Real Time Olfaction Monitoring system & Implementation of E-sensing Technique in Electronic Nose

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Abstract –*E-sensing is basically the detects the particular odor using electronic metal oxide sensors(MOS). Efficient number of Electronic Nose have to be developed to allow embedded systems and electronic circuits to recognize the odors in real time. This deals with real time odor detection using various microcontroller. In this project the odor detection is based on pattern recognition done in LABVIEW. This system consists of a sensor array of four MOS sensors for odor detection. The MOS sensor array is utilized to sense the odor from the sample to recognize the material. The proposed system, based on the input signal from the odor to sensors so as to plot the on LABVIEW. E-nose is ideal instrument to measure and monitor carbon and greenhouse-gas emissions due to their sensitivity to a wide diversity of volatile organic compounds (VOCs).*

Key Words: **E-sensing, MOS, Electronic Nose, LABVIEW, sensor array, VOC.**

1. INTRODUCTION

Electronic noses or e-noses are less a sensor or instrument and more a measurement strategy. Electronic noses have become popular and combine advanced sensors and sensor array strategies with chemo metrics techniques to produce a broad range of intermediate instruments and analyzers. Early e-noses tried to duplicate the behavior and capability of human odor sensing. They combined different sensor types to represent the different cell tissues in the nasal cavity and they took the approach of detecting an odor as a collection of individual chemicals. The name "odor sensor" is used instead of "gas sensor" whenever its sensitivity approaches that of a human. It is based on E-sensing which is basically the detection of odor content through various gas samples and processing it into electric signals. This system is the combination of hardware and software embedded system. E-nose is an artificial application for sniffers, robotic nose and pollution control device .It is used to assist breath analysis and gas leakage detection . Sensor array detects the variety of odors. This system finds its application in robotics and biomedical engineering. This system consists of a sensor array which is capable of reducing accidents due to gas leakages and prevent health hazards.It is also relevant to the corporates employee databases in which we can detect whether which employee is drunk. Police use the drunkometer, which is primitive form of electronic nose, to detect that the driver is within optimum alcohol consumption limit. undertaken this project to improve system of investigation where there is need of human sniffers and to prevent the hazards due to inhaling of poisonous gases which have currently been increased ,nowadays. Alcohol sensor measures the alcohol content in blood,CO_2 sensor detects carbon dioxide ,smoke sensor and combustion sensor detect the pollutant odor content . These sensors are composed of AL_2O_3 ceramic tube,SnO_2 sensitive layer , measuring electrode and heater. The heater provides necessary work conditions for work of sensitive components. Since analytical measurement of odor content requires the fumes of gases to reach out to sensor array and it sends a signal to the ADC to acquire the digital signal ,which causes the buzzer to buzz as a result the odor content is detected . We have equipped this project with LABVIEW so that the data i.e.the odor contents concentrations are compared on the LABVIEW.

2. Literature Review

The Standard approach to odor analysis is to employ analytical chemistry instruments such as Gas Chromatography and Mass Spectrometry (GC/MS). These are helpful in quantifying smells, but they are time consuming, expensive and seldom performed in real-time in the field (Troy Nagle 1998). This paved the way for the development of an alternative device so called "E-nose" with advancements in odor sensing technology and pattern recognition techniques. The main motivation behind this is the development of qualitative, low cost, real-time and portable device to perform reliable, objective and reproducible measures of volatile compounds and 31 odors. The E-nose draws its motivation from biology. In order to develop an E-nose it is useful to examine the physiology behind olfaction as it is necessary to achieve a reliable, subjective and analytically acceptable system (Keller 1999).

2.1 Existing Methodologies

i. Alcohol Detector

First Alcohol Detector was designed by Rolla Neil Harger in 1931 of the Indiana University School of Medicine. The Alcohol Detector collected a motorist's breath sample directly into a balloon inside the machine. The breath sample was then pumped through an acidified potassium permanganate solution. If there was alcohol in the breath sample, the solution changed color. The greater the color change, the more alcohol there was present in the breath.
The Alcohol Detector was manufactured and sold by Stephenson Corporation of Red Bank, New Jersey.

ii. Breath Analyzer

In 1954,Robert Frank Borkenstein ,a professor at Indiana University Bloomington implemented breath analyzer. Breath Analyzer used chemical oxidation and photometry to determine alcohol concentrations. Subsequent breath analyzers have converted primarily to infrared spectroscopy.

iii. Electronic Nose

In 1967 in Britain, Tom Parry Jones developed and marketed the first electronic breathalyzer. He established Lion Laboratories in Cardiff with his colleague, electrical engineer Bill Dulcie.The term “electronic nose” was coined in 1988 by Gardner and Bartlett, who later defined it as *“an instrument which comprises an array of electronic chemical sensors with partial specificity and appropriate pattern recognition system, capable of recognizing simple or complex odors”.*

iv.Timeline research history of electronic nose

Year	Manufacturer	Model
1914	Alexander Graham Bell	First Olfactory approach for odour detection
1931	Rolla Neil Herger	First Alcohol Detector
1954	Robert Frank Bornstein	First practical Drunk meter
1964	Wilkens and Hartman	First sensor arrays including Redox reactions
1967	Tom Parry Jones	First Electronic Breathalyzer.
1988	Gardner and Bartlett	The term Electronic Nose was appeared

