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DEVELOPMENT OF LABVIEW BASED ELECTRONIC NOSE TO DETERMINE THE QUALITY OF FOOD

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ABSTRACT

An electronic nose is designed and developed to study the ripening stages of the fruits and to detect the quality of the fruits and vegetables. The system has its applications in agriculture and food industries, helps to identify good qualities of various fruits and vegetables. The system is low cost, portable easy to handle and non-destructive that gives rapid performance and detection. The system senses gases produced by the fruits and vegetables by means of a gas sensor array and further processed by an artificial neural network (ANN), Laptop/PC with LabVIEW software and NImyDAQ. The GUI for the system is developed using a LabVIEW tool. The results are compared and displayed using radar pattern.

KEYWORDS: *Gas chamber, Sensor array, ANN, NImyDAQ, PCB*

I. INTRODUCTION

Human's life is becoming effortless and protective day by day, since the occurance of fast and smart technologies. Hundreds and thousands of devices are being used by our daily routine and we all are dependent on the electronic technology for the want of the simplest and easiest life. Healthy food is the most important things of all for the human body, which include drinks, fruits, vegetables, fast food, some spicy food, milk, meat, eggs etc. In many cases and more often it is very difficult to determine and judge the quality of the food. In general, the quality can be judged by mere observation or by press or by smell or after eating. But in most of the cases, human can't judge the quality of the fruits and vegetables or the freshness. Food containing pathogenic microorganisms can be extremely harmful for customer's health; while most food-borne diseases are sporadic and often not reported food-borne disease outbreaks may take on massive proportions [1]. Now a days, many researchers are working on the above is use and some systems are successfully launched and worked out on the food quality and food preservation. The purpose of this paper is to present a portable and autonomous electronic nose based on the non-destructive method using LabVIEW software, for the study of various ripening stages and to determine the freshness of the fruits and vegetables.

Aroma is one of the most significant parameters among the sensor properties of the foods. The characteristic flavour of volatile compounds (so-called fingerprint) may provide information about safety and specific characteristics of food, acting sometimes as an indicator of the process fault as well [1]. Indeed, some volatile compounds can originate from biochemical processes of the food, as a consequence of technological treatments or product storage. Unwanted smells (off-flavours) may include substances originating from the metabolism of the spoiled microorganisms, bacteria and fungi, which may naturally or accidentally contaminate the products prior or during its production [2]. The sense of smell is perhaps the least appreciated of the five senses. While many animals rely heavily on their acute sense of smell, it is becoming decreasingly important to man [3]. The field of olfaction science only recently began to enjoy the bouquet of respectability it now has. An instrument that could perform simple odour discrimination and provide measurement of odour intensity would be

the most useful [4]. Such an instrument (an Electronic nose) has received much attention in recent years both from the academic and industrial view points. An electronic nose is a device, which comprises an array of electronic chemical sensors and an appropriate pattern-recognition system, capable of recognising simple or complex odours [5]. These noses are well-known as efficient analytic devices that are widely used for many applications such as quality control of foods [1–5] and beverages [6–9], public safety [10,11], air protection [12,13], medical applications [14–18] etc. Recently, use of e-nose has been made for the measurement of human body odor.
Our system comprises gas sensor array, portable DAQ device, ANN in LabVIEW (version 2014) and a gas chamber. Gas sensor array is made up of SnO_2 type gas sensors and is pioneer for detection of the gas concentration emitted by the samples (fruits/vegetables or any food). NImyDAQ is portable device and is well-suited for LabVIEW software in which GUI is designed for ANN.

II. EXPERIMENTAL SET-UP AND THE DETAILS

An attractive and alternative strategy for determining state of the ripeness of the fruit consists of sensing the aromatic volatiles emitted by the fruit using electronic artificial nose system [24, 25]. The electronic-nose system appear to be very promising for determining fruit ripeness because they are based on the inexpensive, simple and non-specific solid-state sensors, which are sensitive to ethylene (the ripening hormone in climacteric fruits, such as apples, peaches, bananas, etc.) and to some other volatile compounds emitted by the fruits during ripening. Furthermore, once trained the system does not require a skilled operator and works with a faster response (few second) [23].

