IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, October 2026
Impact Factor: 8.2

Cough Sounds for the Recognition of Multiclass Respiratory Diseases With Artificial Intelligence: A Review

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Abstract: *Respiratory diseases such as asthma, pneumonia, chronic obstructive pulmonary disease (COPD), tuberculosis, and COVID-19 require timely recognition and appropriate medical evaluation. Cough is a common symptom of many respiratory conditions and contains acoustic characteristics that can provide useful information for disease recognition. This report presents a review of Artificial Intelligence (AI)-based approaches for recognizing multiclass respiratory diseases using cough sounds. The review examines cough datasets, audio preprocessing, feature extraction, and Machine Learning (ML) and Deep Learning (DL) techniques used for cough analysis. Common methods include noise reduction, cough segmentation, Mel-frequency cepstral coefficients (MFCCs), Mel-spectrograms, Support Vector Machine (SVM), Random Forest, Convolutional Neural Network (CNN), and Long Short-Term Memory (LSTM). The review also discusses applications, advantages, limitations, and evaluation methods. Findings indicate that AI-based cough analysis has potential as a non-invasive and accessible supportive screening technology. However, challenges such as limited datasets, background noise, class imbalance, recording-device variations, similar acoustic patterns, model generalization, privacy, and clinical validation remain. Future research should focus on larger and diverse datasets, explainable AI, smartphone-based systems, multimodal analysis, and clinical validation for reliable respiratory disease recognition.*

Keywords: Artificial Intelligence, Cough Sound Analysis, Respiratory Diseases, Machine Learning, Deep Learning, Multiclass Classification, MFCC, CNN, LSTM

I. INTRODUCTION

Respiratory diseases such as asthma, pneumonia, chronic obstructive pulmonary disease (COPD), tuberculosis, and COVID-19 are major health concerns worldwide. Early recognition of these diseases is important for timely medical evaluation, appropriate treatment, and effective patient management. Cough is one of the most common symptoms of respiratory diseases and contains acoustic characteristics that may provide useful information about the underlying condition. With the advancement of Artificial Intelligence (AI), cough sounds can be analyzed automatically to identify patterns associated with different respiratory conditions

Traditional diagnosis of respiratory diseases generally depends on clinical examination, medical history, laboratory tests, imaging, and specialized medical equipment. Although these methods are important for accurate diagnosis, they may require healthcare facilities, trained professionals, and significant time and resources. AI-based cough sound analysis provides a non-invasive and accessible approach that can support respiratory disease screening. Machine Learning (ML) and Deep Learning (DL) techniques can process recorded cough sounds, extract relevant acoustic features, and classify different respiratory conditions.

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DOI: 10.48175/IJARSCT-38832

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Various techniques such as Mel-frequency cepstral coefficients (MFCC), Mel-spectrograms, Support Vector Machine (SVM), Random Forest, Convolutional Neural Networks (CNN), and Long Short-Term Memory (LSTM) have been explored for cough sound analysis. These methods can identify patterns in cough recordings and support automated disease classification. Multiclass classification is particularly important because similar cough symptoms may occur in different respiratory diseases. AI-based analysis may also support remote monitoring and smartphone-based healthcare applications. The main purpose of this research is to develop a simple and secure approach for sharing healthcare data.

The proposed approach focuses on managing user consent, controlling access, and removing access when it is no longer required. It also keeps a record of sharing activities so that data access can be checked when necessary. The proposed framework aims to provide better control over patient information and support secure data sharing between authorized healthcare users.

However, existing systems face several challenges, including background noise, limited and imbalanced datasets, variations in recording devices, differences among patients, similar acoustic patterns between diseases, privacy concerns, and limited generalization to unseen populations. The quality of preprocessing, feature extraction, and training data can significantly influence model performance. Furthermore, many existing approaches require larger and more diverse datasets and clinical validation before they can be reliably applied in real-world healthcare environments

II. PROBLEM STATEMENT

Respiratory diseases such as asthma, pneumonia, bronchitis, and COVID-19 can affect a person's breathing and overall health. Identifying these diseases at an early stage is important for providing proper treatment. However, diagnosing respiratory diseases can sometimes be difficult because different diseases may produce similar symptoms, including coughing. Traditional diagnosis methods may also require medical tests and clinical examination..

