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Detecting COPD using Convolutional Neural Network

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Abstract Chronic obstructive pulmonary disease (COPD), a preventable and treatable disease characterized by persistent airflow limitation, is a major cause of morbidity and mortality worldwide. COPD comprises a combination ofsmall airways disease and emphysema, resulting from lung damage caused by the inhalation of noxious agents. It also includes chronic bronchitis. Due to the nonavailability of sufficient-size and good-quality chest X-ray image dataset, an effective and accurate CNN classification was a challenge. To deal with these complexities such as the availability clear, small sized and imbalanced dataset with image-quality issues, the dataset has been preprocessed in different phases using different techniques to achieve an effective training dataset for the proposed CNN model to attain its best performance. The preprocessing stages of the datasets performed in this study include dataset balancing, medical experts' image analysis, and different data augmentation methods. This project report flows from a brief introduction of the topic highlighting the need and the existing technologies as compared to the proposed system which gives distinctive features of our project, we then conduct s literature survey where we discover and comprehend preexisting technologies. We are also presenting the research work which aims to apply Convolutional Neural Network based deeplearning methodologies to assist medical experts by providing a detailed and rigorous analysis of the medical respiratory audio data for Chronic Obstructive Pulmonary detection. In the conducted experiments, we have used a Librosa machine learning library feature such as MFCC, Mel-Spectrogram, Chroma, Chroma and Chroma CENS.

Keywords — ANN, Chroma, Chroma CENS, Chroma (Constant-Q), CNN Librosa machine learning library, Mel-Spectrogram and MFCC.

I. INTRODUCTION

1.1 Need of the project

Around 16million humans across the globe suffer from COPD making it the 4th deadliest disease. COPD cannot be cured but treated if detected atan early stage. The standard practices used to detect COPD are

- Arterial blood gas analysis test
- Chest X-ray
- CT scans
- Lung function tests

The limitations of these traditional methods are

- 1.Spirometry cannot be performed on patients with underlying heart problems or those who have recently undergone heart surgery
- 2.Breathlessness, nausea, and dizziness are some symptoms commonly seen after the tests.

More-over these traditional processes are time consuming. With the introduction of CNN and artificial intelligence it aids the medical experts to detect COPD sooner. Our technology and software would minimize errors to a value significantly lesser than that obtained when this task is handed to a human being. Moreover, time would be saved when the process becomesautomated, leaving individuals to handle more important tasks.

1.2 Existing system, and proposed system.

Most of the existing systems have data sets in which they might either have X-ray scans or CTscans and others might have data sets that have audios of breathing cycles in a wav format. In these systems they try to augment the data sets and the algorithm to increase the level of accuracy of the prediction model.

The model that we are proposing is a combinationof the two worlds and give a much higher accuracy. The first part of the system will be trained and will predict on the basis of X-ray scans. The second part will be trained and predict on the basis of breathing cycles. The combinationof the two will give us a much better result and help us give a better picture of the patient's health.

1.3 Objectives

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Coming to the precise objectives and what wewant to achieve during the duration of this project:

1. Comprehend the data sets and get a full understanding of the existing systems.
2. Having a balance between normal and affected data.
3. Gathering the maximum features from the data sets in order to the highest levels of accuracy.
4. To train the system by building the most efficient algorithm.
5. To successfully segregate the testing data into their perspective class.

1.4 Scope and Applications

1. As we have seen the trend of smoking in teenagers and twenty-year old's increase over the years there hasn't been a more pertinent time for building a system that can help detect thepresence of a Lung disorder.

2. There has also been a significant decrease in the quality of air that puts us all at harms way andcould affect people more randomly and again a system that could just analyze breathing cycles from the comfort of your home.

3. As a disease COPD is itself notorious for the detection and alignment for doctors. The accuracy of trained physicians itself when low a robotic system might be better for a second reference.

II. LITERATURE REVIEW

So as to understand the dangers and the increase in the number of cases in COPD (chronic obstructive pulmonary disorder). We went through a lot of research that had listed out the severity and implications of the disease. The study conducted by Lancet Global Health and Prof Lalit Dandona indicated a significant rise inthe number of cases. The number of cases of COPD in India increased from 28·1 million in 1990 to 55·3 million in 2016. COPD and asthma were responsible for 75·6% and 20·0% of the chronic respiratory disease DALYs, respectively,in India in 2016.

Another paper cited by Andrew I Ritchie and Jadwiga A Wedzicha stated a lot of alarming facts about the exacerbation of COPD Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) are episodes of symptom worsening which have significant adverse consequences for patients. Highly heterogeneous events associated with increased airway and systemic inflammation and physiological changes. They are triggered predominantly by respiratory viruses and bacteria, which infect thelower airway and increase airway inflammation. A proportion of patients appear to be more susceptible to exacerbations, with poorer qualityof life and more aggressive disease progression. Prevention and mitigation of exacerbations are therefore, key goals of COPD management. Aftergoing through "Classification of COPD using CTimages and a 3D Convolutional Neural Network"by Ahmed et al published in the year 2020 the techniques used to classify were

Without Transfer Learning and the test accuracy was 58.8% and validation was 68.5%.