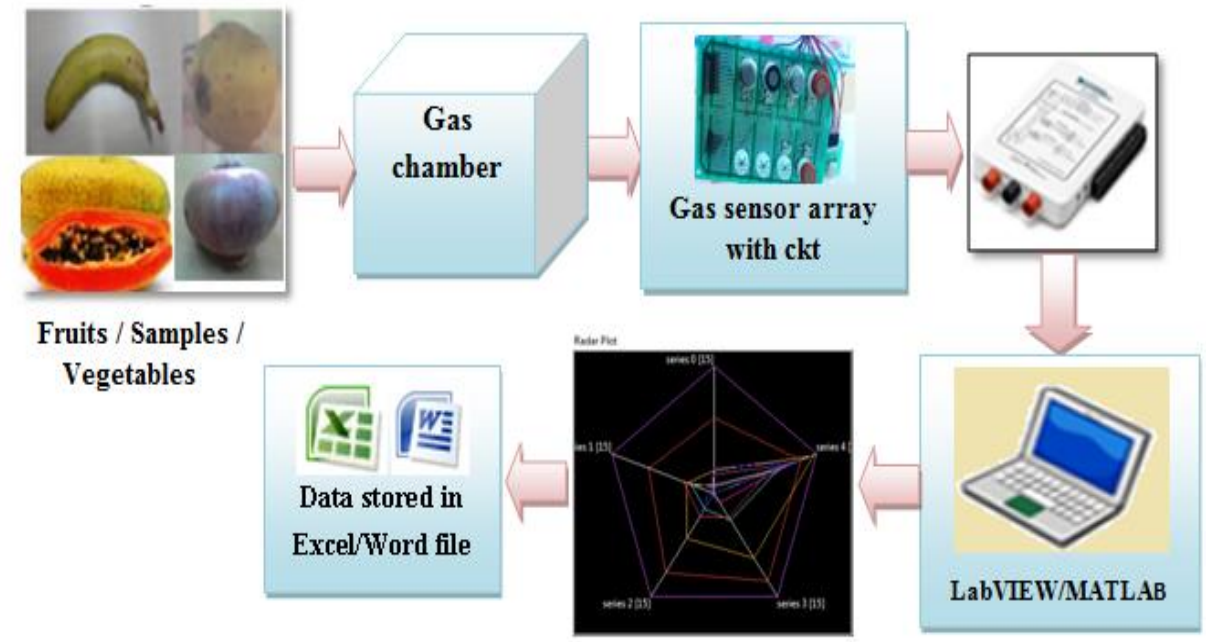

Fig.1.1 The experimental setting of an E-Nose (for fruits or vegetables).

2.1 hardware section:

In electronic-nose equipment, an array of gas sensors detects aroma in the gas chamber and converts it into voltage. We have observed various ripening stages and freshness of various fruits and quality of the vegetables using this system (i.e. Papaya, Banana, and Onion etc.).
An array detects those gases which are emitted by the fruits or vegetables, the various gas sensors in the array were MQ3, MQ7, MQ5, MQ135 and MQ9. These gas sensors detect alcohol, carbon monoxide (CO), natural gases, ammonia, and methane and propane gases respectively. Measurement circuit of sensor array was connected to DAQ card.
NImyDAQ is portable device basically used as an interfacing tool between hardware and software sections. An experimental arrangement of an E-Nose is shown in figure 1.1.

2.2 Software section:

The core part of the software section is LabVIEW 2014 which is a highly interactive language. An ANN GUI is designed in LabVIEW software. The Radar pattern/chart and data are displayed on front panel of the LabVIEW. The real times data are stored in excel or word file for future work.

III. RESULTS AND DISCUSSION

The results of the e-nose analysis performed on the different fruits (papaya, banana, onion) with the LabVIEW front panel are presented in figures 1.2,1. 3 and 1.4. These figures show the radar patterns and the graphical presentation on the front panel developed by G-code for all the sensors. G-code is developed for stand-alone-application, since it is used for other system in same types of applications. The radar pattern should be applied to discriminate between rotten stage and normal condition onion in this study; because this is the general microbiological safety guideline applied for food quality, it also differentiates between fruits (banana and papaya).

Figure 1.2 gives you an idea of the radar pattern and comparative plots of ripening stages of papaya. In the figure 1.2, 'A' part shows radar pattern and 'B' shows the comparatively graph of all sensors with respect to time. Radar pattern helps to distinguish between fruits. Mixed signal graph shows the response of the gas sensors of papaya (i.e. amplitude vs. time). It was decided that a quality and under ripe, ripe and over ripe state of fruit.

A similar system was developed for other types of fruits and analyzed. Figure 1.3 present the radar chart/ pattern and graph of ripening stages of banana. A stand-alone application allows the user to run GUI without installing the LabVIEW software on other PC. LabVIEW Run-Time Engine is necessary for running stand-alone application. Our graphical code (G-Code) will secure and protected by the stand-alone application. It provides other users with executable version VIs. Once stand-alone application is created, other persons cannot change GUI code [27].