Artificial Intelligence (AI) offers a promising approach to analyzing cough sounds and identifying patterns associated with different respiratory diseases. By using machine learning and deep learning techniques, recorded cough sounds can be processed and classified into multiple disease categories.

III. RESEARCH GAP

Existing Approach	Limitation	Proposed Improvement
Traditional respiratory disease diagnosis	May require clinical examinations and additional tests	Ai-based cough Sound analysis
Single-disease cough detection	Focuses on identifying only one disease	Multiclass disease classification
Manual cough sound analysis	Depends on expert knowledge and can take time	Automated cough sound analysis
Machine learning methods	Performance may depend on selected features	Improved feature extraction technique
Limited cough sound datasets	May not represent different age groups and populations	Use of diverse and larger datasets
Noisy cough recordings	Background noise can affect classification accuracy	Noise reduction and sound preprocessing
Different AI models	Performance varies across datasets	Comparison of machine learning and deep

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	and diseases	learning models
Existing cough detection systems	May have limited applicability in remote healthcare	Integration with mobile health and telemedicine system

IV. OBJECTIVES

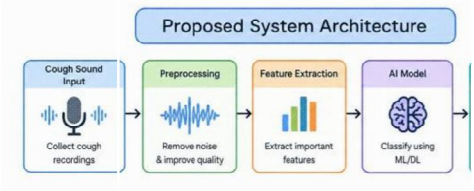
- To study how Artificial Intelligence can be used to analyze cough sounds and identify different respiratory diseases.To reduce unnecessary data sharing by checking whether the requested information is really needed for the required healthcare task.
- To explore machine learning and deep learning techniques for classifying cough sounds into multiple respiratory disease categories.
- To understand how cough sound preprocessing and feature extraction can improve the accuracy of disease classification.
- To review existing AI models and compare their performance in recognizing different respiratory diseases using cough recordings.

V. PROPOSED SYSTEM

The proposed system focuses on using Artificial Intelligence (AI) to identify different respiratory diseases by analyzing cough sounds. In this system, cough recordings are collected and processed to remove background noise and improve sound quality. Important features are then extracted from the recordings to help the AI model identify patterns related to different respiratory diseases. Machine learning and deep learning techniques are used to analyze these features and classify cough sounds into multiple disease categories. The performance of different AI models is reviewed to understand their accuracy and limitations. The system also considers factors such as recording quality, dataset size, and differences in cough sounds among individuals, as these factors can affect the results. This approach may help support early screening and remote respiratory health assessment. It could also be useful in mobile health applications and telemedicine services. The main aim of this review is to understand how AI-based cough sound analysis can help recognize multiple respiratory diseases and identify areas where further research and improvement are needed.

VI. PROPOSED SYSTEM ARCHITECTURE

The proposed system architecture explains how Artificial Intelligence is used to recognize multiple respiratory diseases by analyzing cough sounds. The process begins with collecting cough sound recordings from suitable datasets. The recorded sounds are then preprocessed to reduce background noise and improve sound quality. After preprocessing, important features are extracted from the cough recordings and given to machine learning or deep learning models for analysis. The AI models identify patterns in the sounds and classify them into different respiratory disease categories. Finally, the results are evaluated using performance measures such as accuracy, precision, recall, and F1-score. This architecture helps explain the working process of AI-based cough sound recognition and its potential role in early respiratory disease screening.



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VII. EXISTING SYSTEM

In recent years, Artificial Intelligence (AI) has been increasingly used to analyze cough sounds and help identify respiratory diseases. Traditional methods of respiratory disease diagnosis often depend on clinical examinations, laboratory tests, and other medical assessments. AI-based systems use machine learning and deep learning techniques to study cough sound patterns and recognize differences associated with various respiratory conditions. Some existing approaches focus on detecting a single disease, while others attempt to classify multiple respiratory diseases. However, the performance of these systems can be affected by background noise, poor recording quality, limited datasets, and similarities in cough sounds across different diseases. In addition, some models may not perform equally well on recordings collected from different people or environments. Therefore, there is a need to review existing AI techniques, compare their performance, and understand their limitations in multiclass respiratory disease recognition. This review focuses on how cough sound analysis using AI can support early screening and improve the accessibility of respiratory healthcare.

VIII. ADDITIONAL FEATURES OF THE SYSTEM

The proposed system focuses on using Artificial Intelligence (AI) to recognize multiple respiratory diseases by analyzing cough sounds. Some additional features can help improve the quality of sound analysis and the performance of disease classification.

