RESPIRATORY SOUND BASED DISEASE DETECTION SYSTEM USING MACHINE LEARNING

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Abstract

Based on sounds that people make, like their voice, dry cough, and breath, the models that are based on Machine Learning (ML) were used in the real world to identify a number of diseases. Using the CNN (Convolutional Neural Network), AI-based machines can solve numerous real-world issues. A modified Convolutional Neural Network (DCNN) that will outperform previous models has been proposed and implemented for automatic disease diagnosis based on human respiratory sounds like voice, dry cough, and breath. Human sounds fall into two main categories: speech sounds and non-speech sounds. The proposed methodology takes into account the non-speech human sounds of laughter, scream, sneeze, and snore. Coughing is a common symptom of many diseases. It is helpful to take into consideration both the type of cough and the sound it makes when diagnosing a disease. We demonstrated that AI algorithms can identify and diagnose COVID19, pertussis, pneumonia, pulmonary enema, asthma, and tuberculosis (TB) using the cough symptom. Additionally, we discovered the various approaches that yielded the most accurate diagnoses of respiratory conditions using cough samples. Consequently, we develop a machine learning architecture for the proposed system's disease classification based on human sounds..

Keywords: *Respiratory Sound, Voice Analytics, Respiratory Diseases, Cough Sound, Machine Learning, Spectrogram, Convolutional Neural Networks.*

I. INTRODUCTION

1.1 MACHINE LEARNING

A subfield of artificial intelligence (AI) called "machine learning" is based on the idea that machines should be allowed to learn and explore on their own and have access to data. Large data sets are the primary focus of this method. Machine learning enables a machine to automatically learn from data, improve performance based on experiences, and predict things without being explicitly programmed. Machine learning is always in high demand. Machine learning is required because it can carry out tasks

that are too difficult for a human to directly execute. Making use of machine learning can help us save both time and money. The significance of machine learning is clear from its applications. Machine learning is currently used in Facebook friend suggestion, face recognition for self-driving cars, and other applications. A number of well-known companies, including Netflix and Amazon, have developed machine learning models for analyzing user interest and making product recommendations based on it. Using a training data set, a machine learning algorithm is trained to create a model. Every time it receives new data, the ML algorithm uses the model to make a prediction. If the prediction's accuracy is satisfactory, the Machine Learning algorithm is utilized. If the accuracy is not sufficient, the Machine Learning algorithm is trained once more with a larger training dataset.

1.2 COUGH SOUND DETECTION AND DIAGNOSIS

A number of respiratory conditions commonly present with coughing as a symptom. It is helpful to take into consideration both the type of cough and the sound it makes when diagnosing a disease. Respiratory infections are a significant threat to human life and cause a significant economic downturn in nations with limited therapeutic resources. In this study, we examined the most recent proposed technologies used to control the effects of respiratory diseases. The analysis of data and the prediction of outcomes are made possible by artificial intelligence (AI), a promising technology that safeguards individuals' well-being.

2. LITERATURE SURVEY

2.1 COUGH SOUND DETECTION AND DIAGNOSIS USING ARTIFICIAL INTELLIGENCE

Coughing is a common symptom of a number of respiratory conditions. When diagnosing a disease, it is helpful to take into account both the kind of cough and its sound. In countries with limited therapeutic resources, respiratory infections pose a significant threat to human life and a significant economic downturn. We looked at the most recent proposed technologies that were used to control the effects of respiratory diseases in this study.[1]

The technology known as artificial intelligence, or AI, has the potential to improve people's well-being by assisting in the analysis of data and the prediction of outcomes. We demonstrated that AI algorithms can reliably use the cough symptom to identify and diagnose a variety of known diseases, including COVID19, pertussis, pneumonia, pulmonary edema, asthma, tuberculosis (TB), and other respiratory conditions. Additionally, we discovered the various methods that provided the most accurate results when utilizing cough samples to diagnose respiratory conditions. Researchers and practitioners alike will be able to improve their methods thanks to this study's presentation of the most recent difficulties, solutions, and opportunities in respiratory disease detection and diagnosis.[2]

2.2 CLINICALLY RELEVANT SOUND-BASED FEATURES IN COVID-19 IDENTIFICATION: ROBUSTNESS ASSESSMENT WITH A DATA-CENTRIC MACHINE LEARNING PIPELINE