Table 1 Literature survey of Electronic nose

2.2 Alternate Methods

We can make a device which uses sensor array to convert odor into electrical signal and saved as pattern for further pattern recognition.The proposed system is based on E-Sensing and the differentiation of odor of different samples using Artificial Neural Network (ANN) algorithm and implementation of K-Nearest Neighbor algorithm. This project describes that the microcontroller acts as the brain, sensors acts as the neurons and the ANN acts as the neural system. Active array devices like an e-nose produce complex signals or “signatures,” which have to be processed to extract the desired chemical species component information. It is natural and effective to pair e-nose signals with neural network classification and analysis methods that similarly mimic biological systems. It depicts that neural network algorithms can duplicate the more preferred chemo metrics pattern recognition methods, such as Bayesian classifiers, providing provable and statistically measurable confidence in their results. Neural methods execute simple mathematical operations in a highly parallel fashion and lend themselves to scalable execution from low-cost microcontrollers.

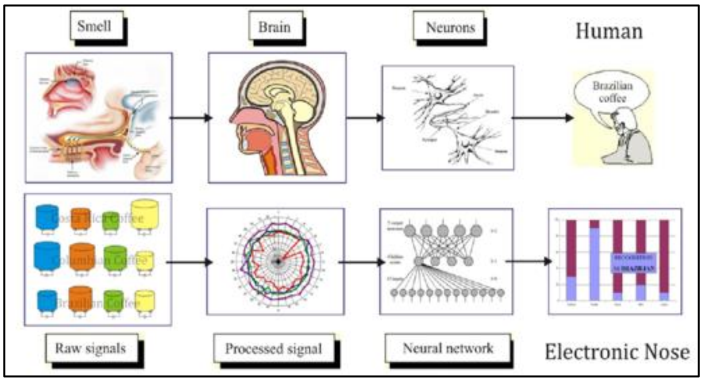

Fig- 1 Electronic Nose model based on Bio-Nose

3. Hardware Architecture

The hardware architecture of this system is composed of different hardware units. These are PIC18F4520 microcontroller, MQ-2, MQ-3, MQ-6, MQ-135 sensors, RS-232 IC for serial communication of data from sensors to PC, LCD display, Buzzer ,printed circuit board for mounting all the hardware, CP-2120 driver cable for interfacing circuit with the computer.

3.1 PIC 18F4520 microcontroller

PIC 18F4520 is a microcontroller which is based on the Von Neumann architecture. PICs are popular with both industrial developers because it has availability of RISC processors, serial-programming,re-programming with flash memory. It has 4 port each of 32bit.It has 4KB of internal data memory and 256KB of internal program memory. It has 4 port each of 32bit. on-chip RC oscillator. It is available in 40 pin DIP package.It requires 5V power supply.

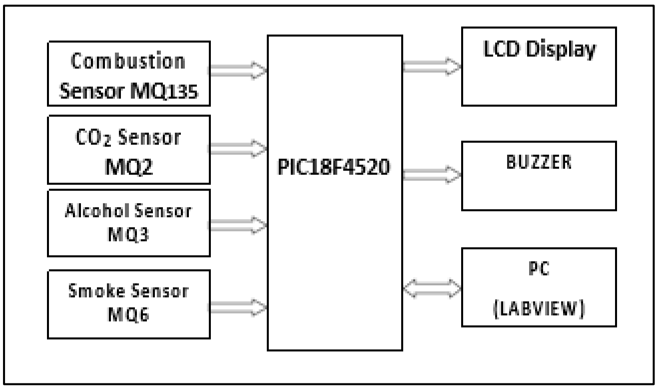

Fig- 2 Hardware Architecture

3.2 MQ-2 sensor

This CO_2 sensor is suitable for detecting carbon dioxide concentration in odor sample. It has a high sensitivity and fast response time. The enveloped MQ-2 have 6 pin ,4 of them are used to fetch signals, and other 2 are used for providing heating current. Sensor provides an analog resistive output based on carbon dioxide concentration. The drive circuit is very simple, all it needs is one resistor. A simple interface could be a 0-3.3V ADC.

Features of MQ-2 sensors are as follows:

- High sensitivity to CO_2 and small sensitivity to carbon monoxide(CO).
- Fast response and high sensitivity.
- Stable and long life.

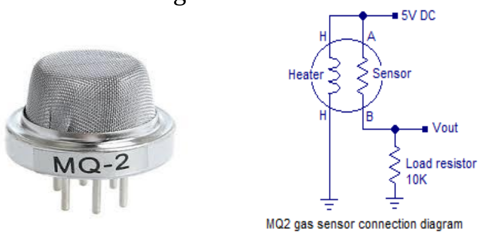

Fig- 3 MQ-2 CO_2 Detection Sensor

3.3 MQ-3 Sensor

This alcohol sensor is suitable for detecting alcohol concentration on your breath, just like your common breathalyzer. It has a high sensitivity and fast response time. