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(57) Abstract :
The present invention provides a system for detection of moisture content in sanitary pad. Urinary incontinence is a problem that diminishes the quality of life not only of the person with the problem but also of a caregiver. In the present invention, When the baby/patient wears the pad, a sensor will be attached to it (which will be totally safe and will not hurt the baby/patient). Firstly, when the pad is filled, the sensor will detect the moisture/wetness). If the value of moisture is reached above the threshold that we set, the sensor will send a signal to the processor. After receiving the signal from the sensor, the processor will complete the connection and will start the buzzer. When the buzzer is activated the nurse/caretaker will get the message to change the pad.

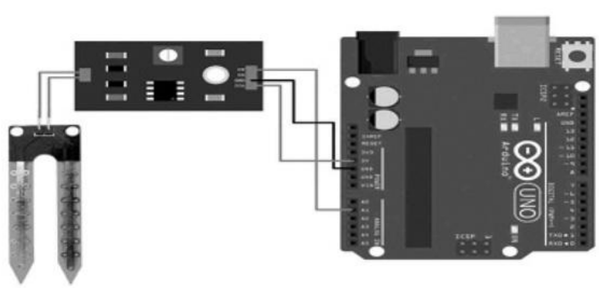

Figure 1

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# Effective UV-C (Ultraviolet) Air Flow Disinfection System for Burn Patients outside Intensive Care Unit

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***Abstract*— In the face of an epidemic, it has become apparent how crucial premises disinfection is to our lives. Microorganisms in the air are as hazardous as coming into contact with an affected person. Patients with serious burns or infectious diseases require medical treatment. Infection of healthy tissues surrounding the wound needs surveillance and infection control, and it is followed by increased concentrated warmth, pain, or discomfort. That's why it necessitates the deployment of a disinfection system capable of purifying the air containing germs and viruses and delivering high air quality to the patient's room. The work presents a system, specifically designed for patients who require special healthcare services along with pure and healthy disinfected air, in order to survive their disease and be protected from microbes and viruses. A comparative study was done to evaluate the effectiveness of the system using nutrient agar medium and 2 hours of sterilized air to eliminate all microbes. There was no bacterial growth on the dish.**

***Keywords*— *Ultraviolet, UVC, air disinfection system, intensive care unit, burn patients, effective disinfection system.***

## I. Introduction

Multi-resistant airborne infectious agent strains have developed around the world over the past decade. Moreover, sterilization and purification to reduce microbial hazards to persons gathering within premises have been valued in light of the confirmed increase in bioterrorism threats. The best economic strategy is to sanitize the places in which most germs thrive, like windows, their locks, the flooring, objects, furniture, and so on, on a regular basis. UV-C radiation, which is routinely utilized within air ducts to disinfect the air, can assist in avoiding such diseases and viruses. This is the safest way to use UV-C radiation because direct UV-C exposure to human skin or eyes may cause injuries, long term exposure can lead to damage to skin or eyes, and installation of UV-C within an air duct is less likely to cause exposure to skin or eyes. The other control module was created to allow UV light control by the high-level management system. Ultraviolet radiation inactivates viral, bacterial, and various pathogens, preventing them from replicating and potentially causing illness [1-4].

For more than 40 years, Ultraviolet light has been used frequently to disinfect surfaces in general, including liquids, air, labs, medicinal products, and housing equipment. Ultraviolet germ reduction mostly utilizes ultraviolet (UV-C) light, even though the term "ultraviolet" refers to any light rays with a wavelength around 100 to 400 nanometers. The UV-C wavelength range is 100–280 nm, and the ultraviolet germ reduction wavelength range must be 250–270 nm, with the highest efficiency occurring at 265 nm [5]. The ozone layer absorbs the UV-C rays that the sun emits, while the UV-A and UV-B spectral bands that reach the Earth's surface are less energetic. Ultraviolet germ reduction, which is known to inactivate airborne and surface-based bacteria, has been utilized in healthcare facilities for years to inhibit their development and multiplication when inhaled or aspirated. Because nucleic acids such as DNA and RNA absorb UV-C radiation extensively, it is an efficient method of killing infections because it induces large changes in their nucleic acids, preventing them from carrying out critical metabolic activities [6,7].

Airborne microbes and allergens pose a far greater risk to people's health than other kinds of microbes in terms of total incidence and total healthcare costs, but there are significantly fewer air disinfection mechanisms in use than liquid and other sterilization mechanisms, and Airborne UV disinfection has significantly less relevant information than water applications.



