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Environment Monitoring Using Electronic Sensors For Detecting Pollution Due To Solid Waste Gases Using Five Sensors

Shri Om Mishra[1], S. Hasan Saeed[2], Pratiksha Rai[3]
[1]*(ECE, Integral University, Lucknow, India)*
[2]*(ECE, Integral University, Lucknow, India)*
[3]*(ECE, Integral University, Lucknow, India)*
Corresponding Author: Shri Om Mishra

Abstract : The main aim of this research work is to detect the butane, Acetone, Propane, ethane, LPG and other organic gases from the solid waste and do environment monitoring. Here the set of sensors used to detect the pollutant gases from solid waste. Green and pollution free environment across the globe is very much required for the health of the nature. The different kinds of pollutions are affecting the quality of the environment around us. This review paper is mainly dealing with environment monitoring of organic gases which is a very sensitive issue in the world and is directly affecting the human health and disturbs the biological balance of earth. E-nose finds application in industrial processes, environmental toxins and pollutants, space stations & space shuttle air quality, medicines body function, food processing, military environment and toxicology. This paper is mainly dealing with environment monitoring of organic gases which is a very sensitive issue in the world and is directly affecting the human health and disturbs the biological balance of earth. Here our aim is to develop a sensor array system which will detect maximum pollutant gases and which is highly responsive, accurate and low cost and low power consuming. We have taken two sensors in place of six sensors and given the results in the form of variance, score plot and loading plot. Electronic noses have provided a plethora of benefits to a variety of commercial industries, including the agricultural, biomedical, cosmetics, environmental, food, manufacturing, military, pharmaceutical, regulatory, and various scientific research fields Here our aim is to develop a sensor array system which will detect maximum pollutant gases and which is highly responsive, accurate and low cost and low power consuming. Here we use the parallel factor analysis technic (PARAFAC) for detection of gases and compare it with the principal component analysis (PCA)

Keywords - discrimination, E-nose device, quantification, Multi sensor array, odor concentration

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I. INTRODUCTION

Here we have taken the five sensors to monitor the environment and detect the harmful gases like methane, propane, and acetone. Environmental monitoring delineates the growth to distinguish the value of the environment. Environmental monitoring is used in grounding of environmental impact valuation additionally in many conditions in which human action takes harmful belongings on natural environment. The monitoring strategies are often designed to set up the current condition of an environment. The smelling sensitivity of electronic nose is more precise than human sense of smell. An electronic nose basically consists of a mechanism for chemical detection. An electronic nose is an intelligent sensing device which uses an array of gas sensors that are overlapping selectively along with pattern reorganization component. Currently benefits has been provided by electronic noses to a verity of application like gas detection, environmental, food and various research and development fields. The electronic nose detects the hazardous gas which is not possible to human sniffers. In all cases the results of monitoring will be reviewed, analyzed statistically and published. The design of a monitoring Programme must therefore have regard to the final use of the data before monitoring starts. The potential applications of electronic-nose devices in the area of environmental-pollution monitoring are many and varied. Some of the more important potential utilities of e-noses in detecting pollution range from monitoring air quality [1, 2], the early or real-time area monitoring of diurnal urban pollution-emission events via sensor monitoring networks (outdoor pollution) [3], localization of stationary (point-source) pollution sources [4, 5], and mapping of chemical plumes [6, 7], to detection of fires at chemical-storage facilities, maintaining chemical security at harbor entrances or importation ports [5], Dimethyl sulphide, dimethyl disulphide, limonene and α-pentene as the most significant odorous VOC in a wastewater sludge composting facility and the latter two compounds releases from the wood chips used as bulking agent. Different types ofter penes (pinene, 3-carene, camphene, myrcene and D-limonene) are responsible for VOC emissions in green waste composting and work predominantly in feedstock natural breakdown. VOCs emissions are closely related to the composting process phases[8,9,10] detection of leaks of toxic or hazardous materials from pipelines or industrial plants, and early warning of the accumulation of toxic fumes such as solvents or explosive fumes, carbon monoxide or carbon dioxide within enclosed areas of buildings or mines (indoor pollution). The following discussion points out some of the differences between electronic-nose devices and current conventional spectrometric monitoring devices, some of the advantages and disadvantages of e-noses relative to conventional pollution monitors, and a summary of the efficacies of e-nose instruments for various pollution monitoring applications as determined from recent scientific research. The electronic nose was developed in order to mimic human olfaction that functions as a non-separative mechanism: i.e. an odor / flavor is perceived as a global fingerprint. Essentially the instrument consists of head space sampling, sensor array, and pattern recognition modules, to generate signal pattern that are used for characterizing odors. Electronic noses include three major parts: a sample delivery system, a detection system, a computing system. The sample delivery system enables the generation of the headspace (volatile compounds) of a sample, which is the fraction analyzed. The system then injects this headspace into the detection system of the electronic nose. The sample delivery system is essential to guarantee constant operating conditions. The detection system, which consists of a sensor set, is the "reactive" part of the instrument. When in contact with volatile compounds, the sensors react, which means they experience a change of electrical properties. Electronic nose instruments are used by research and development laboratories, quality control laboratories and process & production departments for various purposes. The smells are composed of molecules, which has a specific size and shape. Each of these molecules has a corresponding sized and shaped receptor in the human nose. When a specific receptor receives a molecule it sends a signal to the brain and brain identifies the smell associated with the particular molecule. The electronic noses work in a similar manner of human. The electronic nose uses sensors as the receptor. When a specific sensor receives the molecules, it transmits the signal to a program for processing, rather than to the brain.

