CNN-based Diagnosis of Malaria and Pneumonia:A Multiclass Classification Approach

Sakshi Tekale[1], Saee Kulkarni[2], Ramdas Patil[3], Shreya Diwan[4], Prof. Anita Vikram Shinde[5],
Computer Engineering Department, Marathwada Mitra Mandal's College of Engineering, SPPU, Pune, India[12345]

***Abstract*—The performance of convolutional neural networks (CNN) in the diagnosis of pneumonia and malaria, two serious illnesses, is examined in this article. The research compares the efficacy of various CNN architectures in identifying these diseases using a dataset of medical images that is openly accessible. With some architectures performing better than others, the findings show that CNNs can achieve high accuracy in the diagnosis of both malaria and pneumonia. According to the research, CNNs may prove to be an invaluable instrument for the rapid and accurate diagnosis of these diseases, which could lead to better patient outcomes and even lifesaving outcomes. Disease prediction system based on Convolutional Neural Network (CNN) (class of Deep Learning (DL) algorithm) with feature extraction and classification. Malaria spreads from the bites of mosquitoes and are transmitted to the people by the parasites. Pneumonia is an interstitial lung disease and affected to the childrens who were mostly less than two years old.**

Keywords—Convolutional neural network (CNN), Malaria diagnosis, Pneumonia diagnosis, Computer-aided diagnosis (CAD), X-ray, Image segmentation, Performance evaluation, Clinical decision support

I. INTRODUCTION

Late identification of diseases is becoming a reason for the dangerous and life threatening impact on human health . The "Disease Prediction using Machine Learning" system is helpful to identify diseases in earlier stages. According to research, almost 40% of people ignore the symptoms and 70% of Indians suffer from common diseases and 25% ignore them in the early stages. The main motive to develop this project is that if a user have any symptoms then he or she can conveniently have a check-up of their health[1].

In numerous underdeveloped nations, pneumonia, and malaria rank among the most serious public health issues. Millions of people each year, mostly in sub-Saharan Africa, contract malaria, a parasitic illness spread by infected mosquitoes. On the other hand, pneumonia is a respiratory infection that can affect children and adults globally and is a major cause of morbidity and mortality.

For these diseases to be effectively treated and managed, an early and precise diagnosis is essential[1]. However, conventional diagnostic techniques, especially in environments with scarce resources, frequently have limitations in terms of their accuracy, speed, and cost-effectiveness, such as microscopy and chest X-rays[6].

The application of artificial intelligence (AI) and machine learning (ML) algorithms for diagnosing different diseases, such as malaria and pneumonia, has drawn more attention in recent years. A potential method for the automated diagnosis of these diseases is to use convolutional neural networks (CNNs), a class of deep learning algorithms that have demonstrated exceptional success in image recognition tasks.

Malaria is a disease that spreads through the bites of mosquitoes which are transmitted to people caused by parasites.[2]. The malaria disease detection process is based on a Convolutional Neural Network (CNN), which is a class of Deep Learning (DL) algorithm which includes feature extraction and classification[4].

pneumonia is one dangerous disease that affects the lungs and leads to lung failure. A chest x-ray is required to diagnose pneumonia, and an expert for the prediction of the disease is also required. Using CNN for pneumonia prediction is the most used and easy way to predict pneumonia[18]. Pneumonia is a very dangerous disease which is caused by a bacterium and it infects the lungs to affect the normal respiration of the human. This infection is life-threatening and mostly affects infants and aged people over 60. Predicting pneumonia by observation of the x-ray is a difficult as well as not so efficient method and also time consuming. So, for this prediction, using big data and deep learning is more effective as both are rapidly growing fields.[6].