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During the COVID-19 epidemic, research into air disinfection devices increased at an exceptional rate. The effectiveness of ultraviolet germ reduction for air disinfection applications has been the subject of significant interpretation and, in some cases, outright rejection, despite numerous demonstrations of its effectiveness. Despite decades of research, there are still several questions that haven't been addressed, common misconceptions about airborne UV sterilization, and much fewer applications than should be available. The sections that precede make a concerted effort to compile all the material on UV germ reduction and illustrate that the testing of innovative ideas and strong design concepts may provide results that are just as dependable and understandable as those of previous disinfecting methods [4,8,9].

## II. Literature Review

An ambulance may be swiftly and successfully disinfected using a real-time air disinfection system based on pulsed xenon UV light using high-intensity pulse germicidal UV. In this study, a real-time air disinfection system for ambulances based on pulsed xenon ultraviolet light was created. In this system, high-intensity, broad-spectrum ultraviolet light was used to deactivate and kill bacteria and viruses. This light source is known as a pulsed xenon ultraviolet (PX-UV). According to the findings, within 30 minutes of application, PX-UV treatment may reduce numerous viruses and ecological diseases in emergency vehicles by more than 90% [4, 10].

The self-driving robot Ultrabot is designed to stop the emergence of COVID-19 and other dangerous germs and viruses. By shielding people from UV-C radiation and offering the finest autonomous disinfection performance, ultrabot technology can safeguard people from harm. The outcomes of disinfection performance after 10 minutes revealed a 94% decrease in the total number of bacteria at a distance of 2.8 meters from the robot. One person may operate the enclosed cleaning gadget at a time using their phone, disinfecting items like bags. It has several safety features to stop it from operating when a human or animal is nearby, and will completely disinfect everything in 5 minutes or less. This device would be easy to operate; it would plug into a regular power socket and be controlled wirelessly using a phone app. Cleaning frequently utilized items is the major goal of this apparatus. All germs and viruses that have been placed on various items are only rendered inactive by this [11, 12].

Engineered control devices like inside room air cleaners like ACs and room air ultraviolet germ reduction systems can help lower the levels of viruses, germs, and pathogens in the enclosed environment. This study evaluated the effectiveness of a variety of types of ACs for eliminating and/or inactivating atmospheric germs and viruses. Four of the air cleaners have one or more UV lamps included in the flow channels. Additionally, research was done to determine how well ACs worked in conjunction with upper-room ultraviolet germ reduction systems. The air cleaners were tested individually and in combination with the upper room air ultraviolet germ reduction system in a test room with airflow enabling from zero to six air alterations every 60 minutes. Sometimes, with air filtration and upper-room ultraviolet germ reduction systems, active microbes and microscopic organisms were volatilized further into space in exactly the same quantities and physiological states. By calculating the proportion of atmospheric microbes and pathogens trapped on the outer edge of the air filtration system that were rendered inactive by Ultraviolet light, the efficacy of an Ultraviolet light built inside one of the ACs was also assessed. Depending on the AC, average air cleaning rates when using air cleaners along with the upper room ultraviolet germ reduction systems are considerable. The ACs behaved uniformly when exposed to the bacteria during testing. The internal ultraviolet lamps in both ACs haven't sterilised the air further, but they inactivated 75% of the spores and 97% of the bacteria that were collected in the air filter media after 60 minutes [13, 14,15].

This study produced a safeguarded system that uses UV and ozone to disinfect surfaces and the air. In order to give the air particles exposed to UV radiation a larger flow cross-sectional area and a longer course, it has 28 low contrast UV lights of 11 watts arranged in a specifically constructed three-dimensional grid. Air ions are not released, and the ozone concentrations are within the permitted 8-hour average limit [16]. Air can be disinfected in large spaces quickly thanks to the many UV lights and strong blowers. The surface of the floor beneath the equipment is also disinfected at the same time. In disinfection efficiency tests, Escherichia coli and Staphylococcus aureus were decreased by 99.9999 percent after only one run through the system. The device's casing shields it from direct UV radiation. [17].

This indicates that a UV air disinfection system is unable to clean a large room adequately, and its efficiency is rather poor. UV devices release UV radiation, which is exceedingly harmful to the human body, especially for those with skin and body problems such as burning. That is why an air disinfection system that employs UV-C rays and has high air cleaning efficacy is required. This gadget will be considerably more efficient and safe for both patients and people if it is placed outside of the room and transfers clean air into it. Recently, certain UV air disinfection devices were released [15,17].