II. ELECTRONIC NOSE PRINCIPLE

The electronic nose was developed in order to mimic human olfaction whose functions are non separate mechanism. 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.

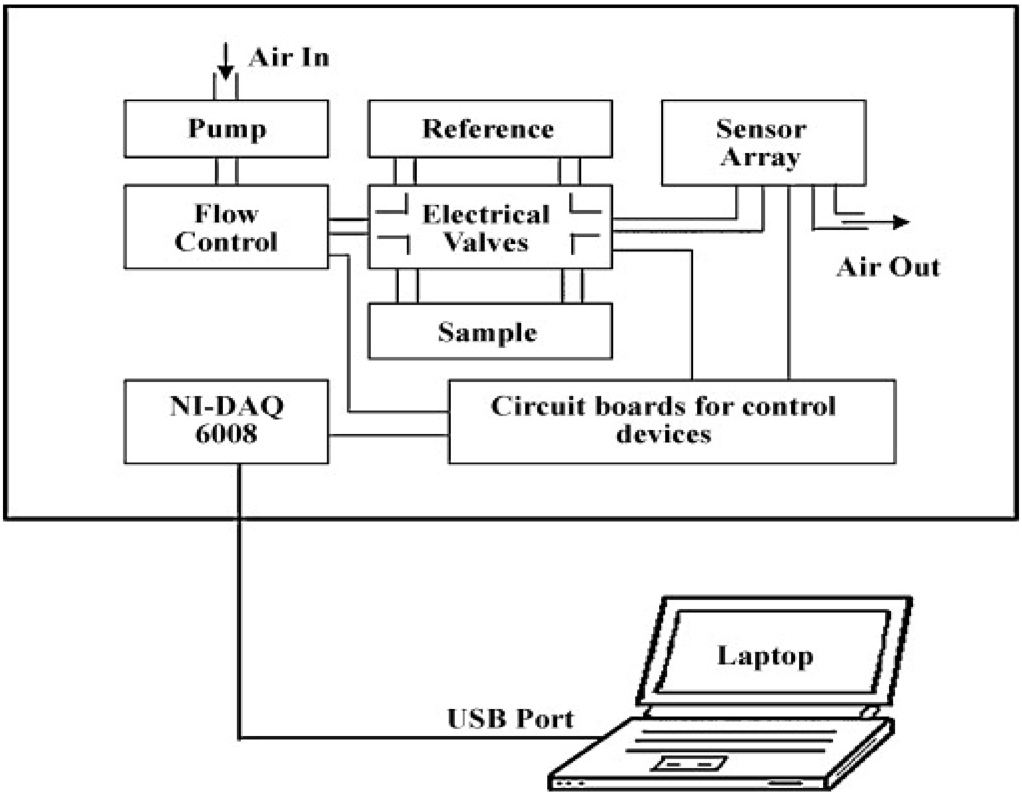

Figure 1. *Electronic nose block diagram*

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.

