RESEARCH ARTICLE OPEN ACCESS

# Diagnosis Chronic Obstructive Pulmonary Disease (Copd) Using E-Nose Technology

M.Karthikkumar[1], P.Logamurthy[2], M.Jothimani[3], G.Lingeswaran[4]
[1,2,3,4] *Assistant Professor, Electronics And Communication Engineering Department, Erode Sengunthar Engineering College, Perundurai-638057, Tamilnadu*

**ABSTRACT:**
Chronic Obstructive Pulmonary Disease (COPD) is a group of progressive lung diseases. Symptoms may be mild at first, beginning with coughing and shortness of breath. As it progresses, it can become increasingly difficult to breathe. You may experience wheezing and tightness in the chest. Some people with COPD have exacerbations, or flare-ups of severe symptoms. The top cause of COPD is smoking. Long-term exposure to chemical irritants can also lead to COPD. It's a disease that takes a long time to develop. Diagnosis usually involves imaging tests, blood tests, and lung function tests. There's no cure for COPD, but treatment can help ease symptoms, lower the chance of complications, and generally improve quality of life. Untreated, COPD can lead to heart problems and worsening respiratory infections. Usually spirometry test is used to measure the lung function which is helpful in assessing breathing patterns that identify conditions such as COPD. In our paper E-nose technology has been used to measure the amount of air inhaled/exhaled during the lung functions to increase the test efficiency in measuring Maximum breathing capacity with low cost.
**Keywords:** E-Nose, Spirometry

---

Date of Submission: 16-12-2017 Date of acceptance: 22-12-2017

---

## I. INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is an umbrella term used to describe progressive lung diseases including emphysema, chronic bronchitis, refractory (non-reversible) asthma, and some forms of bronchiectasis. This disease is characterized by increasing breathlessness. Many people mistake their increased breathlessness and coughing as a normal part of aging. In the early stages of the disease, you may not notice the symptoms. COPD can develop for years without noticeable shortness of breath. You begin to see the symptoms in the more developed stages of the disease. That's why it is important that you talk to your doctor as soon as you notice any of these symptoms.

**Signs and Symptoms of COPD**

- Increased breathlessness
- Frequent coughing (with and without sputum)
- Wheezing
- Tightness in the chest

**Risk factors and common causes of COPD**

Most cases of COPD are caused by inhaling pollutants; that includes smoking (cigarettes, pipes, cigars, etc.), and second-hand smoke. Fumes, chemicals and dust found in many work environments are contributing factors for many individuals who develop COPD. Genetics can also play a role in an individual's development of COPD even if the person has never smoked or has ever been exposed to strong lung irritants in the workplace.

**A. Smoking**

COPD most often occurs in people 40 years of age and older who have a history of smoking. These may be individuals who are current or former smokers. While not everybody who smokes gets COPD, most of the individuals who have COPD (about 90% of them) have smoked.

**B. Environmental Factors**

COPD can also occur in those who have had long-term contact with harmful pollutants in the workplace. Some of these harmful lung irritants include certain chemicals, dust, or fumes. Heavy or long-term contact with secondhand smoke or other lung irritants in the home, such as organic cooking fuel, may also cause COPD.

**C. Genetic Factors**

Even if an individual has never smoked or been exposed to pollutants for an extended period of time, they can still develop COPD. Alpha-1 Antitrypsin Deficiency (AATD) is the most commonly known genetic risk factor for emphysema2. Alpha-1 Antitrypsin related COPD is

caused by a deficiency of the Alpha-1 Antitrypsin protein in the bloodstream. Without the Alpha-1 Antitrypsin protein, white blood cells begin to harm the lungs and lung deterioration occurs. The World Health Organization and the American Thoracic Society recommends that every individual diagnosed with COPD be tested for Alpha-1.

## II. EXISTING SYSTEM

### A.Spirometry testing

The spirometry test is performed using a device called a spirometer, which comes in several different varieties. Most spirometers display the following graphs, called spirograms:

- a *volume-time curve*, showing volume (litres) along the Y-axis and time (seconds) along the X-axis.
- a *flow-volume loop*, which graphically depicts the rate of airflow on the Y-axis and the total volume inspired or expired on the X-axis.

### B. Parameters

**Forced vital capacity (FVC)**

Forced vital capacity (FVC) is the volume of air that can forcibly be blown out after full inspiration, measured in liters. FVC is the most basic maneuver in spirometry tests.

