

Enhancing Monkey Pox Detection with Deep Interpretable Techniques

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Abstract— A serious worldwide health concern is monkey-pox, a viral disease that resembles smallpox in its symptoms. For containment and treatment to be effective, a quick and accurate diagnosis is essential. Conventional diagnostic techniques, such as PCR and ELISA, are frequently inaccessible in environments with limited resources because they call for specialized labs. This research introduces a groundbreaking method employing deep learning techniques for the early detection of the monkey-pox virus. Our research leverages a substantial data set comprising of 2000 images of mpox infected and normal images from diverse sources. This enables us to comprehensive training of AlexNet and DenseNet algorithms, a image classification techniques to analyze the features present in pixels. The model's inference process will be displayed through the use of these deep learning techniques, which will offer insights into the salient characteristics that go into the diagnosis. The constructed model will be assessed based on its interpretability, sensitivity, specificity, and accuracy. The practical usefulness of the model will be evaluated by taking into account real-world scenarios, such as point-of-care diagnostics or distant healthcare settings. The research's conclusions could completely change the way monkey-pox is diagnosed, allowing for early identification, better disease control, and eventually better public health results.

Index Terms— Monekypox (mpox), Deep Learning, AlexNet, DenseNet, image classification, early identification, interpretability.

I. INTRODUCTION

Monkey pox virus is rapid growing virus in recent years, a early diagnostic approaches are needed for to detect the virus of individual, Conventional methods like PCR and ELISA techniques requires more lab resources and more time consuming. Image classification is a technique to extract salient characteristic of image into features and then able to make patterns, these features and patterns helps to detect the infected image quickly Some of major image classification techniques like VGG16, ResNet are succeeded in detection of virus. However, some drawbacks are existed while using these techniques. To overcome the limitations of these techniques, we proposed a novel approach leveraging a hybrid model by combining the AlexNet and DenseNet. Our proposed model is based on combining the features extracted by both algorithms and designing a fully connected layer to detect the virus. Through extensive training and fine-tuning procedures, the model learns the discriminative patterns of mpox infection. To evaluate our proposed model, we conducted experiments using standard indicators and metrics such as accuracy, confusion matrix and precision. Additionally, we validate the generalizability of our model on unknown data to asses it robustness and real-world applicability. Our results

demonstrating promising outcomes of outcomes with the proposed architecture model, achieving high accuracy in distinguishing infected images from normal images. Furthermore, the model exhibits sensitivity and specificity, indicating its potential for early and reliable diagnosis of mpox. The overall work is briefly shown in the below Fig 1, it gives an rough idea of our proposed model.

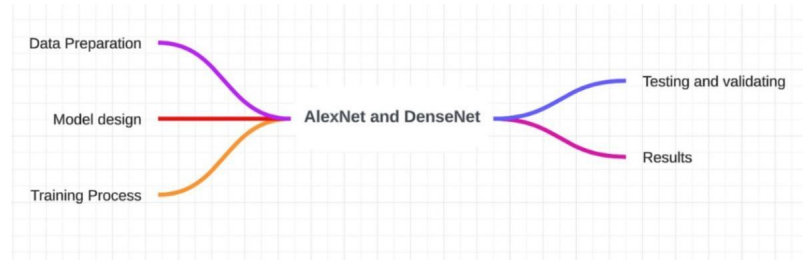


Fig 1: Schematic view representation of process

A. Related Work

Recent studies have demonstrated varied performances, with Gomathi achieving 93.1% accuracy using CNN and ResNet50, Hapsari obtaining 92.8% with particle random forest optimization, and Mir reaching 93.51% using KNN. Additionally, Aswin. applied time series analysis with 90% accuracy, while Kiran. employed an Artificial Neural Network (ANN) achieving 87.13%, highlighting the diverse approaches in mpox detection research. However, existing methods either lack accuracy or require high computational power, making them impractical for real-time detection. To address these limitations, we have implemented a hybrid approach combining AlexNet and LSTM to enhance both accuracy and efficiency in monkey-pox detection.

B. Problem Statement

The monkeypox virus necessitates the rapid development of tools for the early identification of infected samples. Researchers have focused on developing algorithms to analyze samples and classify images as normal or infected. Various deep learning models like VGG16 and ResNet have been explored for monkey-pox detection, but they face limitations in accuracy and computational efficiency. The problem lies in the need for a more reliable and resource-efficient diagnostic model that can accurately classify monkey-pox infections while being practical for real-world deployment. This study aims to provide a diagnostic solution, particularly in resource-limited settings, to facilitate rapid and effective disease control.

II. METHODOLOGY AND SOLUTION APPROACH



Figure 2: Showing the detailed process flow chat.

This section aims to describe the procedure for gathering data and configuring the settings required for training and testing the monkeypox detection models. This ensures that the models have the necessary data to accurately classify infected and normal samples.

A. Model Description

The input data-set, it split into two subsets: one for training and one for testing. The training data is utilized to develop a predictive model through a combination of AlexNet and DenseNet, which are connected via a fully connected layer to enhance feature extraction and representation. Once the model has been trained, the testing data is used to assess the system's performance., focusing on accuracy through the model testing phase. Following this, the model undergoes validation to ensure its reliability and robustness. Finally, the validated model is prepared for deployment, making it ready for real-world application. This architecture emphasizes a structured and efficient approach to designing a deep learning model, ensuring high accuracy and adaptability for the task at hand.

