Classification of Pulmonary Diseases Using Cough Sounds Using Deep Learning

Dr. SK. Mahaboob Basha
Professor, NRI Institute of Technology, A.P, India, mahboob@nriit.edu.in

Dr. Chaitanya Kishore Reddy.M
Professor & HOD-IT, NRI Institute of Technology, A.P, India, chkishore.0007@gmail.com

Abstract

Cough sound analysis has attracted interest as a potential low-cost diagnostic tool for low- resource settings, where the burden of pulmonary disease is quite high. However, published results on cough sound analysis are generally limited to specific pulmonary diseases (e.g. detection of Whooping cough - Pertussis) and the study sizes are small. In this paper, we present a general framework for cough sound analysis, which includes automatic cough segmentation, feature extraction and a general classification design that can be applied to a wide range of pulmonary diseases. For our analysis, three evidence-based features were selected (variance, kurtosis, and zero crossing Irregularity) as well as an additional feature that we developed (rate of decay). Our cough sound analysis framework was tested using voluntary cough data collected from 54 patients presenting a combination of pulmonary conditions (COPD, asthma, and allergic rhinitis) equally sampled from all patients arriving at a pulmonary clinic, as well as 33 healthy individuals. All study subjects were examined with a stethoscope auscultation, clinical questionnaire, and peak flow meter, and were given a full pulmonary function test (spirometer, body plethysmograph), which was the gold standard used to determine each patient's diagnosis.When the classifiers were trained using cough sounds alone, the accuracy (as determined by the AUC of the ROC curve) was 74% for Healthy vs Unhealthy, 80% for Obstructive vs non-Obstructive, and 81% for Asthma vs COPD. We also compared the performance of our cough sound analysis against other low- cost diagnostic tools and observed that cough sounds surprisingly had better performance than lungs oundauscultation alone, but had significantly lower performance compared to our clinical questionnaire or peak flow meter test. From these data, we conclude that cough sounds have value as a rapid and simple screening tool, but are of less diagnostic value compared to a clinical questionnaire or peak flow meter.

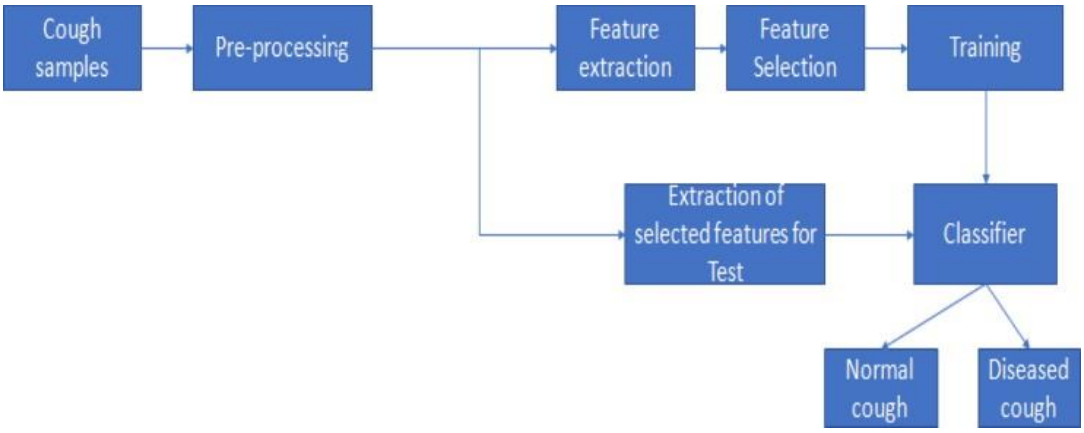
INTRODUCTION

Coughs are a natural physiological response used by the body to expel material from the airway. A cough can be an allergic response to environmental factors, or can be a symptom of disease. Coughs are often characterized in several ways, such as whether or not the cough produces mucus (wet or dry cough). Certain coughs are characterized by their sound, such as a croup cough that contains stridor (barking/quacking sound). Over the past decade, interest in cough sounds has expanded as a result of new technologies that enable continuous monitoring of human sounds. Mobile phones, with connection to voice services in the digital "cloud," and voice recognition products for the home, such as the Amazon Echo or Google Home, now provide the opportunity for consumer devices that can

