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Eczema predication based on AI Model

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Abstract - In this paper we have proposed AI-based model for predicting eczema from medical skin image data set. Skin diseases are endemic health issues, usually leading to physical discomfort and mental depression, with extreme situations resulting in skin cancer. Identifying skin diseases manually is time- consuming and dependent on subjective decision-making, so automated systems are required. The most prevalent skin disease, eczema, is hard to identify because it has similar symptoms. We proposes a CNN-based AI system for the classification of eczema skin disease. The model consists of convolutional layers , feature extraction, pooling, and classification dense layers. Data augmentation is applied to improve performance. Accuracy, precision, recall, and F1-score are calculated. Classification accuracy is 98.2% and maintain reliable diagnosis with improved patient treatment efficiency.

Key Words: CNN, eczema, AI , Skin disease

1. INTRODUCTION

Skin diseases are a significant public health concern that can significantly impact a person's quality of life. Eczema is the most prevalent chronic skin conditions that affect millions of individuals worldwide. Eczema, also known as atopic dermatitis, is a chronic skin condition characterized by red, itchy, and inflamed skin. It affects people of all ages, but it is more common in children. Genetics, environmental factors, stress, and allergies are just a few of the factors that can cause eczema. While there is no cure for eczema, it can be managed with proper treatment, including topical creams, oral medications, and lifestyle changes. The disease is often persistent, with symptoms that can severely impact a patient's quality of life. Early diagnosis and precise classification of eczema are essential for effective treatment, but manual diagnosis is time-consuming and subject to human error. Traditional methods often require expert dermatologists, making it less accessible to individuals in remote or underserved areas. In recent years, advancements in artificial intelligence (AI) and image processing have shown great promise in transforming medical diagnosis. Deep learning, particularly Convolutional Neural Networks (CNNs), has revolutionized image analysis by enabling machines to automatically extract complex features from medical images. CNNs are particularly effective in skin disease detection due to their ability to identify patterns and textures in images with high accuracy. This AI-driven approach can bridge the gap in dermatological care, providing healthcare professionals and patients with a tool for quick and reliable eczema diagnosis. The system has the potential to improve healthcare accessibility, reduce diagnostic costs, and enhance treatment outcomes for individuals suffering from eczema. The system aims to analyze digital images of affected skin areas, identify key features indicative of different eczema types, and classify them effectively. By utilizing a robust dataset of labeled skin images, the model will be trained to recognize patterns that are often overlooked in conventional assessments.

2. PROPOSED MODEL

2.1 Data Collection and Preprocessing:

This module handles the collection of skin image datasets, focusing on images of eczema-affected skin. It also includes preprocessing steps such as resizing, normalization (scaling pixel values), and augmentation prepare the data for model training. This module ensures that the images are standardized and enhanced for better model performance.

2.2 Model Development:

This module implements the core Convolutional Neural Network (CNN) architecture for eczema skin disease prediction. It includes layers like convolutional layers, max-pooling layers, dropout, and dense layers. The CNN model is responsible for feature extraction from skin images and classification into different eczema types.

2.3Model Training:

The model is trained over multiple epochs, and metrics like accuracy, loss, and validation performance are monitored. This module also performs hyper parameter tuning to improve the model's performance.

2.4 Model Evaluation:

This module generates reports such as confusion matrices, classification reports, and visual performance analysis. It provides insights into the accuracy, precision, recall, and F1-scores of the model for various eczema categories. It also handles visualization of model performance, including loss and accuracy plots.

2.5 Model Prediction:

This module is responsible for making predictions on new, unseen images of eczema-affected skin. It processes input images, runs them through the trained CNN model, and returns the predicted eczema type. The module is integrated into a user- friendly interface.