B. Model Preparation

AlexNet and DenseNet are two types of CNN algorithm, which can efficiently extract features from images. Both can individually extract the features and classify the labels. But in our model, we combined the both features of AlexNet and DenseNet and deployed a single custom made fully connected layer to predict the class labels. Both models are proven for their efficiency in extracting the features from images. AlexNet and DenseNet, consists of multiple layers in a convolutional neural network, including the input layer, convolutional layer, pooling layer, max-pooling layer, min-pooling layer, flatten layer, dropout layer, and classification layer.. The input images are initially feuded to both algorithms separately, by removing the last layer in both we can obtain the features in the form of vector. Both features are added to make it one, and an activation function is used to classify the class labels. ReLu is used in our model to predict the class labels.The Rectified Linear Unit (ReLU) functions by permitting positive values to pass through unchanged, while transforming all negative values to zero. this helps our model to maintain to learn the necessary patterns. Adam optimizer is used to optimize the weights and bias while training the model. Adam maintains the adaptive learning rates for each parameter and updates them based on first and second gradients. Adam helps to adjust the learning rates to improve convergence and performance.

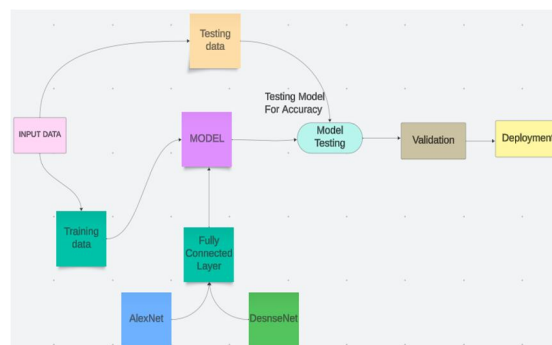


Figure 3: Detailed preparation of model

C. Model Evaluation

Accuracy

Represents the percentage of correctly classified instances, indicating the overall performance of the model.

Precision

Measures the accuracy of positive predictions by calculating the proportion of predicted positives that are actual true positives.

Recall

It represents the model's capacity to detect every case of monkey pox, whereas precision demonstrates the accuracy of positive predictions.

Confusion Matrix

It is a pictorial fashion to assess the model performance by comparing its predicted outcomes with the actual outcomes. It is structured as a table consisting of four essential components:

True Positives (TP): model accurately predicts the mpox class.

True Negatives (TN): model accurately predicts the normal class.

False Positives (FP): model incorrectly predicts the mpox class (Type I error).

False Negatives (FN): model fails to predict the mpox class (Type II error).

	precision	recall	f1-score	support
cell output actions	1.00	0.96	0.98	56
Normal	0.97	1.00	0.98	59
accuracy			0.98	115
macro avg	0.98	0.98	0.98	115
weighted avg	0.98	0.98	0.98	115

Test Accuracy: 0.9826

Figure 4: Model Evaluation

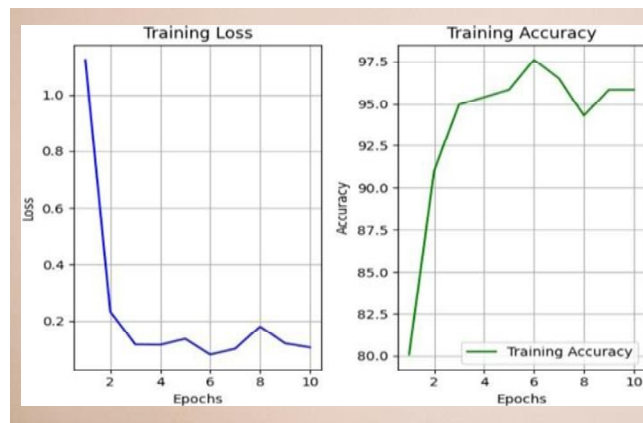


Figure 5: Training loss and training accuracy on epochs.

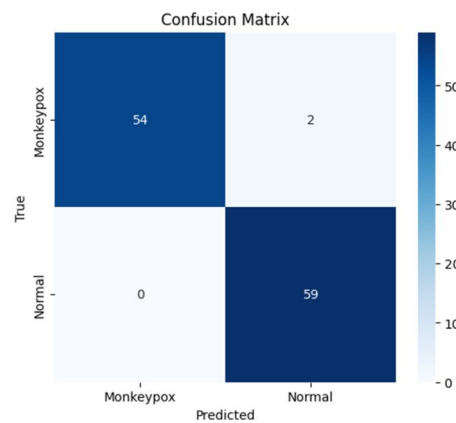


Figure 6: Confusion Matrix.

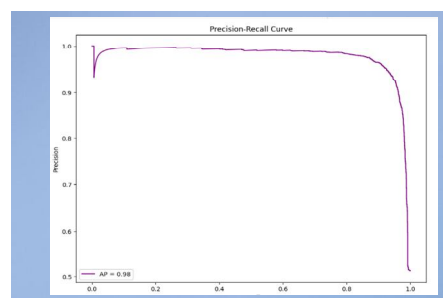


Figure 7: Precision - recall curve.

III. CONCLUSIONS

In summary the monkeypox detection system designed in this research has proven to be highly effective, achieving a notable test accuracy of 98.2%, with strong and balanced metrics across both mpox and normal cases. The use of advanced pretrained models is proven to be effective on classification of class labels. This approach not only improved overall detection accuracy but also significantly reduced false positive and false negative results, making it a trustworthy instrument for application in actual healthcare environments. By addressing limitations identified in earlier studies, such as generalization and less accuracy, our model offers a comprehensive solution that holds potential for contributing to early detection and control of mpox.

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