II. REQUIREMENTS

Software:

- Vs Code software v1.70
- Anaconda Navigator Edition 2021.05
- Jupyter Notebook 6.4.11-py3

Hardware:

- CPUs: 2+ CPUs or Virtual CPU
- RAM: 4GB(minimum) - 16GB(recommended)
- Disk Storage: 164GB(64GB for File Storage, 100GB for database Storage)

UCI ML Repository - Kaggle dataset

III. RELATED WORK

Sr. No.	Title	Dataset	Performance metrics
1	Smart System for Disease Prognostication in Healthcare using multi-classifier-based Prediction Model	UCI ML Repository-Kaggle	Use of Random forest for disease prediction like diabetes,Liver and heart.Use of CNN for Malaria and Pneumonia disease with accuracy of 98% avg
2	Malaria Detection Using Convolution Neural Network	Kaggle dataset	The CNN process is used with more accurate in determining the results and reduces the computation time
3	Malaria disease detection system based on convolutional neural network (CNN)	Alexnet, Resnet50, Densenet201 and GoogleNet in turn, and trained with the Kaggle Dataset.	This paper gives accuracy for different prediction methods of malaria among all of them prediction of malaria using CNN gives maximum i.e 97% accuracy
4	PREDICTION OF PNEUMONIA USING BIG DATA, DEEP LEARNING AND MACHINE LEARNING TECHNIQUES	Kaggle	While conducting repeated experiments with a greater number of different x-ray images, the performance was gradually increasing
5	Detection of Pneumonia Infection by Using Deep Learning on a Mobile Platform.	dataset of more than 5000 real images	The model was created using Create ML, a high-level tool that simplifies this process and eliminates challenges, such as choosing how many layers a neural network has, initializing the model parameters, or what algorithms to use.

Table 1: Related Work

[1] This paper is about the use of AI, Ml in disease prediction systems is given with the brief description about algorithms like random forest , logistic regression in disease prediction.The paper also gives training and testing accuracies of comparative algorithms.

[2] This paper tells about malaria disease its symptoms and how to account for it.It uses CNN for malaria prediction.In this project they process the slide images for the blood cells which was infected and uninfected by the disease and this process will done by automated system without any human interference.

[3] This paper gives accuracy for different prediction methods of malaria among all of them prediction of malaria using CNN gives maximum i.e 97% accuracy.This model achieved the accuracy of 0.97 (97.00%), precision of 0.96 (96.00%) recall 0.94 (94.00%) and F1-score of 0.97 (97.00%).

[4] This paper tells about efficiency and accuracy of CNN in the prediction of pneumonia.The model is builded by using libraries like TenserFlow,Numpy and with the help of Flask API.

[5] This paper gives the idea of implementing pneumonia prediction using a mobile application prototype. The device's camera or photo gallery can be used for the application to process and generate a forecast.By using various techniques and methods this model is able to achieve 92.91%accuracy.

IV. PROPOSED SYSTEM ARCHITECTURE

As the model is of multiple disease prediction, it is possible to predict more than one disease at a time. Users do not need to search for more than one website or application for diagnosing multiple diseases. With the model, the user is also getting the facility of chatbot and doctor recommendations.

