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INTEGRATED CNN MODEL FOR FACIAL SKIN DIAGNOSTICS

Advancing dermatological analysis through Deep Learning

[1]P Suneetha, [2]P B V Ashritha, [3]Ch Adithi,[4]Ch Aparna,[5]K Sowmya Sree
[1]Assistant Professor, [2]Student, [3]Student,[4]Student,[5]Student
[1]Information Technology,
[1]SRKR Engineering College, Bhimavaram, India.

Abstract : The advanced Convolutional Neural Network(CNN) model is developed to excel a dual pupose: the diagnosis of diverse facial skin diseases and basic required prescription. By leveraging transfer learning, the model optimizes the extraction of features, demonstrating high accuracy in identifying a wide range of skin conditions. A specialized Convolutional layer enhances skin disease prediction based on facial features, while ensemble techniques contribute to robust diagnostic insights, establishing the model as a reliable tool for dermatological assessments. The model's performance is rigorously validated using evaluation metrics such as accuracy for disease diagnosis and Mean Absolute Error for estimation across various datasets. This research represents a significant stride in automated dermatological diagnostics, providing an efficient approach for concurrent evaluation of skin health and basic required prescription. The proposed model showcases substantial potential for clinical applications, offering a valuable contribution to personalized healthcare and the evolution of machine learning in dermatology. This innovative approach is composed to redefine diagnostic practices, escorting in a new era of precision and efficiency in dermatological health assessments.

Keywords—Deep Learning,Convolutional Neural Network, Visual Geometry Group, Image processing, Facial Analysis, Computer Vision.

I. INTRODUCTION

Facial skin being the most visible and exposed part in the human's body has a great influence on both mental and physical well being of the person. It is the most crucial and important part that everyone must focus and be taken care of. Looking after the well being of the facial skin is really a difficult task as there are many defined and undefined skin conditions. Though there are some defined conditions regarding the facial skin it's not actually taken care in the way it should be treated. This proves that there is problem with both unawareness and also less exposure of the skin conditions or the un-identified skin conditions that are rarely seen.

To address all these things relating to the importance and the need of facial skin diagnostics CNN, Convolutional Neural Network holds a significant promising nature. There are many disadvantages regarding the existing systems or the existing technologies used in this perspective. CNN has been designed specifically for the sake of image processing. Though there are many use cases or the applications got from Convolutional Neural Networks it is efficient in the image processing perspective.

Machine Learning's contribution in Facial Skin Diagnostics

Machine learning has revolutionized facial skin diagnostics by automating analysis, enhancing accuracy, and enabling early detection of different skin conditions. By utilizing extensive datasets, machine learning algorithms can identify patterns, leading to personalized treatment strategies and remote consultations. The continuous learning process allows these models to adapt to new trends, which in turn contributes to research progress and improves dermatological care and patient results.

Scalability

The proposed solution leverages the natural scalability of deep learning models, effectively managing extensive collections of facial images. This is crucial for addressing the rising need for dermatological diagnostics and ensuring patient care. By handling expanding data quantities, the system can uphold efficiency and dependability, streamlining healthcare services. The scalable design of the solution permits effortless integration into existing healthcare systems, aiding healthcare providers in catering to a wide range of patient requirements.

Adaptability

The project showcases adaptability with its versatile, modular layout and scalable structure, enabling seamless adjustments to evolving requirements and environments. Its scalable architecture ensures efficient handling of increasing demands, while compatibility with diverse platforms promotes accessibility. Ongoing development and agile approaches allow for continuous enhancement through feedback. In essence, the project's adaptability ensures robustness and efficiency in tackling changing healthcare challenges and needs.

