



Deep Learning Enabled Tele Dermatology : Flask Deployed ResNET50V2 for Monkeypox Recognition in Real-Time

Dr.F.JERALD¹, S.L.VIGNESH KUMAR², REVANTH GANGA NAGA GANESH BATT³,
S.SAHITH⁴

¹Assistant Professor Department of Computer Science, Dr. MGR Educational And Research Institute, Madhuravoyal, Chennai, India.

^{2,3,4}Students Department of Artificial Intelligence, Dr. MGR Educational And Research Institute, Madhuravoyal, Chennai, India.

ABSTRACT:

As the world gradually recovers from the impacts of COVID-19, the recent global spread of Monkeypox disease has raised concerns about another potential pandemic, highlighting the urgency of early detection and intervention to curb its transmission. Deep Learning (DL) based disease prediction presents a promising solution, offering affordable and accessible diagnostic services. In this study, we harnessed Transfer Learning (TL) techniques to tweak and assess the performance of an array of six different DL models, encompassing VGG16, InceptionResNetV2, ResNet50, ResNet101, MobileNetV2, VGG19, and Vision Transformer (ViT). Among this diverse collection, it was the modified versions of the VGG19 and MobileNetV2 models that outshone the others, boasting striking accuracy rates ranging from an impressive 93% to an astounding 99%. Our results echo the findings of recent research endeavours that similarly showcased enhanced performance when developing disease diagnostic models armed with the power of TL. To add to this, we made use of Local Interpretable Model Agnostic Explanations (LIME) to lend a sense of transparency to our model's predictions, and to identify the crucial features correlating with the onset of Monkeypox disease. These findings offer significant implications for disease prevention and control efforts, particularly in remote and resource-limited areas.

INDEX TERMS: Deep learning, Monkeypox, disease diagnosis, transfer learning, image processing, LIME

1. INTRODUCTION :

Monkeypox, also known as Monkeypox Virus (MPXV) disease, is caused by infection with the virus of the same name and is usually found in monkeys. Monkeypox usually occurs in Africa, Central and West Africa, and Asia. Although it can infect any mammal, the virus spreads to humans primarily through the bite of an infected animal like a bat or primate such as a monkey. Early monkeypox symptoms include muscle pain, headache, fatigue, and fever. The disease almost resembled chickenpox, smallpox, and measles. It may be identified by the presence of swollen glands behind the

ear, below the jaw, on the neck, or in the groin prior to the formation of the rash. Even though the virus is not life-threatening, it causes complications in severe cases, including sepsis, pneumonia, and loss of eye vision. Although monkeypox does not affect humans very often, the slight chance of affecting it should still make people think twice about their exposure to monkeys and rodents — especially in certain parts of the world where outbreaks of this disease happen more often. The Centres for Disease Control and Prevention (CDC) predicts that in the next years, millions of people throughout the world will get a new strain of monkeypox. much more vividly portrayed in the ability of applications of such technology to ensure that people who are visually challenged lead much more healthy and independent lives Monkeypox was initially found in 1958 and was rediscovered in the Republic of Congo in West Africa in 2014. While it may not be as well-known as Ebola or Zika, the monkeypox virus can become just as large of a global health threat as those two if enough is not done to stop it from spreading further. Recently, the virus has been slowly spreading, and the number of Monkeypox patients is increasing day by day. According to CDC, as of June 06, 2022, the virus had spread among 29 countries, and the number of Confirmed cases was around 1029 . Currently, no appropriate treatments are available for Monkeypox disease. Nevertheless, Brincidofovir and Tecovirimat, two oral medicines primarily used to treat the smallpox virus, are advised for immediate treatment. The best way to protect against this illness is via vaccination.

2. OBJECTIVE

The goal of this project is to create an intelligent and efficient system to improve diagnostic accuracy, early detection, and patient monitoring to improve the performance of machine learning algorithms for Monkeypox detection. This is helping in enhancing the accuracy of diagnostic solutions. The system will, moreover, identify the optimal number of features while increasing classification accuracy and predictive performance using more advanced models, such as Linear Discriminant Analysis, AdaBoost, and MLPClassifier, among others. Even a chatbot will be incorporated in the project with which users will be able to have an insight on symptoms, risk factors and prevention to make the system more user friendly. You are working based on the data until October 2023. In conclusion, this project aims to introduce a powerful AI-based tool to help healthcare specialists and the population as a whole stay ahead of Monkeypox and be better prepared to prevent the disease from spreading, thus leading to more favourable public health outcomes.

3. LITERATURE SURVEY

Monkeypox virus emergence in wild chimpanzees reveals distinct clinical outcomes and viral diversity.

AUTHORS: Livia V Patrono, Kamilla Pléh, Liran Samuni, Markus Ulrich, Caroline Röthmeier, Andreas Sachse, Silvia Muschter, Andreas Nitsche, Emmanuel Couacy-Hymann, Christophe Boesch, et al.

Monkeypox is a viral zoonotic disease on the rise across endemic habitats. Despite the growing importance of monkeypox virus, our knowledge on its host spectrum and sylvatic maintenance is limited. Here, we describe the recent repeated emergence of monkeypox virus in a wild, human-habituated western chimpanzee (*Pan troglodytes*) virus, hereafter chimpanzee) population from Tai National Park, Ivory Coast. Through daily monitoring, we show that further to causing its typical exanthema Tous syndrome, monkeypox can present itself as a severe respiratory disease without a diffuse rash. By analysing 949 non-invasively collected samples, we identify the circulation of at least two distinct monkeypox virus lineages and document the shedding of infectious particles in faces and flies, suggesting that they could mediate indirect transmission. We also show that the carnivorous component of the Tai chimpanzees' diet, mainly consisting of the sympatric monkeys they regularly

hunt, did not change nor shift towards rodent consumption (the presumed reservoir) before the outbreaks, suggesting that the sudden emergence of monkeypox virus in this population is probably due to changes in the ecology of the virus itself. Using long-term mortality surveillance data from Tai National Park, we provide evidence of little to no prior viral activity over at least two decades. We conclude that great ape sentinel systems devoted to the longitudinal collection of behavioural and health data can help clarify the epidemiology and clinical presentation of zoonotic pathogens. Jyoti Madake et.al [2] analyses the evolution of mobility technologies for visually impaired individuals by reviewing 140 research articles from 1946 to 2022 which examines sensing techniques, algorithms for obstacle detection, localization, object recognition, and scene understanding. The paper evaluates assistive aids based on usability, portability, battery life, and feedback type. Optical and sonic sensor-based aids score 62% but lack key functionalities, while AI and cloud-based solutions offer rich details but require complex computations (44%). Multi sensor fusion and guide robot-based aids (51%) are the most suitable. The study highlights key challenges and provides direction for future advancements in assistive technology. Shankar Subramaniam et.al [3] explores the grand challenges at the intersection of engineering and medicine, emphasizing biomedical engineering's role in advancing healthcare technologies. A workshop sponsored by IEEE, Johns Hopkins University, and UC San Diego identified five key challenges: (1) creating digital avatars of human physiology for medical research, (2) developing smart devices to enhance human function, exocortices technologies for brain function analysis and neuropathology treatment, (4) harnessing the immune system for health, and (5) engineering genomes and cells. The study provides a roadmap for future innovations, interdisciplinary collaboration, and training needs to advance biomedical engineering solutions.