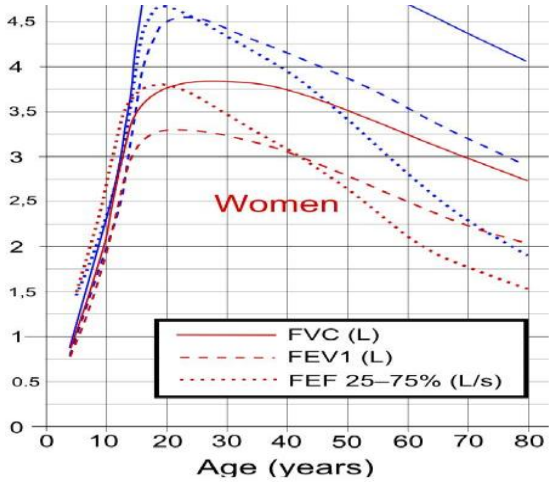


**Fig.1**. Average values for forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1) and forced expiratory flow 25–75% (FEF25–75%), according to a study in the United States 2007 of 3,600 subjects aged 4–80 years. Y-axis is expressed in litres for FVC and FEV1, and in litres/second for FEF25–75%.

**Forced expiratory volume in 1 second (FEV1)**

FEV1 is the volume of air that can forcibly be blown out in one second, after full inspiration. Average values for FEV1 in healthy people depend mainly on sex and age, according to the diagram at left. Values of between 80% and 120% of the average value are considered normal. Predicted normal values for FEV1 can be calculated online and depend on age, sex, height, mass and ethnicity as well as the research study that they are based on.

**FEV1/FVC ratio (FEV1%)**

$FEV_1$/FVC (FEV1%) is the ratio of $FEV_1$ to FVC. In healthy adults this should be approximately 70–85% (declining with age). In obstructive diseases (asthma, COPD, chronic bronchitis, emphysema) $FEV_1$ is diminished because of increased airway resistance to expiratory flow; the FVC may be decreased as well, due to the premature closure of airway in expiration, just not in the same proportion as $FEV_1$ (for instance, both $FEV_1$ and FVC are reduced, but the former is more affected because of the increased airway resistance). This generates a reduced value (<80%, often ~45%). In restrictive diseases (such as pulmonary fibrosis) the $FEV_1$ and FVC are both reduced proportionally and the value may be normal or even increased as a result of decreased lung compliance.

A derived value of FEV1% is FEV1% predicted, which is defined as FEV1% of the patient divided by the average FEV1% in the population for any person of similar age, sex and body composition.

### C. Procedure & Methodology

Spirometry (spy-ROM-uh-tree) is a common office test used to assess how well your lungs work by measuring how much air you inhale, how much you exhale and how quickly you exhale.

Spirometry is used to diagnose asthma, chronic obstructive pulmonary disease (COPD) and other conditions that affect breathing. Spirometry may also be used periodically to monitor the lung condition and check whether a treatment for a chronic lung condition is helping you breathe better. Through routine spirometry, lung diseases can often be diagnosed in the early stages when treatment is most effective. Once a lung disease is diagnosed and treated, routine spirometry tests can monitor changes in lung functions with specific treatment. This will help your doctor find the best treatment plan for you and it will be instructed how to perform spirometry. Basically, you will take in a deep breath and blow into a mouthpiece attached to the spirometer. You will blow out as hard and as fast as you can until your lungs feel absolutely empty. You will be asked to repeat the test several more times until there are two to three good efforts. You will be coached and encouraged to do your best during the test. A good effort during the test is important to get good results.

A computerized sensor (which is part of the spirometer) calculates and graphs the results. The results demonstrate a person's air flow rates or the volume forced out within the first second. This is the Forced Expiratory Volume in the first second (FEV1). This indicates whether or not there is airway obstruction. Spirometry also records the total volume of air forced out of the lungs. This is the Forced Vital Capacity (FVC). The percentage of the FVC exhaled in the first second (FEV1) is also calculated with spirometry. This is the FEV1/FVC. These spirometry results will help your doctor determine the best treatment for you.

