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ANN Based Electronic Nose using LabVIEW and Arduino

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Abstract:
This paper explains the implementation of microcontroller to design low cost electronic nose. The system is based on Artificial Neural Network (ANN), which uses an array of gas sensors to detect the quality of fruit samples given to it. The system is low cost and becomes intelligent gradually as we repeatedly train the hardware. ANN based microcontroller operated system can be used not only in fruit quality monitoring but also in all industrial and home equipment where there is always a necessity of low cost E-nose technology. The system can be connected to LabVIEW which makes it more versatile for research and development

Keywords: ANN, Microcontroller, E-nose , Lab VIEW , LIFA , Arduino

I.INTRODUCTION

Existing E-nose are used only in laboratory applications. They are very costly and of several lakh of rupees and quite complex in nature. Special skilled person is required to operate such type of equipment. Although they are very useful but they are out of reach for small industrial application and household task. This is due to its high cost, complexity and maintenance. The idea behind this project is to replace such complex hardware sophisticated E-noses with low cost microcontroller and different types of sensors. In order to maintain its accuracy ANN is brought in to the system and we train the system repeatedly to make it more intelligent. This is very near to the conventional E-nose with a very low cost and quite simple hardware design. The system is a microcontroller operated device in which an array of sensors is used to collect the raw data from the sample. The sensor used are methane sensor (MQ-7), humidity sensor, moisture sensor, temperature sensor(LM35) and a RGB color sensor. All the sensors fetch the data from the fruit sample and sent it back to the controller. The controllers used are “Arduino Mega”and “Arduino Uno”. The data processing is done in “Arduino Mega” while “Arduino Uno” is used to transmit the raw data to LabVIEW through an interface called LIFA. In order to maintain the air flow through the sample a pair of fan and SOV are used which again controlled by the Arduino Mega itself.

II. BLOCK DIAGRAM REPRESENTATION

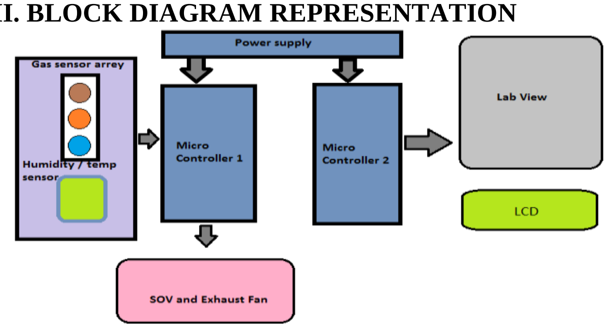

Figure.1. Block diagram

As it is seen in the block diagram, that the system consists of an array of sensors comprising of methane gas sensor, humidity sensor, air quality sensor & RGB color sensor.All these sensors work as an input device to the system collecting data from the sample and the data is fed to the controller. In the output section there are LCD and LabVIEW work as a display unit to provide visual information to the user. Relay and the SOV are other output to the system for its proper functioning. The program is fed to the controller Arduino Mega by the open source software “Arduino IDE” and is powered through a constant power supply.

III. CIRCUIT DIAGRAM

Figure 2 shows the circuit diagram for the system

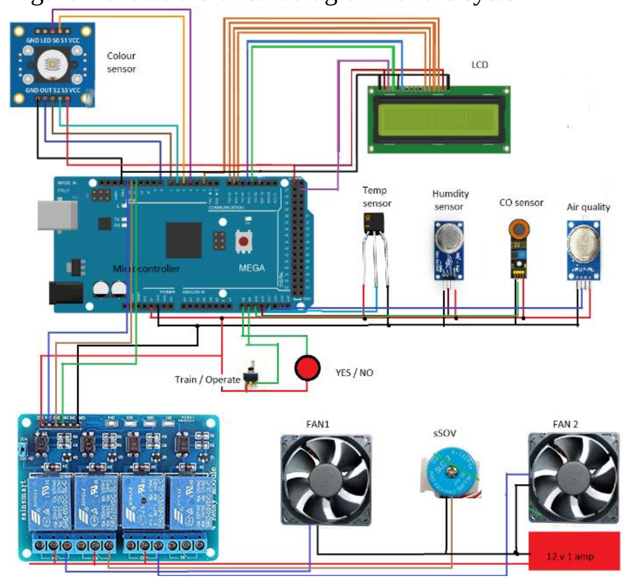

Figure.2. Circuit diagram for the e nose

IV.WORKING:

