

Survey Paper On “Diagnosing Respiratory Conditions Via Lung Sounds using CNN-LSTM”

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Abstract— In this project, we developed an easy-to-use and affordable algorithm to analyze respiratory sounds, which can be used on any device. The goal was to classify different types of breathing sounds using machine learning techniques. We used two types of features to represent the sounds: Gammatone Cepstrum Coefficients (GTCC) and Short-Time Fourier Coefficients (STFC). These features help the system understand the characteristics of the sounds. The algorithm then uses a combination of a Convolutional Neural Network (CNN) and a Long Short-Term Memory (LSTM) network to classify the sounds accurately. We created four datasets to train and test the algorithm. These datasets include: Healthy versus pathological sounds (to distinguish between normal and abnormal breathing), Classification of different types of sounds, like rales, rhonchi, and normal breath sounds, Classification of individual types of respiratory sounds, and A complete classification that includes all types of breathing sounds. The algorithm is designed to be simple, cost-effective, and can work on various devices, making it accessible for a wide range of users, including healthcare professionals, researchers, or anyone interested in analyzing respiratory sounds.

Index Terms:- Respiratory Sound Analysis, Breathing Sound Classification, Gammatone Cepstrum Coefficients (GTCC), Short-Time Fourier Coefficients (STFC), CNN (Convolutional Neural Networks) LSTM (Long Short-Term Memory), Machine Learning, Healthcare Applications,

I. INTRODUCTION

Respiratory sounds, provide valuable insights into lung health and can help diagnose conditions like asthma, pneumonia, and COPD. Traditionally, diagnosis requires expert interpretation, but machine learning has made automated analysis of healthcare lung sounds feasible. This study explores the use of

Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks for classifying respiratory sounds. CNNs efficiently detect patterns in the audio, while LSTMs capture the temporal relationships in sequential data. By combining these techniques, the proposed system offers a cost-effective, non-invasive method for diagnosing respiratory conditions, aiding professionals in early detection and monitoring

II. METHODOLOGY

Compare the model against existing methods such as MFCC-Inception networks. Analyze the classification accuracy across various lung diseases like asthma, pneumonia, COPD, etc.

Feature Extraction:- Extract Gammatone Cepstrum Coefficients (GTCC) and Short Time Fourier Coefficients (STFC) from audio recordings. These features provide significant insights into sound patterns relevant to lung condition diagnosis. Model

Design:- Implement a hybrid CNN-LSTM architecture: CNN layers to extract spatial features from the sound spectrograms. LSTM layers to capture temporal patterns in the lung sound sequences. The model aims to optimize accuracy while being lightweight and computationally efficient. Respiratory conditions are diagnosed through spirometry and lung auscultation. Spirometry is measuring the volume of air mobilized in respiration. Even though, this method is one of the most commonly available lung function tests and well validated for the diagnosis and monitoring of upper and lower airway abnormalities, it is limited to patient’s cooperation and therefore, is error prone. Moreover, traditional spirometers are normally used only in clinical settings due to their high cost and required calibration along with challenges in

patient guiding. Auscultation is other technique which involves listening to the internal human body sounds with the aid of a stethoscope and typically performed on the anterior and posterior chest. From past few years, it has been an effective tool to understand lung disorders and possible abnormalities. However, this process is limited to physicians as they are well trained. For various reasons like faulty instrument or noisy environment, false positives can happen. Therefore, it opens a door to develop computerized lung sound analysis tools/techniques, where automation is the integral part.

III. LITERATURE SURVEY

1] Author: Liqun Wu and Ling Li

Paper Name: A Respiratory Sound Database for the Development of Automated Classification.

In This proposed a framework combining Random Forest classifier and Empirical Mode Decomposition (EMD) method for multi-classification of respiratory diseases using adventitious respiratory sounds (ARSs). Their system achieved a classification accuracy of 88% and focused on 6 respiratory conditions: healthy, bronchiectasis, bronchiolitis, COPD, pneumonia, and URTI. The study emphasized the importance of segmentation in accurate classification, with the best performance achieved using a combination of early inspiratory and entire inspiratory phases.

[2] Author: B. M. Rocha, D. Filos, L. Mendes, I. Vogiatzis, E. Perantoni, E. Kaimakamis, P. Natsiavas, A. Oliveira, C. Jácome, A. Marques, R. P. Paiva, I. Chouvarda, P. Carvalho, N. Maglaveras

Paper Name : Respiratory sound classification for crackles, wheezes, and rhonchi in the clinical field using deep learning.