monitor human signals and detect adverse health Coughs are a natural physiological response used by the body to expel material from the airway. Coughs are characterized in several ways, such as whether or not the cough produces mucus (wet or dry cough). Certain coughs are characterized by their sound, such as a croup cough that contains stridor (barking/quacking sound). Over the past decade, interest in cough sounds has expanded as a result of new technologies that enable continuous monitoring of human sounds. Mobile phones, with connection to voice services in the digital "cloud," and voice recognition products for the home, such as the Amazon Echo or Google Home, now provide the opportunity for consumer devices that can monitor human signals and detect adverse health events.

The structural design of systems is defined as system architecture. It's a theoretical model that describes a system's structure, behavior, and other aspects. It shows how numerous components and subsystems, including as software applications, network devices, and hardware, interact. The basic goal of system architecture is to define a comprehensive solution based on logically related and consistent principles, concepts, and properties.

Fig 1 structural design of system



LITERATURE SURVEY

The World Health Organization (WHO) has announced a Cough realted diseases was a global pandemic in March 2020. It was initially started in china in the year 2019 December and affected an expanding number of nations in various countries in the last few months. In this particular situation, many techniques, methods, and AI-based classification algorithms are put in the spotlight in reacting to fight against it and reduce the rate of such a global health crisis. Cough related diseases main signs are heavy temperature, different cough, cold, breathing shortness, and a combination of loss of sense of smell and chest tightness. The digital world isgrowing day by day, in this context digital stethoscope can read all of these symptoms and diagnose respiratory disease. In this study, we majorly focus on literature reviews of how SARS-CoV-2 is spreading and in-depth analysis of the diagnosis of disease from human respiratory sounds like cough, voice, and breath by analyzing the respiratory sound parameters. We hope this review will provide an initiative for the clinical scientists and researcher's community to initiate open access, scalable, and accessible work in the collective battle against lung diseases.

PROPOSED SYSTEM CONFIGURATION

In the existing system or the approach followed now is a time consuming process and need to consult a doctor for checkup which is again a worthy and time taking process. In the existing Model where algorithms used only few extraction features in which rate of decay was absent and gives you inaccurate results. There are many pulmonary diseases which cause to death such as COPD, Asthma, Pertussis, Pneumonia, etc.. It is prevalent mainly in developing countries where it is difficult to diagnose due to the lack of healthcare facilities and medical professionals. Hence, a low-cost, quick and easily accessible solution is needed to classify the diseases. , etc. Identifying suitable features to detect the pulmonary disease and classifies the pulmonary disease using Machine Learning algorithm. The project is implemented in python language. And the project implementation is done in Jupyter notebook.. The biggest strength of Python is huge collection of standard library which can be used or the following –

Machine Learning

GUI Applications (like Kivy, Tkinter, PyQtetc.)

Web frameworks like Django (used by YouTube, Instagram, Dropbox)

Image processing (like Opencv, Pillow) Web scraping (like Scrapy, Beautiful Soup, Selenium)

Test frameworks Multimedia

A CNN model can effectively extract features from images, and then complete tasks such as classification and recognition. Therefore, we use the CNN model to effectively classify the audio and to realize the accurate recognition and detection of coughing. We propose a method for cough recognition based on a Mel-spectrogram and a Convolutional Neural Network called the Cough Recognition Network (CRN), which can effectively distinguish cough sounds. As a disease with a long incubation period and high infection rate, lung diseases have caused millions of people to be infected and hundreds of thousands of people to died. How to avoid the rapid spread of the epidemic and effectively control the number of infected people has become an urgent issue. Asif et al. found that data from 10,172 COVID-19 laboratory- confirmed cases have shown a correlation with coughing in 54.08% (Sattar Hashmiand Asif, 2020). Therefore, coughing, as a typical symptom of pneumonia, is of great significance in controlling the potential infectious source if it can be quickly and accurately monitored in the population. Many scholars have studied how to extract features of sound and recognize the sound. Mel Frequency Cepstrum Coefficient (MFCC), as a method of extracting audio features (Shintri and Bhatia, 2015), is widelyused in various audio recognition tasks. Xie et al. used MFCC to recognize abnormal voice (Xie et al., 2012). Wang et al. proposed to recognize speech emotion based on improved MFCC (Wang and Hu, 2018). Suksri described a method that used MFCC extracted from the speech signals of spoken words for speech recognition (Ittichaichareon et al., 2012). The Fourier transform (FT) is also widely used in audio processing. Jozef et al. presented a new procedure for the frequency analysis of audio signals (Pucik et al., 2014). Although these traditional methods are very effective for the extraction of audio features, considering the complexity of the real scene, the method of deep learning may achieve better results. With the development of deep learning, the neural network has played an important role in audio recognition. Oren et al. proposed