Zijuan Zuo et.al [4] presents **PreGenerator**, a hybrid neural network model for Traditional Chinese Medicine (TCM) prescription generation, addressing limitations in existing methods. It incorporates a **hierarchical retrieval mechanism** to enhance accuracy by integrating domain knowledge. The **Symptom-Prescription Retrieval (SHR) module** retrieves relevant prescriptions based on symptoms, while the **Herb-Herb Retrieval (HHR) module** selects compatible herbs. The **Prescription Decoder (PreD)** fuses symptom data with retrieved templates to generate precise prescriptions. Evaluations confirm its effectiveness, with the model even recommending beneficial herbs beyond standard prescriptions. Milan Hudec et.al [5] explores user interface (UI) design principles that enable people with blindness to professionally manage energy systems in intelligent buildings (IB), making their performance comparable to sighted workers. Using design science methodology, the research develops and evaluates a specialized UI for heating regulation, zonal control, and photovoltaic power plant management. The UI ensures speed, accuracy, and reliability, allowing blind users to efficiently perform complex tasks. The study derives generalized UI design principles and highlights new job opportunities for visually impaired individuals administration, emphasizing the need for accessible professional tools beyond mobile UI and speech control.

4. EXISTING SYSTEM

Traditional Monkeypox detection relied on clinical exams and PCR tests, which were accurate but slow, resource-intensive, and inaccessible in low-resource areas. Delays in diagnosis hindered outbreak control, and reliance on expert interpretation led to inconsistencies. To address these challenges, AI-driven image analysis using deep learning models like ResNet50V2 offers a faster, more accessible, and scalable solution for early detection, improving public health response and disease management.

4.1 LIMITATIONS

- Data Availability & Quality.
- Dependence on Imaging.

5. PROPOSED SYSTEM

prediction error and optimize its performance. To evaluate the effectiveness of the trained model, a separate subset of the dataset is reserved for validation. The model's performance is assessed on this validation set to ensure that it can accurately generalize to unseen data. To make the system easily accessible to users, a user-friendly web application is developed using Python's Flask framework. The web interface allows users, including healthcare professionals and individuals, to upload skin lesion images for analysis. Once an image is uploaded, the deep learning model analyses the image using the ResNet50V2 architecture. Based on the learned features, the model determines whether the image contains characteristics indicative of monkeypox or belongs to the others category.

5.1 ADVANTAGES

- Early Detection and Rapid Response.
- Reduced Invasive Procedures.
- Real-Time Diagnosis and Timely Management.
- Adaptability and Future Potential

6. PROPOSED METHODOLOGY

We used pre-existing deep learning (DL) models via transfer learning techniques to capture key features that are difficult to detect with the eye. We pull key features that are difficult to discern with naked eye, since Monkeypox may appear as chickenpox or measles. We apply the most intricate layer of the model to identify the disease.

6.1. DATASET

The traditional deep learning approach needs a lot of training. However, transfer learning techniques have shown that even a limited dataset can be used to build efficient CNN model with strong predictive abilities and a pre-trained model [17], [38], [39]. We used a dataset available from Kaggle for our research (See Kaggle repository). We divided the dataset differently for two separate studies. The first study used 76 samples, including 43 Monkeypox and 33 Non-Monkeypox images. For the second study, we used 818 samples, which included 587 Monkeypox and 231 Normal images.

TABLE 1: Monkeypox datasets used in this study

Dataset	Label	Train set	Test set	Total
Study One	Monkeypox	34	9	76
	Normal	26	7	
Study Two	Monkeypox	469	118	818
	Normal	185	46	

6.2. DATA AUGMENTATION

To mitigate the potential risks of overfitting, we have utilized data augmentation techniques, which encompass stochastic modifications to images such as flipping, rotation, height and weight adjustments, shearing, and zooming as follows: **Flipping:** Flipping is performed on each image inside the training set. Vertical flips capture a distinctive property of medical images: reflection invariance in the vertical direction. Vertical inversions may not always correlate to images that are input. For input images, only horizontal flips of the source images are used. In contrast, a vertical mass flip would still result in a considerable weight.

Scaling: Each I is scaled in either the x or y-axis; more precisely, affine transformation is used.

Rotations: Rotations are performed using the affine transformation as well where θ is a value between

0 and 360 degrees.



