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On Some Aspects of Odour Detection System

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Abstract

Objective: Developing an efficient computer aided odour detection system for odour classifying and categorizing samples in more efficiency. **Methods/Analysis:** Among few approaches, the author have proposed the approach for the identification of chemical vapor is to build a cluster of sensors where each cluster will sense a specific chemical. During the experimental analysis, a sensor array consisting of two sensors have been used with an Arduino board and a PC or Laptop. Verification program has been developed in order to verify the system functions. Authors have used MS Visual C++ for developing the computational interface. **Findings:** Results generated from experiments gives an indication that the developed system was capable of identifying the odors' of LPG and Alcohol. The developed system shows the intensity of both LPG and Alcohol odour present at certain time. A siren also blows if intensity of any odors' goes beyond any threshold value. **Application/Improvement:** If the proposed system uses large number of various type of sensors instead of only two sensors it will shows the intensity of different odors' present at that time and different sensor's result do not interfere with each other, that is they are very selective in nature.

Keywords: Alcohol Odours, LPG, Odour Detection System, Sensors

1. Introduction

The human nasal system has been widely used as a diagnostic device in industries for the extent of the quality and smell of food, drinks, perfumes, cosmetic, chemical products and many other substances which includes health care, safety and security, environmental monitoring, quality control of food products, medical diagnosis, psychoanalysis, agriculture, pharmaceuticals, military applications, and detection of hazardous gases and others. It is used to measure the worth of odour and it is performed by means of sensory panels where a cluster of people seals out an inquiry forms on the odors allied with the ingredient being scrutinized. These sensory panels are enormously idiosyncratic because of the fact that the odor valuation by human is marked by several factors. The occurrence of individual distinctions can be well exaggerated by bodily and psychological fitness along with exhaustion. Owing to this motive, gas chromatography and mass spectrometry have been engaged in supporting human panels for evaluating the eminence of items by odour assessment and documentation for the achievement of more steady outcomes. However, these assistive procedures have the major drawback as having slow performances. In addition to it they are costly, as well as not transferrable.

Thus, in order to overcome the flaw of the sensory panels and the allied diagnostic procedures this study has derived with the concept of the electronic nose (e-nose). E-nose structure consumes a collection of sensors for providing a thumb print reaction to a given odour, and the software for acknowledgement of a pattern then accomplishes the documentation and judgement of odour. The e-nose is an economical clarification towards difficulties concomitant with sensory panels and with chromatographic and mass-spectrometric procedures and can lodge tangible spell performance in the arena when instigated in moveable form.

E-Nose products are still problematic in commercialization due to the fact of reduction in the size of E-Nose systems, the necessity in performing odour signal handling and arrangement, which claim

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high motorized Central Processing Units (CPUs), the complexity of the set of rules tangled, has increased in due course of time. In spite of the above facts a very few of the E-Nose applications which requires to accomplish comparatively simple tasks, do not require such intricate algorithms[1,2].

A sensor array are used, a microcontroller board which is connected to a laptop.

2. The Proposed E-Nose System

The block diagram of the proposed E-Nose system, embraces a cluster of sensors, a crossing point Printed Circuit Board (PCB), and an 8051 microprocessor board set in with a set of procedures which will produce pattern acknowledgment as well as authorization. In achieving the motive of verification of the function of the developed system, self-developed LabVIEW program carries the Sensor retorts concluded a Data Attainment Card (DAQ) into a computing device[3].

2.1 Sensors

In order to simulate the olfaction in mammals, a methodology for chemical sensing system has evolved. A wide range of varied receptor genes have been recognized in the olfactory structure of mammals. Gathering the idea from the mammalian system, a cluster of diverse sensors are used for the documentation of odours, with apiece sensor nominated to react to a variety of diverse chemicals. In that particular cluster, no distinct sensor reacts lonely to a particular odour. Rather, the combined reaction of the intact cluster crops a matchless design for the odour of concern. Preferably, the constituents of the sensor cluster should possess a wide range of chemical variety so as to react to the biggest cross-section of analytes. Within this given range of variety, the collection of interrelated sensors yields a diverse pattern, which is engaged as an odour signature (odour fingerprint) and can be exploited for grouping and identifying the odour[4–6].

