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SURVEY PAPER ON CHEST X-RAY CLASSIFICATION

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Abstract-- India faces acute shortage of radiologists. As per NCBI, USA India has one radiologist per1,00,000 people. In past two years we have seen unprecedented COVID-19 pandemic which has posed a huge burden on our health care infrastructure and health care professionals. The rural parts are hit worst struggling to provide lifesaving health care access causing millions of Indians to lose their lives. In this regard our project focuses on developing a web based application which may reduce the burden on health care professionals and help in timely diagnosis of chest x-ray findings without delays and withprecision. This will help to treat patients with utmost care, can avoid unnecessary surgeriesand save lives.

In the recent years Artificial Intelligence(AI) empowered systems have proven to be dominant in all domains. Artificial Intelligence has attracted most of the researchers of therecent past. Artificial Intelligence which encompasses all the industries has been proven to be vital in Health care by helping healthcare professionals in taking decisions and also in diagnosis and detection of several critical ailments like cancers and others.

In this project we have leveraged the transfer learning as benchmark to obtain the models for our task of classification. We have executed the experiment through the various standard models available retaining the similar experimental conditions and did the comparative analysis to evaluate them and to pick the best one among them. The results achieved show that Densenet-169 provided the best results with 95.56 percentage validation accuracy which has been used for making predictions in the web application.

KEYWORDS: *Pneumonia, Convolutional Neural Networks, Detection, Deep Learning, Transfer Learning.*

I. INTRODUCTION

Access to healthcare is one of the basic and most important necessity for the human life when compared other necessities of life. India is a country of villages which directly takesus to conditions where we are striving to provide with basic amenities. During last two years the healthcare and the healthcare professionals are over burdened with the pandemic since our population and the health care facilities are still not matching the expected thresholds especially in the rural regions of the nation. The pandemic has made us understand that the healthcare needs to upgraded drastically and it needs scaled up as per the need of the hour. The reality is that we cannot overcome the acute shortage of doctors and other support staff and we cannot scale up the human resources overnight to match theneeds instead we can assist the working professionals with technology to speed up the diagnosis by automating the processing of the different medical tests conducted during theprocess of treatment and we can draw inferences from the tests through artificial intelligence powered systems without waiting for the human to interfere and extract the results from the tests.

Chest X-ray is one of the predominant test carried out to diagnose the ailments in the chestregion and can study the abnormalities if any in the internal organs like heart and lungs. The procedure is not invasive in nature and we can derive the results swiftly. The bottleneckin this case is the availability of the radiologists who will examine the chest x-ray and reportthe findings to further treatment. As specified earlier we face shortage of radiologists whichwill delay the process of treatment.

Deep Learning inset of Machine Learning(ML) which deals with Artificial neural networksis performing exceptionally well in the areas of Computer vision (consisting of Image recognition and object detection) and speech recognition.

Deep Learning (DL) especially Convolutional Neural Networks (CNNs) have given extremely good outcomes in the image classification by doing exceptionally well in feature extraction tasks.

In this project we are leveraging the most important potential of CNNs through transfer learning where we use the previously trained CNN models to classify the images of chest X-ray. Convolutional neural networks are trained with Chest x-ray images to extract the features in them and later classify them whether there are any findings in them or they areNormal.

The pre trained models like VGGNet, Xception, Inception, ResNet, DenseNet and NASNet which are trained on largescale dataset like ImageNet are employed to our required task of feature extraction and image classification task at hand.

We do a comparative analysis of the results based on the metrics for which the model has been evaluated. We find a best model to use it in the web based application for making predictions.

There are different services offered to combat the shortage of the radiologists like Teleradiology where the radiologists located far away from the patients receive thetransmitted digital radiographs and examine them and provide the diagnosis. But yet thereis a human radiologist sitting at the other end and doing the duty. Again since the radiologists are getting overloaded from the demand from every geographical area we mayface lag in obtaining results. Our work goes

further to remove this bottleneck of having radiologists to infer the chest x-ray by delegating the task to the artificial intelligence enabled machines which can work round the clock without fatigue and with same precisionon each case it handles. Facial expressions are the important and successful requirement in image analysis in the field of image processing. Facial expressions are mainly based on mouth and eye for analyzing and recognizing the human mood. Many segmentation techniques are available for to analyze and recognize the facial expressions based on human mood. The main aim of facial expressions is to recognize the facial features such as mouth and eye from an given input facial image M.Prasad et al. [7].