PEDRO MATIAS et al. have proposed this system. In order to lessen the impact of seasonal infection waves, it is essential to carry out rapid diagnostics as long as the COVID-19 pandemic continues to affect most countries worldwide. [3]
The commercially available rapid antigen self-tests have demonstrated that they cannot withstand the most demanding conditions, resulting in decreased availability and increased costs. Therefore, the creation of a less expensive, more decentralized, and non-invasive technology that could provide individuals with feedback regarding the likelihood of COVID-19 infection would be the method by which these gaps would be filled. This paper investigates a sound-based analysis of vocal and respiratory audio data to accomplish this objective. This work presents a modular data-centric Machine Learning pipeline for COVID-19 identification from a voice audio sample and respiratory data.[4]

2.3 VOICES-PATHOLOGY ANALYSIS BASED ON AR-HMM

According to Akira Sasol* et al.'s proposal, a promising technology for pre-diagnosis of larynx diseases is voice-pathology detection from a subject's voice. In particular, one of the most important aspects of voice-pathology analysis is estimating the glottal source.[5]
For improved pathology voice spectral envelope and glottal source estimation, we propose a method for automatically generating the topology of the glottal source Hidden Markov Model (HMM) and estimating the Auto-Regressive (AR)-HMM parameter by combining the AR-HMM parameter estimation with the Minimum Description Length-based Successive State Splitting (MDL-SSS) algorithm. The AR-HMM employs a single Gaussian distribution for the output Probability Distribution Function (PDF) of each state in the glottal source HMM. In this paper, we propose a novel AR-HMM-based voice-pathology detection method with

automatic topology generation based on the output PDF variances normalized in relation to the maximum variance as clues. We demonstrate experimentally that other normalized variances are more evenly distributed than normal voice maximum variance. [6]

2.4 COUGH SOUND DETECTION AND DIAGNOSIS USING ARTIFICIAL INTELLIGENCE TECHNIQUES: CHALLENGES AND OPPORTUNITIES

KAWTHER S. ALQUDAIHI et al. came up with the idea for this system. Coughing is a common symptom of a number of respiratory conditions. It is helpful to take into consideration both the type of cough and the sound it makes when diagnosing a disease. Respiratory infections are a significant threat to human life and a significant economic downturn in nations with limited therapeutic resources. In this study, we examined the most recent proposed technologies used to control the effects of respiratory diseases. [7]

By facilitating data analysis and outcome prediction, the artificial intelligence (AI) technology has the potential to enhance people's well-being. We demonstrated that COVID19, pertussis, pneumonia, pulmonary enema, asthma, tuberculosis (TB), and other respiratory conditions could be reliably identified and diagnosed using the cough symptom by AI algorithms. Additionally, we discovered the various approaches that yielded the most accurate diagnoses of respiratory conditions using cough samples. This study presents the most recent challenges, solutions, and opportunities in respiratory disease detection and diagnosis, allowing practitioners and researchers alike to enhance their methods.[8]

2.5 COUGHER IDENTIFICATION AND VERIFICATION FROM CONTACT-FREE SMARTPHONE-BASED AUDIO RECORDINGS USING METRIC LEARNING

Stefan Jokic et al. have proposed this system. A biomarker for disease diagnosis and progression may be cough, a symptom of numerous prevalent respiratory conditions. Since the beginning of the 2000s, automatic cough detection algorithms and cough monitoring systems have been the focus of research. A scalable and affordable method for monitoring cough with contact-free sensors could be implemented on consumer-centric devices like smartphones. As a result, the efficacy of such algorithms has received more attention in recent years.[9]

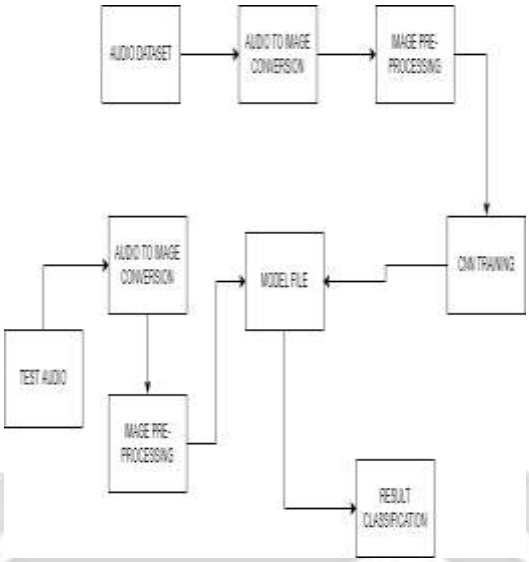
However, the algorithms that are currently in use are unable to differentiate between the coughs of various individuals, so they are unable to function reliably in environments where potentially multiple individuals need to be monitored. We propose a weakly supervised metric learning strategy for cougher recognition based on smartphone audio recordings of coughs. Our method makes use of triplet network architecture and makes use of convolutional neural networks (CNNs). [10]