III. DATA ANALYSIS FOR ELECTRONIC NOSE SENSORS

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 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. 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. The proposed electronic nose system was tested with the smells of three fruits namely, leman, banana, litchi. The smells were prepared by placing a sample of fruits in the breakers sealed with a cover. The 8051 was set in to testing or training mode. If the system is in training mode, sensor value is shown on the LCD. If the system is in testing mode, classification result of the target fruit is shown on the LCD. The sensor array gets the gas through Valve1, which is normally closed. The vacuum pump is turned on for 20 sec to pump the gas out of the sensor array.

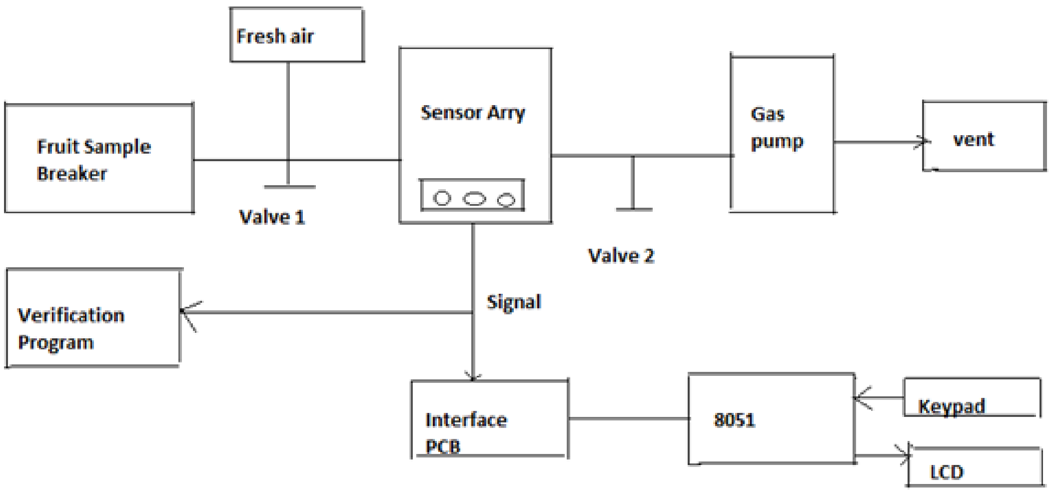

Figure2. Gas testing setup for the proposed E-Nose system

The value1 was closed and the sensor resistance was given 60 sec to reach a study state mode. The classification result of sensors characteristic value appeared on the LCD. The sensor array chamber was disconnected from the fruit sample breaker and the valve1 was opened to turn fresh air, the valve 2 was opened so that the smells were pumped out. The chamber was aired out with fresh air for two minutes. An odor is composed of molecules, each of which has a specific size and shape. Each of these molecules has a correspondingly sized and shaped receptor in the human nose. When a specific receptor receives a molecule, it sends a signal to the brain and the brain identifies the smell associated with that particular molecule. Electronic noses based on the biological model work in a similar manner, albeit substituting sensors for the receptors, and transmitting the signal to a program for processing, rather than to the brain. Electronic noses are one example of a growing research area called biomimetic, or bio mimicry, which involves human-made applications patterned on natural phenomena. Electronic noses were originally used for quality control applications in the food, beverage and cosmetics industries. Current applications include detection of odors specific to diseases for medical diagnosis, and detection of pollutants and gas leaks for environmental protection. In a recent study, the World Health Organization(WHO) reported that over 3 million people die each year from the effects of air pollution. Furthermore, reports from World Energy Congress (WEC) suggest that if the world continues to use fuels reserves at the current rate, the environmental pollution in 2025 will create irreversible environmental damage. Long-term exposure to air pollution provokes inflammation and alters cardiac function. Within the general population, medical studies suggest that inhaling particulate matter(PM) is associated with increased mortality rates which are further magnified for people suffering from diabetes,chronic pulmonary diseases, and inflammatory diseases. Pollution, in general is contamination that renders part of the environment unfit for intended or desired use. Natural processes release toxic chemicals into the environment as a result of ongoing industrialization and urbanization. Major contributors to large-scale pollution crisis are deforestation, polluted rivers, and contaminated soils.