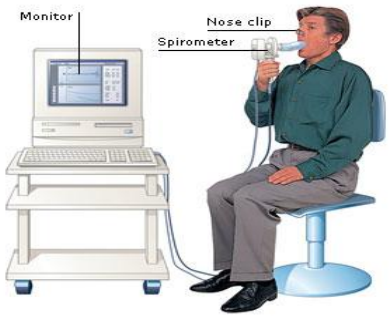


**Fig.2.** Spirometry Test Setup

**D. Limitations of test**

The maneuver is highly dependent on patient cooperation and effort, and is normally repeated at least three times to ensure reproducibility. Since results are dependent on patient cooperation, FVC can only be underestimated, never overestimated.

Due to the patient cooperation required, spirometry can only be used on children old enough to comprehend and follow the instructions given (6 years old or more), and only on patients who are able to understand and follow instructions thus, this test is not suitable for patients who are unconscious, heavily sedated, or have limitations that would interfere with vigorous respiratory efforts. Other types of lung function tests are available for infants and unconscious persons.

Another major limitation is the fact that many intermittent or mild asthmatics have normal spirometry between acute exacerbations, limiting spirometry's usefulness as a diagnostic. It is more useful as a monitoring tool a sudden decrease in FEV1 or other spirometric measure in the same patient can signal worsening control, even if the raw value is still normal. Patients are encouraged to record their personal best measures.

## III. PROPOSED SYSTEM

**A. E-Nose Technology**

The concept of an electronic nose originated in the seventies. Up to then, analytical chemistry had been pre-occupied with developing highly specific sensors and methods, aimed at identifying unique. The new availability of personal computing made it possible to apply pattern recognition techniques to complex measurement data. An important consequence of the concept is that a substance, or mixtures of substances, can only be recognized after a calibration phase: in order to match a pattern, it must be known before hand substances.

The proposal was to have a general, broadly responsive sensor system generating complex multi-dimensional measurement data and use pattern recognition techniques to match measured ‘patterns’ to previously ‘seen’ patterns. This is analogous to how we smell, hence the name ‘electronic nose’.

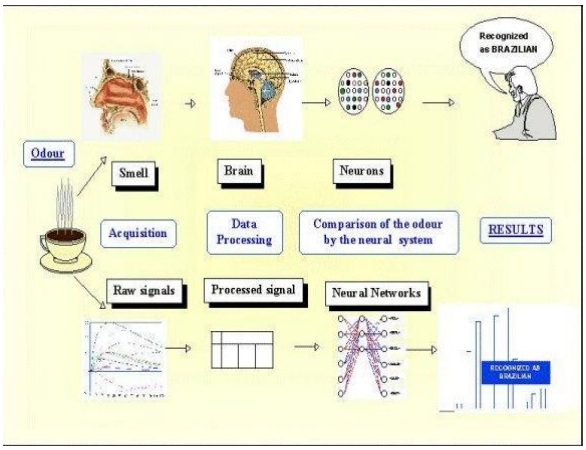


**Fig.3.** E-Nose Technology

**B. E-Nose Methodology**

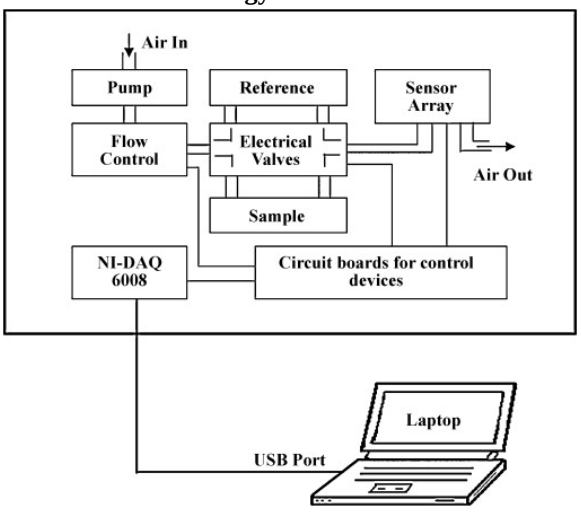


**Fig.4.** E-Nose Working Principle

The electronic nose was developed in order to mimic human olfaction whose functions are non separate mechanism, i.e., the smell or flavor is perceived as a global finger print. Essentially the instrument consists of sensor array, pattern reorganization modules, and headspace sampling, to generate signal pattern that are used for characterizing smells. The electronic nose consists of three major parts which are detecting system, computing system, sample delivery system.

**The sample delivery system:** The sample delivery system enables the generation of headspace of sample or volatile compounds which is a fraction analyzed. The system then sends this head space into the detection system of the electronic nose.