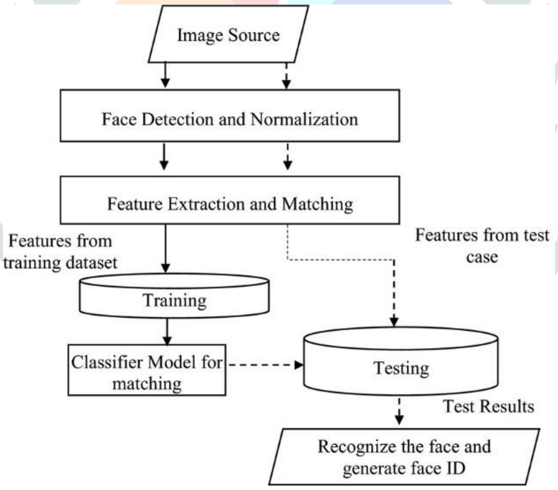
II. LITERATURE SURVEY

1. "Facial Skin Disease Classification Using a Deep Convolutional Neural Network" Zhang et al.(2019) presented a deep CNN model for facial skin disease classification. This model leverages texture features extracted from facial images and features learned from CNN to improve diagnostic accuracy.
2."Survey paper based critical reviews for Cosmetic Skin Diseases" by Shwetambari Borade and Dhananjay Kalbande [2021]. This paper is related to normal skin issues as well as cosmetology. Comparison between various types of skins like dry, oily and normal skin.
3."Image Analysis Model for Skin Disease Detection : Framework" [2018] by Alaa Haddad and Shihab A. Hameed aims to detect skin disease from skin image to analyze by applying filter and removing noise and unwanted things.
4."Face Skin Disease Detection and Community based Doctor Recommendation System [2022] by M.A.A. Udara, D.G.Wimalki Dilshani, M.S.W.Mahalekam, V.Y.Wickramaarachchi, Jenny Krishara and Dinuka Wijendra reports a smart solution that assists the patients by detecting the disease, identify the current infected area of the disease, recommend best doctor, provide community-based prevention guidelines, and predict the future risk.

III. PROBLEM STATEMENT

Skin conditions pose a significant healthcare challenge globally, and all the traditional methods of dermatological diagnostics often rely on manual examination, leading to delays in diagnosis and potential misinterpretations. The need for efficient, accurate, and accessible diagnostic tools is paramount. In this context, there exists a gap in the field of dermatology for an automated and integrated solution leveraging Convolutional Neural Networks(CNNs) to analyze facial images for the early detection and classification of various skin conditions.

IV. ARCHITECTURE



Existing Systems:

- Manual Dermatological Examination: Dermatologists rely on visual inspection and manual examination techniques to diagnose skin conditions. This involves observing the skin's texture, color, lesions, and other visible characteristics.
- Clinical History and Patient Interviews: Dermatologists gather information about a patient's medical history, lifestyle factors, and symptoms through interviews. This helps in understanding the context of skin conditions and potential triggers.
- Diagnostic Criteria and Guidelines: Dermatologists follow established diagnostic criteria and guidelines for various skin conditions. These criteria are based on clinical observations, historical data, and medical literature.
- Specialized Dermatological Training: Dermatologists undergo specialized training and education in dermatology to develop expertise in diagnosing and treating skin conditions. This includes knowledge of dermatological patterns, differential diagnoses, and treatment modalities.
- Collaboration and Consultations: Dermatologists often collaborate with other healthcare professionals, such as pathologists, to obtain additional insights and confirm diagnoses. They may also consult with colleagues for challenging cases or second opinions.
- Continuing Education and Research: Dermatologists engage in continuing education and stay updated with the latest research and advancements in dermatology. This ongoing learning process helps improve diagnostic accuracy and patient care.
- Patient Education and Empowerment: Dermatologists educate patients about their skin conditions, treatment options, and preventive measures. Empowering patients with knowledge and self-care practices promotes better management of skin health.

V. ALGORITHMS

Convolutional Neural Network(CNN) is a cornerstone in the realm of facial skin diagnostics. It offers a sophisticated framework for analyzing visual data, particularly facial images. It is designed based on a part of human brain called cortex which functions on recognizing the visual data. CNN enables precise detection and classification of various skin conditions. It has an unparalleled ability to discern intricate patterns and subtle features inherent in facial skin facilitates early intervention, ultimately improving patient outcomes.

It works by applying filters to the input images for detecting the features. Here there's no need of feature extraction manually CNN does it by itself. Some of the applications are image classification, object detection, image segmentation.

VGG19

In this project VGG19 is used for several reasons, VGG19 is a variant of Visual Geometry Group with 19 layers. It is a part of CNN with broader benefits.

- VGG19 is pre-trained on ImageNet, that can be valuable for transfer learning tasks, especially when there is limited amount of data.
- Known for straightforward design, multiple convolutional layers followed by pooling layers and topped with fully connected layers.

VI. IMPLEMENTATION

Input :
- Dataset containing images of various classes of skin conditions.
- Deep Learning model(CNN-VGG19).

