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ELECTRONIC NOSE APPLICATIONS IN MEDICAL FIELD

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ABSTRACT: According to the research by the World Health Organisation (WHO), 36 million people die each year due to various health problems. However, this number can be reduced if patients are detected early and treated properly. The expansion and use of electronic nose have many applications in the healthcare, and a bio-medical field is rapid to accelerate over the past 25 years. Many e-nose technologies have given answers or provided results of complex biomedical and healthcare problems. The purpose of this review is to present the use of e-nose in the medical field, or how e-nose helps in detecting various diseases in human at an early stage so that it can be cured easily. E-nose is a device which is being developed as systems for the detection of miscellaneous odors. These odors can be of food, drinks, cosmetics, medicines, etc. With the help of an array of sensors placed inside it, detection is possible. Various diseases like lung cancer, asthma in children, diagnosis of illness by breathing analysis, prostate cancer, bladder infection, liver cancer, anaerobic infection, yellow fever, smallpox, diabetes, typhoid, uremia, cholera, chronic hepatitis, and many more can be detected with the e-nose device. It is helpful in the medical field, and it can save a number of lives. The growth of e-nose is increasing rapidly due to higher demand. Hence e-nose senses the odor emitted by the body and can detect the possible disease (illness).

Keywords: E-nose, An array of sensors, Diagnosis

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INTRODUCTION: Electronic nose is an instrument used to detect various odors, gases or vapors through sensors which are placed inside it. The electronic nose has wide applications in the medical field and other fields like in the food industry, environmental pollution, in space, in the detection of explosives, etc. In the medical field, e-nose is used as a diagnostic tool. It diagnoses the odor or analyzes breathe sweat, *etc.* and detects the problems in advance [1-3].

My friend's aunt died from uremia 7 years ago. When she was diagnosed, the level of the disease was quite high. At that time, she was a patient with a serious condition. She missed the best treatment and left us forever. This happens with most of the cancer patients. When they got to know about the disease, it was too late. What happens for most of the diseases at the early stage, the symptom is just the common cold. Therefore, people don't pay much heed to it. Even if though they go to the hospital, doctors may make mistakes in diagnosis [4].

This is not the doctor's fault, but it is very tough to detect cancer or any other serious disease at the early stage correctly with the variant technologies. At the early stage, minor changes occur in the body which is sometimes hard to detect and when are

diagnosed, they reach the terminal stage. Hence with the help of e-nose, it becomes easy and accurate to diagnose the diseases. It is a helpful device in the medical field. Not only cancer but many other severe diseases can be detected through e-nose and cured at early as possible [5, 6].
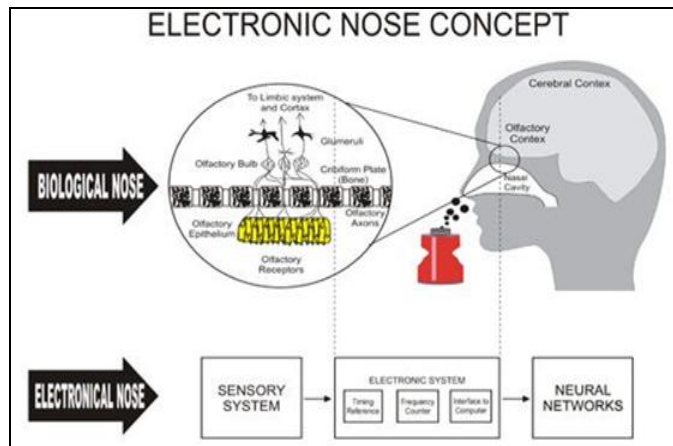

FIG. 1: E-NOSE CONCEPT

What is an Electronic Nose? The electronic nose does not look like our human nose but functions similar to it. It is an instrument which senses the miscellaneous odors, gases or vapors with the help of an array of sensors and detects the possible problems. This device is different from the human nose. An electronic nose is a successful invention in the advancement of science and technology areas. This sensor device termed e-nose by Gardner & Barlett in 1994 is capable of detecting, recognizing, and differentiating among various types and sources and mixtures of compounds present in sampled air, including VOCs [7].

FIG. 2: ELECTRONIC NOSE

Recent advances in e-nose technologies, based on various aroma detection (EAD) principles and mechanisms have made possible the development of e-nose applications useful in commercial industries, including the agriculture, food, environmental, cosmetics, manufacturing, military, pharmaceuticals, etc. The use of e-nose is rapidly increasing in biomedical applications and in the healthcare industry due to higher available capitalization for products. This tool is cheap, accurate, gives high- performance, and is effective. Despite repeated use, this e-nose gives consistently accurate results and also accurate qualitative and quantitative results with large-sample throughput [8].