This working principle has the benefit of identifying and classifying a composite combination of odours, such as those of fruits where it requires viewing a sensing mode of one-to-one (a specific odour is detected by varied sensor). Practically, the odours which are to be studied are generally complex mixtures, rather than pure gases. One of such complex mixture of many individual scents that is to be studied is the fragrance of a fruit. This complication makes the task of finding sensor for each distinct constituent of the gas blend it almost impossible. For illustration, the aroma of banana comprises of numerous ester groups, and litchi comprises greater volumes of monoterpene hydrocarbons in its scent. The odour edges of the human nose to these gaseous integrals largely plunge in the assortment of ppb. Nevertheless, it has been shown by the researchers that the classifications of fruit by an electronic nose very close to section of tasters. Thus, an E-Nose can prove to be beneficial in assembling of the odour of fruits[7,8].

Description of the System: The authors have used a sensor array, a microcontroller board and a laptop to implement the system. There are three sensors one is LPG gas sensor and the other two are alcohol sensor. Our system can detect the odour of the LPG and also alcohol. First the sensor senses the smell or odour after that its values are sent to the microcontroller board. Authors have used the Arduino Uno board. After receiving the values of the sensor the microcontroller sends this data to the laptop. Laptop receives this data via its USB port. Verification program has been developed to verify system functions. Authors have used Visual C++ to develop the program. The details of the hardware and software used are described below.

2.1.1 MQ303A Alcohol Sensor

MQ303A is semiconductor sensor which detects Alcohol, it is highly sensitive and provides a quick reaction to alcohol. Therefore they are most convenient and suitable in designing a portable alcohol detector.

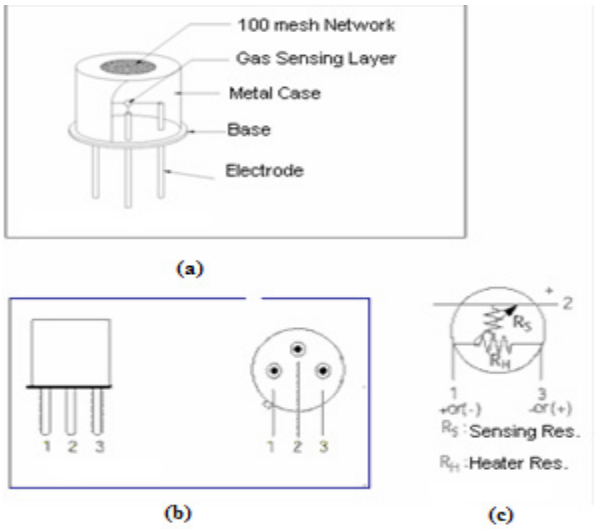

Figure 1. (a) Configuration. (b) Pins. (c) Circuit.

2.2.2 MQ6 LPG Gas Sensor

This LPG Gas Sensor (MQ6) has proven to be a perfect sensor for the detection of the hazardous LPG outflow in our household, car, service station or even a storage tank environment. Authors can effortlessly incorporate this unit into an alarm unit which will blow an alarm or produce some indication in an open eye upon detecting the presence of a Combustible Gas/LPG concentration. The sensor has an outstanding sensitivity in conjunction with a fast response time. The sensor also bears the capability to sense iso-butane, propane, LNG and cigarette smoke. For all these advantages, this LPG Gas Sensor has been proved to be useful in making a wireless Gas outflow gauge in home security system[1,9].

2.2 Arduino Uno Board

ATmega328 has formed the basis of preparing the Arduino Uno microcontroller board. Its components include 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It comprises of the whole lot desired for supporting the microcontroller. So for its start, authors simply require it to connect it with the USB cable of the computer or influence it with an AC-to-DC connecter or battery. The difference of the Uno with entirely former boards lies on the fact that it does not custom FTDI USB-to-serial driver chip. As an alternative, it uses the Atmega 16U2 (Atmega 8U2 up to version R2) which has been programmed for the usage as a USB-to-serial converter.

Revision 2 of the Uno board comes with a resistor which pulls the 8U2 HWB line to earth, thus creating it simpler to be placed into DFU mode.

Revision 3 of the board has the subsequent fresh topographies:

- 1.0 pinout: added SDA and SCL pins adjacent to the AREF pin and two other additional pins retained near to the RESET pin: The IOREF which allows the armors in regulating the voltage offered starting the panel. In upcoming days, armors will be well-matched with both the panel using the AVR and operating with 5V and the Arduino Due operating with 3.3V. The second one has a non-connected pin which will be earmarked for its use in the future.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2

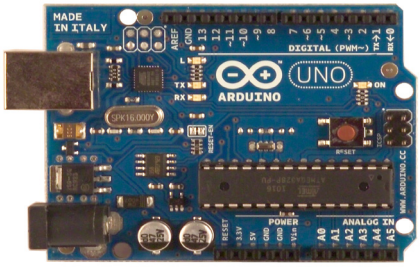

Figure 2. Arduino Uno.