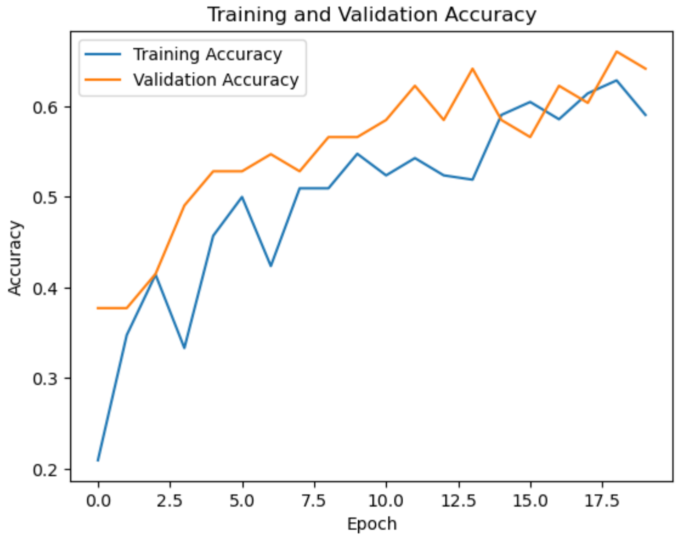
Output :
- Skin condition class
- Basic prescription (Precautions, Sources to explore more on that skin condition).

Data Preparation :
- Loading the dataset containing facial skin images.
- Preprocessing of images.

Data Splitting :
- Splitting of preprocessed dataset into training and testing sets.

Model Building :
- Constructing of VGG19 model using TensorFlow's Keras.

Model Training and Evaluation :
- Training of the compiled model using the train data by specifying the number of epochs and validation data for monitoring performance.
- Evaluating the trained model using test data and assess accuracy.

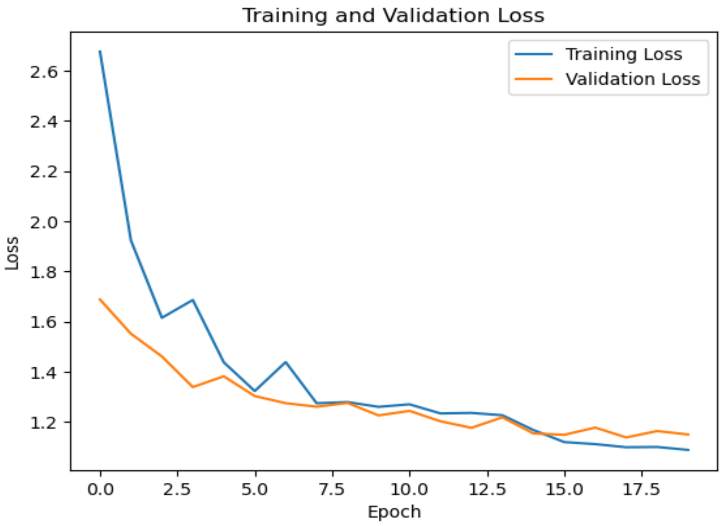


- Save the model for future use (deployment).

Epoch 1/20
7/7 [==============================] - 26s 3s/step - loss: 2.6761 - accuracy: 0.2095 - val_loss: 1.6880 - val_accuracy: 0.3774
Epoch 2/20
7/7 [==============================] - 23s 3s/step - loss: 1.9235 - accuracy: 0.3476 - val_loss: 1.5516 - val_accuracy: 0.3774
Epoch 3/20

7/7 [==============================] - 23s 3s/step - loss: 1.6151 - accuracy: 0.4143 - val_loss: 1.4610 - val_accuracy: 0.4151
Epoch 4/20
7/7 [==============================] - 23s 3s/step - loss: 1.6861 - accuracy: 0.3333 - val_loss: 1.3389 - val_accuracy: 0.4906
Epoch 5/20
7/7 [==============================] - 23s 3s/step - loss: 1.4376 - accuracy: 0.4571 - val_loss: 1.3818 - val_accuracy: 0.5283
Epoch 6/20
7/7 [==============================] - 22s 3s/step - loss: 1.3231 - accuracy: 0.5000 - val_loss: 1.3031 - val_accuracy: 0.5283
Epoch 7/20
7/7 [==============================] - 25s 4s/step - loss: 1.4385 - accuracy: 0.4238 - val_loss: 1.2747 - val_accuracy: 0.5472
Epoch 8/20
7/7 [==============================] - 27s 4s/step - loss: 1.2745 - accuracy: 0.5095 - val_loss: 1.2606 - val_accuracy: 0.5283
Epoch 9/20
7/7 [==============================] - 28s 4s/step - loss: 1.2789 - accuracy: 0.5095 - val_loss: 1.2755 - val_accuracy: 0.5660
Epoch 10/20
7/7 [==============================] - 27s 4s/step - loss: 1.2601 - accuracy: 0.5476 - val_loss: 1.2259 - val_accuracy: 0.5660
Epoch 11/20
7/7 [==============================] - 27s 4s/step - loss: 1.2701 - accuracy: 0.5238 - val_loss: 1.2440 - val_accuracy: 0.5849
Epoch 12/20
7/7 [==============================] - 27s 4s/step - loss: 1.2338 - accuracy: 0.5429 - val_loss: 1.2025 - val_accuracy: 0.6226
Epoch 13/20
7/7 [==============================] - 27s 4s/step - loss: 1.2358 - accuracy: 0.5238 - val_loss: 1.1764 - val_accuracy: 0.5849
Epoch 14/20
7/7 [==============================] - 28s 4s/step - loss: 1.2267 - accuracy: 0.5190 - val_loss: 1.2183 - val_accuracy: 0.6415
Epoch 15/20
7/7 [==============================] - 13737s 2289s/step - loss: 1.1678 - accuracy: 0.5905 - val_loss: 1.1541 - val_accuracy: 0.5849
Epoch 16/20
7/7 [==============================] - 43s 6s/step - loss: 1.1196 - accuracy: 0.6048 - val_loss: 1.1486 - val_accuracy: 0.5660
Epoch 17/20
7/7 [==============================] - 39s 6s/step - loss: 1.1115 - accuracy: 0.5857 - val_loss: 1.1774 - val_accuracy: 0.6226
Epoch 18/20
7/7 [==============================] - 36s 5s/step - loss: 1.0990 - accuracy: 0.6143 - val_loss: 1.1381 - val_accuracy: 0.6038
Epoch 19/20
7/7 [==============================] - 32s 5s/step - loss: 1.1001 - accuracy: 0.6286 - val_loss: 1.1635 - val_accuracy: 0.6604
Epoch 20/20
7/7 [==============================] - 38s 5s/step - loss: 1.0883 - accuracy: 0.5905 - val_loss: 1.1499 - val_accuracy:

From the implementation it is prevalent that there is an increase in the accuracy from 21% to 59% over the 20 epochs, indicating that the model is learning from the training data and improving its predictive capabilities.



Accuracy 64.8956445%

VII. DEPLOYMENT

Setup Flask Project :

- Creating a new directory for flask project.
- Setting up virtual environment and installing required dependencies.
- Creation of Flask app file for defining the application routes and functionality.

Model Loading :

- Loading the trained CNN Model (Use ‘load_model’ function from TensorFlow Keras to load the model).

Image Upload and Preprocessing :

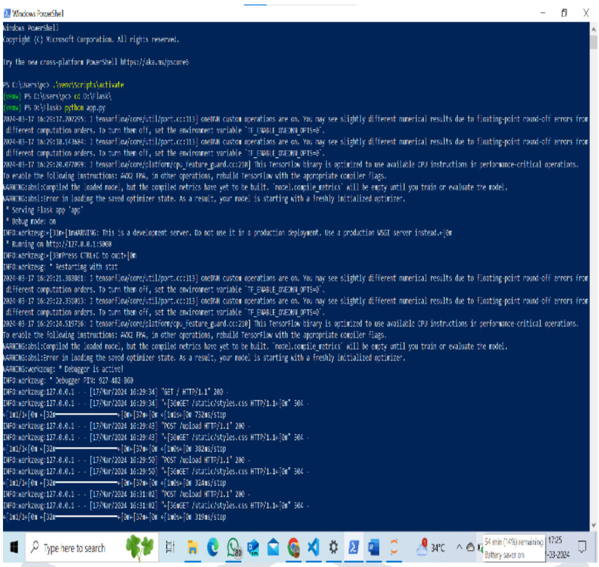
- Creating HTML form to allow users to upload images, can include OpenCV for accessing the web camera.
- Defining of route for handling the uploaded images and preprocess them to pass it through the model.

Run the Flask application :

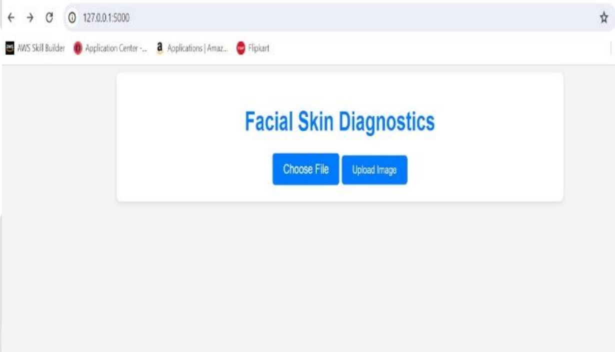
- Flask app can be run using command ‘python app.py’ on the powershell.

```
├── pickle
│   ├── model.pkl
├── static
│   ├── styles.css
├── templates
│   ├── index.html
├── Phishing URL Detection.ipynb
├── Procfile
├── README.md
├── app.py
├── feature.py
├── phishing.csv
├── requirements.txt
```