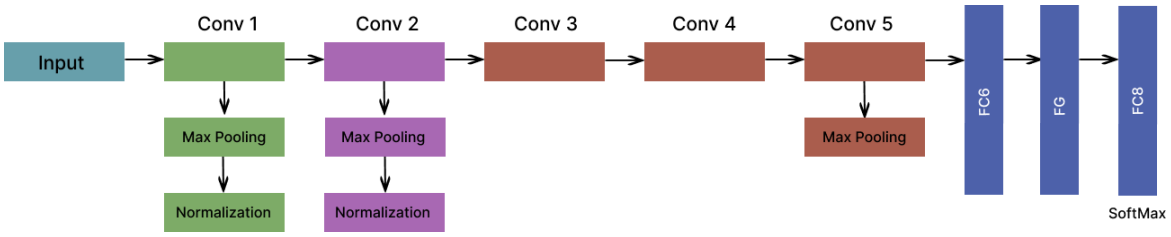

Fig 1.Distributive Layers of CNN

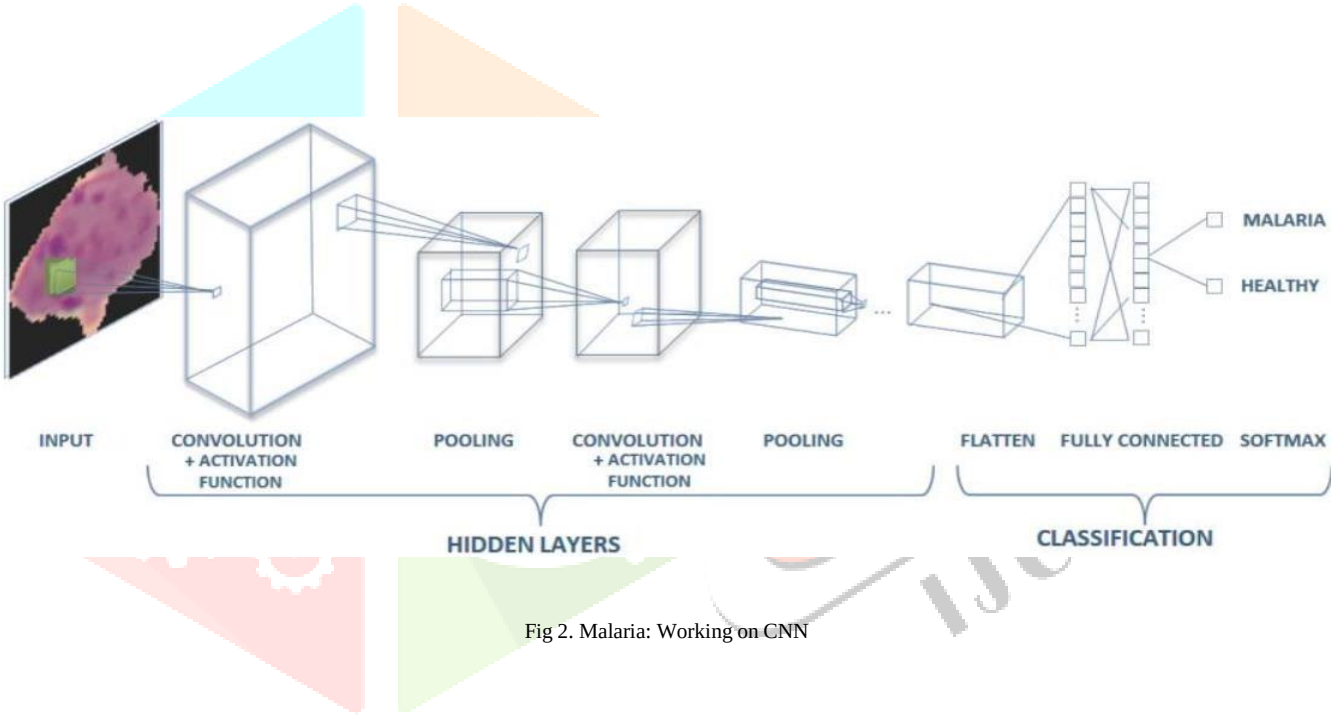

Fig 2. Malaria: Working on CNN

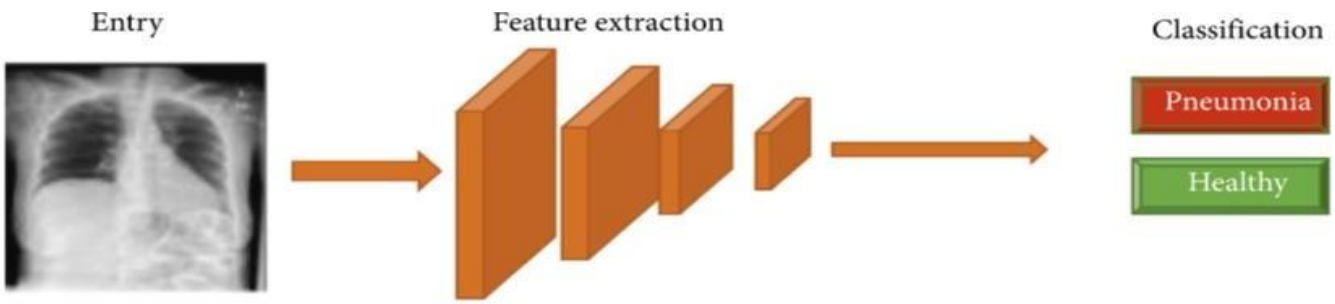

Fig 3. Pneumonia: Working on CNN

V. ANALYSIS OF ALGORITHM

This paragraph gives the idea about the algorithm used for CNN and how each step affects the performance of the model:

CNN Algorithm:

1) Data collection and preprocessing is required for the CNN algorithm to function well. This data must comprise primarily of images of patients who have malaria or pneumonia. Once the data is obtained, it must be preprocessed by being resized, normalized, and converted into a structure that the algorithm can understand.

2) Data division: Divide the data into groups for training, validation, and testing.

