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# Deep Facial Diagnosis: Deep Transfer Learning from Face Recognition to Facial Diagnosis

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**Abstract**

One of the most crucial uses for facial analysis is facial diagnosis. Practitioners of traditional medicine have used their expertise to assess a person's health state for tens of thousands of years. Since then, a lot has changed, and this long-standing tradition has been supplanted by computerised face diagnosis. The proposed method of utilizing deep transfer learning from face recognition for face illness diagnosis with computer assistance is an interesting approach that can potentially provide a low-cost and non-invasive way for disease screening and detection. The objective of this research endeavor is to investigate whether techniques based on deep learning may be employed to detect malignancies through uncontrolled 2D face images. By leveraging the pre-trained face recognition models, the system can effectively learn relevant features from the face images and use them to diagnose different diseases. The proposed system will be using data augmentation to handle the imbalance of data in the system and reduce over-fitting. By artificially generating new data from the existing dataset, the system can increase the amount of data and diversity of the samples, leading to better generalization and improved accuracies.

**Keywords:** Facial diagnosis, deep transfer learning (DTL), face recognition, data augmentation.

## Introduction

Deep facial diagnosis is a technology that analyses facial features and provides medical diagnoses for a variety of conditions using deep learning algorithms. The technology analyses facial images to identify specific features and patterns that may indicate underlying medical conditions. The deep facial diagnosis project involves developing and deploying a deep learning algorithm that can accurately diagnose medical conditions based on facial features. The project may entail gathering and analysing large datasets of facial images and medical data, training and fine-tuning deep learning models, and assessing the models' performance. Recent advances in generic face recognition have been made thanks to very deep neural networks' exceptional potential for learning[6].Face recognition

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technology can help with facial diagnosis by generating accurate and consistent facial images. Medical professionals frequently rely on visual assessments of facial features to diagnose medical conditions. However, factors such as lighting, camera angles, and facial expressions can all affect the accuracy of these assessments.

Medical professionals can improve the accuracy and consistency of their visual assessments by using face recognition technology to capture standardised facial images. Deep learning algorithms can be used to identify specific facial features and patterns in these images.

In this paper, we selected five diseases to perform the validations.

Beta-thalassemia is an recessive ailment which is brought through mutations in the HBB gene, which is housed on chromosome 11 and put into thethe beta-globin protein. Bone malformations can be brought on by beta-thalassemia, particularly in the facial region. Comparatively tiny eye apertures, a flat mid-face, a petite nose, a smooth philtrum, a thin upper lip, and an undersized jaw are characteristics of beta-thalassemia on the face.

Leprosy, also known as Hansen's disease, can affect the face and other parts of the body. Loss of brows or eyelashes is one of the facial symptoms of leprosy. Skin thickening on the face, nodules or lumps on the face, facial swelling Congestion or discharge from the nose, Ulcers or sores on the face, Paralysis or weakness of facial muscles. Leprosy can cause significant facial disfigurement in advanced cases, such as a collapsed nose or drooping eyelids.

Down syndrome is an inherited disorder caused by an extra copy of chromosome 21. This extra genetic material has the potential to affect many different parts of the body, including the face. A small head with a flat facial profile, upward slanting eyes with epicanthal folds, a small nose with a flat bridge and small nostrils, as mall mouth with a tongue that may stick out, small, rounded ears, excessive skin at the nape of the neck, and a single crease across the palm of the hand are all characteristics of Down syndrome.

In hyperthyroidism, the thyroid gland generates an excessive quantity of thyroid hormone. This can cause various problems in the face. Exophthalmos (bulging or protruding eyes), redness or irritation of the eyes, puffiness or swelling of the face or eyelids, fine tremors of the hands or fingers, and sweating are some of the facial symptoms of hyperthyroidism.

Vitiligo is a skin ailment that results in pigment loss in certain areas of the skin. It has the potential to affect various parts of the body, including the face. Patches of depigmented skin on the face, including around the eyes, mouth, and nose, loss of pigmentation in the hair on the face, such as the brows and eyelashes, white or grey hair in the affected areas, and symmetrical patches on both sides of the face are all symptoms of vitiligo.

