ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
IJARMATE Vol. 7, Issue 4, April 2021

SMART BREATH ANALYSER: ASTHMA AND COPD PREDICTION SYSTEM USING IOT

Amal Jagadeesh, Athul Jaison, Femin Simon, Harikrishnan V

Department of Biomedical Engineering

Dhanalakshmi Srinivasan Enginering College, Perambalur

***ABSTRACT*-Smart Breath Analyzers were developed as sensing terminals of a telemedicine architecture devoted to remote monitoring of patients suffering from Chronic Obstructive Pulmonary Disease (COPD) and asthma and also home-assisted by non-invasive mechanical ventilation via respiratory face mask. The devices based on different sensors (CO_2, Smoke Sensor and Volatile Organic Compounds (VOCs), relative humidity and temperature (R.H. & T) and Heart rate, respiration sensors) monitor the breath air exhaled into the expiratory line of the bi-tube patient breathing circuit.**

The sensor raw signals are transmitted to National Health Service units .Doctor by TCP/IP communication through a cloud remote platform using IoT module.The work is a proof-of-concept of a sensors-based IoT system with the perspective to predict continuously the effectiveness of monitoring and or any state of exacerbation of the disease requiring healthcare using machine learning techniques.By a gas-mixing bench towards gas, smoke in environment and acetone concentrations in exhaled breath collected in a sampling bag were carried out to test the realized prototypes.The paper reports on the longitudinal use of Health Tags among high- risk COPD patients in the indoor & outdoor environment using machine learning algorithms.

I. INTRODUCTION

E-Health systems, together with smart sensor devices that allow real-time monitoring of relevant clinical parameters at home, are considered a promising approach to the prevention and treatment of respiratory diseases.Although the respiratory rate is a vital sign of special importance in the context of the monitoring and follow-up of respiratory diseases, especially to avoid dangerous situations in critically-ill patients.

It is still considered as the most neglected vital sign. However, it could indicate a variety of pathological conditions in respiratory diseases, like COPD or sleep apnea, but also in cardiovascular and metabolic disorders.

The respiratory rate has been used to anticipate dangerous events such as cardiac arrest, to classify patients in intensive care units and to predict complications or exacerbations in patients with cardiopulmonary diseases. It is an essential parameter for the monitoring of postoperative patients and for the detection of apnea or hypopnea events in pathologies related to sleep disorders.

Wearable Health Devices (WHDs) are increasingly helping people to better monitor their health status both at an activity/fitness level for self-health tracking and at a medical level providing more data to clinicians with a potential for earlier diagnostic and guidance of treatment. The technology revolution in the miniaturization of electronic devices is enabling to design more reliable and adaptable wearables, contributing for a world-wide change in the health monitoring approach.

In this paper we review important aspects in the WHDs area, listing the state-of-the-art of wearable vital signs sensing technologies plus their system architectures and specifications. Spirometry and capnography are the common techniques used for the monitoring of respiratory rate but they represent an uncomfortable experience for the subject, disturbing the natural breathing; hence, they are not suitable for long-term application.However, many of the proposed developments have the drawback of special sensor placement location, many times uncomfortable, or require thorough signal processing that severely impacts battery lifetime. In addition, they do not have an accuracy comparable to that obtained by the obstructive methods , even in experiments at rest.

From the point of view of communications, the rapid adoption of the Internet of Things (IoT) paradigm in different technological ecosystems is also having a significant impact on health information services, particularly on e-Health systems. In this sense, IoT is a concept that refers to the interconnection through the Internet of computing devices embedded in everyday objects. These objects are physical elements with communication capability and programmable logic, including mainly sensor devices and actuators.

In the field of e-Health, the Internet of Medical Things (IoMT) paradigm is managing the technological transition from the traditional centralized systems, where the patient is considered as a passive element, towards patient-centered ecosystems and highly mobile environments. The ubiquitous nature of IoT enables the distribution of data between all communication entities, regardless of the underlying network topology, geographic location, type of

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com
International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 7, Issue 4, April 2021

Real-time communications support, Quality of Service (QoS) policies and the publisher/subscriber-based communication pattern are some advantages of the IoT paradigm, which represents an added value in e-Health systems to overcome some technological barriers that have limited the deployment of these types of systems.

The IoT facilitates the communication and cooperation between systems and the parametrization and filtering of data handled. This allows the establishment of thresholds on the different types of data considered, thus also simplifying the management of alarms.Health management and monitoring platforms integrated with the IoT technologies paradigm can further increase the intelligence, flexibility, scalability and interoperability of these systems.For continuous respiratory monitoring, numerous sensorization technologies have been proposed.