**The detection system:** The detection system which consists of a group of sensors is the reactive part of the instrument. When in contact with volatile compounds at that time the sensors reacts causing changes in electrical characteristics.

**The Computing system:** In most electronic noses each sensor is sensitive to all molecules in their specific way. However in bioelectric noses the receptor proteins which respond to specific smell molecules are used. Most of electronic noses use sensor arrays that react to volatile compounds. Whenever the sensors sense any smell, a specific response is recorded that signal is transmitted into the digital value.

**The more commonly used sensors in electronic nose**

- Metal oxide semiconductor (MOSFET)
- Conducting polymers
- Quartz crystal microbalance
- Piezoelectric sensors
- Metal Oxide sensors

**Metal Oxide semiconductor sensor:**

This is used for switching or amplifying electronic signals. The Working principle of MOSFET is that molecules entering into the sensor area will be charged positively or negatively which have directly effect on the electric field inside MOSFET.

**Metal Oxide sensors:** This sensor is based on adsorption of gas molecules to provoke change in conductivity. This conductivity change is the measure of the amount of volatile organic compounds adsorbed.

**Piezoelectric sensors:** The adsorption of gas onto the surface of the polymer leads to change in mass on the sensor surface. This is turn produce a change in the resonant frequency of the crystal.

**Quartz crystal microbalance:** This is a way of measuring mass per unit area by measuring the change in frequency of crystal resonator. This can be stored in a data base.

**Conducting polymers:** Conductive polymer gas sensors operate based on changed in electrical resistance caused by adsorption of gases onto the sensor surface.

**Data Analysis for Electronic Nose:**

The digital output generated by electronic nose sensors has to be analyzed and interpreted in order to provide. There are three main types of commercially available techniques.

- Graphical analysis
- Multivariate data analysis
- Network analysis

The simplest form of a data reduction is a graphical analysis useful for comparing samples or comparing smells identification elements of unknown analysts relative to those of known sources in reference libraries. The multivariate data analysis generates a set of techniques for the analysis of data that is trained or untrained technique. The untrained techniques are used when a data base of known samples has not been built previously. The simplest and most widely used untrained MDA technique is a principle component analysis. The electronic nose data analysis MDA is a very useful when sensors have partially coverage sensitivities to individual compounds present in a sample mixer. The PCA is a most useful when no known sample is available. The neural network is the best known and most derived analysis techniques utilized in a statistical software packages for commercially available electronic nose.

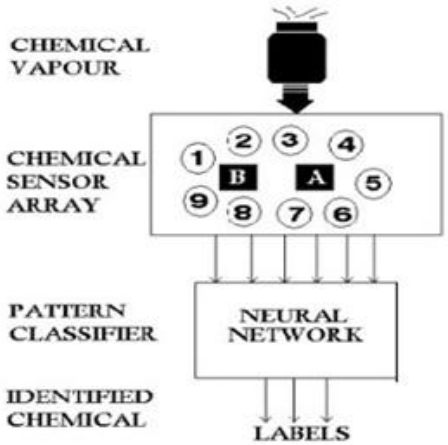


**Fig.5.** Data Analysis for E-Nose

Electronic noses (e-noses) are artificial sensor systems, usually consisting of chemical cross-reactive sensor arrays for characterization of patterns of breath volatile compounds, and algorithms for breathprints classification. E-

noses are handheld, portable, and provide real-time data. E-nose breathprints can reflect respiratory inflammation.

**Application of Electronic nose:**

- Medical diagnostics and health monitoring
- Environmental monitoring
- Application in food industry
- Detection of explosive
- Research and development industries
- Quality control laboratories
- The process and production department
- Detection of drug smells
- Detection of harmful bacteria

## IV. CONCLUSION

A universal electronic nose capable of identifying or discriminating any gas sample type with high efficiency and for all possible applications has not as yet been built. This fact is largely due to the selectivity and sensitivity limitations of e-nose sensor arrays for specific analyze gases. Electronic noses are not designed to be universally appropriate sensor systems for every conceivable gas-sensing application nor are they capable of serving every possible analytical need. Thus, the suitability of an electronic nose for a specific application is highly dependent on the required operating conditions of the sensors in the array and the composition of the analyze gases being detected.