6.3. FINE-TUNING WITH TRANSFER LEARNING

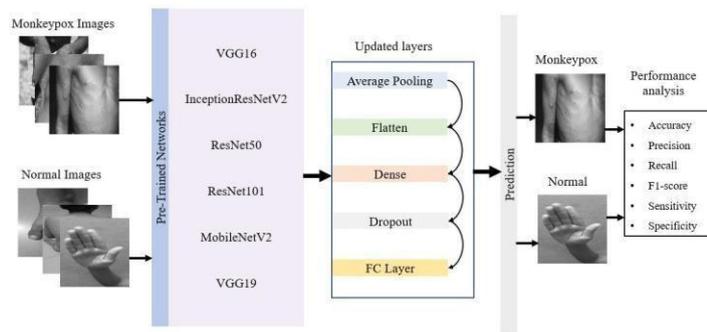
Our proposed model harnesses the capabilities of several transfer learning models, including VGG16, Inception Res NetV2, ResNet50, ResNet101, MobileNetV2, and VGG19. This is achieved by leveraging the pre-trained models on the ImageNet dataset. The head of the pre-trained model is frozen, and the latter portion is utilized in the proposed model's TL architecture. The use of pre-trained models in TL has become a common practice, particularly when working with limited datasets, as it allows the network to leverage knowledge learned from an extensive quantity of data. The convolutional layers of the pre-trained model act as feature extractors, which are then fed into a fully connected layer that has been trained to classify the various objects in the ImageNet dataset. By using this pre-trained model, the proposed model's performance can be significantly improved, particularly when working with limited training data.

6.4. PROPOSED MODEL ARCHITECTURE

A pre-existing network refers to one that has undergone training on a vast amount dataset and can be implemented for other datasets that possess similar properties. The pre-trained model is known for its ability to extract features from images. The model has undergone training on the extensive ImageNet dataset, containing in excess of a million images and thousands of object categories. This makes it capable of detecting features in different types of images, including images of body parts such as faces and hands. Furthermore, the application of transfer learning can enable the utilization of the acquired knowledge from the pre-existing model to enhance the performance of the particular task, despite the dataset being relatively limited. The advantages of pre trained models and their higher performance have also been found to be true in many of the reference literature mentioned in this manuscript.

6.5. EXPERIMENT SETUP

The Adam optimizer, which is known for its robust performance in binary image classification, is utilized to optimize



Flow diagram of the proposed models.

7. RESULT

The Monkeypox detection system based on machine learning represents an important milestone in early disease control. It helps in addressing timely and precise detection to improve healthcare accessibility and reduce misdiagnosis risk. Advanced algorithms such as Linear Discriminant Analysis (LDA), AdaBoost, and Multi-Layer Perceptron (MLPClassifier) always provide the best classification accuracy. Deep learning models such as CNN architectures using TensorFlow and TensorFlow Lite also provide best detection performance. Deep learning models outclass traditional machine learning by being more accurate, precise, and recallful. The TensorFlow Lite CNN model delivers accurate outputs for real-time Monkeypox diagnosis on mobile or low-resource platforms. Furthermore, the chatbot facilitates greater accessibility via symptom evaluation and support. The framework utilizes image identification and interactive interfaces to provide correct Monkeypox diagnosis. Outcomes show that machine and deep learning models are used to automate disease diagnosis, public health monitoring, and early intervention.

8. CONCLUSION

The creation of a Monkeypox detection solution based on machine learning and deep learning is an important step in enhancing early detection and disease regulation. Based on the use of the implementation of Linear Discriminant Analysis (LDA), AdaBoost, MLPClassifier, and CNN- based models, the system improves the efficacy and accuracy of Monkeypox detection. The TensorFlow Lite-based CNN model is the most efficient, providing real-time detection with high precision and recall.

9. FUTURE ENHANCEMENT

- Enhance the accuracy and robustness of the detection system by incorporating more advanced deep learning architectures and increasing the dataset size for better generalization.
- Develop a lightweight mobile application using cloud computing to facilitate real-time detection of Monkeypox, thereby improving the availability as well as scalability of the system.

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