3. EXSISTING SYSTEM

Neurodegenerative disease known as Parkinson's disease (PD) affects nerve cells in the human brain. Vocal disorders have been identified as a harbinger for PD detection in recent PD studies because patients with Parkinson's disease experience vocal changes and impairments in the early stages. There is only one disease that can be found. low accuracy and low rate of classification

4. PROPOSED SYSTEM

The audio dataset is transformed into an image using the spectrogram method, and each image is improved before being sent for convolution neural network training. After the training phase, the final result is classified after the test audio is converted into an image and evaluated with the model file using CNN. Utilizing the human voice and the sound of the body is a clinical method for evaluating a person's health. Utilizing reasonable methods to extract specific features from voice signals in order to generate compelling speech is the fundamental step in speech analysis. This system uses the convolution neural network method to classify the various diseases based on how they sound to humans.



4.1 Block Diagram

4.1 DATASET

You don't have to flatten the input images to 1D with the CNNs because they can work with image data in 2D. This helps keep the images' "spatial" properties. Using CNNs rather than NNs has this as a major advantage. As a result, we have a variety of categories in our audio database.

4.2 PRE-PROCESSING

During the pre-processing steps, resizing, patching, and augmentation were the methods used. In the first step of pre-processing, the size of the input images is normalized. The majority of the radiographs were disproportionately large rectangles of varying heights (median matrix size of 1,800). Consequently, we resized all images using zero-padding to a standard square of 224 x 224 pixels while maintaining their aspect ratios. The input data are crucial to determining the effectiveness of deep learning; Consequently, prior to the second processing step, a patch—a portion of each image that has been cropped—was used to pre-process the input images. A patch was extracted using a bounding box to ensure that it contained sufficient maxillary sinus segmentation for analysis. Last but not least, mirror images rotated 30, 10, 10, and 30 degrees from left to right were used for data augmentation only for the training dataset.

4.3 IMAGE LABELING AND DATASET DISTRIBUTIONS

Each subject was independently categorized as either "normal" or "sinusitis" by two radiologists. The initial images and the resized images that were used for the actual learning data were evaluated for labelling on a picture archiving communication system (PACS). The test was evaluated using two types of datasets: the internal dataset and the temporal dataset.

4.4 ACTIVATION FUCTION

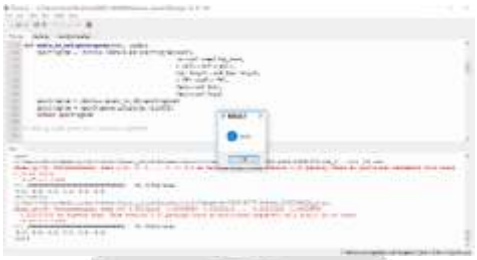
An important decision function in pattern recognition is the activation function. The learning process can be accelerated by selecting the appropriate activation function. Various activation functions, such as sigmoid, tanh, mahout, SWISH, ReLU, and variants of ReLU, such as leaky ReLU, ELU, and PReLU, are used in the literature to inculcate non-linear combination of features.

4.5 OPERATIONS USING NUMPY

NumPy can be used by developers to complete the following tasks: logical and mathematical operations on arrays, routines for manipulating shapes, Fourier transforms, and operations related to linear algebra, and so on. NumPy incorporates the generation of random numbers and linear algebra. The most significant definition of an object in NumPy is the N-dimensional array type known as ndarray. It discusses a collection of comparable items. Access to the items in the collection can be gained through the use of a zero-based index. Each item in an ndarray uses the same size memory block.

5. RESULTS

Finally, after training with the model file, the testing process starts when the testing audio is fed into the model file, converted into an image with a spectrogram, and the final result is classified.



5.1 Result

6. CONCLUSION

Without a doctor-to-patient recommendation system that notifies the doctor of the patient's condition and ensures that the patient always has access to a doctor, the problem persists. The problematic statement refers to developing a disease prediction model based on voice recognition. Because there is a significant issue with the lack of a normalized text for sample collection, our project aims to make it language independent. This system could one day detect a person's illness while they are using a mobile device and immediately notify them.

7. REFERENCES

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