With Transfer Learning the validation: 78.3% and test accuracy was 70%. The features of this paperwere CT images from these two datasets consisting of inspiration scans used soft kernel.

The issues faced during the process were validating the model while comparing it with other methods on bigger and balanced data setsand it used k-fold cross-validation.

In the year 2020 Du et al published "To detect COPD using images of 3D lung airway tree and with the help of deep CNN architecture" under which the techniques used were classification bycolorful snapshot with an accuracy of 88.2%, classification by gray snapshot with an accuracy of 88.6% and classification by binary snapshot with an accuracy of 86.4%. The main features recognized were the features from the spirometrytests. Issues faced were the amount of dataset used is very small in size and it only includes COPD patients and normal humans.

It utilizes the information of the airway, but does not include lung parenchyma, air trapping, pulmonary blood vessels.

Altan, Kutlu & Allahwardi in the year 2019 published "Deep Learning for COPD Detection using Lung Sounds". The techniques used were Deep Belief Networks with an accuracy of 70.28%, sensitivity as 67.22% and specificity of 73.33% and Sequential Forward Feature selection applied to DBN with an accuracy of 90.83%, sensitivity of 94.44% and specificity of 87.22%. The issues faced were the results were suffered due to the presence of noise

The dataset is very small and overall, the accuracy, sensitivity and specificity are less without SFFS. In the year 2010 Washko GR published "Diagnostic imaging in COPD exacerbations using AI" the features used in this paper were Decision Tree Classifier with an accuracy of 87.8% and sensitivity of 78.1%. The features were extracted using a wavelet transform. Input dataset contained 18 wavelet features. The issues faced were there wasn't sufficient data to train the data and larger sample data to get more accurate results and it does not differentiate the severity of the disease.

III. PROBLEM REVIEW

3.1 Design:

The Language used is Python, since it is simple, flexible and has a rich machine learning library ecosystem. It is being performed in Google Collaboratory Platform. It can also be used to test basic machine learning models, gain experience, and develop an intuition about deep learning

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aspects such as hyperparameter tuning, preprocessing data, model complexity, overfittingand more. Algorithms used here are CNN, with ANN, concrete data points must be provided. Forexample, in a model where we are trying to distinguish between dogs and cats, the width of the noses and length of the ears must be explicitlyprovided as data points.

When using CNN, these spatial features are extracted from image input. This makes CNN ideal when thousands of features need to be extracted. Instead of having to measure each individual feature, CNN gathers these features onits own. Using ANN, image classification problems become difficult because 2-dimensional images need to be converted to 1-dimensional vectors. This increases the number of trainable parameters exponentially. Increasing trainable parameters takes storage and processing capability.

The main advantage of CNN is that it automatically detects the important features without any human supervision. This is whyCNN would be an ideal solution to computervision and image classification problems.

3.2 System design:

Image processing operations, such as flipping, rotating, cropping, or padding for augmentation. The dataset is then extended by these transformed images resulted from the existing image set, which increases the size of dataset to train the neural networks. To solve the problem of the availability of a small size dataset that was affecting the performance of the proposed CNN, the data augmentation method has been used in this study. This technique increased the size of the dataset; in addition, it provides more learning features to the learning model. Two image processing operations, flipping and rotation, have been used in this study for data augmentation.

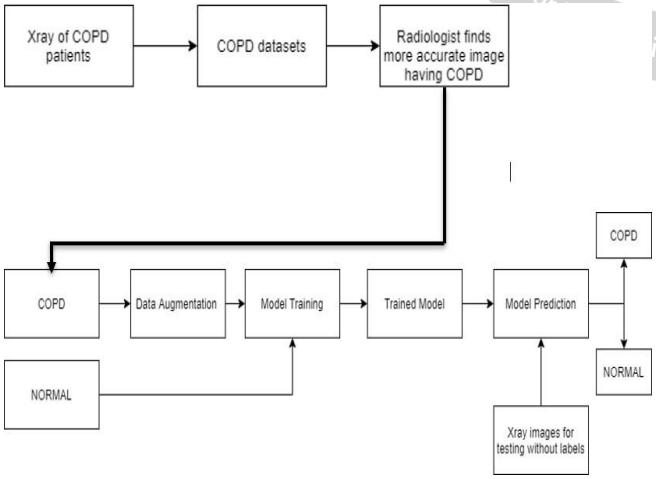

Fig. 1. Project Flow

IV. METHODOLOGY

4.1 Analysis of X-Ray Images by Medical Experts

A deep analysis was done on the X-ray images by medical specialists. Out of 183 X-ray images of confirmed COPD patients, only a set of 148 X-ray images was selected as a perfect candidate to train the models. The resulted dataset now was reduced to 148 COPD confirmed cases and 130 normal X-ray images. The resulted dataset was again usedin

4.2 Balancing Dataset Classes

To balance the given dataset, in order to improve the performance of the proposed CNN models in the detection of COPD cases, normal chest X-ray images have been used. These concatenated extra X-ray images were downloaded from Kaggle. After balancing the dataset when the models have been trained again on the resulted in training the proposed CNN model there was again an improvement in the performance of the model. training the proposed CNN model there was again an improvement in the performance of the model

4.3 Data Augmentation

Data augmentation is a technique that can significantly increase the data instances of a dataset to train a model. In the case of image datasets, the technique uses the basic

V. PLANS FOR NEXT PHASE

5.1 Limitations of X-ray scans

1. When it comes to detect COPD using X-ray scans its not completely accurate as the symptoms may not always appear.
2. X-rays are extremely harmful for the patients suffering from lung cancer or any kind of cancer as they emit radiation.