Cough Sound Quality Checking: The system checks the quality of recorded cough sounds before analysis. If the recording contains too much background noise or is unclear, it can be processed to improve sound quality.

Sound Preprocessing: The system applies preprocessing techniques to reduce unwanted noise and prepare cough recordings for further analysis. This helps the AI model work with clearer sound data.

Feature Extraction: Important characteristics of cough sounds are extracted to identify patterns that may be associated with different respiratory diseases. These features help the AI model analyze the recordings more effectively.

Multiclass Disease Classification: The system uses machine learning or deep learning techniques to classify cough sounds into different respiratory disease categories, depending on the diseases included in the dataset.

Disease Classification Accuracy = Correctly Classified Cough Recordings / Total Cough Recordings Tested × 100

For example, if the AI model correctly classifies 85 out of 100 cough recordings, the classification accuracy will be 85%. This helps evaluate how effectively the AI model recognizes different respiratory disease categories. However, accuracy alone may not show the complete performance of the model, so precision, recall, and F1-score should also be considered.

IX. NEW FEATURES FOR BETTER DATA SHARING

The proposed system uses Artificial Intelligence (AI) to analyze cough sounds and recognize different respiratory diseases. It includes several features that help prepare sound recordings, identify useful patterns, classify diseases, and evaluate the results.

The main features are explained below.

Cough Sound Collection:

The process begins with collecting cough sound recordings from available datasets or suitable recording sources. These recordings may come from people with different respiratory conditions. The quality and variety of the recordings are important because they can affect how well the AI model recognizes different diseases.

Cough Sound Preprocessing:

Before analyzing the recordings, the system processes the sound data to reduce background noise and improve sound quality. It can also standardize the recordings to make them suitable for further analysis. This step helps prepare the cough sounds for the AI model.

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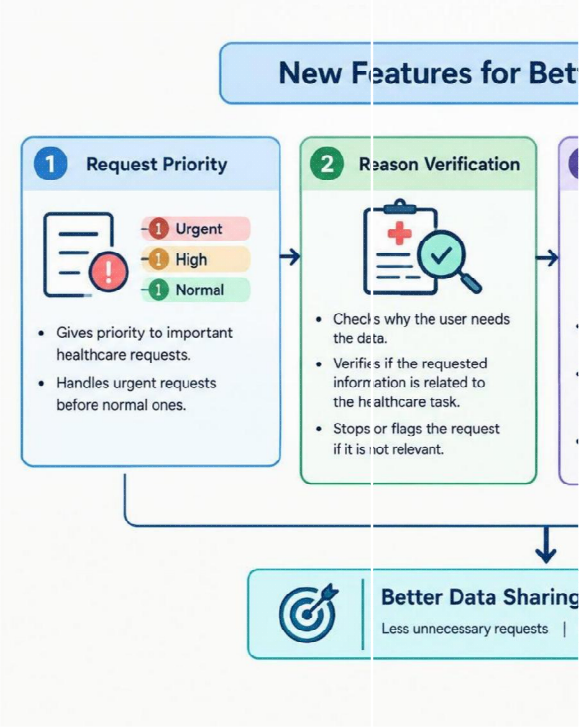


Fig. 1. Proposed Data Sharing Improvement Process

Feature Extraction:

After preprocessing, important characteristics of the cough sounds are extracted. These features may include sound frequency, intensity, duration, and Mel-frequency cepstral coefficients (MFCCs). Such features help the AI model identify patterns that may be associated with different respiratory diseases.

AI-Based Disease Classification:

The extracted features are analyzed using machine learning or deep learning techniques. The model learns patterns from the available data and uses them to classify cough recordings into multiple respiratory disease categories, depending on the dataset and training process.

Classification Result and Feedback:

After analyzing a cough recording, the model produces a predicted disease category. The result can be compared with the actual labels in the dataset to check whether the prediction is correct. This feedback helps researchers understand classification errors and identify areas where the model needs improvement.

Model Evaluation and Improvement:

The system evaluates the AI model using performance measures such as accuracy, precision, recall, and F1-score. The results can be used to compare different models and understand their strengths and limitations. This process also helps identify challenges related to noisy recordings, limited datasets, and similarities between cough sounds from different diseases.