II. PROBLEM STATEMENT

Diagnosis of the chest x-ray to pick up the inferences is a skillful task and requires expertisein the job. Several images may get misinterpreted as different diseases since the images will be unclear and ambiguous. India faces shortage of these skilled radiologists to meet the growing demand due to increase in population and hence leading to poor access to health care especially in remote areas and over burden on the currently serving professionals. Developing an artificial intelligence powered system to diagnose and reportthe results will help us to extend the access to healthcare to the remotest part of the countryand help us in saving lives.

A. EXISTING SYSTEM

The images of chest x-ray are examined by a radiologist who is trained and possessing expertise will study the image and report the findings so that doctors will decide and plan the treatment of the patient accordingly. The speed with which the treatment is given to the patient relies on how fast we diagnose the chest x-ray and get the result report. This phase is very crucial to patients since delay in the diagnosis and starting the treatment will lead to increase in the severity in the disease. In several cases timely diagnosis can avoid unwanted surgeries also. Due to less number of available radiologists they are overloaded and hence we suffer delays in getting results.

B. DEMERITS OF THE EXISTING SYSTEM

The existing procedure requires an expert radiologist to examine the chest x-ray andreport the findings.
Expert radiologists are very less in number and are overburdened.
The turn around time to get the results increase with increase in number of patients.

Every radiologist needs the same level of expertise and should work without fatigue.

C. PROPOSED SYSTEM

The proposed system is an artificial intelligence empowered web application hosted in a typical web server which will receive the image of chest x-ray from the user and uses the deep learning model which will diagnose the image and report us the findings.

D. MERITS OF THE PROPOSED SYSTEM

The proposed system will help us provide access to healthcare to the rural areas as well.
The system will scale up and handle the demand in case of pandemic and will reduce the burden on the healthcare professionals.
The system will reduce the dependency on the radiologists and help us diagnose faster.
The system has consistent accuracy and precision dealing with all the cases and it does notsuffer fatigue.

III. LITERATURE SURVEY

Dimpy Varshni et al. [1], worked on the chest x-ray classification using CNNs for feature extraction in which they have worked on ChestX-ray14 dataset which was released by Wang et al. In their work they used various CNNs for feature extraction and presented themto the various classifiers and did an analysis to find the best CNN and the classifier. Their work focussed on the binary classification of the images whether the images have pneumonia or normal They have reported the best accuracy of 80.02 % with DenseNet-169 for feature extraction and SVM as the classifier.

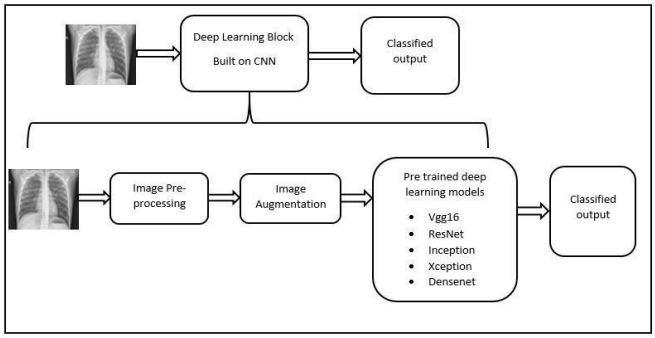
Hongyu Wang et al. [2], have proposed a deep CNN named ChestNet for the identificationand classification of thoracic ailments through the chest radiographs. Their work put forth a model which was divided into 2 sub sections one was a classification and another one was called attention section which dealt with leveraging the interdependence between the target class labels and the areas of the abnormalities found in the pathology and adapts themodel to focus on only the areas with abnormalities.

Rahib H. Abiyev et al. [3] in their work studied the different models built which are based on deep CNNs, Back propagation neural networks which is supervised learning and competitive NNs which are based on unsupervised learning. The results shown that when recognition rate was used as comparison factor the back propagation neural networks outperformed the competitive NNs.

Pranav Rajpurkar et al. [4] have developed a model CheXNet based on Dense CNN which possess 121 layers. These networks are better at flow of gradients and details through the network. Their work shown that the ChexNet was superior in performance when comparedto radiologists in the F1 score metric.

T. Rahman et al. [5] have worked on publicly available dataset through kaggle to classify the images as pneumonia

and normal and further they have worked to classify them as viraland bacterial pneumonia. They have employed different



previously trained models like ResNet, AlexNet, DenseNet and SqueezeNet. They have worked with 5247 images. Their work has demonstrated that DenseNet201 has outperformed other models and achieved accuracy of 98% during classification of images into normal and pneumonia, accuracy of 95% during classification of images into viral pneumonia and bacterial pneumonia and accuracy of 93.3% during classification of images into all the three categories. Their work states that transfer learning can be leveraged to classify chest radiograph images quiteeffectively.