Presented a respiratory sound database developed for automated classification systems. The database includes 920 recordings from 126 subjects and contains annotations for various types of adventitious respiratory sounds, such as crackles and wheezes. This dataset, gathered from clinical and non-clinical environments, includes noisy recordings, making it suitable for developing algorithms that work under real-life conditions. The study aims to advance respiratory sound analysis by providing a publicly

available resource for algorithm development and testing.

[3] Paper Name : Respiratory sound classification for crackles, wheezes, and rhonchi in the clinical field using deep learning.

Author: Yoonjoo Kim, YunKyong Hyon, Sung Soo Jung, Sunju Lee, Geon Yoo, Chaeuk Chung & Taeyoung Ha

Developed a deep learning model using Convolutional Neural Networks (CNNs) to classify respiratory sounds (normal, crackles, wheezes, rhonchi). The model achieved an accuracy of 86.5% in detecting abnormal sounds, with an AUC of 0.93. It further classified abnormal sounds into crackles, wheezes, or rhonchi with an accuracy of 85.7%. The study also highlighted the varying diagnostic accuracy among medical professionals, demonstrating the potential for deep learning systems to complement clinician auscultation in diagnosing respiratory diseases.

[4] Paper Name: Performance evaluation of lung sounds classification using deep learning under variable parameters.

Author: Zhaoping Wang and Zhiqiang Sun

Investigated the impact of various parameters on deep learning model performance for lung sound classification. Using the ICBHI 2017 dataset, the authors analyzed the effect of frame length, overlap percentage, and feature types (spectrogram and Mel-frequency cepstrum coefficients) on classification accuracy. The study concluded that a higher overlap percentage (OP) improves performance, with the optimal configuration being a frame size of 128, 75% OP, and spectrogram features, under a fixed sampling frequency of 8 kHz.

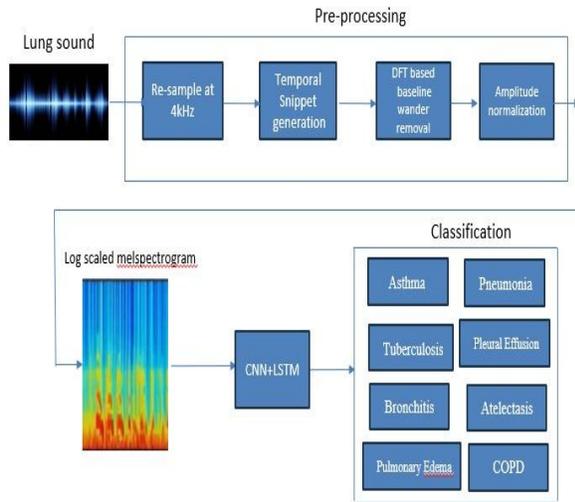
[5] Paper Name: Automated Detection of Pulmonary Diseases From Lung Sound Signals Using Fixed Boundary-Based Empirical Wavelet Transforms.

Author: Rajesh Kumar Tripathy and Ram Bilas Pachori , Shaswati Dash , Adyasha Rath, Ganapati Panda

Proposed an automated method for detecting pulmonary diseases (PDs) using lung sound signals and fixed-boundary-based empirical wavelet transforms. The model achieved high classification

accuracy for differentiating between normal lung sounds and various pulmonary diseases, such as asthma, pneumonia, and COPD. Using the Light Gradient Boosting Machine (LGBM) classifier, the study demonstrated improved detection rates, with an overall accuracy of 84.76% for the multi-class classification scheme involving normal, pneumonia, asthma, and COPD.

IV. SYSTEM ARCHITECTURE



V. CONCLUSION

In this study, a deep learning model leveraging convolutional neural networks (CNNs) and long short-term memory (LSTM) networks was employed for the classification of lung sounds. The model demonstrated an impressive overall average accuracy of 99.62% in categorizing lung sounds associated with various respiratory diseases. This research lays the groundwork for the integration of deep learning models in clinical environments, thereby aiding clinicians in their decision-making processes. Future research endeavors will aim to expand the dataset to encompass a broader demographic and a more diverse array of diseases, including COVID-19, which will enhance the reliability of the proposed model. While the current classification model exhibits high performance metrics, there remains potential for further enhancement through the refinement of preprocessing techniques and the training framework.

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