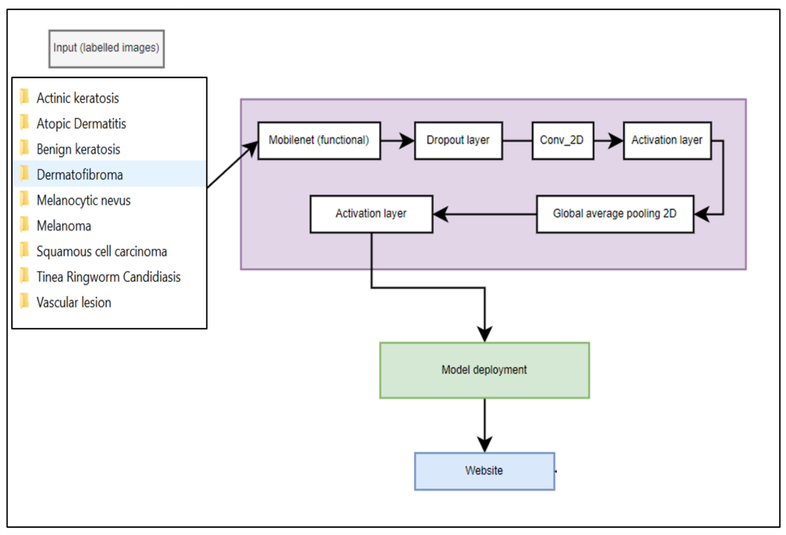
The motivation behind this project is to enable early detection of potentially cancerous skin developments through a user-friendly system, improving chances of timely medical intervention.

SCOPE of the Project

The scope of this project involves developing a web-based application that utilizes deep learning techniques to classify skin diseases based on uploaded images. The application will provide users with probability assessments for various skin conditions, enabling them to gauge the severity of their condition. It will also offer guidance on whether further consultation with a specialist is recommended. The project will focus on implementing and integrating the DenseNet deep learning model using Flask, HTML, and CSS, ensuring a seamless and user-friendly experience for individuals seeking preliminary skin disease diagnosis.

Methodology

A dataset of skin disease 6021 images was collected, comprising nine diseases: Actinic keratosis, Atopic Dermatitis, Benign keratosis, Dermatofibroma, Melanocytic nevus, Melanoma, Squamous cell carcinoma, Tinea Ringworm Candidiasis, and Vascular lesion.



A flowchart showing the workflow of the proposed system

The dataset was divided into training and testing sets with an 80:20 split, and three models, namely CNN, MobileNet, and DenseNet, were trained on the data. DenseNet demonstrated the highest accuracy during testing and was subsequently deployed in a web application.

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_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 densenet121 (Functional)    (None, 7, 7, 1024)        7037504

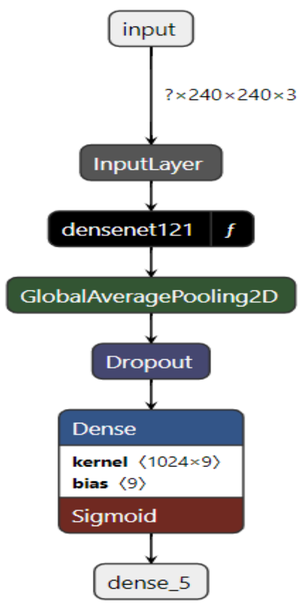
 global_average_pooling2d (G  (None, 1024)             0
 lobalAveragePooling2D)