Furthermore, e-noses generally are far less expensive than analytical systems, easier and cheaper to operate, and have greater potential for portability and field use compared with complex analytical laboratory instruments. Thus, electronic noses have far greater potential to be used eventually by unskilled consumers for innumerable practical applications in residential and public settings. Some disadvantages of e-nose sensing include problems with reproducibility, recovery, negative effects of humidity and temperature on the sensor responses, and inability to identify individual chemical species with sample gases.

Thus, electronic noses will never completely replace complex analytical equipment or odor panels for all applications, but offer quick real-time detection and discrimination solutions for applications requiring accurate, rapid and repeated determinations. Such applications are becoming increasingly common and required for highly-mechanized industrial manufacturing processes.

## REFERENCES

[1]. [1] An electronic nose system to diagnose illness JW Gardner, HW Shin, EL Hines - Sensors and Actuators B: Chemical, 2000 – Elsevier

[2]. Electronic noses and their applications Northcon 95. I EEE Technical Applications Conference and Workshops Northcon95 10-12 Oct. 1995

[3]. A review of gas sensors employed in electronic nose applications K. Arshak, E. Moore, G.M. Lyons, J. Harris, S. Clifford, (2004) "A review of gas sensors employed in electronic nose applications", Sensor Review, Vol. 24 Issue: 2, pp.181-198,https://doi.org/10.1108/02602280410525977

[4]. An investigation on electronic nose diagnosis of lung cancer A D'Amico, G Pennazza, M Santonico, E Martinelli… - Lung cancer, 2010 – Elsevier Conductive polymer-carbon black composites-based sensor arrays for use in an electronic nose BC Munoz, G Steinthal, S Sunshine - Sensor Review, 1999 - emeraldinsight.com

[5]. Detection and identification of cancers by the electronic nose Arnaldo D'Amico, Corrado Di Natale, Christian Falconi, Eugenio Martinelli, Roberto Paolesse, Giorgio Pennazza, Marco Santonico &Peter Jason Sterk show less Pages 175-185 | Published online: 24 Apr 2012

[6]. Power-efficient readout circuit for miniaturized electronic nose Violeta Petrescu, Julia Pettine. Devrez M. Karabacak Published in: Solid-State Circuits Conference Digest of Technical Papers (ISSCC), 2012 IEEE International

[7]. A study of an electronic nose for detection of lung cancer based on a virtual SAW gas sensors array and imaging recognition method Xing Chen[1], Mingfu Cao[1], Yi Li[1], Weijun Hu[1], Ping Wang[1], Kejing Ying[2] and Hongming Pan[2] Published 29 June 2005 • 2005 IOP Publishing Ltd Measurement Science and Technology, Volume 16, Number 8

[8]. A powerful method for feature extraction and compression of electronic nose responses Author links open overlay panel A.Leone C.Distante N.Ancona K.C.Persaud E.Stella P.Siciliano Received 30 April 2004, Revised 16 June 2004, Accepted 21 June 2004, Available online 27 July 2004.

[9]. Application of an electronic nose in the diagnosis of head and neck cancer Authors Nicoline Leunis MD, Marie-Louise Boumans, Bernd Kremer MD, PhD, Sinh Din MD, Ellen Stobberingh MD, PhD,

Alfons G. H. Kessels PhD, Kenneth W. Kross MD, PhD-19 November 2013
[10]. Electronic Nose Technology and its Applications Mahmoudi, Esmaeil. Sensors & Transducers; Toronto Vol. 107, Iss. 8, (Aug 2009): 17-25.
[11]. Data analysis for electronic nose systems Simon M. Scott, David James, Zulfiqur Ali - - Microchimica Acta December 2006, Volume 156, Issue 3–4, pp 183–207
[12]. Anesthetic Level Prediction Using a QCM Based E-Nose H. M. Saraoğlu, A. Özmen, M. A. Ebeoğlu, Journal of Medical Systems June 2008, Volume 32, Issue 3, pp 251–257

International Journal of Engineering Research and Applications (IJERA) is **UGC approved** Journal with Sl. No. 4525, Journal no. 47088. Indexed in Cross Ref, Index Copernicus (ICV 80.82), NASA, Ads, Researcher Id Thomson Reuters, DOAJ.

M.Karthikkumar "Diagnosis Chronic Obstructive Pulmonary Disease (Copd) Using E-Nose Technology." International Journal of Engineering Research and Applications (IJERA) , vol. 7, no. 12, 2017, pp. 43-48.