Chronic Obstructive Pulmonary Disease (COPD) affects 12–16 million people in the United States and is the third leading cause of death. The prevalence and mortality of COPD is expected to increase in the coming decades. COPD is characterized by symptoms of wheeze, shortness of breath and cough.

In addition, intermittent exacerbations of disease often change the trajectory of disease course, leading to worse health related quality of life, hastened lung function decline, reduced functional capacity and increased risk of death.

The World Health Organization (WHO) estimates that ambient air pollution is responsible for 3.7 million premature death worldwide in 2012 and 14% of these deaths were due to COPD or acute lower respiratory infections. Integrated exposure-response modeling suggests that the population attributable mortality risk due to ambient air pollution for COPD varies and was estimated to range from < 1 to 21% depending on country.

In particular, particulate matter (PM) which is a complex mixture of solid and liquid particles made up of a number.

Components [including acids, organic chemicals, metals and soil or dust particles]; nitrogen dioxide (NO_2), which is a gaseous product of high-temperature combustion [including emissions from automobiles, power plants and off-road equipment}; and ozone (O_3) which is a strong oxidizing agent with a variety of effects including lung inflammation, alveolar epithelial damage and changes in chemical composition of lung lavage fluid have been linked to COPD.

In addition, there has been increased attention to the effects of heat exposure with the anticipated increases in temperature projected in the context of climate change. Extremes of temperature may affect COPD outcomes and may even modify the effects of pollutant exposure. Therefore, understanding the effects of air pollution and temperature on COPD is a crucial step to the development of preventative strategies and patient care.

II. MATERIALS REQUIRED

A. *Hardware Required*

PRECISE RECTIFIER

TEMPERATURE SENSOR

ACCELEROMETER SENSOR

HEART BEAT SENSOR

RESPIRATION SENSOR

GAS SENSOR

SOUND SENSOR

FORCE SENSOR

ACETONE SENSOR

SMOKE SENSOR

ARDUINO UNO

IOT MODULE

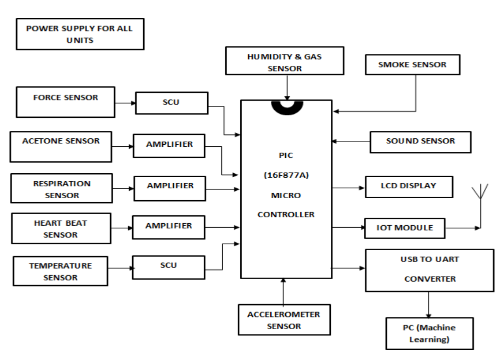
LCD DISPLAY

USB TO UART CONVERTER

B. *Software Required*

- MPLAB IDE – PIC programming software.
- CAYENNE APP & Server – IoT Monitoring & Control.

III. BLOCK DIAGRAM



- *Description*

The given block diagram is used to detect the pulmonary diseases like asthma and COPD. It contains a power supply system which act as a source of electric power. Here we are using 12V step down transformer for converting high voltage into low voltage.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 7, Issue 4, April 2021

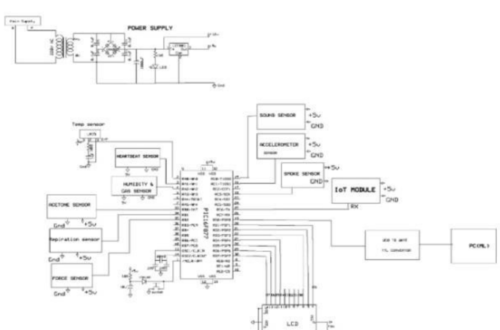
Then we are using bridge rectifier to convert AC to DC. Then voltage regulator is used to regulate 5V DC voltage. Then we are using numerous numbers of sensors in order to measure the different body conditions. Temperature sensor is used to measure the body temperature of the asthma patient. The accelerometer sensors is used to measuring the movement of asthma patient. Heart beat sensor is used for measuring the heart beat of asthma patient.

The basic reflectance PPG probe to extract the pulse signal from the fingertip.The respiration sensor is used for measuring the respiration of asthma patient. The respiration is used to monitor the abnormal and thoracic breathing and it also gives you an indication of the relative depth of breathing..The gas sensors are used to measure the condition of gases in the atmosphere. Sound sensor is used to detect the cough rate of the patient. It detect the sound waves through intensity and converting it to electrical signals. The humidity sensor is used to measure the humidity in the atmosphere.Force sensor is used for detecting the force present during breathing.