 dropout (Dropout)           (None, 1024)              0

 dense (Dense)               (None, 9)                 9225

=================================================================
Total params: 7,046,729
Trainable params: 6,963,081
Non-trainable params: 83,648
_________________________________________________________________
```

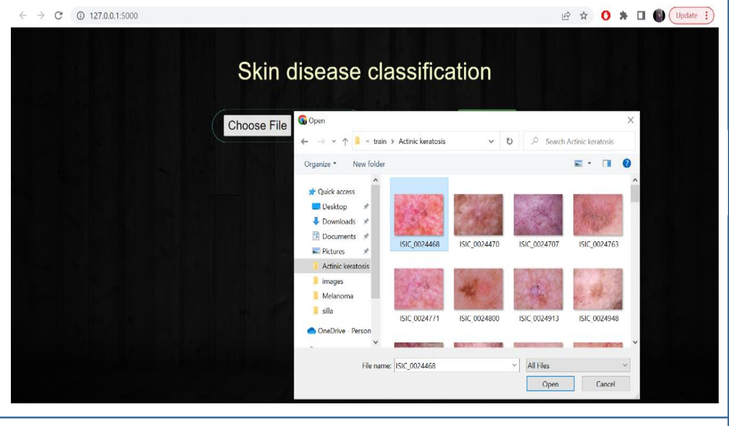
Layers of the DenseNet model



The web app's front-end was developed using HTML and CSS, providing a user-friendly interface for disease prediction. The back-end was implemented in Python, utilizing the Flask framework for seamless integration.

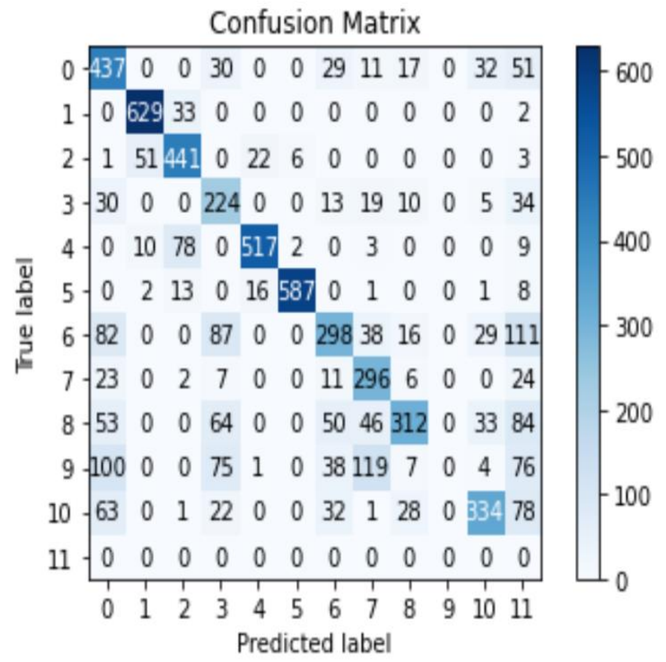
Rather than training the model, the web app imports a pre-trained model in the form of an ".h5" file. It incorporates a Python code snippet to leverage the pre-trained model for disease prediction.

Users are prompted to upload an image through the web interface, which is then processed by the back-end to generate predictions regarding the possible disease.



Results

The DenseNet model predicts with an accuracy of **73%.** The total images used for testing was 6021 out of which 4075 were predicted correctly.



The confusion matrix showing predictions using the test images

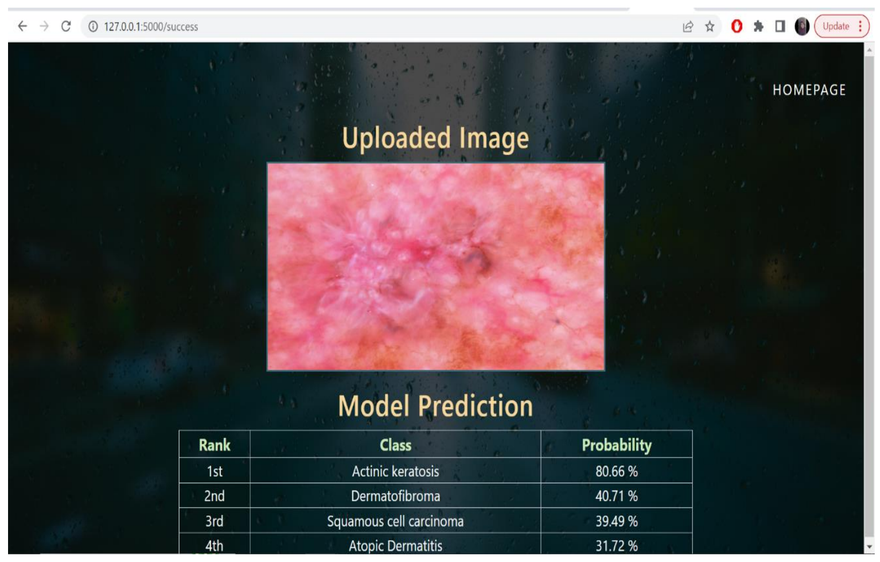
The model was expected to accurately classify the images into 9 diseases which were labelled 0-8. If the model identified the images as “NONE” of the trained labels, it would classify it into the “10”th label. The model being trained only on images is unable to classify with more than 75% accuracy due to the very close visual similarity of skin anomalies. In order to improve the model, text prompts must be included.

Models	Training Accuracy	Testing Accuracy	Training Loss	Testing Loss	Avg time to train/step (s/step)
CNN	0.31	0.28	1.806	2.10	58
MobileNet	0.99	0.45	0.06	1.82	150
DenseNet	0.73	0.36	0.25	0.45	850

Table showing various metrics - training and testing the model

The developed web app operates smoothly, providing quick results within a timeframe of **less than 2 seconds**. Upon uploading an image, the web app promptly returns a list of four disease classifications, ordered in descending order of probability. This efficient and user-friendly interface allows users to swiftly obtain predictions for the potential skin diseases based on the input image.

Example of a classification on the web-app. Web results predict correctly with 80%-95% accuracy



Conclusion

The successful implementation of the proposed system has the potential to address several limitations in the current healthcare landscape, including limited access to dermatologists, long waiting times for appointments, and the potential risks associated with delayed diagnosis. By leveraging the power of deep learning algorithms and integrating them into a user-friendly web application, individuals can gain valuable insights into their skin conditions and receive appropriate recommendations for further medical consultation. Furthermore, the project's focus on using pre-trained models, optimization techniques, and potential future enhancements such as incorporating text prompts and training with text/NLP can further enhance the accuracy and effectiveness of the system.

References

1. J. Velasco, “A smartphone-based skin disease classification using MobileNet CNN,” *International Journal of Advanced Trends in Computer Science and Engineering*, pp. 2632–2637, 2019.

2. M. Cullell-Dalmau, S. Noé, M. Otero-Viñas, I. Meić, and C. Manzo, “Convolutional neural network for skin lesion classification: Understanding the fundamentals through hands-on learning,” *Frontiers in Medicine*, vol. 8, 2021.