   Hence the next phase we've planned is to detect COPD using breathing cycles

5.2 DETECTING COPD USING BREATHING CYCLES

1. The developed application can be described as a series of interconnected processes across multiple layers. The user layer consists of the doctor taking the recording of lung sounds.

2. These recordings are then forwarded to the front-end layer, which is the interface with which the doctor can upload the patients recording into the system. The network layer provides connectivity and access to the back-end layer on the cloud.

Finally, the back-end layer consists of a feature extraction module and a classifier module to analyze and provide results back to the front-endinterface. Using Librosa library as it is one of several libraries dedicated to analyzing sounds. Many individuals have used this library for machine learning purposes and using its features such asMFCC and Mel frequency spectrogram.

5.2 MAKING THE SYSTEM INTO A WEB APPLICATION

Since the number of smokers have increased worldwide the

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chances of people contracting COPD will drastically increase. So creating a web application that is readily available for the public which uses just breathing cycles would be a convenient way for getting a diagnosis.

VI. CONCLUSION

This study has been conducted to demonstrate theeffective and accurate diagnosis of COPD using CNN which was trained on chest X-ray image datasets. The model training was performed incrementally with different datasets to attain the maximum accuracy and performance. The primary dataset was very limited in size and also imbalanced in terms of class distribution. These two issues with the primary dataset affected the performance of the models very badly. To overcome these issues, the dataset was preprocessed using different techniques, including dataset balancing technique, manual analysis of X-ray images by concerned medical experts, and data augmentation techniques. To balance the dataset for model training and also to test its performance parameters, an ample numberof chest X-rays were collected from different available sources. After training and testing the CNN model on the fully processed dataset, the performance results have been reported.

REFERENCES

[1] Sørensen L, Shaker SB, de Bruijne M. Quantitative analysis of pulmonary emphysema using local binary patterns. IEEE Trans Med Imaging

[2] Mendoza CS, Washko G, Ross J et al. Emphysema Quantification in a Multi-Scanner Hrct Cohort Using Local Intensity Distributions. Proc IEEE Int Symp Biomed Imaging.

[3] ava R, Escalante-Ramírez B, Cristobal G, San José Estépar R. Extended Gabor approach applied to classification of emphysematous patterns in computed tomography. Med Biol Eng Comput.

[4] Castaldi PJ, San José Estépar R, Mendoza CS et al. Distinct Quantitative Computed Tomography Emphysema Patterns Are Associated with Physiology and Function in Smokers

[5] Castaldi PJ, Cho MH, San José Estépar R et al. Genome-Wide Association Identifies Regulatory Loci Associated with Distinct Local Histogram Emphysema Patterns. Am J Respir Crit Care Med. 2014;190:399–409

[6] Humphries SM, Notary AM, Centeno JP et al. Deep Learning Enables Automatic Classification of Emphysema Pattern at CT.

[7] Smith BM, Austin JHM, Newell JD Jr et al. Pulmonary Emphysema Subtypes on Computed Tomography: The MESA COPD Study. Am J Med. 201

[8] Asaithambi, Manoharan & Subramanian (2012) Asaithambi M, Manoharan SC, Subramanian S. Classification of respiratory abnormalities using adaptive neuro-fuzzy inference system. In: Pan J-S, Chen S-M, Nguyen NT, editors. Intelligent Informationand Database Systems. Berlin

[9] Altan, Kutlu & Allahwardi (2019) Altan G, Kutlu Y, Allahwardi N. Deep learning on computerized analysis of chronic obstructive pulmonary disease. IEEE Journal of Biomedical and Health Informatics.2019

[10] Fernandez-Granero, Sanchez-Morillo & Leon-Jimenez (2018) Fernandez-Granero MA, Sanchez-Morillo D, Leon-Jimenez A. An artificial intelligence approach to early predict symptom-based exacerbations of COPD.

[11] Librosa (2019) Librosa Librosa 0.8.0 documentation. 2019.

[12] Librosa (2020) Librosa Feature extraction—Librosa

0.8.0 documentation. 2020

[13] Weese & Lorenz (2016) Weese J, Lorenz C. Four challenges in medical image analysis from an industrial perspective. Medical Image Analysis. 2016;33:44–49.doi: 10.1016/j.media.2016.06.023

[14] Andrew I. Ritchie and Jadwiga A. Wedzicha, Definition, Causes, Pathogenesis, and Consequences of Chronic Obstructive Pulmonary Disease Exacerbations

[15] Lalit Dandona Lancet Glob Health, and Prof Lalit Dandona The burden of chronic respiratory diseases and their heterogeneity across the states of India: the Global Burden of Disease Study 1990–2016

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