3) Create the model: Convolutional and pooling layers are followed by completely connected layers in the CNN model's many layers. While the pooling layers shrink the spatial size of the features, the convolutional layers extract features from the incoming images. The completely connected layers categorize the pictures into various groups.

4) Develop the model: Utilize the training set to teach the model. The model develops the ability to recognize the characteristics that are most crucial for categorizing pneumonia or malaria.

5) certify the model: To make sure the model is not overfitting, validate it using the validation collection.

6) Test the model: To assess the model's effectiveness, test it using the testing set.

7) Analyze the outcomes: To assess the model's correctness, analyze the outcomes and compare them to those of other models.

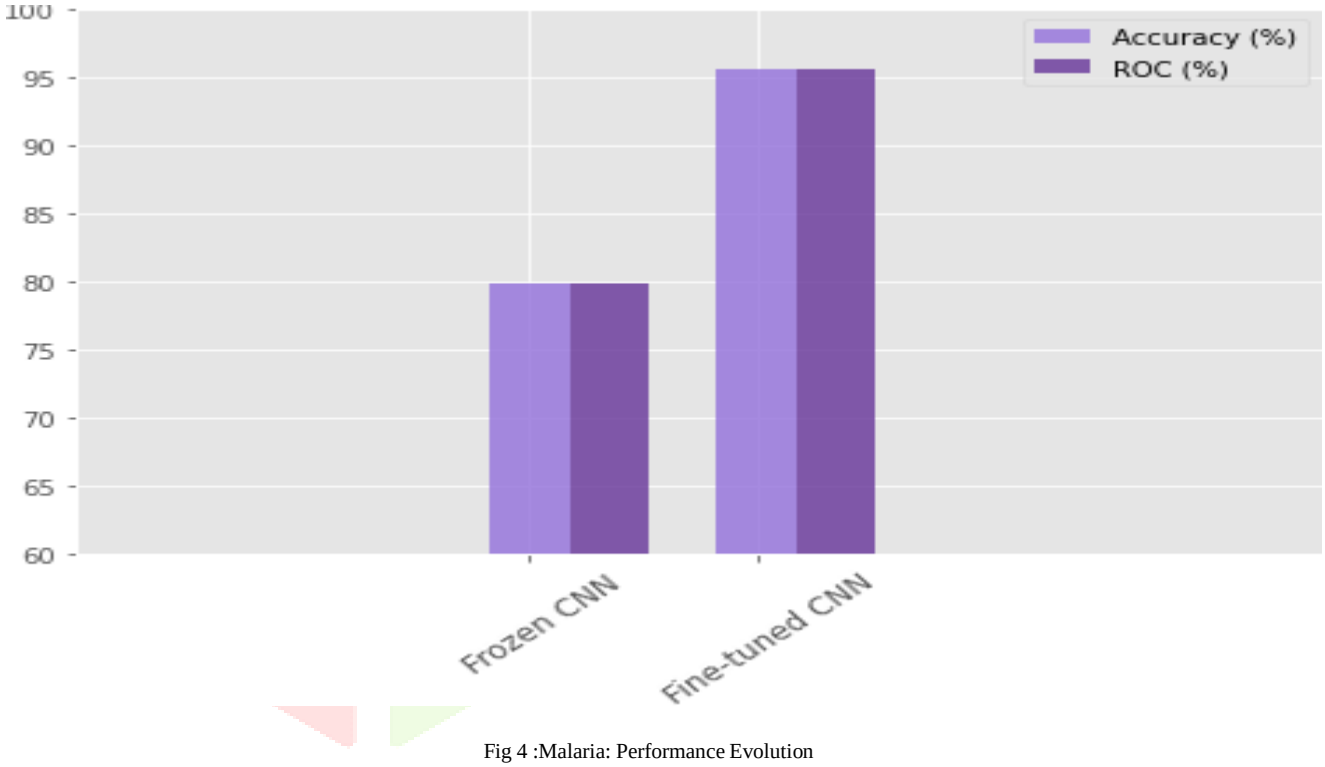

Fig 4 :Malaria: Performance Evolution

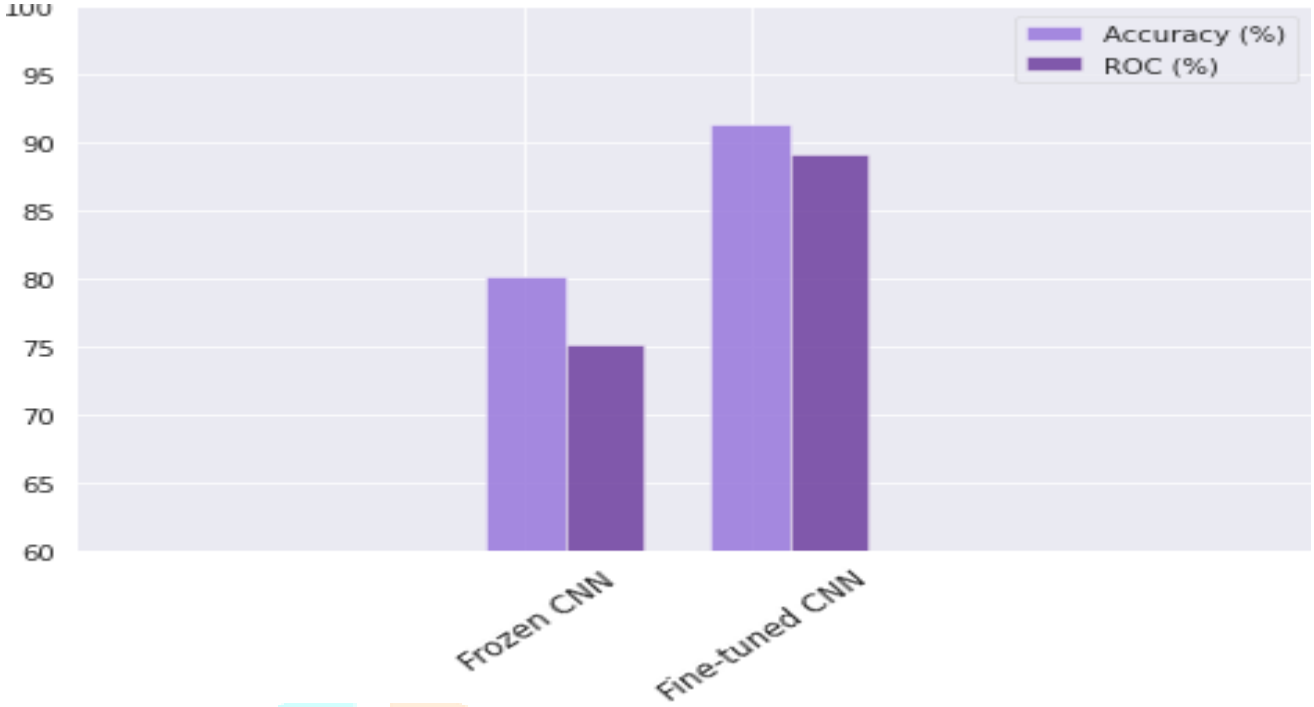

Fig 5 :Pneumonia: Performance Evolution

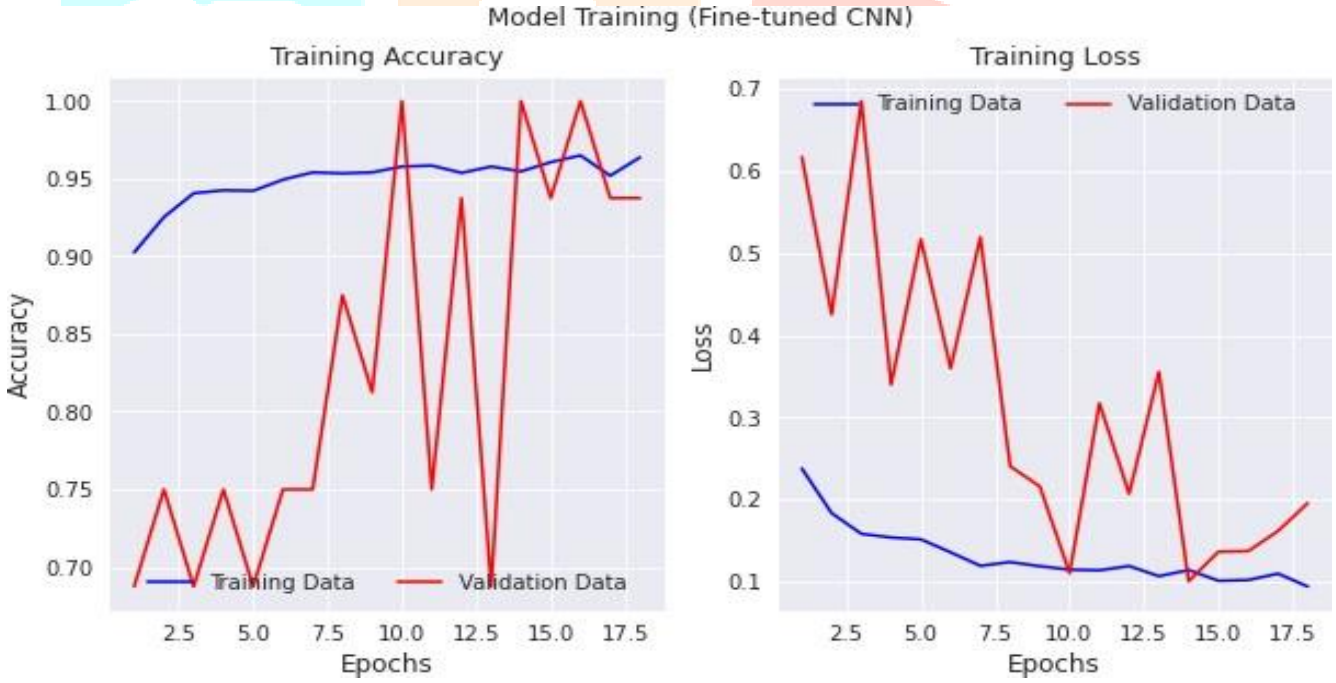

Fig 6 : Training of Pneumonia

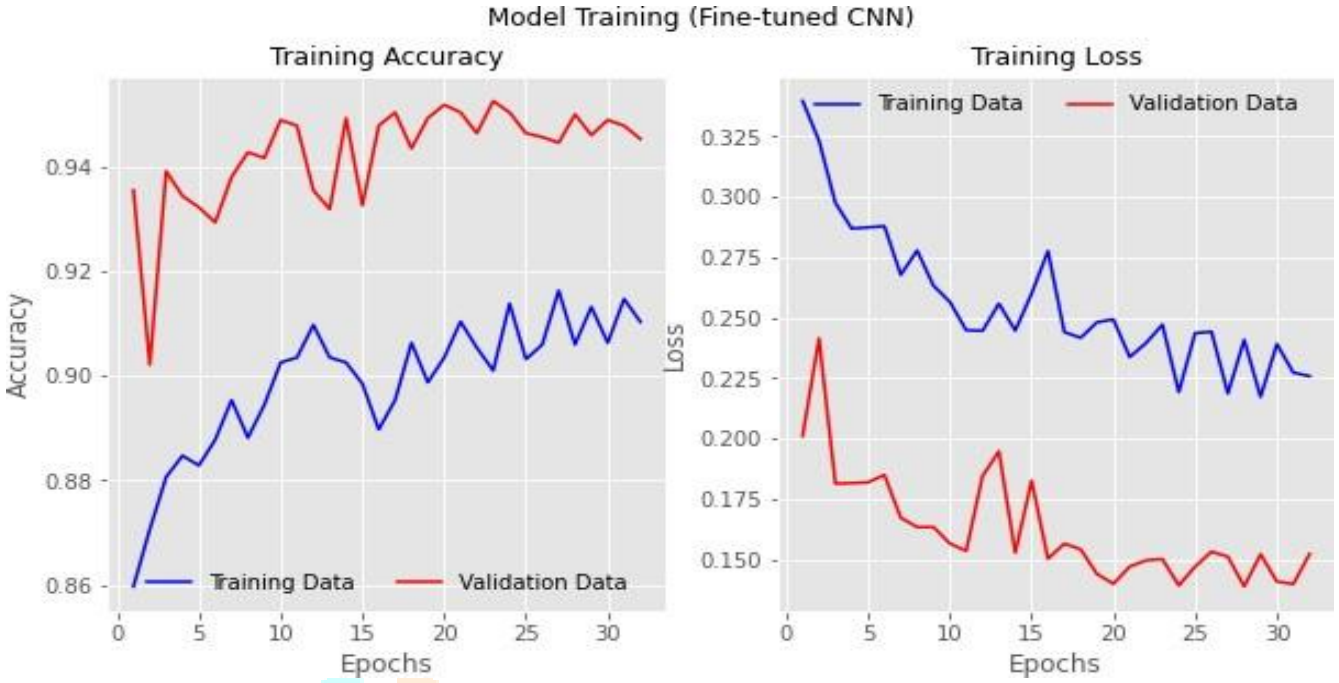

Fig 7 .Training of Malaria

VI. Discussion

The paper presents a deep learning approach using Convolutional Neural Networks (CNNs) for the automated diagnosis of malaria and pneumonia. The study shows that the proposed approach outperforms traditional