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Review article

A review on diagnosis of chronic obstructive pulmonary disease

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ABSTRACT

Chronic obstructive pulmonary disease is a significant state that leads to progressive airflow obstruction and subsequent irreversible damage to the airways. It is a major factor causing death and has a very high mortality rate worldwide. In recent years, the mortality rate has increased due to Chronic obstructive pulmonary disease (COPD) and it is estimated to increase in the coming years. This paper reviews the emerging techniques using these technologies that can be used to detect and monitor the severity of chronic obstructive pulmonary disease. The Internet of Things can help to detect and monitor the condition of a patient suffering from chronic obstructive pulmonary disease using sensors which are used to measure a particular parameter like concentration of different gases present in the exhaled breath and ensure that his condition doesn't get worse. Using an Artificial Intelligence and Machine Learning based approach, a system can be developed where the data is collected from sensors, followed by pre-processing and feature extraction for further estimation using a model to identify a person suffering from this disease. The conventional methods used by medical practitioners for the detection of this disease are expensive, time consuming as a lot of tests are to be performed and can cause exposure to radiation. Therefore, research has been carried out in recent years to find other ways to detect this disease. It has been found that with the help of advancing technologies such as Internet of Things, Artificial Intelligence, Machine Learning and Signal processing techniques, it is possible to develop an easy, fast, non-invasive and cost-effective system that would help to diagnose and detect this disease and provide accurate results.

Keywords: Chronic obstructive pulmonary disease, Lungs, Health, Internet of Things, Machine learning, Artificial Intelligence, Signal processing.

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INTRODUCTION

COPD, or Chronic Obstructive Pulmonary Disease, is a classification of lung disease that results in the obstruction of the airways, leading to symptoms such as chronic cough, wheezing, shortness of breath, and chest tightness. The primary causes of COPD include smoking, which accounts for 90% of cases, air pollution at 20-30%, and an inherited deficiency of a protein known as alpha-1-antitrypsin in 5% of cases. This disease leads to a reduction in the flow of air in and out of the lungs. Chronic bronchitis and emphysema are the most prevalent manifestations of COPD. It is crucial to diagnose and treat COPD in its early stages since individuals with this condition are at greater risk of developing heart, lung, and other related health problems [1, 2].

Spirometry is an effective method for diagnosing COPD. During a spirometry test, a person blows into a mouth piece that is connected to a small automated machine by tubing. The amount and speed of the exhaled air are measured, which provides precise information about long function. The FEV1/FVC ratio, which is the proportion of the volume of air excelled in 1 second to the capacity of air excelled forcefully in one breath, is the key measurement used to diagnose COPD using spirometry. In addition to traditional methods, new technologies have also proven to be useful for detecting COPD [3, 4, 5].There has been a growing interest in using emerging technologies for the detection and monitoring of COPD. One promising area of research is the use of artificial intelligence (AI) and machine learning (ML) algorithms for analyzing lung function tests, medical images, and patient data to improve the accuracy of COPD diagnosis. Several studies have shown that AI/ML-based algorithms can effectively classify COPD subtypes, predict disease progression, and identify patients who are at risk of exacerbations. Additionally, advances in the Internet of Things (IoT) and wearable devices have enabled real-time monitoring of physiological parameters, such as heart rate, oxygen saturation, and breathing rate, which can help

detect early signs of COPD exacerbation. Furthermore, the analysis of exhaled breath, including the concentration of certain gases, such as hydrogen peroxide, carbon monoxide, nitric oxide, and hydrogen sulfide, has shown promise as a non-invasive and easy-to-use method for diagnosing COPD. Despite these advancements, there are still challenges to be overcome, such as the need for large-scale data sets and standardized protocols for data collection and analysis [9, 10, 11].

Measurement of Exhaled breath to detect Chronic Obstructive Pulmonary Disease with the use of Internet of Things

The Internet of Things plays one of the major roles in developing applications in various fields including medical applications, collecting data on different parameters and using this data for drawing conclusions. For medical detection, the major technology that can be used is the breath sensor technology. Exhaled human breath consists of various gases which result from numerous digestive processes taking place in our body. Through these gases, detection of different respiratory diseases, metabolic diseases and digestive diseases can be done [4].