Ground-based monitoring Air pollutant measurements have been carried out with analytical instruments such as optical spectroscopy, gas chromatography, mass spectrometry, non-dispersive infrared(NDIR), and chemiluminescence. Such monitoring systems are bulky, expensive, time-consuming, and can seldom be used for real-time monitoring in the field despite their capabilities of delivering accurate readings. Furthermore, the use of aforementioned systems as stand alone is not practical. Recent development of thin semiconductor films employing nanostructured materials, Nernst-type potentiometric devices based on solid-electrolyte membrane, and NiO/ZnO capacitor-type gas sensors and detectors offer excellent alternatives for environmental monitoring. The devices are low cost, light weight, and relatively small in size. Several different kinds of thin-film sensors are commercially available for detection and monitoring of NOx gas.

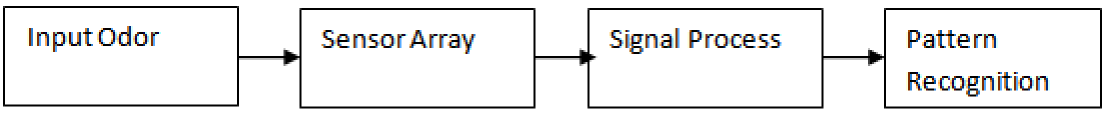

Figure 3. Functional component of Electronic nose

IV. SENSOR USED IN ENVIRONMENT MONITORING

In the broadest definition, a **sensor** is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as a light or as complex as a computer. Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micro machinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement,[1] for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life. The e-nose used is this experiment contains an array of six different MOX gas sensors whose readings are recorded to obtain an odor fingerprint of the odor. These sensors are Figaro TGS-2600, TGS-2602, TGS-2611 and TGS-2620, and e2v MICS-5135 and MICS-5521.

Those sensors are hosted within a small-volume chamber where a continuous airflow is injected through a pneumatic circuit powered by a pump. The aspiration of that circuit is done through a thin tube, allowing an easy handling in the smelling process described below. Odor data collection has been carried out in a fixed systematic way for all the samples and test runs.

V. RESULT AND ANALYSIS

- Sensors: MICS 5521= M1
- MICS 5135= M2
- TGS 2602=   T1
- TGS 2600=   T2

- TGS 2611= T3
- TGS 2620= T4.
- Acetone=A
- Ethanol =E
- Propane =P
- Good:-Distance between two gas clusters is large means detection easy.
- Average:- Distance between two gas clusters is less but can be detected.
- Poor: Distance between two gas clusters is close/overlap.
- Score plot shows sample clustering
- Loading plot shows the sensors performance classification as each sensor is at some distance from other.
- Variance plot shows scattering of cluster of gases samples.
- Principal Component Analysis (PCA) is used to explain the variance structure of a set of variables through linear combinations. It is often used as a dimensionality-reduction technique.
- PC1 is the axis that spans most variation.
- PC2 is axis that spans second most variation.

Good= 3
Average = 2
Poor = 1

Table 1. Different combination of sensors and best combination is M2M2T1T2T4

SR. NO.	SENSORS	ACETONE & PROPANE	PROPANE & ETHANOL	ETHANOL & ACETONE	VALUE ON PC1	VALUE ON PC2
1	M1M2T1T2T3	3	1	2	93.4	97.9
2	M1M2T1T2T4	3	2	3	**91.4**	**97.7**
3	M1M2T1T3T4	3	2	3	94.7	99.2
4	M1M2T2T3T4	3	2	2	94.4	98.6
5	M1T1T2T3T4	3	2	2	96.6	99.3
6	M2T1T2T3T4	3	1	2	94.1	98.5