Principle of Operation of E-Nose: The principle of operation of an e-nose is based on three units – Sensing unit (sensors), Processing unit, and Interface circuit unit. Sensing unit consists of a group of sensors which senses the odor samples. Process it in the processing unit, or it can be said that an e-nose includes three systems – delivery system, detecting system, and computing system. The delivery system takes the odor or gas samples, analyze it and sends it to the detecting system. An array of sensors are placed in detecting system. Sensors sense the smell, and finally, pattern is generated in digital form in a computing system.

Sensors: Ideal sensors are fitted in an e-nose which should have the respective criteria: highly stable, highly reliable, robust, short recovery time, durable, easily arranged high delicacy towards chemical compounds, low sensation towards temperature and humidity, should be cheap and safe, low power consumption. In market varieties of sensors are present, but only four types of sensors are used- MOS, MOSFET sensors, conducting sensors, and piezoelectric sensor [9, 10].

Applications: E-nose is being used for the last 20 years. Its applications range is huge and wide and is in almost all the respective fields. [11-12]

- In the food industry.

- In pharmaceuticals.

- In environmental monitoring.

- In space (ISRO and NASA)

- In the detection of explosives.

- Possible application in the field of crime prevention and security.

- In agriculture.

- In manufacturing.
- In cosmetics.
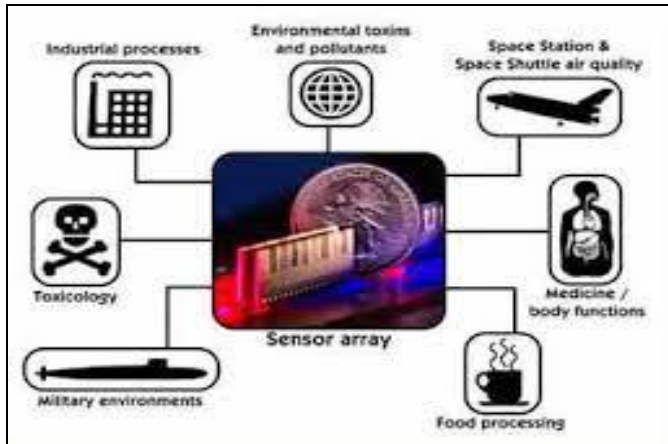- During soil contamination tests.
- In airline transportation.

FIG. 3: APPLICATIONS IN VARIOUS FIELDS

Electronic Nose as a Novel Tool in Medical and Health Care Field: [13-15]

In Medicines: E-nose helps in analyzing medicines. It smells the medicine and identifies whether it is fine or expired. E-nose examines the body odors, breathes, wounds, body fluids, etc. and recognize the problems. And also various kinds of diseases like TB, diabetes, sinus problems, infections, typhoid, pneumonia, etc. can be sensed and detected.

Diagnosis of Illness: Breathe is analyzed for diagnosing illness. It is exhaled in the e-nose, which is analyzed by the sensors, and the illness is detected. E-nose detects or analyze breathe accurately and gives the result fastly.

E-Nose in Clinical Diagnosis: E-noses are painless, non-invasive, and simple that has been developed for early medical diagnosis to detect miscellaneous odors from diseases and bacteria cells. The electronic noses have shown the ability to recognize and differentiate between various bacteria and fungi from the human body. The swabs, breathe, feces, urine, serum, or sputum sampled from the human body that can be measured directly. Various past and recent research findings and developments of e-nose technologies in medicine are discussed below.

Detection of Prostate Cancer: This is new research from Finland. Researchers from the University of Tampere with the help of e-nose successfully distinguished between prostate cancer and benign prostatic hyperplasia (BPH) by analyzing the "small print" of the headspace of a urine sample, reports the Journal of Urology. The team says the result from the e-nose can be compared with the result obtained from the prostate-specific antigen (PSA) tests. The –nose achieved, which discriminate prostate cancers from BOH a sensitivity of 78% and a specificity of 67%. Prostate cancer is the second most common serious disease in men and one of the leading causes of death from cancer.

