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IoT-Enabled Electronic Nose for Fragrance Measurement of Textiles

Dr.S.Kavitha
Assistant Professor III,
Dept. of Fashion Technology,
Kumaraguru College of Technology,
Coimbatore– 641 049, India.

Dr. J.Srinivasan
Professor,
Dept. of Textile Technology,
Kumaraguru College of Technology,
Coimbatore– 641 049, India.

Abstract:- The electronic nose is a device that detects the smell more effectively than the human sense of smell. An electronic nose consists of a mechanism for chemical detection. The electronic nose is an intelligent sensing device that uses an array of gas sensors which are overlapping selectively along with a pattern reorganization component. Now a days the electronic noses are used in commercial industries, agriculture, biomedical, cosmetics, environmental, food, water and various scientific research fields. The measuring process of fragrance still becomes a difficult task in the textile field.In this paper, design and development of IoT enabled E-Nose system to measure the intensity of fragrance released from fragrance finished fabric is discussed.. The E-Nose system has successfully detected and recorded the concentration of alcohol and other volatile organic compounds using LABVIEW.

Keywords:- *Fragrance Finished Textiles, IoT Enabled E Nose, Sensors, LABVIEW.*

I. INTRODUCTION

Fragrances and perfumes have become important products of day-to-day life and changed the grooming habits of individuals. Perfumes should be applied directly to the skin especially on the pulse points which makes a person more noticeable and engaging. Many people apply perfumes on clothes also. Perfumes applied on clothes can either stain them or the weather marks might remain for some time until which the person will have to wait and can get out only when it has dried up. Spraying perfume directly can damage some fabrics and so it might end up spoiling of outfits. Fragrance finishing of textiles is the innovative process where fragrance is incorporated into the fabric by different finishing techniques during fabric manufacturing stage itself. Nowadays, fabric conditioners with fragrance are also used after every laundry cycle. Whatever methods are used for fragrance finishing, there should be a method to measure the intensity and durability of the fragrance applied to the fabric. The measuring process of aroma still becomes a difficult task in the textile field. It is generally measured through sensorial analysis which consists of trained panelists to evaluate the odour. They use rating scales to describe the odour presence and their intensity and rank the samples. The problems faced are;

- The same panelist's response from one day to the next can vary by as much as three-fold, possibly due to health or mood of the individual.
- Variability in the sensitivity of the individual conducting the evaluation and odour fatigue are further concerns that are commonly addressed in procedural protocol.
- Odour fatigue is a temporary condition where a person becomes acclimated to an odorant or odour to the point that they are no longer aware that the odour is present.
- Onsite methods are complicated by the influence that visual perception might have in an evaluation (smelling with your eyes, so to speak). Each of us has a unique odour acuity. While methods try to minimize panelist variation, the difference in sense of smell from one person is another consideration in human assessment methods.

Olfactometers are instruments in which a panelist must simply identify the presence or absence of an odour and is generally a better method than ranking, as the human nose cannot distinguish small differences between levels of intensity. So, there is a need for measuring the fragrance intensity by objective measurement. Recent applications of electronic nose technologies have come through advances in sensor design, material improvements, software innovations and progress in microcircuitry design and systems integration.

II. E-NOSE SYSTEM

The fragrances are volatile compounds and it is difficult to measure it due to various factors including the compounds themselves, the olfactory receptors to bind them, Temperature, humidity, the matrix in which the chemicals are embedded etc. The presence of a small amount of impurities may cause a significant change in the fragrance detection process. In order to have an accurate measurement of the test fragrance, a characterization system is being developed. Hence due to the above-mentioned reasons, a test box is developed to characterize the sensor and to process its signals based on the electrical parameters of the sensor.

A. E nose setup

The developed test box contains fabric sample handling space and set of sensors fixed to the box is shown in figure 1. The locally developed test box made of metal sheets covered on five sides and a door on the front side, having a total volume of 6336 cubic cm. The test box is provided with electrical connections for sensor characterization in presence

of any fragrance from the fragrance finished fabric sample. A small 5 V DC fan is fitted inside the box for the homogeneous spread of the fragrance. All the sensors are fitted on top of the box while the fabric sample is kept on the holder. The output is taken to the laptop for processing of the results.

Figure 1: Enose setup fabricated connected with Laptop

B. Sensors

In this present work, a set of six Sno_2 based volatile organic compound (VOC) sensors including alcohol sensors used for the measurement of the fragrance from the fabric. The sensor composed by micro AL_2O_3 ceramic tube, tin oxide (Sno_2) sensitive layer, measuring electrode and heater is fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for the work of sensitive components. The sensor has 6 pins, 4 of them are used to fetch signals and the other two are used for providing heating current. The standard detecting condition can be Temp: 20±2 Vc: 5V±0.1, Humidity: 65±5% Vh : 5V±0.1 and the sensing resistance can be 30 KΩ - 200 KΩ.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.