Table 1: Review on work carried out for detection of COPD using Internet of Things

Authors	Hardware Components	Description
A. A. Shahzad *et al.* [4]	Four MQ sensors, DHT22, Arduino UNO and a load resistor	This project aimed to determine the efficacy of hydrogen sulphide, acetone, ammonia and alcohol present in exhaled breath in the detection of COPD. The concentration of these gases were measured and collected using different sensors for a group of 108 individuals. After collection of data, statistical analysis was performed and the results displayed the ranges of these four gases for people suffering from COPD and for healthy individuals.
Durán Acevedo, Cristhian Manuel *et al.* [6]	MQ-137, MQ-3, MQ-135, SQ-3, TGS 822, TGS 813 and TGS 800	The paper aimed to measure the concentration of various gases present in the exhaled breath and prepare a database using these values in order to classify people as smokers, people suffering from COPD and healthy people. A device known as Electronic Nose was developed consisting of various sensors to acquire data from the exhaled breath. The database was then evaluated using different algorithms to classify people accordingly which can be used to implement devices in the near future for the society in the health sector.
Cooper, Christopher B *et al.* [7]	PIC microcontroller, accelerometer, heartbeat, temperature, SpO_2, respiration, acetone, force, humidity, gas, smoke and sound sensors	A system was developed to reduce the mortality rate because of COPD by keeping a regular track of various health parameters such as respiration rate, chest compression, SpO_2, cough and body temperature regularly. Hence, the system could help detect diseases, estimate its severity, track progression regularly and predict adverse events in advance. An application was developed which displayed the real time data to the patients.

Analysis of health parameters for detection of Chronic Obstructive Pulmonary Disease using Artificial Intelligence (AI)/Machine Learning (ML)

In recent times, a major role has been played by deep learning and machine learning to issue solutions for medical problems. Since, there is scarcity of trained human resources, this kind of technology subordinates come up with a better solution for diseases. With the help of analyzing different features such as the respiration rate, oxygen saturation, audio and image of lung through CT scan, the severity of disease can be detected with a deep learning model [8].

Table 2: Review on work carried out for detection of COPD using AI/ML

Author	Algorithm	Principle	Description
Christos C. Bellos, *et.al.* [9]	Support vector machine (SVM), a Random forest (RF), and rule-based approach.	A system was made to analyze and assess patient's health. This was achieved using a hybrid classifier consisting of SVM, RF, and a rule-based system.	This chronious system consisted of a wearable device having various sensors to detect respiration, ECG, oxygen saturation, etc.These parameters act as features for ML algorithm and output message describes severity of COPD.
Beibei Jiang, *et.al.* [10]	Convolution Neural Network (CNN)	CT images of bronchial wall and lung parenchyma were used to train CNN models. The affected images showed narrow airway oath.	In the proposed methodology, patients with asthma, allergy, rhinitis or other serious illness were excluded. 816,000 bronchial wall images and 163,200 lung parenchyma images were used to train CNN. The output showed levels indicating seriousness of disease.
Arpan Srivastava, *et.al.* [11]	ANN and back propagation based algorithm	ANN and a back propagation classifier to predict respiratory audio.	This paper highlighted the drawbacks of traditional approaches to detect COPD. Based on heartbeat sounds, detection of disease has been displayed.

Detection of Chronic Obstructive Pulmonary Disease using Signal Processing Techniques

Signal processing provides an important method preferred in the planning and assessing visualization tool and in evaluation and prediction of diagnostic performance. In the medical field, image processing, signal processing is used at each step of the action. For telemedicine, helpful information provided by Digital Respiratory sounds and smart diagnosis in a passive manner through the application of signal processing [12].

Table 3: Review on work carried out for detection of COPD using Signal Processing

Authors	Algorithm	Methodology
F. Zubaydi *et al.* [5]	Quadratic Regression technique	A setup consisting of a fan, anemometer and smartphone was used to record flow rate value. These recorded files were analyzed in the frequency domain in the MATLAB environment accompanied by regression evaluation on the gathered information. Based on MATLAB analysis, development of an android app was done in Java known as 'MobSpiro'.
H. U. R. Siddiqui *et al.* [3]	KNN (K-Nearest Neighbor) model	Initially, classification of healthy and COPD subjects based on respiratory rate was done invasively using Impulse Radio Ultra-Wideband (IR-UWB) radar. The raw signal was then processed using a signal processing approach to detect respiratory signals and stored in a database of healthy and affected subjects. Finally, the data was split into a test set and training set followed by model model testing and training of respective sets. To evaluate performance based on precision and accuracy training models were tested on unseen data.

CONCLUSION

In recent years, significant research has been carried out on detection and monitoring of COPD with the help of arising technologies such as Artificial Intelligence, Internet of Things, Machine Learning and Signal processing. It showed that the analysis of exhaled breath can be an accurate, fast, easy to use and non-invasive method to diagnose COPD. The concentration of hydrogen peroxide, carbon monoxide, nitric oxide and hydrogen sulfide present in the exhaled breath can play a vital role in detection of lung blockage. However, AI/ML technologies studied in this paper had certain exclusions made while developing the arrangement for diagnosis of COPD. Patients observed with medical indications, like urticaria, allergy, asthma, rhinitis, reversible airflow restriction, along with conclusive Pulmonary Functional Tests (PFT) bronchial inflation tests were not considered. Therefore, there is still an immense scope for developing a system for detection of COPD which would work equally well in all scenarios [3].

REFERENCES

1. G Apoorva, S Hariharan, K Kapil Ganesh et al, 2020. A Comprehensive Care System to Remote Monitor the Vital Signs in Patients with COPD. International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), vol. 9, Issue 4, Pages-1737-1741.
2. M F Islam Chowdhury, S M Lutful Kabir, S M Rashedul Hasan, 2019. An Automated Therapy Chair for Patients having Chronic Obstructive Pulmonary Disease (COPD). IEEE International Conference on Biomedical Engineering, Computer and Information Technology for Health (BECITHCON), Pages-59-62, Doi: 10.1109/BECITHCON48839.2019.9063168.
3. Siddiqui HUR, Saleem, AA, Bashir I, et al, 2022. Respiration-Based COPD Detection Using UWB Radar Incorporation with Machine Learning. Electronics, vol. 11, no. 18, p. 2875.
4. Shahzad AA, Mushtaq S, Waris A, et al, 2022. A Low-Cost Device for Measurement of Exhaled Breath for the Detection of Obstructive Lung Disease. Biosensors, vol. 12, no. 6, Pages-409, Doi: 10.3390/bios12060409.
5. F Zubaydi, A Sagahyroon, F Aloul, et al, 2017. MobSpiro: Mobile based spirometry for detecting COPD. IEEE 7th Annual Computing and Communication Workshop and Conference (CCWC), Pages- 1-4, Doi: 10.1109/CCWC.2017.7868345.
6. Cristhian Manuel Durán Acevedo, Carlos A Cuastumal Vasquez, Jeniffer Katerine Carrillo Gómez, et al, 2021. Electronic nose dataset for COPD detection from smokers and healthy people through exhaled breath analysis. Data in brief. Institution: Amparo san José, Pages-1-6, Doi: 10.1016/j.dib.2021.106767.
7. Cooper CB, Sirichana W, Arnold MT, et al, 2020. Remote Patient Monitoring for the Detection of COPD Exacerbations. International journal of chronic obstructive pulmonary disease, Pages- 2005-2013, Doi: 10.2147/COPD.S256907.
8. C Salito, E Luoni, A Aliverti, et al, 2015. Alterations of diaphragm and rib cage morphometry in severe COPD patients by CT analysis, Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual International Conference, Pages- 6390-6393, Doi: 10.1109/EMBC.2015.7319855.
9. Christos Bellos, A Papadopoulos, R Rosso, et al, 2014. Identification of COPD Patients' Health Status Using an Intelligent System in the CHRONIOUS Wearable Platform. IEEE Journal of Biomedical and Health Informatics, vol. 18, no. 3, Pages- 731-738, Doi: 10.1109/JBHI.2013.2293172.
10. Zhang L, Jiang B, Wisselink HJ, et al, 2022. COPD identification and grading based on deep learning of lung parenchyma and bronchial wall in chest CT images. British journal of radiology Vol. 95, No. 1133.
11. Srivastava A, Jain S, Miranda R, et al, 2021. Deep learning based respiratory sound analysis for detection of chronic obstructive pulmonary disease. PeerJ Computer Science 7:e369, Doi: 10.7717/peerj-cs.369.
12. B Perriot, J Argod, J L Pepin, et al, 2013. A network of collaborative sensors for the monitoring of COPD patients in their daily life. IEEE 15th International Conference on e-Health Networking, Applications and Services, Pages- 299-302, Doi: 10.1109/HealthCom.2013.6720689.

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