In the figure 1.3, 'a' part shows radar pattern and 'b' part shows the comparatively graph of all sensors with respect to time of banana. The graph shows response of all sensors from the beginning (i.e. under ripe stage) to the end (over ripe stage). The voltage (amplitude) of the sensors goes to decreases up to the ripened stage. At the ripened stage voltage is low and it was increased when banana goes to over ripe stage. At the ripened stage the voltage is low.

In the case of onion actual experiment is divided into 2 steps. In the first step the samples or the given onions which are used for experiment are in the good condition, i.e. is in edible form. And in the second step, some of the onions are replaced with rotten onions. In the following figures 1.4 "a" shows the pattern for those onions which were in the good condition and figure "b" shows the pattern for rotten onion after replacing. [26] Radar pattern of papaya and banana are different.

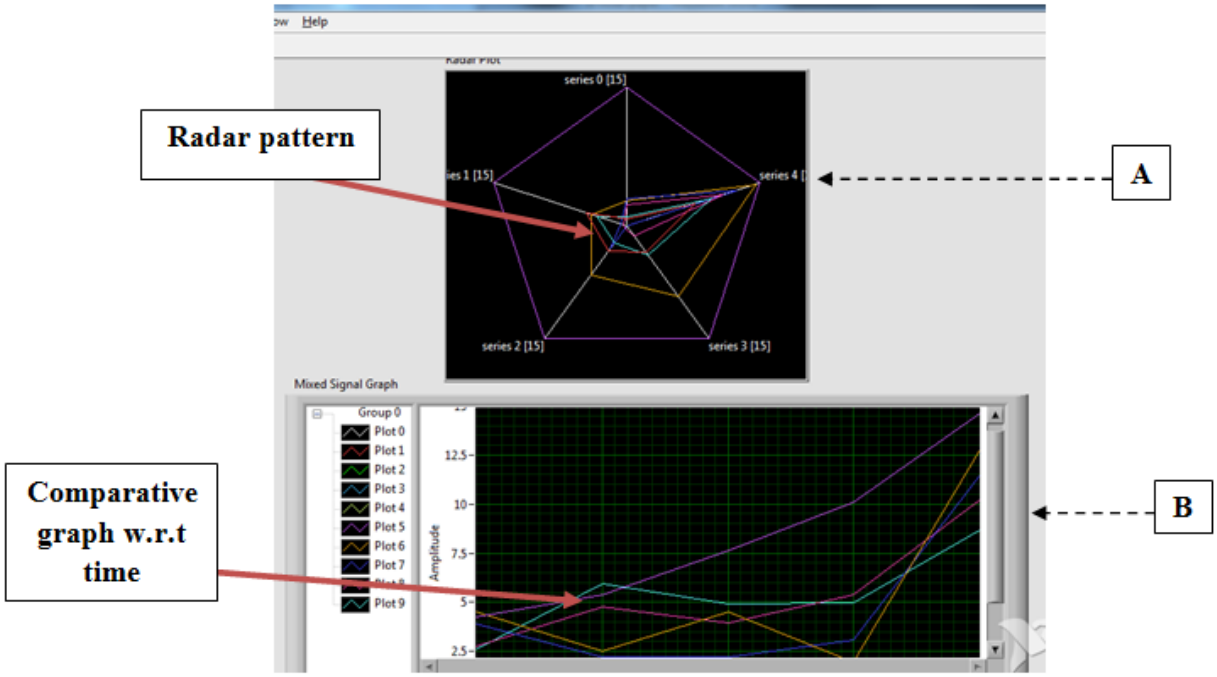

Fig 1.2 (A,B) Radar pattern and ripening stages of Papaya

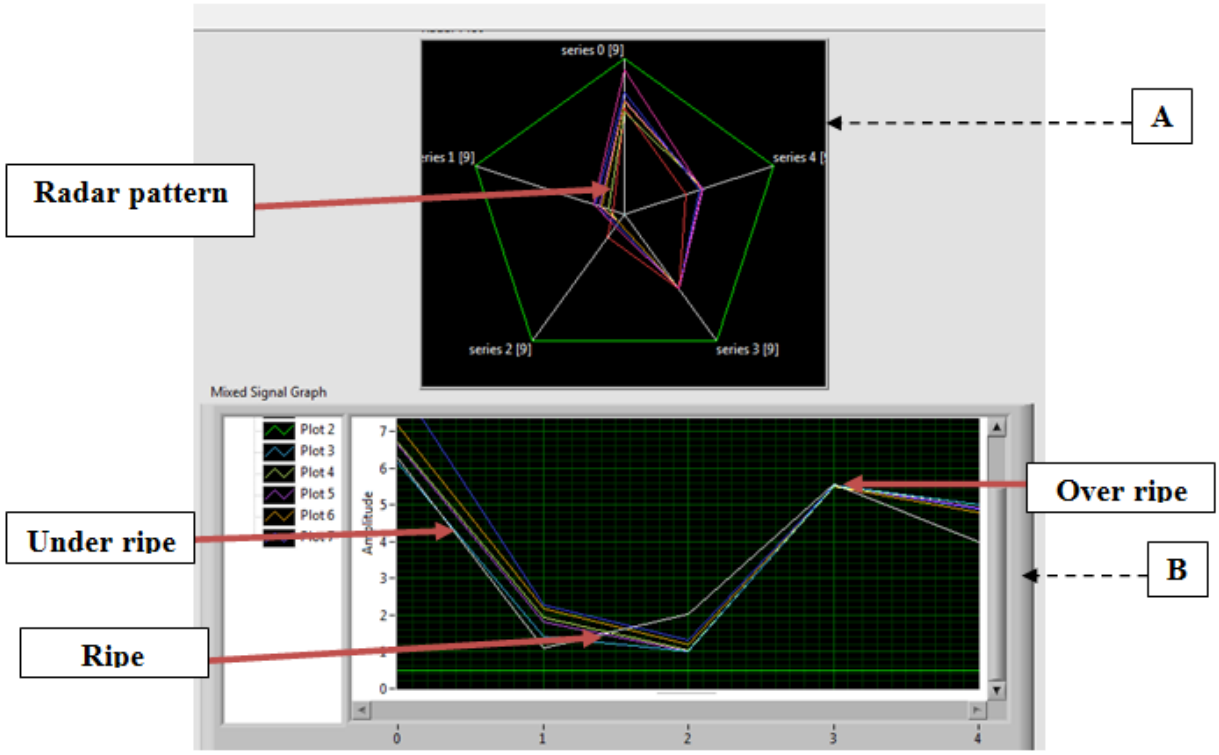

Fig. 1.3(A,B) Radar pattern and ripening stages of Banana