2.3 Block Diagram

From Figure 3, authors can see that sample i.e., the substance whose odour is to detect have to bring closer to the sensor chamber. Here sensor chamber means where the array of sensors are situated. Now odours come in to the sensor and the sensor sense the odour and gives analog signal. The interface PCB, Microcontroller and the level converter are situated in the Arduino Uno board is connected to the PC or Laptop with the help of a USB cable.

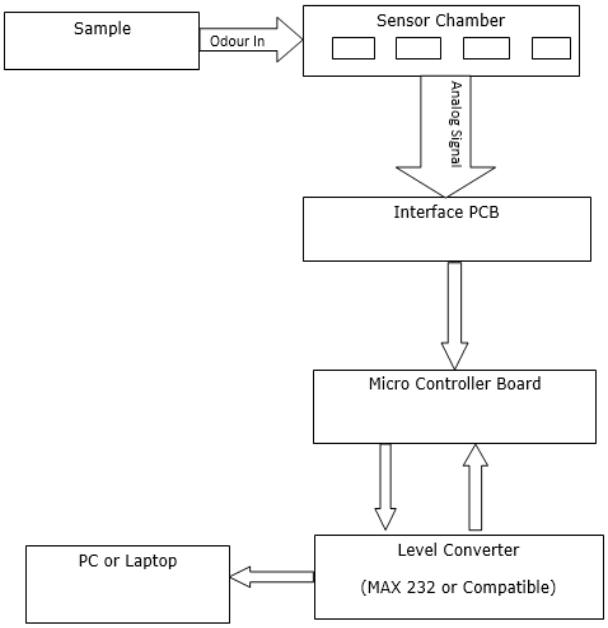

Figure 3. Block diagram of the proposed system.

2.4 Circuit Diagram

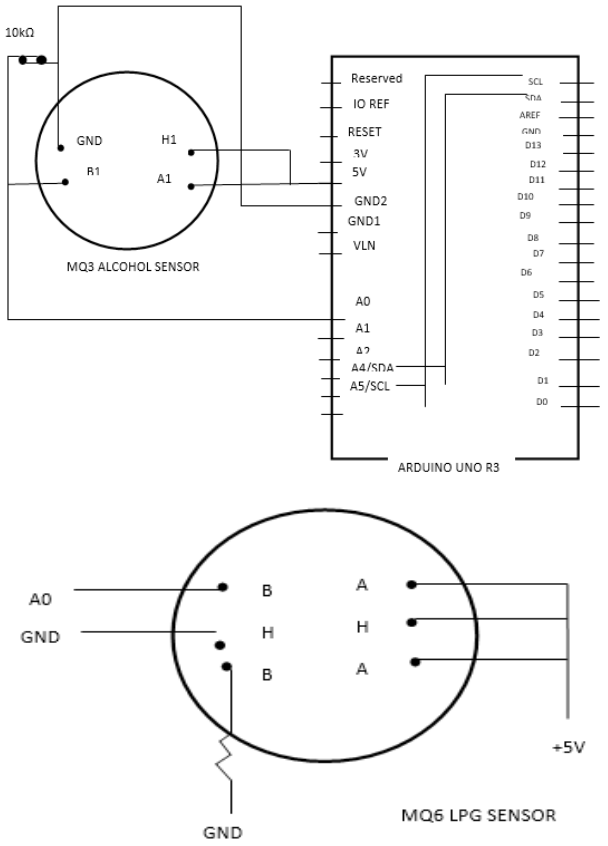

Figure 4. Circuit diagram of the proposed system.

3. Software Specifications and Data Analysis Methods

Microsoft Visual C++ 2010 is used as the main method for data analysis in this study. Authors need to install Microsoft Visual C++ 2010, Visual Micro for Arduino and MySQL.

The basic approach is to perform the coding in MS Visual Studio and then compile and upload using Arduino IDE. Arduino IDE has a very suitable "Use External Editor" option which will enable us to revise sketches somewhere else and merely click compile/upload options in the IDE.

Two programs are needed- arduino program which is needed to be burned on the arduino uno board microcontroller and MS Visual C++ program for the analysis of the available data.

Arduino board sends data to the PC or Laptop. This data comes as a character array. First the array elements are separated and this data is stored in the database. Our program fetches data from the database and draw graph. The graph changes depending on the intensity of the odour come in to the sensor array.