IX. REVIEW METHODOLOGY

This study follows a review-based approach to understand how Artificial Intelligence (AI) is used to recognize multiple respiratory diseases through cough sound analysis. The main focus is on existing methods, including machine learning and deep learning techniques, and how effectively they identify different respiratory conditions. First, research papers

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related to AI-based cough sound analysis, respiratory disease classification, sound processing, and healthcare applications were identified from relevant research databases. Greater attention was given to studies that discuss multiclass disease recognition and recent developments in AI techniques.

After collecting the research papers, their titles and abstracts were reviewed to identify studies relevant to the topic. Papers that focused on unrelated applications or did not involve cough sound analysis for respiratory disease recognition were excluded from further consideration.

The selected studies were then examined based on important factors, including the datasets used, preprocessing methods, feature extraction techniques, AI models, classification results, and evaluation measures. The limitations of each approach were also considered, particularly issues related to background noise, limited datasets, recording quality, and similarities between cough sounds from different diseases.

X. PRIVACY AND SECURITY

Cough sound recordings may contain sensitive information about a person's health, so they must be handled carefully. In AI-based respiratory disease recognition, recordings and related health information should be collected and used responsibly. Personal details should be protected, and access to the data should be limited to authorized researchers or healthcare professionals. The collected recordings should be stored securely, and suitable privacy measures should be followed during data processing and analysis. If patient recordings are used for research, informed consent and applicable ethical guidelines should also be considered. These measures help protect patient privacy and support the responsible use of Artificial Intelligence for recognizing multiple respiratory diseases through cough sound analysis..

XI. AI-BASED COUGH SOUND RECOGNITION ALGORITHM

Input: Input: Cough Sound Recordings and Trained AI Model Output: Predicted Respiratory Disease Category and Classification Result

The system collects cough sound recordings from available datasets or suitable recording sources.

The recorded cough sounds are preprocessed to reduce background noise and improve sound quality.

Important features are extracted from the processed recordings to identify useful sound patterns.

The extracted features are provided to a trained machine learning or deep learning model for analysis.

The AI model examines the cough sound patterns and compares them with patterns learned during training.

The model classifies the recording into one of the respiratory disease categories supported by the dataset.

The predicted disease category is generated as the model's output.

The prediction is compared with the actual disease label, when available, to check the classification result

The model's performance is evaluated using measures such as accuracy, precision, recall, and F1-score.

Classification errors and limitations are analyzed to understand where the model may need improvement.

The evaluation results help researchers compare AI techniques and identify opportunities to improve multiclass respiratory disease recognition.

EXPECTED RESULTS

The proposed review is expected to provide a better understanding of how Artificial Intelligence can be used to recognize multiple respiratory diseases through cough sound analysis. Machine learning and deep learning techniques may help identify patterns in cough recordings and classify them into different respiratory disease categories.

The use of sound preprocessing and feature extraction is expected to improve the quality of cough recordings and help AI models analyze useful sound patterns. Comparing different AI models using measures such as accuracy, precision, recall, and F1-score will help researchers understand their performance and identify the most suitable approaches for multiclass disease recognition.

The review is also expected to highlight common challenges, including background noise, limited datasets, differences in recording quality, and similarities between cough sounds associated with different diseases. Understanding these limitations can help identify areas for future research and model improvement.

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COMPARISON WITH EXISTING SYSTEM

Point	Existing System	Our Approach
Cough Sound Analysis	May focus on detecting a single respiratory disease..	Reviews AI techniques for recognizing multiple respiratory diseases.
Disease Classification	Some models classify only a limited number of disease categories.	Focuses on multiclass respiratory disease classification.
Sound Preprocessing	Recording quality and background noise may affect the results.	Examines preprocessing techniques to improve sound quality.
Feature Extraction	Different methods use different sound features.	Reviews features that help identify patterns in cough recordings.
AI Techniques	May use a specific machine learning or deep learning model.	Compares different AI approaches for cough sound recognition.
Model Evaluation	Evaluation methods and reported performance may vary.	Compares models using accuracy, precision, recall, and F1-score.
Dataset Quality	Limited or unbalanced datasets may affect classification performance.	Highlights the importance of diverse and reliable datasets.
Research Challenges	Limitations may not be discussed consistently across studies.	Identifies challenges and research gaps in multiclass disease recognition.

XII. ADVANTAGES

Early Disease Screening:

AI-based cough sound analysis may help identify patterns associated with respiratory diseases and support preliminary screening.