C. 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 the 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 principle of the developed Electronic nose is described briefly below using block diagram. E-Nose system, comprises a sensor array, an interface printed circuit board (PCB), and an 8051 microprocessor board embedded with a pattern recognition algorithm, as well as a verification program. Sensor responses pass through a data acquisition card (DAQ) to a laptop with a LabVIEW program for the purpose of verifying the function of the portable E-Nose system.

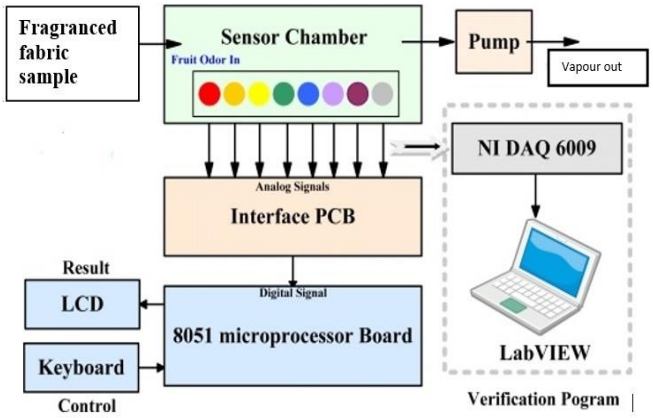

Figure 2.Block diagram

The fragrance finished samples were cut into standard sizes of 10x10 cm and placed on a sample holder in the text box. The test box was designed with the provision to keep the sample inside the box using a sample holder with handle. When the fragrance finished samples kept inside the box, the responses of the sensor changes to the time of exposure of the fragrance. In LCD "Electronic nose sensing" will display. Sensor readings will display continuously on the Lab view screen.

Figure 3. Fabric Sample holder

III. FRAGRANCE DETECTION

The finished sample consists of benzene derivatives and the sensor can detect the compound when it is exposed along with the dry air through the fan fitted inside the box. Firstly, the evaluated finished samples should be taken as the learning samples for proper training. The samples made in three concentrations and the number of samples in the training set is 36. In order to alleviate the disturbances from the environment, operating error, measuring circuits and the stability of the sensor etc., these samples from the same kind of fragrance should be measured. But these samples should be measured only one time since it can be oxidized in air. After learning and recollecting all the characteristics of the jasmine fragrance, the developed electronic nose can be used for the recognition, classification and the quantitative evaluation or concentration estimating tasks.

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After the fragrance from the fabric was drawn into the box, it adsorbs on the active material or the sensitive membrane surfaces of the sensor which influences the physical parameters of the sensor. For each measuring sample, the sensor can produce multiple responding curves concerning the change in voltage Vs exposure time. Through filtering and A/D conversion, the maximum value of each curve is taken and it is transformed into multidimensional voltage response patterns. Then, by the recollection of the corresponding relationships between the characteristics through analysis of components and the sensor responses, the electronic nose can swiftly produce the required results such as concentration according to the multidimensional patterns.

A.DATA PROCESSING AND CONTROL

The sensor produces analog signals when the fragrance is recognized by it. The analog signals is then sent into the microcontroller where the data processing and control is done. When it enters the control unit, Microcontroller performs the conversion of analog to digital signals using 8 channels of 10-bit Analog-to-Digital (A/D) converter. Then, it enters Arithmetic logic unit where logical operations are done and finally the concentration values are displayed in LABVIEW Screen. The Program has also been designed to display the present-day values of concentration of the new samples. The block diagram showing the principle is given in figure 6