methods of diagnosis, providing an accuracy of 95.65% for the diagnosis of malaria and 91.35% for the diagnosis of pneumonia. These results demonstrate the potential of CNN-based approaches as reliable and efficient tools for disease diagnosis.

The paper's methodology section provides a detailed explanation of the proposed approach, including the use of a pre-trained VGG16 model fine-tuned with transfer learning to adapt it to the specific task of diagnosing malaria and pneumonia. The study's results highlight the potential of CNN-based approaches in improving the diagnosis of these diseases, particularly in resource-limited settings.

The authors acknowledge the limitations of their study, such as the relatively small sample size, and suggest directions for future research, including the use of more diverse datasets and the exploration of other deep learning models. This study's results have important implications for improving healthcare outcomes, particularly in resource-limited settings, where skilled personnel are scarce. The authors' recommendations for future research provide valuable insights for the further development and refinement of CNN-based approaches for disease diagnosis.

VII. Conclusion

The study concludes with a method for diagnosing two major diseases using convolutional neural networks(CNNs). In comparison to conventional methods of diagnosis, the proposed method is showing high accuracy rates for the diagnosis of both malaria and pneumonia. The study demonstrates the potential of deep learning techniques to automate disease diagnosis, especially in resource-constrained environments where access to knowledgeable personnel is constrained.

Using a dataset of microscopic images of blood smears and chest X-rays, we were able to effectively adjust a pre-trained model. It has been shown how well transfer learning works by modifying the previously trained model for their particular job. The paper also emphasizes the significance of using varied datasets and exploring additional deep-learning algorithms for future studies.

The findings of this research, especially in developing nations, have significant effects for enhancing healthcare outcomes and reducing the strain on healthcare systems. Better patient outcomes may result from the suggested approach's ability to increase the speed of the diagnosis process while reducing errors and increasing accuracy. This paper represents a major advancement in the field of deep learning-based medical diagnosis and lays the groundwork for further investigation in this field.

The research highlights several future scopes for further advancements. The study's dataset can be expanded to include more diverse and larger datasets to improve the model's performance and robustness. The