Multiclass Disease Recognition:

Machine learning and deep learning models can analyze cough recordings to classify multiple respiratory disease categories, depending on the training data

Faster Sound Analysis:

Automated processing can analyze cough recordings more efficiently than manual examination of every recording.

Improved Classification:

Sound preprocessing and feature extraction can help AI models identify useful patterns and may improve classification performance.

Performance Evaluation:

Measures such as accuracy, precision, recall, and F1-score help researchers compare AI models and understand their strengths and limitations.

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XIII. LIMITATIONS

The use of Artificial Intelligence for recognizing multiple respiratory diseases through cough sounds has some limitations that need to be considered. The accuracy of the AI model may vary depending on the quality and quantity of the cough recordings used for training. Background noise, unclear recordings, and differences in coughing patterns can affect the classification results. The model may also find it difficult to distinguish between diseases that produce similar cough sounds.

Another limitation is the availability of reliable and diverse datasets. If the training data does not represent different age groups, populations, and recording environments, the model may not perform equally well for everyone. Different machine learning and deep learning techniques may also produce different results depending on the dataset and selected features.

In addition, cough sounds alone may not provide enough information to confirm a respiratory disease. Other symptoms, medical history, and clinical tests may be required for an accurate diagnosis. Protecting patient privacy and obtaining proper consent when using medical recordings are also important considerations.

Therefore, further research and testing with diverse datasets are needed to improve the reliability and practical usefulness of AIbased cough sound recognition. These systems should be considered tools for preliminary screening and research rather than replacements for professional medical diagnosis.

FUTURE SCOPE

In the future, AI-based cough sound recognition can be improved by using larger and more diverse datasets containing recordings from different age groups, populations, and recording environments. This can help researchers develop models that recognize multiple respiratory diseases more reliably.

The system can also be improved by exploring advanced machine learning and deep learning techniques. Better sound preprocessing and feature extraction methods may help reduce the effect of background noise and identify useful patterns in cough recordings. Comparing different AI models can help researchers understand which techniques are more suitable for multiclass respiratory disease recognition.

Another possible improvement is to develop mobile applications that allow users to record cough sounds and receive preliminary screening results. Integration with telemedicine platforms could make cough sound analysis more accessible, particularly for people in remote areas. However, such applications would require proper clinical validation before being used in healthcare practice.

XIV. CONCLUSION

Respiratory diseases are a major health concern, and identifying them at an early stage is important for providing appropriate treatment. Artificial Intelligence (AI) offers a promising approach to analyzing cough sounds and recognizing patterns associated with different respiratory diseases. This review focuses on existing machine learning and deep learning techniques used for multiclass respiratory disease recognition through cough sound analysis.

The review discusses important stages such as sound preprocessing, feature extraction, disease classification, and model evaluation. It also highlights challenges that can affect the performance of AI models, including background noise, limited datasets, variations in cough recordings, and similarities between different respiratory diseases. Comparing existing approaches can help researchers understand their strengths, limitations, and potential areas for improvement.

Overall, AI-based cough sound analysis may support preliminary respiratory disease screening and remote healthcare applications. However, cough sounds alone cannot always provide a reliable diagnosis, and clinical evaluation may still be necessary. Further research using larger and more diverse datasets, improved AI techniques, and proper clinical validation is required to improve the reliability of these systems. In conclusion, AI-based cough sound recognition has the potential to contribute to more accessible respiratory healthcare when used responsibly alongside professional medical assessment.

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ACKNOWLEDGMENT

I would like to express my sincere gratitude to my project guide for providing valuable guidance, suggestions, and support throughout this research work. The advice and feedback received helped me understand the topic of AI-based cough sound recognition and improve my understanding of multiclass respiratory disease classification.

I am also thankful to my department and college for providing the necessary facilities and a supportive environment to complete this research paper. I would like to thank my classmates and friends for their helpful discussions, encouragement, and support during the preparation of this work.

I am especially grateful to my family for their continuous motivation and support throughout the research and writing process. Finally, I would like to acknowledge the researchers and authors whose published studies on Artificial Intelligence, machine learning, deep learning, and cough sound analysis helped me understand existing approaches, identify research gaps, and prepare this review paper on "Using Cough Sounds for the Recognition of Multiclass Respiratory Diseases With Artificial Intelligence: A Review."

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