FIG. 4: URINE SAMPLE

FIG. 5: E-NOSE USED FOR DETECTION OF PROSTATE CANCER

It is not like a child's play to diagnose and make certain prognoses about prostate cancer because it does not seem consistent in prostate tissue. The biopsies are costly, provide discomfort to the patient, and can have a risk of infection. Thus, there is a need for a novel diagnostic tool, i.e., e-nose. Earlier in the 1980s trained dogs sniff out and detect cancer. However, there were some variations in the performance of sniffer dogs during the

findings, which were of limited applications. Hence this led to the invention of e-nose.

Lung Cancer: Lung cancer is also one of a fatal disease. The e-nose identified various exhaled breathe from lung cancer patients and investigated it. Machado *et al.,* used an electronic nose to identify and differentiate between 14 bronchogenic carcinoma patients and 45 healthy controls. The sensors in the e-nose are based on a group of 32 polymer composite sensors using Savitzky-Golay filtering and baseline correction and then analyzed using PCA. The result determined effective difference between samples from patients suffering from lung cancer and those from healthy controls.

In affirmation study, the e-nose had 71.4% sensitive it, and 91.9% specificity for detecting lung cancer, positive and negative prognostic values were 66.6% and 93.4% respectively.

Tuberculosis Detection by E-nose: TB kills approximately 1.7 million people globally every year. According to WHO, India leads the world in TB infections, which kills approx 1000 people each day. After the study conducted between TB patients and healthy patients, it was examined that the e-nose discriminated between TB patients & healthy controls with a sensitivity of 76.5% specificity of 87.2%.

FIG. 6: TUBERCULOSIS DETECTION

Asthma in Children: According to new research held at the European Respiratory Society (ERS) International Congress in Munich, Germany (7 September 2014), an e-nose can be used successfully to detect asthma subtypes in children. Asthma is one of the most common ataxia in childhood, affecting approx 7.1 million children in the US. According to Paul Brinkman, one of the lead authors of the study from the Academic Medical Centre in Amsterdam said that there are various forms of asthma that affects people or children in various ways.

Brinkman with his team used an e-nose to diagnose particles known as VOCs in the exhaled breathe of over 106 children, all of them suffering from asthma or wheeze. The e-nose was able to detect 5 specific asthma subtypes among the children, which depends on various breathe profiles. After the diagnosis, the team then observed the clinical characteristics of each of 5 subtypes and recorded different symptoms in the children and varied by

age. Hence with the help of e-nose, it becomes easy to determine the difference between people with asthma.

FIG. 7: E-NOSE DETECTING ASTHMA

Detection of Licorice Root by Electronic Nose: Licorice or liquorice is the root of *Glycyrrhiza glabra* from which sweet flavor is extracted. It is a plant, and its roots are mixed in medicines to make

it sweet. This sweetness is about 30-50 times the sweetness of sugar. This sweet taste is very different from sugar and long lasting. Licorice is very useful for various ailments including asthma, athlete's foot, baldness, body odor, canker sores, dandruff, colds and flu, coughs, viral & fungal infections, ulcers, liver problems, TB, menopause, prostate enlargement & arthritis. On the other hand, if taken in excess can cause water retention & raise blood pressure. It can also cause mild adrenal stimulation. This root is cultivated in geographical areas such as Iran, China, Afghanistan, Turkey, and Italy. E-nose is used to detect the authenticity of licorice root. This diagnostic tool detects whether the root is raw or ripe or rotten or whether in good condition [16].

FIG. 8: LICORICE ROOT

Why E-Nose in Medical?

✓ It is cheap.

✓ It is very effective. With the presence of e-nose, people do not need to spend several hours in the hospital or with doctors for their diseases. Patients undergo a lot of medical equipment and tests to make sure which type of disease they are suffering from. This diagnosis is torture. But with the use of e-nose, all they need to do is to breathe, and the problem is detected. Therefore, it saves the time of the patients as well as of doctors.

✓ A high percentage of accuracy.

✓ It is much reliable.

✓ An electronic nose is non-invasive. It does not harm the patient. However, this medical equipment, like the X-rays up to some extent, can harm.

CONCLUSION: Although the electronic nose was invented several years back, but it is still in progress in health and security field. This device helps the people to know whether they are suffering from any disease or not at an early stage. It is simple and painless method of detecting disease and at the same time cheap also. It gives the accurate and in less time. E-nose can also detect the danger at any time around the individual with greater efficiency and effectiveness. Today in the developing society, people are not only concerned about the diversity of life but also the quality of life. The e-nose gives the quality to living conditions and also protects it.

CONFLICT OF INTEREST: Nil

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