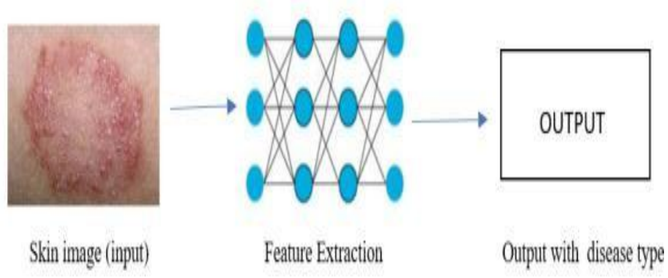

Fig -1 Shows Feature extraction and Classification

3. METHODOLOGY

Eczema is a chronic skin disease that impacts millions of people globally. Early detection and proper classification are important for proper treatment and symptom control. The conventional diagnostic approaches depend on subjective evaluation by dermatologists, which may be time-consuming, subjective, and less available in distant or underdeveloped regions. In order to solve these problems, a system based on AI utilizing Convolutional Neural Networks (CNNs) is designed to make predictions about different kinds of eczema using medical image processing methods. Below is the step-by-step methodology for designing the system.

3.1 Data Collection:

The initial task in creating an AI-powered eczema prediction tool is to collect a robust dataset of images of the skin. The images must contain different forms of eczema, including atopic dermatitis, nummular eczema, dyshidrotic eczema, seborrheic dermatitis, stasis dermatitis, and contact dermatitis. The database needs to contain images of healthy skin as well to serve as an appropriate baseline for classification.

To guarantee strong model performance, the dataset should be varied, encompassing:

- Varying skin colors and ethnicities to prevent bias.
- Varying lighting conditions to enhance generalization.
- Varying levels of eczema severity (mild, moderate, and severe).

High-quality images from credible dermatological sources, such as medical databases, clinical trials, and publicly available repositories.

Data augmentation methods can also be performed here to enhance dataset size and diversity.

3.2 Data Preprocessing

Prior to training the CNN model, raw image data needs to be preprocessed to facilitate the learning process and improve model performance. This includes a few important steps:

- Image Resizing: Resizing all images to a uniform resolution (e.g., 224x224 pixels) to ensure consistency.
- Pixel Scaling: Scaling pixel values to the range [0,1] (dividing pixel values by 255) to promote quicker and more effective model convergence.
- Data Augmentation: Augmenting the dataset through application of the following transformations:
  - ✓ Rotation
  - ✓ Zooming
  - ✓ Flipping (horizontal and vertical)
  - ✓ Brightness modifications
  - ✓ Addition of noise

These methods assist in avoiding overfitting and enhancing model generalization.

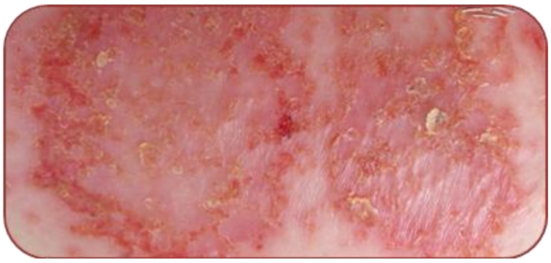

Fig -2 Shows Skin disease Eczema.

3.3 Dataset Splitting

To test the model reasonably, the dataset is divided into three subsets:

- Training Set (80%): Trained for the CNN model.
- Validation Set (10%): Utilized for tuning hyperparameters and avoiding overfitting.
- Test Set (10%): Employed for the final model evaluation to assess performance.

A stratified split guarantees every dataset has an equal representation of eczema types.

3.4 Model Building

A CNN-based deep learning model is developed to learn significant features from images and predict the type of eczema. The CNN model is comprised of the following units:

- Convolutional Layers: Convolutional layers with ReLU activation function learn spatial and texture features from images of skin.
- Max Pooling Layers: Max Pooling layers down sample feature maps, thereby reducing computational requirements without losing important information.
- Flatten: Translates the output from convolutional layers to a one- dimensional vector used as input by dense layers.
- Dense Layers: Fully connected dense layers with the ReLU activation function process features extracted. The output layer takes the softmax activation function to label images into a number of different eczema types.
- Dropout Layers: Added to minimize overfitting by randomly discarding neurons at training time.

