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Low-cost E-nose: To identify and study the ripeness of fruit

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ABSTRACT

This paper explains the E-nose to monitoring fruit ripeness & to identify fruits with the implementation of Artificial Neural Network based Micro-controller. We are using or array of sensors (both gas & color) to monitor the ripeness. Though, at first, it gives the result of low accuracy, after repeated training it becomes intelligent. The system's outpost can be given in lab view for the more versatile outcome. This project can be used in both supermarkets or by vendors or for domestic purposes for both the use of identification of the fruit & as visual appearance does not always give proper result.

Keywords— *E-nose, Lab view, Arduino, Micro controller, Artificial Neural Network*

1. INTRODUCTION

Fruits quality is monitored by consumers primarily from their visual appeal (Colors, Size, Lack of blemishes, texture), Ripeness aroma & Scent. From pre-harvest to the post-harvest stage, fruits change their chemical, physical properties. Fruits varieties depend on aroma characteristics due to differences in the composition of the aromatic volatiles present in fruit aroma, which depends on plant genetics previously, the ripeness of fruit is determined by only visual appearance. E-nose gives qualitative & Quantitative aroma study.

E-noses are costly, complex & need advance technologist to operate. But, this model is simple, easy to operate & of low cost. So that general people can use it for small industries or domestic purposes. Though its Artificial Neural Network based, at first it gives results with low accuracy. But after repeated training, we can make it an artificial one.

The Arduino Mega & Arduino Uno controllers are used here. Data processing is mainly done in Arduino Mega and the output is transmitted to Lab view via LIFA interface in Arduino UNO Controller. RBG color sensor gas sensor, (CH_4) temperature sensor (LM35), humidity sensor & moisture sensor. Their seven sensors are used to sense the quality of the fruit with its identification. This array of sensors take rates from the raw data's.

2. BLOCK DIAGRAM REPRESENTATION

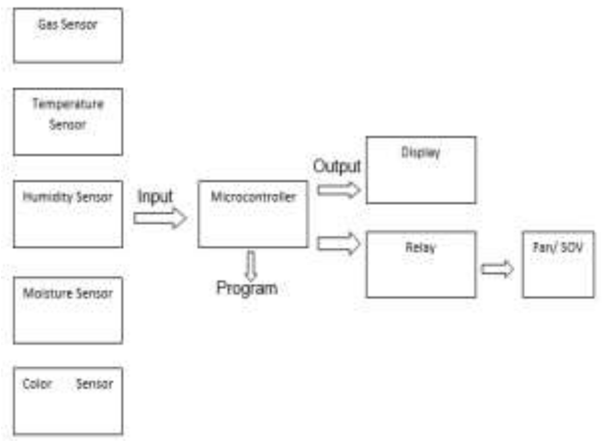

Fig. 1: Block diagram

The main sensors of the project area gas sensor, temperature sensor, humidity sensor, moisture sensor & RGB color sensor. This array of sensors gives the raw data to the microcontroller.

The program is fed by the Arduino software to the microcontroller. LCD and relay are the final output section LCD give the display of the output while the relay is the actuator for the FCE (Final Control Element) like the fan and SOV.

The program is fed to the controller Arduino Mega by the open source software 'Arduino IDE'. Again Arduino Uro is also used in this project.

3. CONNECTION DIAGRAM OR CIRCUIT DIAGRAM

From the connection diagram, we can say that the primary system has these components – microcontroller LCD, Colour Sensor, Temperature Sensor, Humidity Sensor, CH_4 Sensor, Humidity Sensor, air quality sensor, and switch. When the switch is in training mode, it works as the training process and when it's in control mode, it controls. All sensors are analog exact RGB. They give analog output. All the sensors have three pins. One goes to +5 Volt, one to ground and other to output. There is also a color sensor, i.e., RGB (Red Green Blue) sensor. The LCD is 16/2 LCD (Liquid Crystal Display).

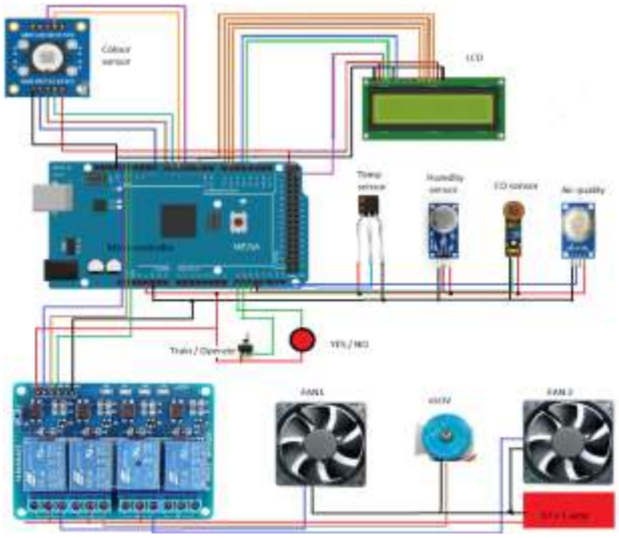

Fig. 2: Circuit diagram for the e-nose

4. WORKING

The overview of the project is very simple but the actual calculation running inside the controller is quite complex.