The acetone sensor is used for detecting the acetone gas present on stomach of the asthma patient and it is used to identify the lung is infected. The smoke sensor is used to detect the smoke present in the atmosphere and the photoelectric type alarms aim a light source.

The IoT is used for monitoring the asthma patient health information and using an IoT we can monitor and control the physical device with the help of internet it is used to connect the physical device to internet. The LCD display is used to display the required parameter in the entire system. The device contains a predicting system by using USB to UART converter and it gets connected to PC and finally it produces the output.

IV. CIRCUIT DIAGRAM



The given circuit diagram is used to detect the pulmonary diseases like asthma and COPD. It contains a power supply system which act as a source of electric power. Here we are using 12V step down transformer for converting high voltage into low voltage. Then we are using bridge rectifier to convert AC to DC. Then voltage regulator is used to regulate 5V DC voltage.

Then we are using numerous numbers of sensors in order to measure the different body conditions. Temperature sensor is used to measure the body temperature of the asthma patient. The accelerometer sensors is used to measuring the movement of asthma patient. Heart beat sensor is used for measuring the heart beat of asthma patient.

The basic reflectance PPG probe to extract the pulse signal from the fingertip.The respiration sensor is used for measuring the respiration of asthma patient. The respiration is used to monitor the abnormal and thoracic breathing and it also gives you an indication of the relative depth of breathing..The gas sensors are used to measure the condition of gases in the atmosphere.

Sound sensor is used to detect the cough rate of the patient. It detect the sound waves through intensity and converting it to electrical signals. The humidity sensor is used to measure the humidity in the atmosphere.Force sensor is used for detecting the force present during breathing. The acetone sensor is used for detecting the acetone gas present on stomach of the asthma patient and it is used to identify the lung is infected. The LCD display is used to display the required parameter in the entire system. The device contains a predicting system by using USB to UART converter and it gets connected to PC and finally it produces the output.

- KNN ALGORITHM

The KNN calculation utilizes classification of neighboring pixel as the predictive estimation of the new test. On the basis of distance traveled nearer neighbors are calculated. The KNN strategy calculation is basic, works dependent on the most short distance from the sample used in training to decide the KNN. Subsequent to gathering KNN, at that point most of KNNs were taken to be anticipated from the test. The information for the KNN calculation comprises of some multi-variate qualities.

Using the algorithm, the machine is trained to make specific decisions. It works this way: the machine is exposed to an environment where it trains itself continually using trial and error. This machine learns from past experience and tries to capture the best possible knowledge to make accurate business decisions. Example of Reinforcement Learning: Markov Decision Process.

V. IOT

- IoT is used for monitoring the asthma patient health informations.
- NodeMCU is an open source IoT platform.
- It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

- The term "Node MCU" by default refers to the firmware rather than the dev kits.
- The firmware uses the Lua scripting language.
- It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266.

Using IoT we can monitorit.

VI. LIQUID CRYSTAL DISPLAY

LCD display is used to display the required parameter in the entire system.

- Liquid crystal displays (LCDs) are used in similar applications where LEDs are used.
- These applications are display of numeric and alphanumeric characters in dot matrix and segmental displays.
- The liquid crystal material may be one of the several components, which exhibit optical properties of a crystal though they remain in liquid form.

VII. RESULTS AND ANALYSIS

Based on the classification result of COPD severity level using the algorithm of K-Nearest Neighbour, obtained accuracy is 92.30%. This study focuses on the factors that characterize the classifying of asthma, COPD and healthy control with machine learning algorithms for early prediction and diagnosis of pulmonary diseases.

Compared to existing literature about diagnosing asthma and COPD diseases, the main contributions of this paper can be summarized as follows:

(1) Comprehensive comparisons based on the most successful and well-known machine learning algorithms including grid search have been provided.

(2) Real and current data sets have been considered for both asthma and COPD diseases.

(3) The most important determinants affecting aforementioned diseases have been determined and ranked based on both machine learning algorithms and statistical significance tests, separately.

The k-nearest neighbors (KNN) is a simple and efficient algorithm which can be used both classification and regression tasks. It's amember of instance-based learning algorithm family.

In other words, the algorithm makes predictions about new units from training units by storing and using the information of them. The idea behind KNN in classification is to determine the k closest training units to an exact unit over the feature (i.e. variable) space and assign the most common class of these units to the final class estimation. The number of neighbors (k) is user-defined tuning parameter which is dramatically effective on the performance. Generally, this parameter is determined via cross validation approaches.