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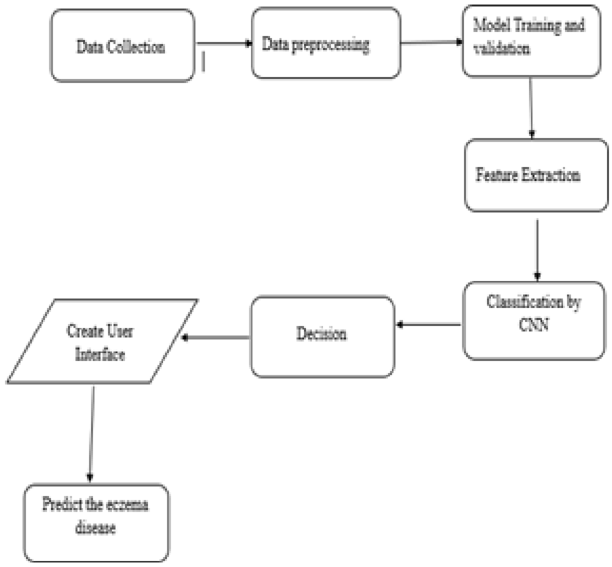

Fig -3 Shows Block diagram of the model

4.RESULT AND DISCUSSION

In eczema disease prediction with AI, the assessment of model performance is very important to realize how well the system can classify different types of eczema from medical images. Our data set contains total 143 images by using Adam optimizer technique, the learning rate is 0.001 and the model achieving accuracy is 98.2%. The outcomes of the model's performance are usually measured using the following: Accuracy, Precision, Recall, and F1-Score.

$$\text{Accuracy} = \frac{TP + TN}{TP+FP+TN+FN}$$

- TP: True Positives (correct eczema predictions)
- TN: True Negatives (correct healthy skin predictions)
- FP: False Positives (incorrect eczema predictions)
- FN: False Negatives (incorrect healthy skin predictions)

$$\text{Precision} = \frac{TP}{TP+FP}$$

$$\text{Recall} = \frac{TP}{TP+FN}$$

$$\text{F1 -score} = 2X \frac{\text{Precision} + \text{Recall}}{\text{Precision} + \text{Recall}}$$