The main function of an ANN system is to adjust the weight in order to minimize the error. In this system there are five sensors. Four of them are analog sensor while the RGB color sensor is digital in nature. These five sensors give seven different value for a single sampling. Each of four analog sensors give a single value, while the RGB gives three data (forred, green and blue in the range of 0-255). Thus, generating seven values in a single sampling. The system takes such seven samples and produce a 7X7 matrix. Now this is the input matrix to the ANN system. The input is fed to the controller and the controller process the data according to the ANN program fed in to it. 1000 cycle are taken to minimize the error with a satisfactory execution time of about 10 seconds. Finally, the data is displayed in LCD. During the fetching process of data, controller also do its auxiliary task.It opens and closes the SOV and Fan in order to provide a smooth air flow from the sample chamber to sensor chamber. This exhaust air is also used in cooling the processor.

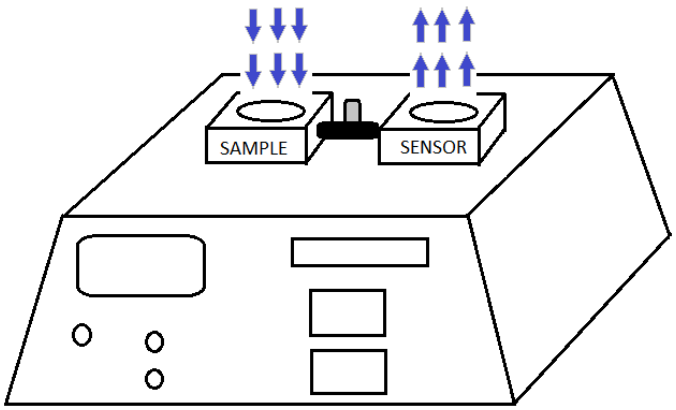

Figure.3. Air flow in the system

There is another one microcontroller unit (Arduino UNO). This controller provides information to the LabVIEW. For this operation LIFA (LabVIEW Interface for Arduino) software is deployed in the controller and the VI is designed to provide Graphical user interface(GUI). The LabVIEW interface for the system is shown in figure 4

Figure.4. Lab VIEW front panel

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

Figure.5. Actual Hardware

V. PROCEDURE OF OPERATION

The system operates on ANN. So handling the device is not similar to any other control system. Here, after the power is provided to the system, the user has two choices. Either train or operate. In training mode, we must train the system. A sample is introduced by inserting it to the sample chamber. The system returns a result, and the user must verify the result with “YES/NO” button, if the user pressed YES, the weight is kept otherwise it discards and repeats the calculation for another weight. After training the system, it is shifted to operating mode, where the sample is again placed in the sample chamber and the result is checked. If the system gives error the training process is repeated, and this process continues for different samples at different environment. The accuracy increases gradually after each train of ANN.

VI.RESULTS AND DISCUSSION:

After implementing the system on hardware following data are obtained

Table.1. Sample testing chart

Experiment No	Sample	Result	Remarks
1	Guava	Unable to recognized	Fail
2	mango	mango	pass
3	banana	mango	fail
4	Guava	Guava	pass
5	mango	mango	pass
6	banana	banana	pass
7	Guava(yellow)	banana	fail
8	Guava(yellow)	guava	pass
9	banana	banana	pass
10	mango	mango	pass

As we observed that the data we have found that out of 10 samples the system can be able to recognize seven sample correctly, with an accuracy of 70%. It is also observed that when the system is exposed to a new situation it sometime fails this is due to the adjustment of the weight. The beauty of the system is that it corrects the error automatically and gives accurate result next time which is quite impressive. More over the accuracy increases gradually.

VII. CONCLUSION

ANN based system works like a human brain. As we train the system more and more, the system becomes more accurate. So, we can conclude that the system can be used in the field level to recognize the odor of flavor of different food samples. Moreover, by replacing one type of sensor with another, the system can be made more reliable and versatile.

VIII. REFFERENCES:

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