Since coronaviruses are extremely sensitive to UV, UV-C air disinfection solutions will be capable of eliminating the infection. A one-of-a-kind test rig consisting primarily of a breathing tube and a system was built to investigate the antiviral and antibacterial effectiveness of UV air disinfection systems. In the evaluation of such a UV-C air flow disinfection system using nasal spray and a sample time of 30 min, a mean bactericidal decrease of 99.98% was obtained. A mean viral load drop of 93.4 % was recorded after 10 minutes of antibacterial treatment of the coronavirus surrogate. These transportable UV-C air disinfection systems may be employed in hospitals [18,19].

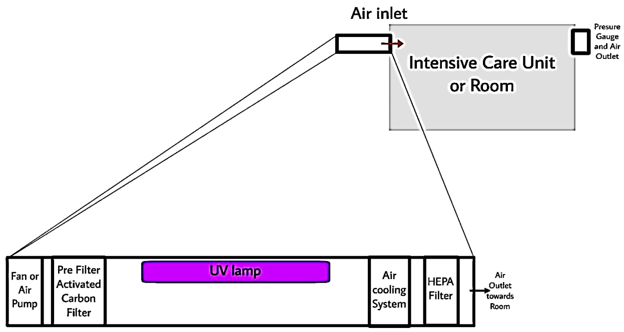



Fig. 1. Proposed UV-C air flow disinfection System

## III. PROPOSED SYSTEM

The proposed technique includes an outdoor room system. UV lamps with a power rating of 11-200 watts are the system's primary component. As indicated in the illustration, this system consists mostly of a hollow tube for air. An air pump is located at the system's entrance to transport outside air inside. A prefilter removes dust, smoke, and other pollutants from the air, while an activated charcoal filter removes VOCs (Volatile Organic Compounds). This eliminates all particles from the air and allows only pure air to pass through the tube. The size of the system depends on the size and airflow of the room. It also depends on the size of the components used inside the system. UV lamps, the system's main component, are installed in the tube. These UV lights have a wavelength of 200–280 nanometers, which deactivates any microorganisms in the air that are 0.2nm long. This disinfected air must be cold in order to be supplied, so a cooling copper coil mechanism is used to cool the air, and finally, a high-efficiency particulate absorption filter (HePA) is used as a last filter before the air is supplied to the patient's room. To eliminate any undesired particles from the cleaned air, a HePA filter is utilized. The system is designed particularly to push sterile air under high pressure inside the single room for burn patients and not for whole ICU. High pressure inside the patient room restricts the entry of impure air from outside while opening the door. So it reduces the chances of post burn infection in patients.

## IV. WORKING PRINCIPLE

Ultraviolet (UV-C) air flow disinfectant system primarily focuses on removing bacteria and viruses that harm burned patients bodies and skin. All the inventions and research are not focused on burned patients, they are only focused on the removal of viruses and bacteria from air and surfaces. This research and invention are made for Intensive Care Units (ICU) in hospitals. It is an outdoor system in which all the components are installed outside the room. It only transfers filtered and disinfected air in the patient's room, so UV rays cannot affect patients inside the room. That is why this system is much more efficient than other systems. Also in this system, there is a large air-to-UV rays contact time. This is because it passes normal air through a long duct or pipe like structure having UV lights in it, so that air will stay longer in contact with UV rays and get disinfected. This will increase the efficacy of the system and the total air filtration rate.

## V. HARDWARE DESCRIPTION

This system operates by utilizing components such as filters, UV-C lamps, and inlet pipes (in spiral shape). The inlet is connected to the input side Fan or Air pump, which transports air into the tubes. A pre-filter eliminates dust and air pollutants from the air, and an activated carbon filter removes gases and odors from the air. This air is then transmitted to the tube, which includes numerous UV-C lamps. When these lights come into contact with UV rays, they kill all microbes, bacteria, and other pathogens. A cooling system with copper cooling coils is used to chill this cleaned air.