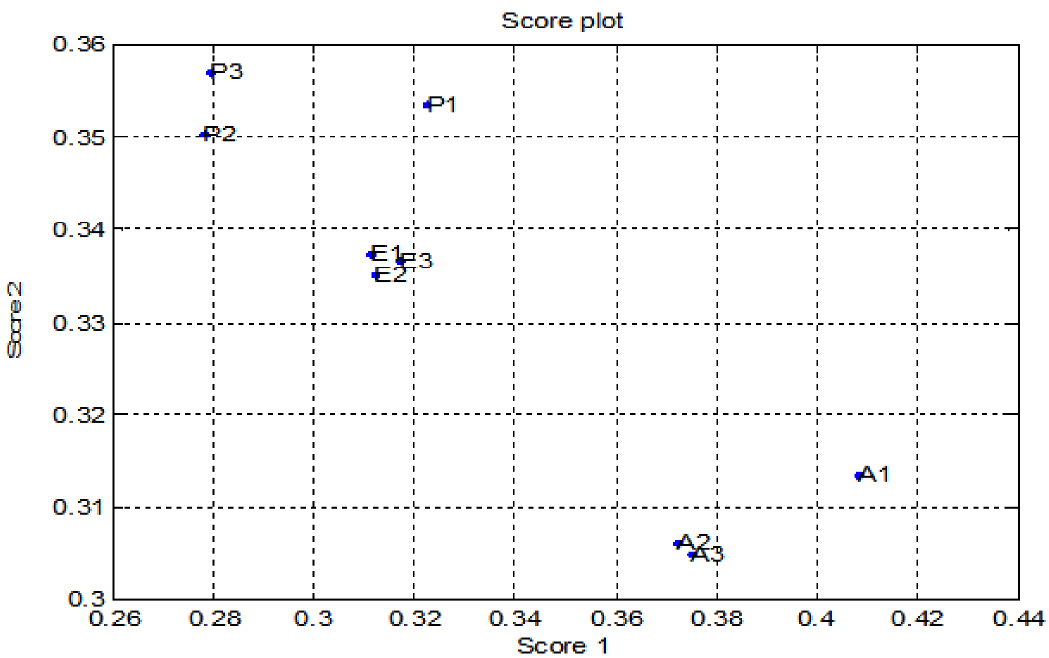

Figure.4: Score plot for all three gases combination using five sensor M1M2T1T2T4

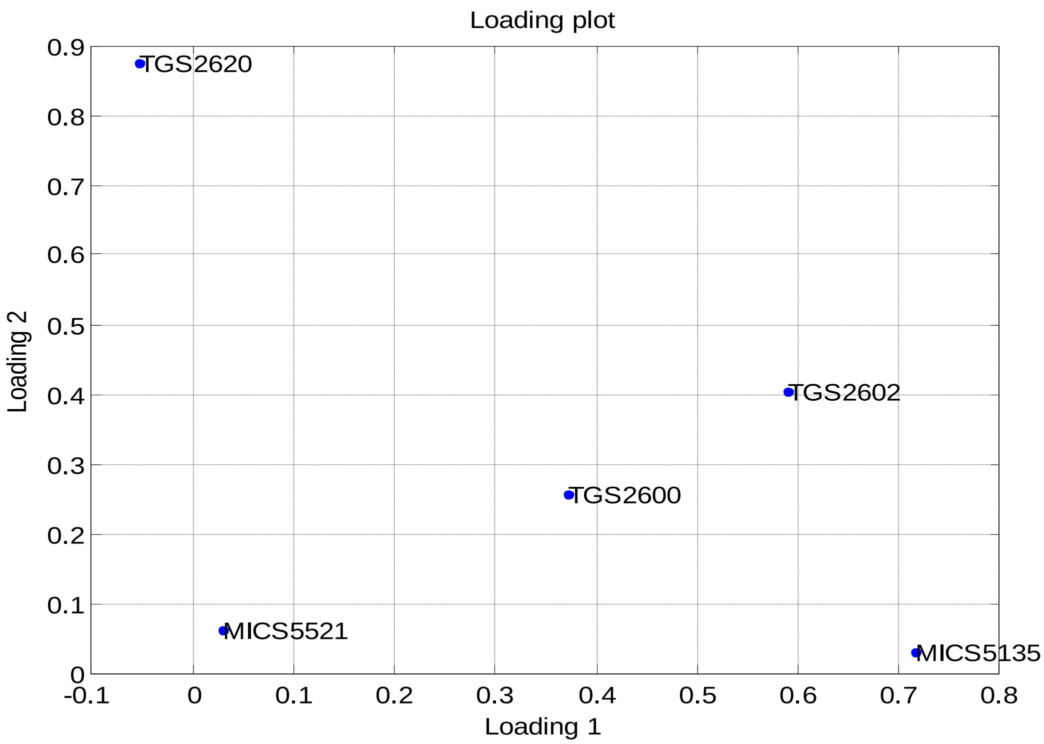

Figure.5: Loading plot for all three gases combination using five sensor M1M2T1T2T4