spectral representations for convolutional neural networks (Rippel et al., 2015). Some LSTM-based networks for speech recognition are also presented (Pundak and Sainath, 2017; Trianto et al., 2018). Compared with traditional methods, deep learning can extract more complex and robust features.

Test Table

S No	Actions	Test Case Description	Expected Output	Actual Output	Test Result
1	Upload Respiratory audio set	Training data	Successfully Uploaded	Success	Pass
2	Extraction of features	Feature Extraction	Displays Features	Displays Features	Pass
3	Upload Test Audio Set	Predicts the Disease	Displays the name of the disease	Either Displays Disease name or Displays healthy	Pass

Fig 2 Home Page

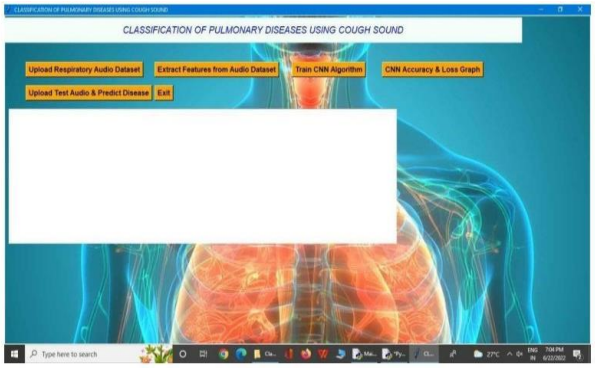


Fig 3 Upload Audio set

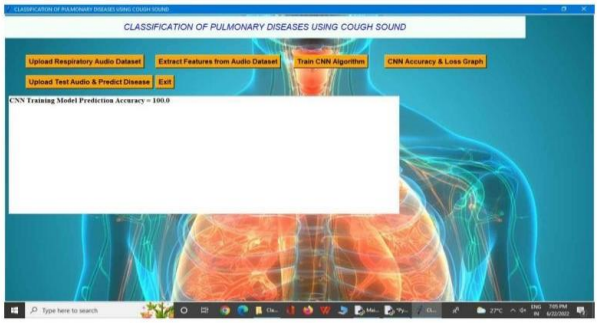


Fig 4 Healthy Person Values

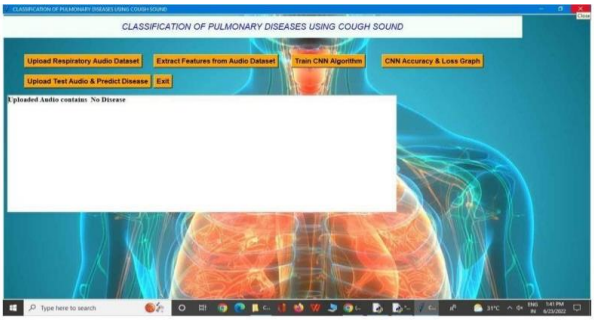


Fig 5 Diseased Person Prediction

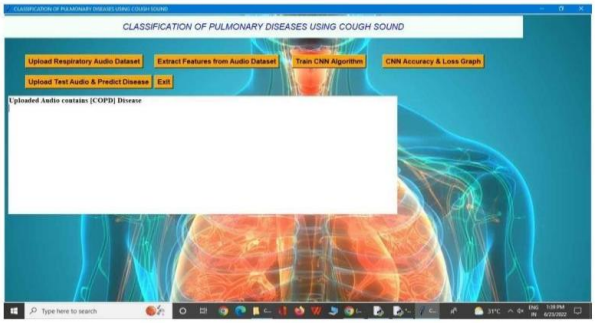


Fig 6 Extraction of features

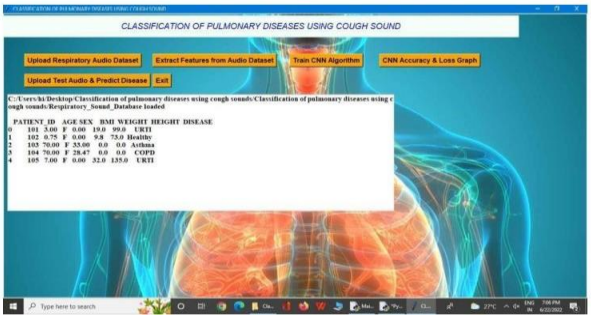
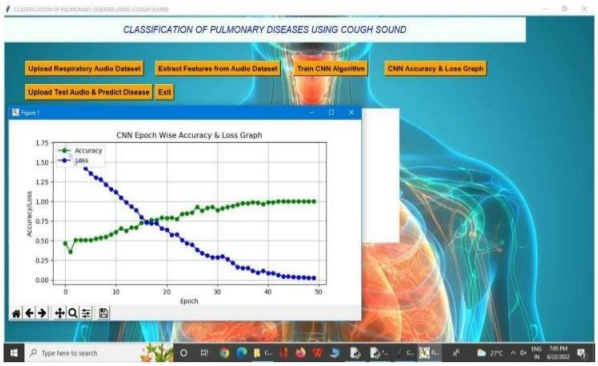


Fig 7 CNN Graph output



CONCLUSION AND FUTURESCOPE

The lungs are important organs in the respiratory system and used for gas exchange (oxygen and carbon dioxide). When we breathe. Our lungs transfer oxygen from the air into the blood, and carbon dioxide from the blood into the air. To implement this project we have taken disease diagnosis dataset and respiratory audio dataset and then extract features from all audio dataset and then trained a convolution neural network (CNN) algorithm model. After training model we can upload any new test data to predict disease from it. By using CNN Algorithm we get more Accurate results as it contains additional feature called rate of decay. Due to a lack of tools and resources, healthcare professionals found it difficult to locate and Analyze healthcare data. However, machine learning has