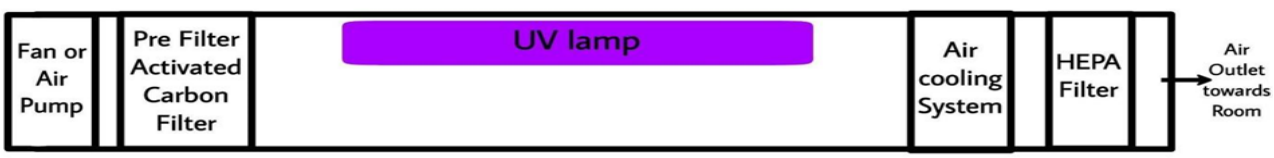



Fig.2 UV-C air flow disinfection System

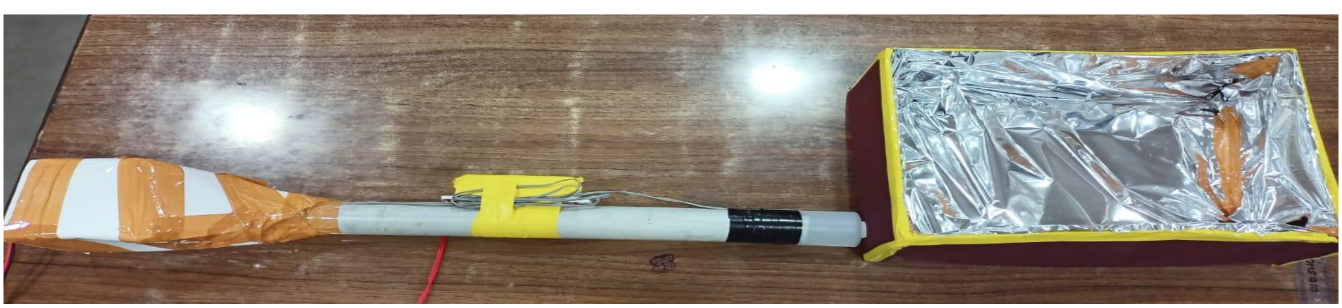


Fig.3 Implemented hardware model of UV-C air flow Disinfection system

Finally, a HePA filter eliminates any remaining undesired particles from the cleansed air. This air is delivered to the patient's room via a clean and sterilize intake. To keep the pressure of the room constant, it has a pressure gauge installed at the room's outlet, which continuously measures the pressure and keeps the pressure of the room constant and sterilized. The hardware model shown in Fig. 3 is a miniature form of the proposed system, implemented for testing purposes.

Fig. 1. Results of the nutrient agar medium testing method.

**1.** exposed in normal air outside the disinfection system for 1 hour; presence of bacterial growth.
**2.** exposed in sterilized air inside the disinfection system for 1 hour; presence of very less bacterial growth.
**3.** exposed in normal air outside the disinfection system for 2 hours; presence of bacterial growth.
**4.** exposed in sterilized air inside the disinfection system for 2 hours; no significant bacterial growth.

## VI. TESTING METHODOLOGY

Various microbiological procedures can be used to evaluate the efficiency of the UV-C Air Flow Disinfection system. One of the most effective methods for antifungal and antibacterial testing is nutrient agar medium. Agar media is renowned as it can help the growth of a wide variety of bacteria and microbes and offers a diverse range of ingredients necessary for bacterial development. The core principle behind testing is to place a Petri dish with nutrient agar medium in a designated room as well as in the normal environment for a certain period of time, then incubate it in an incubator at standard settings and look for microbial growth. This allows us to conduct a comparative analysis and determine the UV Disinfection system's performance [17,20].

To prepare agar media, nutrient agar powder is dissolved in the appropriate amount of distilled water, then heated and stirred until it becomes a transparent slurry. Then there's the translucent combination. Autoclaved at 121 degrees Celsius for 15 to 30 minutes, then cooled and put onto sterile petri dishes until the agar hardened. These dishes are placed in a specially prepared chamber as well as in an open atmosphere for various periods of time, such as one hour and two hours. This will allow the microorganisms to settle on the petri dish.

## VII. RESULT AND CONCLUSION

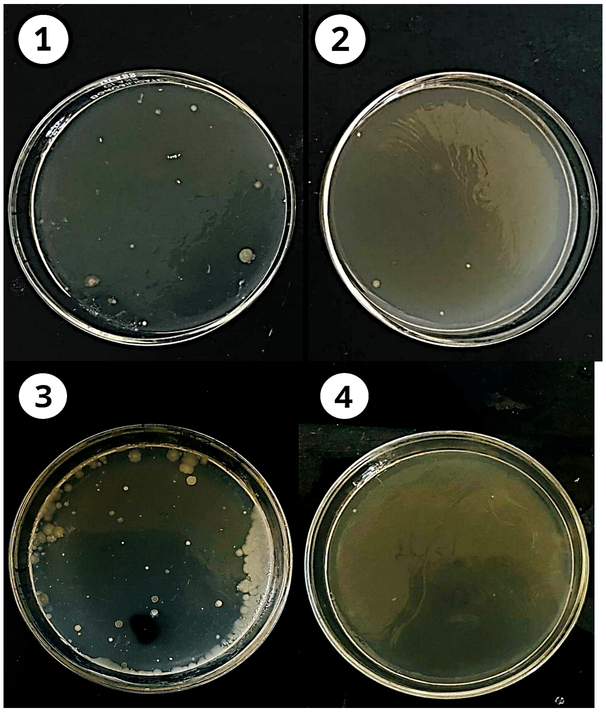
The purpose was to develop UV-C air disinfection technology that could be quickly and efficiently manufactured and implemented in hospital ICUs and emergency care units. As a result, to enhance the system by implementing efficient and low-cost solutions that might lessen the effect of microbes on patients while also improving overall safety, Figure 3 shows the designed UV-C air flow disinfection device during testing. The box shown in the figure is used as a chamber or room that is disinfected by the system.

The comparative testing was performed on this disinfection system to assess overall effectiveness for various bacteria and germs in the air. The basic principle of exposing nutrient media petri dishes in our designed room environment for a certain amount of time, as well as other petri dishes in an open air environment for the same amount of time, and then allowing it to incubate in an incubator at standard conditions and then checking microbial growth. If no microbial development occurs, then infer that the air is sterilized. Testing done for two time periods, 1 hour and 2 hours, and placed petri dishes in different conditions. Table 1 displays the findings.

The dishes that have been exposed to air inside and outside of the disinfection system are shown in Fig. 4. Dishes that are exposed to regular air have bacterial growth on them these are airborne microorganisms that are common. A dish in Fig. 4.1 with 1 hour of exposure to normal air has around 47 colonies, whereas the dish in Fig. 4.2 with 1 hour of exposure to disinfected air has about 7 colonies. A dish in Fig. 4.3 with 2 hours of exposure to normal air has around 124 colonies, whereas the dish in Fig. 4.4 with 2 hours of exposure to disinfected air has significantly no bacterial growth on it. This demonstrates how effectively the system performs in terms of timing.

TABLE I. EXPERIMENT RESULTS FOR DIFFERENT AIR

| Petri Dish Number | Type of air exposure | Incubation Temperature (±2 °C) | No of colonies |
|---|---|---|---|
| 1 | 1 Hour exposed inside of disinfection system | 37 | 7 |
| 2 | 1 Hour exposed outside of disinfection system | 37 | 47 |
| 3 | 2 Hours exposed inside of disinfection system | 37 | 3 |
| 4 | 2 Hours exposed outside of disinfection system | 37 | 124 |




In contrast to currently performed related work, such as UVC ICU disinfection devices. In this study, disinfection is carried out by a disinfection system with human interventions. Comparing this with a UV-C air flow disinfection system, it does not need human intervention, and as it is an external system, no one is going to come into direct contact with the system. After using the ICU disinfection device, air samples were analyzed. In this, they inferred that the UVC ICU disinfection device is effective in cleaning the environment but not very efficient. In a UV-C air flow disinfection system, efficiency is significant as it sterilizes the entire room air, and after time passes, it disinfects all the air in the room. A Common thing of all existing disinfection devices is that it cannot be operated when a patient is present in the room. The UV-C air flow disinfection system works with or without human presence in the room. UV rays are harmful to human health, especially for people who have burned skin [17].

Because of safety concerns, it was not possible to conduct testing on viruses like Methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas aeruginosa, etc. with the actual proposed setup in the ICU; therefore, our findings cannot be used to conclude micro bacterial efficiency against microorganisms and viruses. There were considerable differences in the density of colonies in the dishes exposed to room air compared to the dishes exposed to the disinfection system. This demonstrates the UV-C air flow disinfection system's efficiency against the numerous bacteria and viruses found in the air. However, it cannot be inferred that this system is accurate and effective for all viruses. The effectiveness of the design and the system after installation and testing can be evaluated.

Designed a UV-C air flow disinfection system, manufactured it, and tested it for several applications in hospitals, especially in intensive care units. All hospital intensive care units (ICUs) require clean air to eliminate health concerns. To get the desired results, it necessitates a significant amount of Ultraviolet light power in addition to a significant number of lamps inside the system. If the duration of air contact can be increased to UV-C by expanding the tube size, the system will operate more smoothly throughout health facilities. This system is designed to decrease the overall rate of infection in the air, limiting the possibility of infections and diseases.

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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].

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