3.1 New Ideas in this System

On the output screen of our system, there is a graph. In graph, y axis shows Intensity and time is drawn along the x axis of the graph. Now within that graph there are two different lines for two different odors'. That is there are separate lines for each odour in the graph. Those lines separately show the intensity of a particular odour and different odors' do not interfere with each other. As said in the objective or problem definition our system shows the intensity of both LPG and Alcohol odour present at that time. A siren also blows if intensity of any odors' goes beyond any threshold value. If authors use a large number of various type of sensors instead of only two sensors it will shows the intensity of different odors' present at that time and different odors' do not interfere with each other. Then this system can be used in any organization or in any institution to indicate the intensity of different odors' present at that time inside of that organization or institution. If intensity of any hazardous gas or unhealthy gas goes beyond any threshold value then a siren will be blown. This concept is very helpful to maintain the indoor air quality of any organization and the people working inside that organization or institution can be work in a healthy environment. This system can also be used in the aroma industry to detect the different odours present in that particular aroma and it also indicate the intensity of different odours and it also changes with time. So it can indicate that which odour is long lasting and which odour does not lasts for long time. It can be also used to analyze the sillage that is the degree to which a perfume's fragrance lingers in the air[4,5].

4. Implementing Artificial Neural Network based Concepts for Odour Detection

For recognizing the electronic nose, authors have used a cluster of sensor which will comprise of six samples of metal oxide gas sensors and is listed in Table 1. Owing to their low price and high sensitivity sensors of tin oxide (Tagushi Gas Sensor -TGS) based devices are used in commercial electronic nose applications. Due to the lack

of selectiveness in this sensor type, it can even prove to be beneficial in revealing of odour (gas mixture) by ordering the cluster items. Hence, it is noticeable that if authors unite a quantity of non-selective sensors, the collective sensor signals which will be generated will produce more facts on an aroma or flavor than that of any individual sensor signal. Here, each of the gas sensors will contribute to the development of patterns of odour. The set-up for electronic based nose system for tea cataloguing is demonstrated in Figure 5[8,9].

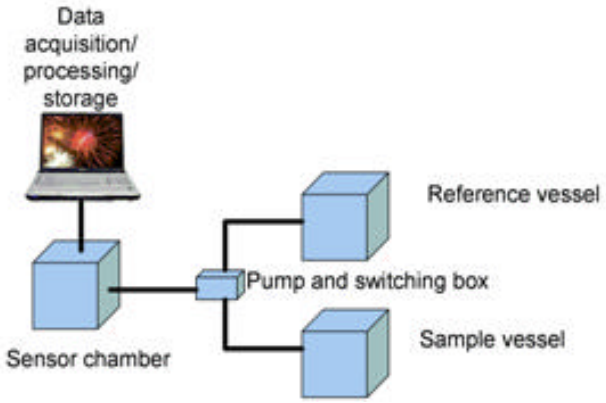

Figure 5. Set-up for electronic nose system for tea classification.

The electronic nose system comprises of three functional constituents operating in sequence on odorant samples, sample handler, a cluster of gas detection sensors, and a system based on signal processing. The result of this system is capable of identifying odorant. Since odour is a combination of volatile compounds with each sensor acts as 'e nose' has different sensitivity from which will help them to recognize the odorant sample and guess the concentration. Database of famous odorants be generated for clusters of sensors. From the aspect of the system being an intelligent one, the given system should able to distinguish among the patterns of odour that have been tasted with it[8].

During experiments, authors have collected four samples of tea (namely black, green, vanilla and jasmine tea). Each of the samples was kept in the glass vessel devoid of any added operation (Figure 4). Two holes, small in size covers the vessels and allows the analysis of the headspace with the electronic nose based equipment.

As shown in Figure 5, back propagation based neural network which consists of input layer having six neurons hidden layer having, three neurons and two neurons in the output layer having two layers are involved for recognizing the pattern in the system. Input layer uses six neurons for the fact that the numbers of gas sensors used in the array are six in number. Meanwhile, the output layer comprises of two neurons which can be combined to make four different samples of tea[2].