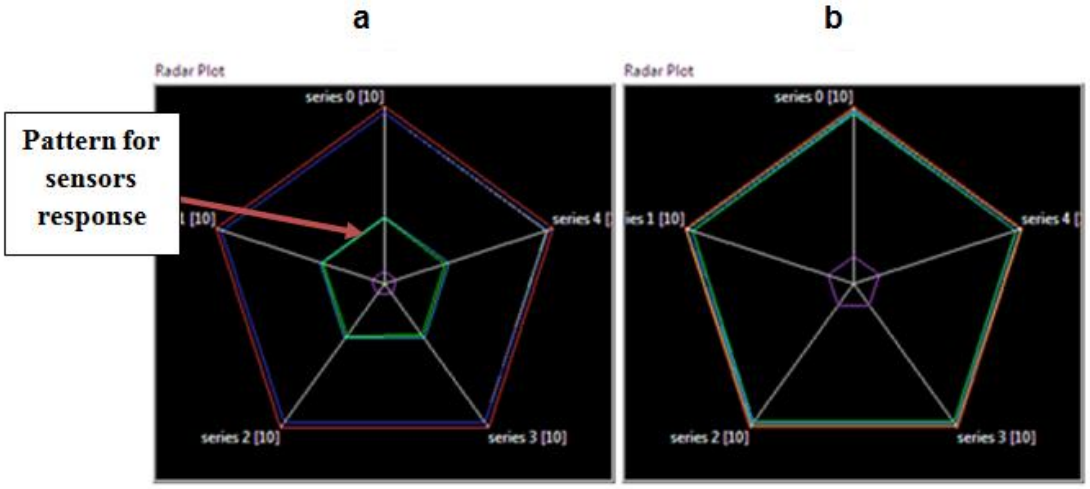

Fig. 1.4 Radar patterns of all the gas sensors for Onion: a) Good condition and b) Rotten onion [26]

IV. CONCLUSIONS

In the present investigation, we have successfully developed a simple and rapid electronic nose technique for the fruits freshness and spoilage classification of onion. The electronic nose technique, has the advantage of being fast and non destructive. The efficiency of the electronic nose in the quality control of food was demonstrated in different applications. First, the electronic nose was used to detect the freshness and to study the ripening stages of fruits. And then it was successfully classified the types fruit.

In our work, an application-specific sensor system designed to measure fruit ripeness has been implemented and tested. Studies with Papaya and Banana, where electronic nose measurements have been correlated with well-established fruit-quality techniques, have shown that some quality parameters can be predicted reasonably well using electronic nose signals without destroying the fruit.

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