The value of k is critical because of that it serves a balance between over-fitting and underfitting. While low k value causes overdependency to local few units, higher value than necessary may cause underfitting and poor representations of locally similarity.

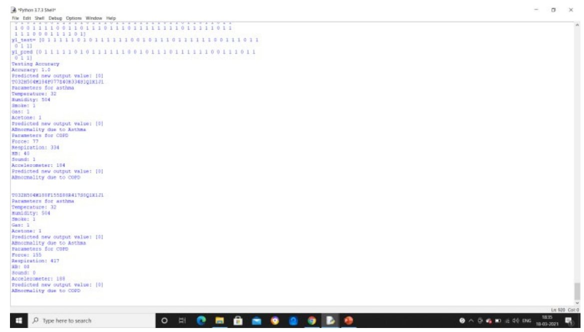


Fig: Result Screenshot

VIII. CONCLUSION

Several ailments compromise human wellbeing by influencing life span and its prosperity from in many ways. Among them, Lung Diseases as Chronic Obstructive Pulmonary Disease (COPD), lung cancer, pneumonia, and asthma are considered as genuine wellbeing difficulties and one noteworthy reason for death in both developed and developing nations. Specialists affirm that the prior an illness is analyzed and classified, the higher is the chances of patient cure.

In this situation, Artificial Intelligence Algorithm and Expert System have been effectively used to take care of various issues in different areas including medical field, which have benefits like shortening of the diagnosis and classification period, time gain and expanded proficiency.

Thus, Artificial Neural Networks appear to have an effective utilization in COPD classification. This permits a framework that would assist the doctor with determining COPD level all the more quickly with high performance. In this paper, we utilize the K-Nearest Neighbor (KNN) strategy to arrange COPD severity level. These methodologies are assessed utilizing a test dataset from real time sensor values.

The exploratory outcomes demonstrated the effectiveness of these strategies.In this paper, a comprehensive machine learning study is conducted. Most of well-known and highly efficient machine learning algorithms have been considered in order to diagnose asthma and COPD diseases groups in relatively large and separate data sets via repeated k-fold cross validation and grid search approaches.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 7, Issue 4, April 2021

REFERANCES

[1] Bernstein AS, Rice MB. Lungs in a warming world: climate change and respiratory health. Chest. 2013;143(5):1455–1459. [PubMed] [Google Scholar]

[2] Burnett RT, Pope CA, Ezzati M, Olives C, Lim SS, Mehta S, et al. An integrated risk function for estimating the global burden of disease attributable to ambient fine particulate matter exposure. Environ Health Perspect. 2014;122(4):397–403. [PMC free article] [PubMed] [Google Scholar]

[3] Committee of the Environmental and Occupational Health Assembly of the American Thoracic Society Health effects of outdoor air pollution. Am J RespirCrit Care Med. 1996;153(1):3–50. [PubMed] [Google Scholar]

[4] Connors AF, Dawson NV, Thomas C, Harrell FE, Desbiens N, Fulkerson WJ, et al. Outcomes following acute exacerbation of severe chronic obstructive lung disease. The SUPPORT investigators (Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments) Am J RespirCrit Care Med. 1996;154(4 Pt 1):959–967. [PubMed] [Google Scholar]

[5].Donaldson GC, Seemungal TA, Bhowmik A, Wedzicha JA. Relationship between exacerbation frequency and lung function decline in chronic obstructive pulmonary disease.Thorax. 2002;57(10):847–852. [PMC free article] [PubMed] [Google Scholar

[6] Donaldson GC, Wedzicha JA. COPD exacerbations—1: Epidemiology. Thorax. 2006;61(2):164–168. [PMC free article] [PubMed] [Google Scholar]

[7] Epstein PR. Climate change and human health. N Engl J Med. 2005;353(14):1433–1436. [PubMed] [Google Scholar]

[8] Global Initiative for Chronic Obstructive Lung Disease (GOLD) [accessed 17 June, 2015];Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease. 2015 Available from: http://www.goldcopd.org/guidelines-global-strategy-for-diagnosis-management.html.[PubMed]

[9] Gotschi T, Heinrich J, Sunyer J, Kunzli N. Long-term effects of ambient air pollution on lung function: a review. Epidemiology. 2008;19(5):690–701. [PubMed] [Google Scholar]

[10] Lepeule J, Litonjua AA, Coull B, Koutrakis P, Sparrow D, Vokonas PS, et al. Long-term effects of traffic particles on lung function decline in the elderly. Am J RespirCrit Care Med. 2014;190(5):542–548. [PMC free article] [PubMed] [Google Scholar].