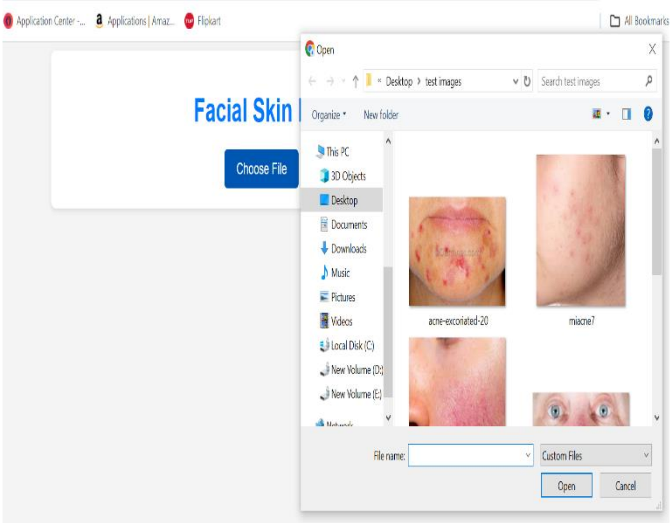
This is the format in which the files and folders be created for Flask project deployment. Once we run the app.py file there will be a line saying application running on a address copy and paste the url in the browser then the Flask project can be used successfully.



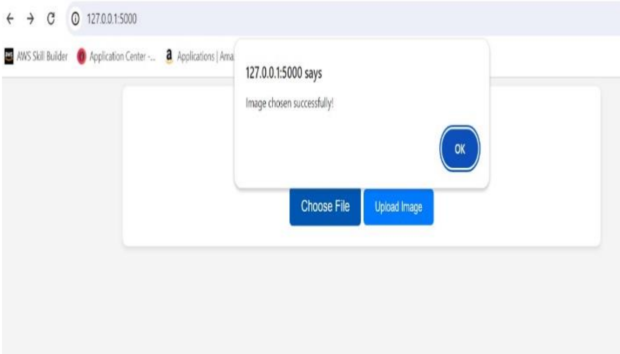
(Picture showing running of Flask project)
(Windows Powershell)



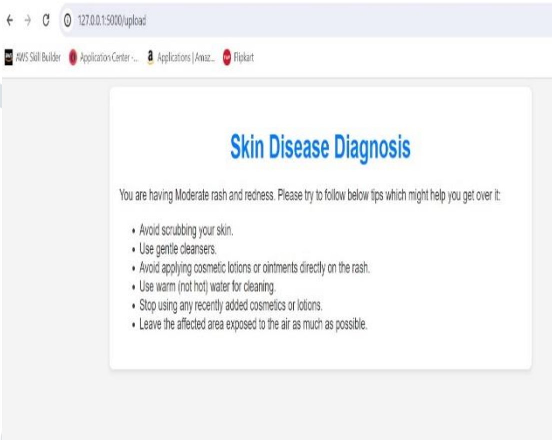
(Simple UI for uploading image)



(Uploading image)



(Alert for successful and unsuccessful uploading of image)



(Prediction class related information)

VIII. CONCLUSION

This implementation of CNN model (VGG19) for facial skin diagnostics is a significant advancement in the fields of both healthcare and also machine learning. By taking and implementing VGG19 it becomes possible to automate and improve the accuracy of diagnosing the skin conditions using visual analysis of the facial skin images.The deployed CNN model is integrated into a Flask web application which allows users to upload images of facial skin conditions which are processed by the
CNN model in the backend and delivers the accurate outputs as desired. This type of analysis carried by models like CNN or VGG19 has many benefits such as reduction of human errors, enhancing of patient care in dermatology and related medical fields. It's important to take a note that CNN models can achieve high accuracy in image classification problems still they're not with limitations. There are challenges like data bias, generalization to diverse populations must be carefully done and considered, to apply in the real-world.
Overall, the CNN model for facial skin diagnostics demonstrates the power of deep learning and it's grip and depth in terms of image processing and classification which is pertaining to successful predictions in the healthcare field. It has overcome many disadvantages in the existing systems.

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[6]. Alaa Haddad and Shihab A. Hameed "Image Analysis Model for Skin Disease Detection : Framework" [2018] regarding cosmetology.
[7]. "Survey paper based critical reviews for Cosmetic Skin diseases" by Shwetambari Borade and Dhananjay Kalbande [2021] regarding various types of skin nature.
[8]. "Facial Skin Disease Classification Using a Deep Convolutional Neural Network (CNN)" by Zhang et al.(2019) based on texture features and also features learned automatically by CNN.