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**Literature Survey**

1) Schroff et al., [1] details the efficiency of deep learning-based facial recognition methods. For the purpose of face recognition, the approach combines a deep network of neurons to acquire a feature representation, or anchoring, of a query image. It recommends tweaks to the conventional deep learning architecture, such as employing a narrower convolutional kernel size, a greater number of feature maps, and the addition of residual connections. It is trained on large-scale datasets using a triplet loss function. The suggested method obtains cutting-edge results on a number of benchmark datasets and offers a solid framework for additional field study.

2)Yan Peiet al., [2] researched on tuner syndrome using photographs of faces focuses on a female-specific genetic condition. The researchers examined the faces of people with Turner Syndrome and healthy people using a deep learning algorithm. The algorithm was able to identify between those with Turner Syndrome and healthy people with higher accuracy.

3) Dian Hong et al., [3] has examined the Noonan Syndrome, a genetic condition that affects various body parts. An article presented a deep learning model for the automatic diagnosis of facial phenotypic features in Noonan Syndrome. The model had an accuracy of 96.25% when it came to diagnosing Noonan Syndrome after being trained on a dataset of facial images of both healthy people and people with the condition.

4)Bin Liang et al., [4] assessed the reliability and relevance of past research on deep learning-based face image processing for medical investigations. The authors conducted searches across several databases to find pertinent papers, and they included studies that employ deep learning methods to examine face photos for medical research. A subgroup analysis carried out to investigate the impact of various deep learning models, patient demographics, and research designs on the results, and potential biases in the included papers will also be evaluated.

5)Shiyu Chen et al., [5] suggested a novel face recognition system that makes use of both support vector machines and convolutional neural networks (CNNs) (SVMs). The two steps of the suggested system are feature extraction and categorization. A pre-trained CNN is utilised to extract high-level characteristics from facial photos during the feature extraction step. SVMs are then employed for classification using the characteristics that were extracted. [7-15]

**Problem Identification**

Conventional face illness therapy often entails a subjective manual examination by a skilled medical expert.Prompt medical illness discovery can bring in earlier treatment and enhanced results for patients.Sometimes manual diagnosis may be challenging and time consuming. To help the medical practitioners, deep learning techniques can be used for better diagnosis. It can also potentially reduce the need for invasive diagnostic procedures,

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such as biopsies, which can be uncomfortable and carry some risks.The potential benefit of deep learning techniques is that they may be able to swiftly and effectively evaluate enormous volumes of data, which might result in quicker diagnosis and earlier treatments. This may be crucial in cases when early action is necessary to get the greatest results.

## Methodology

Deep facial diagnosis is the use of deep learning techniques to analyze facial images and extract diagnostic information. The initiation phase is to assemble a sizable collection of face photos that have the corresponding diagnosis or medical condition. Pre-processing involves cleaning and preparing the data for analysis. Model selection involves choosing from popular models such as CNNs, Recurrent Neural Networks (RNNs), or Transformers. Training involves minimizing the loss function by adjusting the weights of the model during training.

Validation involves testing the model on a new dataset to evaluate its performance. Interpretation involves consulting with medical professionals to verify the accuracy and clinical relevance of the diagnostic information extracted from the facial images. It is important to follow rigorous methodology and quality control measures to ensure that the results are valid and clinically relevant.