Each sensor generates three values at a time. So, total 7 sensors will give 7x3 =21 values at a time. RGB gives value in the range of 0-255. The system takes such sever samples & generates 7x7= matrix, which is the input matrix for that ANN. Inputs are fed to the controller will non-analyze it by dividing by 1024. But for the RGB output, it'll multiply the value by four & then only division by 1024 is done by the controller. Controller feds the data according to the program given to it. 1000 cycles are done in 10 seconds as one cycle gives 21 values in only 1 milli sec. The final outcome will be displayed on the LCD.

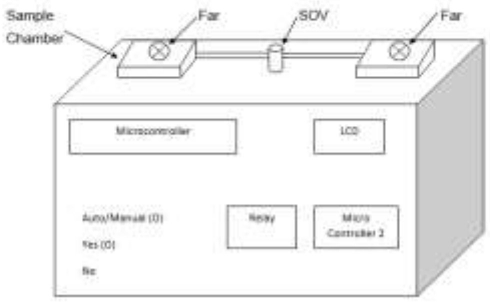

Fig. 3: Air flow in the system

Microcontroller 2 is mainly to give data on the sensors to Lab view. LIFA software is deployed in the controller & V1 is designed to provide graphical user Interface (GUI).

The LabVIEW interface for the system is shown in figure 4:

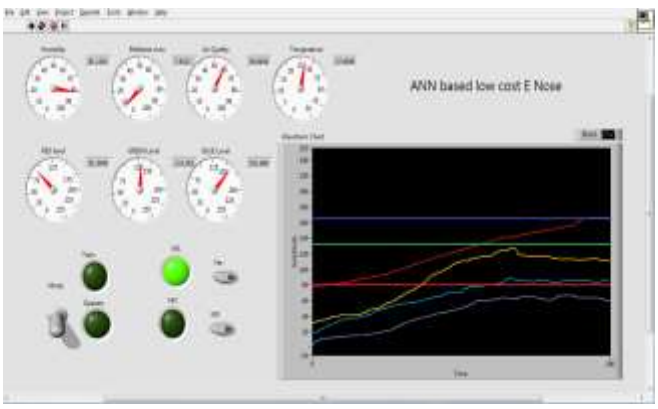

Fig. 4: Lab VIEW front panel

The actual hardware fabrication and connections are shown in figure 5.

Fig. 5: Actual hardware

5. PROCEDURE OF OPERATION

There are two modes of training mode & operate mode. In the training mode by inserting different samples in the sample chamber, the system introduces sample system gives the output and we should respond by YES/NO button to train about its result. If the answer is YES it keeps the weight, otherwise, it takes another weight and repeats the process.

After training, operation mode starts. This time if it gives error result, then again training starts. Thus, training is repeated to get a more accurate result with different environment & different samples gradually it gives more, accuracy.

6. RESULTS AND DISCUSSION

After implementing the system on hardware following data are obtained

Table 1: Sample testing

S. No.	Sample	Output
1	Apple	Guava
2	Guava	Guava
3	Banana	Apple
4	Apple	Banana
5	Guava	Apple
6	Banana	Apple
7	Apple	Banana
8	Guava	Guava
9	Banana	Banana
10	Apple	Apple
11	Guava	Guava
12	Banana	Banana

We have observed for twelve results with error previously after sometimes, we are getting a more accurate result. We may say that we have got 70% accuracy. First, we have done the identification of the fruit & then the ripeness.

Table 2: Ripeness test

S. No.	Sample	Actual Ripeness	Result
1	Apple	Under-ripe	Ripe
2	Guava	Ripe	Under-ripe
3	Banana	Over Ripe	Under Ripe
4	Apple	Under-ripe	Ripe
5	Guava	Ripe	Over Ripe
6	Banana	Over ripe	Ripe
7	Apple	Under ripe	Under ripe
8	Guava	Ripe	Over ripe
9	Banana	Over ripe	Over ripe
10	Apple	Under ripe	Under ripe
11	Guava	Ripe	Ripe
12	Banana	Over ripe	Overripe

7. CONCLUSION

Artificial Intelligence is an advanced process. As like as the human brain, the artificial intelligence can be trained for the more accurate result. That's the sweetness of the artificial intelligence. So we will get the more accurate result by training repeatedly. By inserting other sensor or by replacing sensors, we can use this projects in other fields also.

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