proposed approach can be extended to diagnose other diseases such as tuberculosis, COVID-19, and other respiratory diseases using chest X-rays. Deploying the CNN-based approach in real-world healthcare settings can assess its performance in real-time and enable more widespread use. To aid in decision-making, researchers could focus on developing techniques to improve the interpretability of CNN-based approaches, which can be challenging due to their black-box nature. This research shows the potential of CNN-based approaches in medical diagnosis and highlights the need for further research in this area to improve healthcare outcomes.

VIII. REFERENCES

[1] Sakshi Tekale, Saee Kulkarni, Ramdas Patil, Shreya Diwan, Prof. Anita Vikram Shinde, Smart System for Disease Prognostication in Healthcare using multi-classifier-based Prediction Model, DOI Link: https://doi.org/10.22214/ijraset.2022.47684

[2] G.Hanitha , A.RajyaLakshmi , B.Hemasree ,B.Parthasaradhi , Dr Balajee Maram , Malaria Detection Using Convolution Neural Network , ISSN: 2643-9085 Vol. 4, Issue 3, March – 2020, Pages: 6-12

[3] Fuhad KMF, Tuba JF, Sarker MRA, Momen S, Mohammed N, Rahman T. Deep Learning Based Automatic Malaria Parasite Detection from Blood Smear and its Smartphone Based Application. Diagnostics (Basel). 2020 May 20;10(5):329. doi: 10.3390/diagnostics10050329. PMID: 32443868; PMCID: PMC7277980.