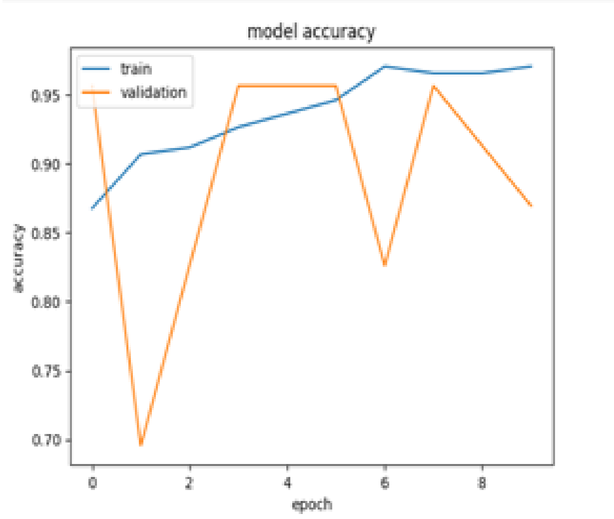

Fig- 4 Shows Eczema Model accuracy

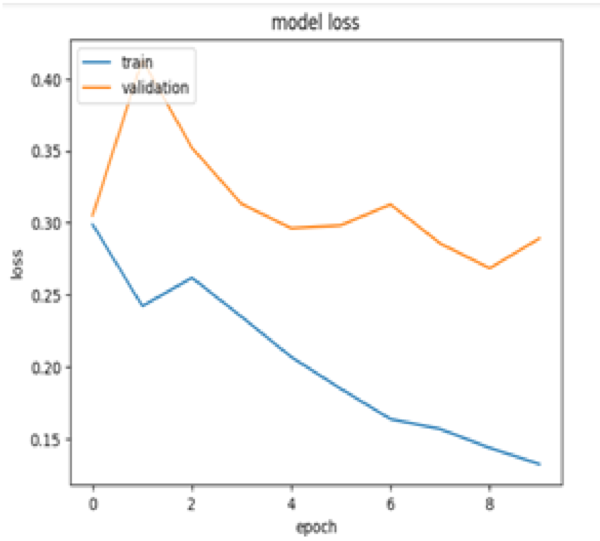

Fig- 5 Shows Model loss using binary cross entropy

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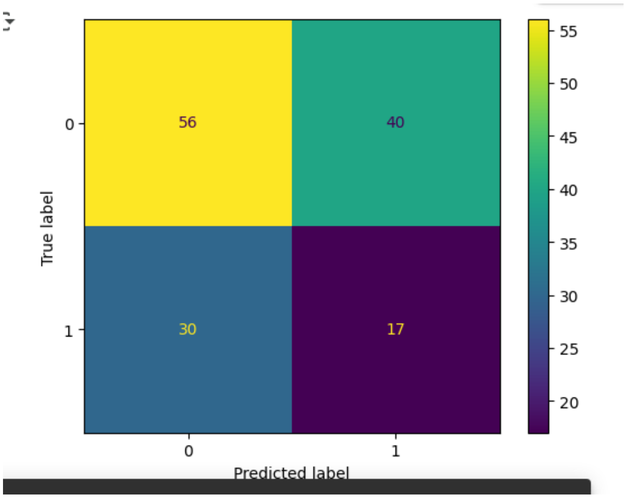

Fig- 6 Shows Confusion matrix

Fig-9 Shows eczema prediction

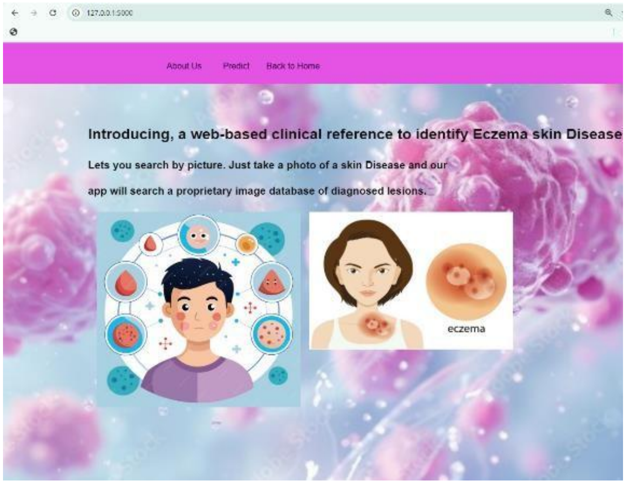

Fig-7 Shows web application based eczema identification

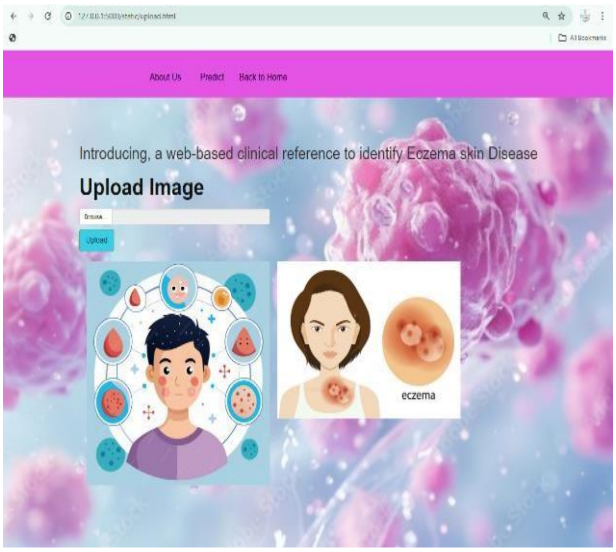

Fig-8 Shows eczema identification

5. CONCLUSIONS

Thus the eczema skin disease prediction system developed using Convolution Neural Networks (CNNs) effectively automates the diagnosis of eczema through image processing. By extracting critical features from high- resolution skin images, the model demonstrates reliable performance in classifying various eczema types. This system provides an efficient, non-invasive solution for early detection and can significantly assist dermatologists and healthcare professionals in making faster, more accurate diagnoses. The integration of data augmentation ensures that the model generalizes well and achieving accuracy 98.2%, and even with limited datasets, contributing to its robustness and effectiveness.

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