Development of Low Cost Electronic Nose

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Abstract

The development of electronic noses have been on the rise due to their apparent benefits as it has been proved to solve many problems which is included food quality control, environmental monitoring and etc. However, the commercial electronic nose always known as an expensive and complicated system in recent market. This paper presents the work of the development of a low cost electronic nose which is developed to be cost efficient as it was made using off-the-shelf components. The electronic nose consists of an array of sensory system which integrated with RCM 4000 microcontroller and artificial neural network as the pattern recognition. The completed electronic nose, then, was tested to discriminate a few essences and the test conducted showed that electronic nose was able to perform a profile for the each essence and can be trained using artificial neural network analysis.

Keywords: Electronic nose, Low cost, Sensory system, Artificial neural network, Microcontroller

1 Introduction

An electronic nose is an instrument developed in order to mimic human olfaction that functions as non-separative mechanism which comprises an array of electronic chemical sensors [1-3].

In the past decade, it has been developed for its potential to solve a wide variety of problems over a diverse range of applications which included quality control of food and beverages manufacturing, fragrance and cosmetic production, chemical engineering, environmental monitoring, and more recently, medical diagnostics and bioprocess [1].

Presently, there are many commercially available electronic noses in the market such as FOX 2000 (Alpha MOS, France), AromaScanner (AromaScan, UK) and The Nose (Neotronics, UK). These electronic noses use a variety of sensing elements and the most sensors used are conducting polymer (CP), quartz crystal microbalance (QCM), metal-oxide semiconductor (MOS) sensors and surface acoustic wave (SAW). The ability of electronic noses to discriminate odour is based on pattern recognition algorithm. Statistical approach, artificial neural network or the combination of both techniques has been widely used in electronic noses system.

However, these available electronic noses are very costly and most of them retails for RM60k and above. Hence the development of a low-cost electronic nose equipped with an artificial intelligence-based pattern recognition algorithm was initiated. Proposed is the fabrication of low cost electronic nose which is can be addressed to market solution. Also, it is simple, portable and multi-functional product.

The fabrication of the electronic nose involves the development of the hardware, the software and the case prototype and the enclosure system as shown by figure 1 [2-3].

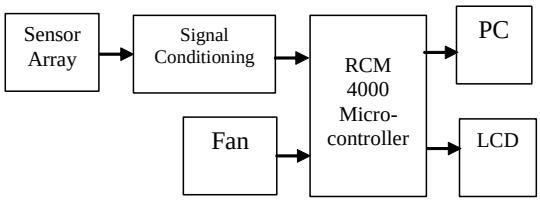

Figure 1. Hand-held Electronic Nose System

2 Methodology

The development and fabrication of the electronic nose was completed in several stages. The first involved the design and fabrication of the internal modules of the electronic nose, which includes the odour capturing module, the microcontrollers as well as the signal conditioning circuits, voltage regulators for the sensors, battery and power supply.

The electronic nose is composed by an array of eight Figaro TGS series metal oxide semiconductor (MOS) and thick film gas sensor. The sensor used in this electronic nose as shown in table 1. The sensor array was mounted on a PCB with necessary signal conditional circuits. An odour concentration system and a fan are used to concentrate the odour and mix the air before being sense by the array of gas sensor.

Table 1 - Sensors' sensitivity

	Sensitivity
Sensor 1	Gasoline engine exhaust gas
Sensor 2	Diesel engine exhaust gas
Sensor 3	Water vapour
Sensor 4	Air contaminants
Sensor 5	Alcohol, organic vapour
Sensor 6	Organic solvent vapour
Sensor 7	Hydrogen sulphide
Sensor 8	Ammonia

Software development included the microcontroller programmed. Listed below are the functions for the microcontroller:

1. To obtain data from ADC.
2. To save data to EEPROM.
3. To download data from personal computer to microcontroller.
4. To process input data to do the classification for sample.
5. To interact with personal computer.
6. To perform data to be displayed.

The prototype electronic nose was designed using SolidWorks 3D software and fabricated using prototype 3D printer. The SolidWorks 3D software allows engineers to create four to five design options rather than only one or two for each project within tight timeframes which is let the electronic nose design complete faster. Once the design is completed, then, it was printed. The prototype CAD drawing as shown in figure 2.

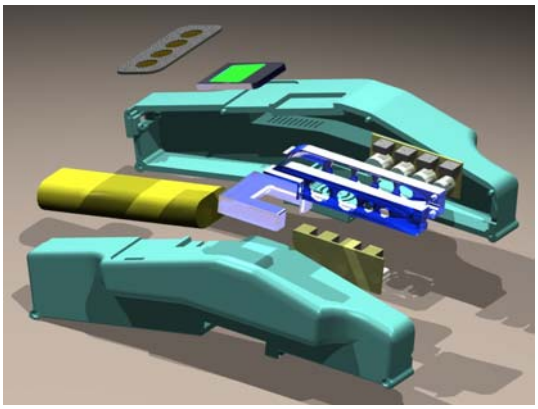

Figure 2. The CAD drawing of the electronic nose

In this study, the Multi-Layer Perceptron (MLP) which is trained using the Backpropagation (BP) with Levenberg-Marquardt algorithm was done and it available in MATLAB Neural Network Toolbox 6.5. The MLP comprises of an input, output and a hidden layer.

At the beginning of the training, all the weights are arbitrarily chosen. Through iteration of the network, the weights are refined until they generate the desired output. This process determines a neural model.

The weight and the ANN model that obtained from the training, then, were saved and upload into the microcontroller. The microcontroller will do the classification process using the new sample data by running the identification program.

3 Result and Discussion

The completed electronic nose, then, was tested using a few essences in laboratory. The data were collected a few times using the same procedure and the same sample condition to reduce any noises that maybe caused by experimental measurement. The collected data showed that the electronic nose can perform stable.

The result showed that the training data can be trained using neural network and then can be classified.

This testing showed that the FIGARO sensors array that had been used in the system successes to give a profile or fingerprint to volatile sample as shown in figure 3. The microcontroller also can function according to the program.

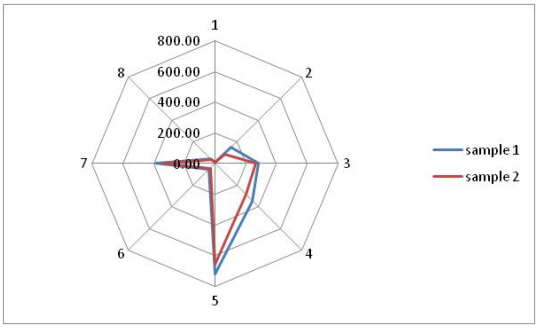

Figure 3: Sample 1 and sample 2 profile

4 Conclusion

The development of the electronic nose has proven to be successful by using off-the-shelf sensors and microcontroller. This truly provides feasible alternative to the commercially available electronic noses which are very costly.

5 Reference

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