the potential to solve this issue.Since the proposed system perform the analysis on real-time data which intern gives better prediction results. In future we can also include many other algorithms as well as hybrid algorithms such that the best among them can be used for prediction which gives us the better accuracy and efficiency. Since the data set, we used here is small and is not up to the mark we are only able to predict the disease but not the type of the disease.

Hence, we can improve it and in return we can increase the accuracy and the related treatment can be given accordingly. With the improvement in the data set we can also predict the pulmonary diseases in young adults. This can can be implemented in real time as we have many existing models such as India's Mobile Health Program for maternal and child care . Phone-based diagnostic tools would provide an automated means to screen for disease and refer these patients to a clinic. This model is convinient for any user to use just by uploading his cough audio in wave form extension.

REFERENCES

[1] Pulmonary breath Sounds. East Tennessee State University, November 2002.

[2] J. J, Ward. R.A.L.E. Lung Sounds Demo. Med. RRT in RespiratoryCare, Canada, 2005.

[3] Think labs Digital Stethoscope Lung Library.

[4] 3M Littmann Stethoscope Lung Sound Library.

[5] Tiago H. Falk, Wai-Yip Chan, Ervin Sejdic´ and Tom Chau, "Spectro-Temporal Analysis of Auscultatory Sounds", New Developments in Biomedical Engineering, Intech, 2010.

[6] Gadge PB and Rode SV, "Automatic Wheeze Detection System as Symptoms of Asthma Using Spectral Power Analysis", Journal of Bioengineering & Biomedical Science, 2016.

[7] Bor-Shing Lin, Huey-Dong Wu and Sao-Jie Chen, "Automatic Wheezing Detection Based on Signal Processing of Spectrogram and Back - Propagation Neural Network", Journal of Healthcare Engineering, Vol. 6, No. 4, pp. 649- 672, 2015.