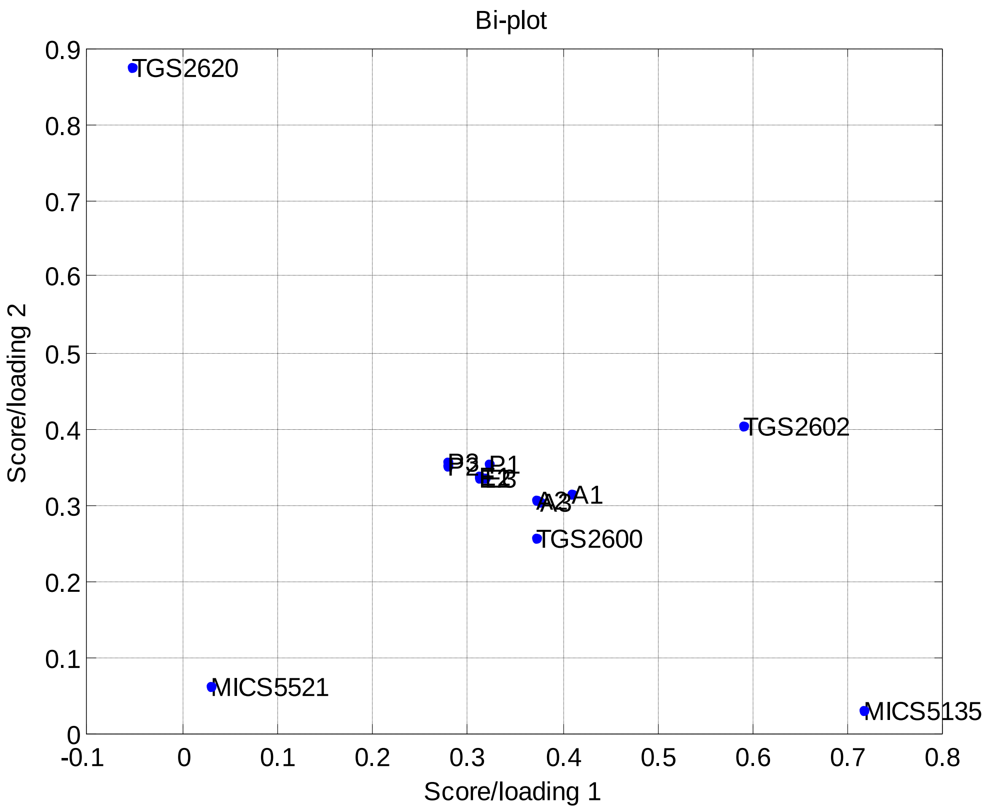

Figure.6: Bi plot for all three gases combination using five sensors M1M2T1T2T4

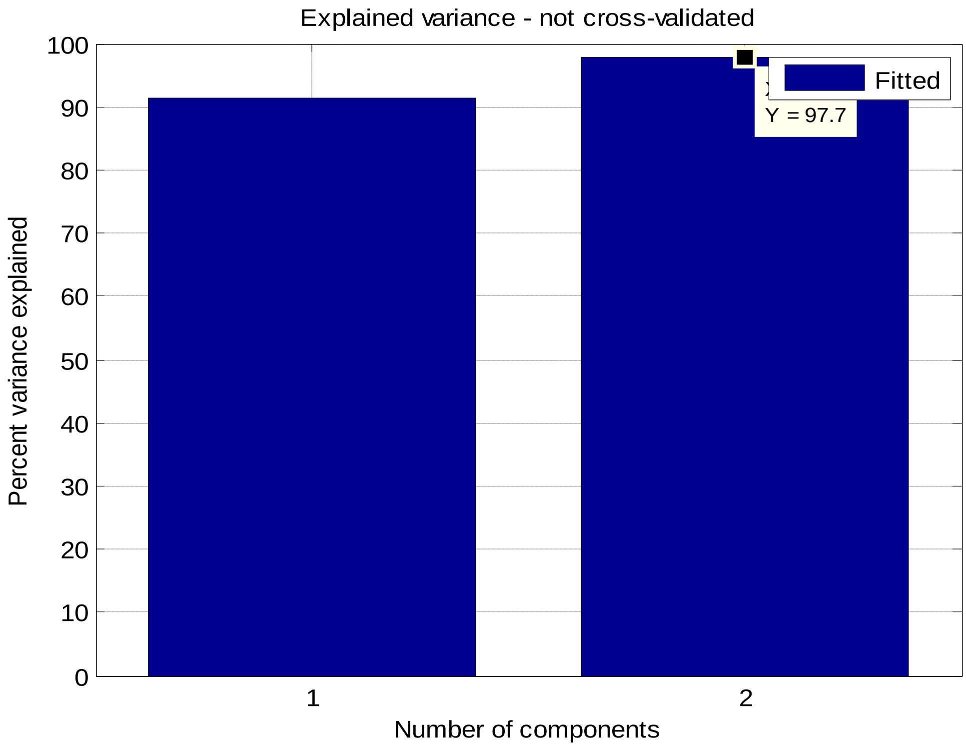

Figure.7: Variance plot for all three gases combination using five sensors M1M2T1T2T4

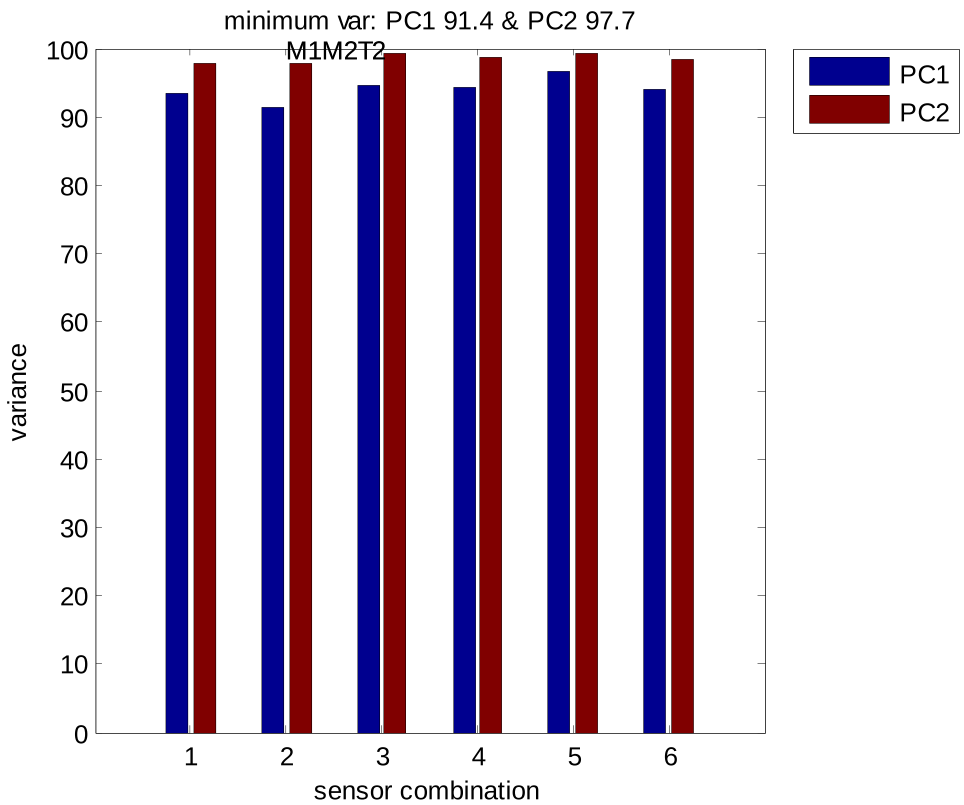

Figure.8: Variance plot for all the combination of sensors and gases.

VI. CONCLUSION

The real success of the sensor network technology depends mainly on its application in eradicating a harmful situation or in maintaining a good one. Designing an efficient application is one of the major challenges and sensor network challenges are application dependent. Air quality monitoring is a prospective application domain which is of particular value to our country. Large cities with high concentration of industry, intensive transport networks and high population density are major sources of air pollution. Predicting air quality from multiple sources by using modeling is very complicated. So, air quality models are best used for isolated sources or situations. Actually, there are several extremely simple devices commercially available, which are generically defined as “electronic noses”, able for instance to detect gas leaks or evaluate single gas concentrations. It is important to highlight that such simple instruments are unsuitable for environmental monitoring purposes. Here we have concluded the all data related to sensors and the graphs those are valuable for this work. Now we can say that by using two sensors we can give the less variance and low cost in place of using six sensors. All the sensor combination given above but only MICS5135, MICS 5521, TGS 2620, TGS 2602 TGS2600 combination give the best result. It is our research work that shows this paper

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