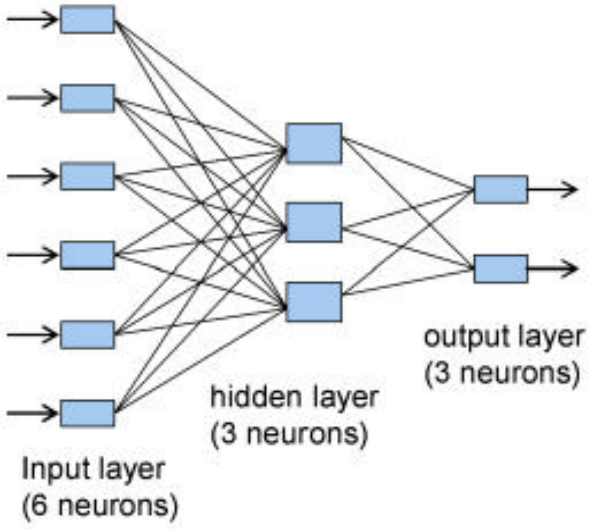

Figure 6. Back propagation artificial neural network for pattern recognition system of tea.

The sensor system having six samples of tin oxide based gas sensors from the same part of sensor chamber. The selections of sensors are based on the observation on responds on different odours that evolve from tea, and is demonstrated Table 1. The sensors, those are selected are targeted to respond to gases which includes cooking vapors, ammonia, hydrogen-sulphide, alcohol, toluene, xylene, etc, and manufacturer specified.

Table 1. Classified tea (output target) based on the value of output layer

No	Neuron 1	Neuron 2	Classified Tea
1	0	0	Black Tea
2	0	1	Green Tea
3	1	0	Jasmine Tea
4	1	1	Vanilla tea

The sensor belongs to electrical conductance of differs in the occurrence of gas reduction or oxidization. A thin tube made of plastic coupled from the input upto the chamber where sensors are available. The pipe is further connected upto one of the two holes that covers the glass vessels. The headspace of the vessel having tea

samples (four sample of tea were used for experiment) and the reference vessel, in sequence were sampled and observed[2,3,10].

5. Result and Discussions

After running the application program there is a graph in the output screen. Intensity is plotted through the axis 'y' of the graph, axis 'x' is plotted as time plotted through the x-axis of the graph. Now the graph changes time to time depending on the intensity of the odour coming into the sensor. Also a siren will blow when the intensity of the odour goes beyond a predefined value. Figure 7 shows the output window.

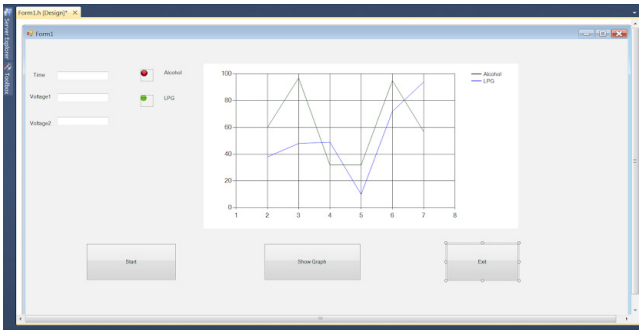

Figure 7. Output window.

In this proposed work the authors have used only LPG sensor and alcohol sensor. So it identifies alcohol and LPG odours only. But in near future the authors want to implement this device to identify various types of odours so that it can be used in different areas. If authors use a large number of various type of sensors instead of only two sensors it will shows the intensity of different odours present at that time and different sensors sensitivity do not interfere with each other. Then this system can be used in any organization or in any institution to indicate the intensity of different odours present at that time inside of that organization or institution. If intensity of any hazardous gas or unhealthy gas goes beyond any threshold value then a siren will be blown. This concept is very helpful to maintain the indoor air quality of any organization and the people working inside that organization or institution can be work in a healthy environment. This system can also be used in the aroma industry to detect the different odours present in that particular aroma and it also indicate the intensity of different odours and it also changes with time. So it can indicate that which odour is long lasting and which odour does not lasts for long time. It can be also used to analyse the sillage that is the degree to which a perfume's fragrance lingers in the air.

6. Conclusion

Throughout this paper, authors have emphasized on the proposed odour detection system and how efficiently it can detect the presence of alcohol and LPG odours. Though the success was observed in many areas of application, the author's work to reach at a generalized device that can able to classify fine discrimination of flavors perfumes and smells and gradually replacing the human nose are observed as dissatisfactory. The early expectation was to replicate the ability of human odour sensing was by increasing sensors. The performance of nose is due to presence of high number of different human receptor cells and capability of selectivity and unsurpassed sensitivity gas analysis. Sensors with new sensitive layers are in course of development are based on concepts of DNA, molecular imprinted molecules, or even immobilized natural receptors (up to whole cells), which is expected to increase in sensitivity and selectivity.

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