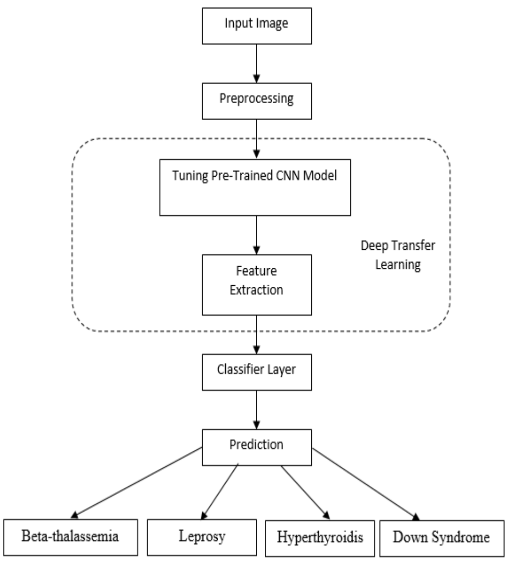


Fig.1.Methodology

## Implementation

In this paper, we used ResNet50 model for the identification of facial diseases and it is compared with the results of a custom CNN model and VGG16 model.

**Data Augmentation:**

Data augmentation is a technique used in deep learning to increase the amount and diversity of training data available to the model. It involves generating new data points from

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existing ones by applying various transformations and modifications. Data augmentation can help in several ways, such as increased data diversity, reduced overfitting, improved accuracy, and improved bias and robustness. It can also improve the performance of deep facial diagnosis models by providing them with more diverse and abundant training data. Data augmentation results in augmented datasets which will be further passed to the relevant model for the prediction.

Custom CNN:

Convolutional Neural Network is an approach to deep learning that is frequently used to problems involving image and video processing. CNNs are intended to automatically recognise and learn picture characteristics, such as edges, lines, and patterns. They are composed of convolutional layers that apply a set of learned filters or kernels to the input image. Pooling layers reduce the number of parameters and computational requirements. Finally, fully connected layers combine the output of the convolutional and pooling layers to produce a final classification or regression output.

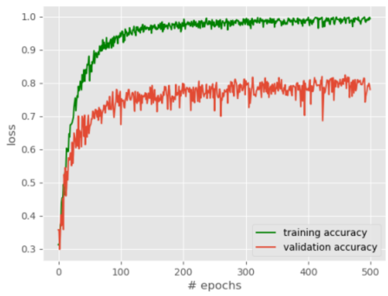


Fig.2. Training and validation accuracy

ResNet50:

ResNet50 is a deep learning model architecturewhich involves adding shortcut connections that bypass one or more layers in the network. ResNet50 consists of 50 layers and has a total of 25 million parameters. It uses a combination of convolutional layers, pooling layers, fully connected layers, and shortcut connections to process images and make predictions. It also uses batch normalization to reduce the impact of internal covariate shift and improve the training of deep neural networks.


Fig.3. Accuracy rate of ResNet50 model

VGG16:

VGG16 is a deep convolutional neural network architecture that is indeed extensively utilized in image recognition tasks.In several image identification applications, including deep facial diagnosis, the deep convolutional neural network architecture VGG16 has been employed. The VGG16 model has 16 layers, including 3 fully connected levels and 13 convolutional layers.


Fig.4. Training and validation accuracy of VGG16

**Results and Conclusion**

In this paper, five kinds of facial diseases which includebeta-thalassemia, hyperthyroidism, leprosy, down syndrome and vitiligo are predicted using deep learning techniques. The main focus of the proposed system is on ResNet50 model which also compared with other deep learning techniques such as custom CNN and VGG16. The resilience of the ResNet50 model may be increased by using data augmentation techniques to broaden the variety of the training data.Initially, face detection on 2D images is performed. Then facial landmarks are extracted which can be found on the margins of the lips, chin, bridge, and bottom of the nose, as well as the brows, eyes, and jaw lines.

Through the selected model features are extracted from the 2D images. Based on the trained features, the model classifies the input image into the relevant disease category.

Here, the ResNet50 model has yielded a higher accuracy which is above 90% when compared to the other considered models.

| Model | Accuracy(%) |
|---|---|
| Custom CNN | 0.78 |
| ResNet50 | 0.97 |
| VGG16 | 0.82 |

Table 1: Accuracy Comparision of models

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**Future Work**

The proposed system detects the stated dematology diseases effectively and the stated models yields better accuracies.

In future, it could be extended to include multiple facial diseases as well as new models like Xception and Inception can also be included for model performance comparison.

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