IV. SYSTEM REQUIREMENT SPECIFICATIONS

A good quality SRS is highly recommended in order to achieve good quality software. Therequirements elucidated should be aligned with all the stakeholders of the project. The requirements should obey all the characteristics suggested for a good SRS. In this chapter we define the requirements of the system at a high level.

DESCRIPTION OF FUNCTIONALITY IN TERMS OFUSE CASES

In this section we specify the necessary functions of the system through use cases which describe functionality by extracting the interactions conducted by the user with the system.It also encompasses the behavior of the system.

UC1: Disease Prediction of an image

Primary actor: User

Precondition: The user has navigated to the Home page of the web application.

Main expected Scenario:

User selects the image through the browse option by Choose file button in the web pageUser posts the selected image to the web server

User clicks on the predict button to know the displayed results of the prediction.

Exception Scenario:

The user tries to upload a file which is not supported. The only supported files are images of jpg, jpeg, png and gif formats. System alerts the user by displaying proper image.

i. SYSTEM ARCHITECTURE:

The proposed system has an architecture as shown in the figure 1 below.

Figure 1 Showing the architecture of the system.

The block diagram depicts the overall architecture of the system where it illustrates the important components which are explained in this chapter. The system takes input in the form of chest x-ray image which is fed in to deep learning block for the classification. Theclassified output is rendered to the user through the web page.

ii. TRANSFER LEARNING:

The project leverages technique known as transfer learning where in the models which aretrained over a large dataset like ImageNet can be adapted to similar classification taskswith respect to smaller datasets Russakovsky et al.[6]. This technique may be used in different scenarios.

We can use different models with the already learned weights straight away in similar image classification tasks.

We can leverage the previously trained models with learned weights and these weights can be used as initial weights instead of random weights in training the models with new datasets which will help the models to converge faster.

We can use the pre trained models and train only the last few layers of the neural network by freezing the initial layers which can prove effective in fine tuning the model to the task in hand.

The process of the transfer learning is depicted in the figure 2 below.

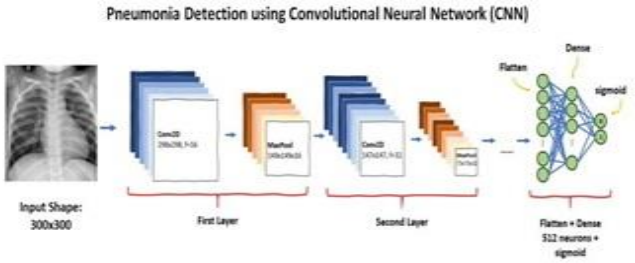


Figure 2 depicting the transfer learning process.

The transfer learning involves adapting the previously trained model to suit the needs of the task in hand since models trained on ImageNet dataset are trained for object detection of 1000 classes. The process of adapting is shown in the figure 3 below.

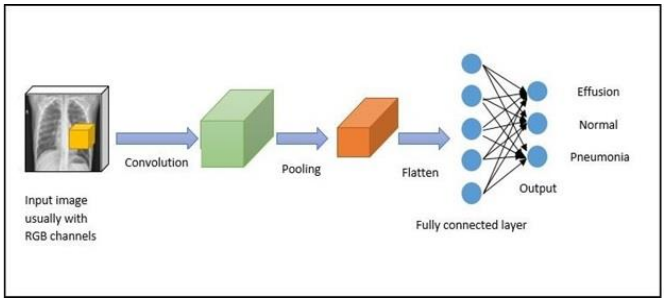


Figure 3 Adapting the transfer learning process.

V. FUTURE SCOPE AND CONCLUSION

We have assessed the performance of 3 CNN models namely:
VGG16, VGG19 and a CNN model that we built from scratch.
For VGG16 we got validation accuracy of 92%and training accuracy of about 97% and for VGG19 we got validation accuracy of 89%and training accuracy of about 95%
And for the model that we built we got validation accuracy of 93%and training accuracy of about 99%.
Physically so that the framework in the feature extractionis employed. The pneumonia infected diseases and normal chest x-ray image dataset are acquired. Our study enables to identify among the three models the best model to detect pneumonia. All the models have performed well on detecting pneumonia and normal chest x-rays. We have demonstrated how to classify positive and negative pneumonia data from a collection of X-ray images. We build our model from scratch, which separates it from other methods that rely heavily on transfer learning approach. We also used transfer learning approach to solve and we got good results with the CNN model we built and it was more accurate than the transfer learning models that we used.

In the future, this work will be extended to detect and classify X-ray images consisting of Covid-19 and pneumonia. Distinguishing X-ray images that contain Covid-19 and pneumonia has been a big issue in recent times, and our next approach will tackle this problem.

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