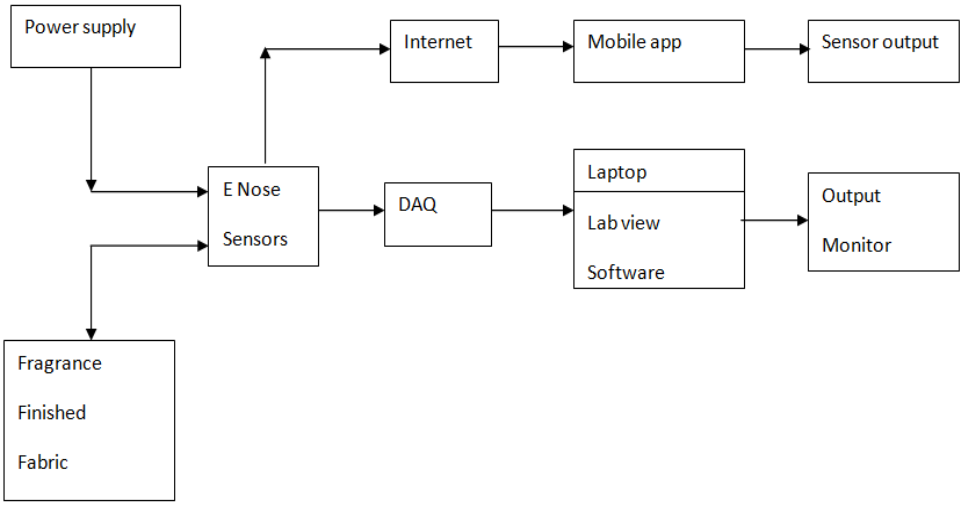

Fig 4. Block diagram of the principle of E Nose

B.LABVIEW

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a platform for system designing and provides a development oriented environment for visual programming in National Instruments. It is a graphical programming language used for creating, measurement and automation applications. Here we use graphical icons instead of text to create applications**.** The Programming language used in LabVIEW is dataflow programming language commonly known as G.G is used to execute the flow of data. It is used for parallel execution, multi processing and multi threading. LabVIEW is used for user interfacing. It consists of subroutines or programs called virtual instruments (VI). The VI comprises of a block diagram, a front panel and a connector panel. The front panel consists of control and indicator. The control is used for providing input and the indicator displays the output. The block diagram comprises of the graphical source code. Lab View program for Enose is shown in figure 5.

Figure 5: LabVIEW screen on laptop

C.INTERNET OF THINGS

Common Internet connection (named as enose2020) is made between Enose and Mobile of the end user where fragrance reports to be received. Blink -An app is installed in the mobile with new separate email ID. When the mobile got connected, the sensor output and graphs can be recorded as shown in figure. As the sensor senses the volatile compunds, the siganls are shown in the display and also in the graph form.

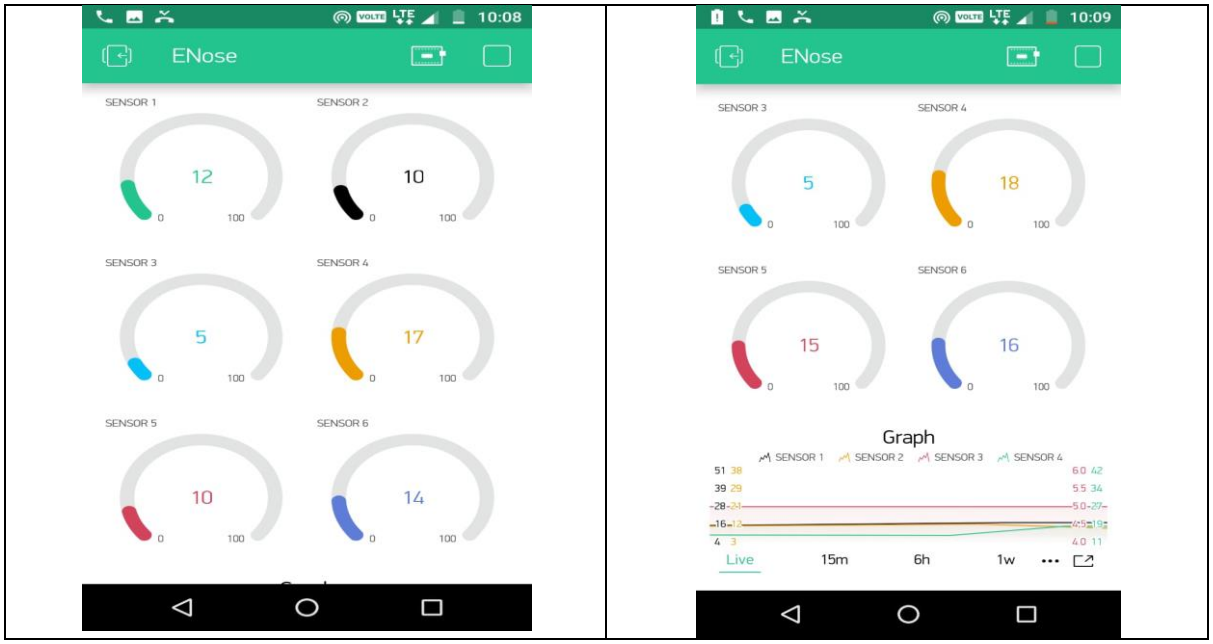

Figure 6: Sensor output screen in mobile

IV. CONCLUSION

The Electronic Nose is successfully fabricated to detect the fragrance applied over the fabrics for Quantitative evaluation of its durability over repeated washing cycles and ageing. It consists of ENose setup box connected with LapTop installed with Lab VIEW to view the sensor output. The samples were tested through Electronic nose and human sensory test. The developed Electronic Nose has been proved to have higher classification accuracy for detecting fragrance finished fabrics by overwhelming the complications in the human panels rating system. Based on the number and selection of sensors, Enose measurement can be improved further.

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