[4] Osuji Collins Ifeanyi , Binyamin A. Ajayi and Muhammad Umar Abdullahi, Malaria disease detection system based on convolutional neural network (CNN) ,DOI: https://doi.org/10.30574/wjarr.2022.16.3.1304

[5] Kaustubh Chakradeo,Sofya Titarenko,Michael J Delves,
Malaria Parasite Detection Using Deep Learning Methods,DOI: 10.5281/zenodo.4569849,February 2021,Conference: International Conference on Machine Learning Methods for Computer Vision At: New York

[6] kumar bmh, srikanth pc, vaibhav am. a novel computation method for detection of malaria in rbc using photonic biosensor. int j inf technol. 2021;13(5):2053-2058. doi: 10.1007/s41870-021-00782-z. epub 2021 sep 2. pmid: 34493995; pmcid: pmc8412864..

[7] Amulya m p,niranjan murthy m, prediction of pneumonia using big data, deep learning and machine learning techniques, doi: 10.1109/icces51350.2021.9489188, 2021 6th international conference on communication and electronics systems (icces)

[8]s. grampurohit and c. sagarnal, "disease prediction using machine learning algorithms," 2020 international conference for emerging technology (incet), 2020, pp. 1-7, doi: 10.1109/incet49848.2020.9154130.

[9] l. athota, v. k. shukla, n. pandey and a. rana, "chatbot for healthcare system using artificial intelligence," 2020 8th international conference on reliability, infocom technologies and optimization (trends and future directions) (icrito), 2020, pp. 619-622, doi: 10.1109/icrito48877.2020.9197833.

[10] marouane ferjani,disease prediction using machine learning,doi:10.13140/rg.2.2.18279.47521DOI: 10.1007/978-981-15-3369-3_36

[11] bhanuteja talasila,saipoornachand kolli,symptoms based multiple disease prediction model using machine learning approach,august 2021 international journal of innovative technology and exploring engineering ,doi: 10.35940/ijitee.i9364.0710921

[12] prof. swati dhabarde, rohit mahajan, satyam mishra, sanjiv chaudhari, satish manelu, prof. dr. n s shelke , disease prediction using machine learning algorithms , volume:04/issue:03/march-2022 ,international research journal of modernization in engineering technology and science

[13] v. sirish kaushik,gaurav kataria,anand nayyar,rachna jain , pneumonia detection using convolutional neural networks (cnns) , doi: 10.1007/978-981-15-3369-3_36 , conference: proceedings of first international conference on computing, communications, and cyber-security (ic4s 2019)

[14] Anjali bhatt, Shruti singasane, neha chaube, disease prediction using machine learning , volume:04/issue:01/january-2022 , international research journal of modernization in engineering technology and science

[15] V. Sirish Kaushik, Anand Nayyar, Gaurav Kataria and Rachna Jain,Pneumonia Detection Using Convolutional Neural Networks (CNNs),DOI: 10.1007/978-981-15-3369-3_36,April 2020, Conference: Proceedings of First International Conference on Computing, Communications, and Cyber-Security (IC4S 2019)

[16] Lamia A, Fawaz A. Detection of Pneumonia Infection by Using Deep Learning on a Mobile Platform. Comput Intell Neurosci. 2022 Jul 30;2022:7925668. doi: 10.1155/2022/7925668. PMID: 35942467; PMCID: PMC9356824.

[17] Kundu, R., Das, R., Geem, Z. W., Han, T., & Sarkar, R. (2021). Pneumonia detection in chest X-ray images using an ensemble of deep learning models. *PLOS ONE*, *16*(9), e0256630. https://doi.org/10.1371/journal.pone.0256630

[18] Manjunatha S, Meghashree A.C,PREDICTION OF PNEUMONIA USING BIG DATA, DEEP LEARNING AND MACHINE LEARNING TECHNIQUES,DOI : https://www.doi.org/10.56726/IRJMETS29620 , Volume:04/Issue:09/September-2022

[19] K. Mitrović and D. Milošević, "Classification of Malaria-Infected Cells using Convolutional Neural Networks," 2021 IEEE 15th International Symposium on Applied Computational Intelligence and Informatics (SACI), Timisoara, Romania, 2021, pp. 000323-000328, doi: 10.1109/SACI51354.2021.9465636.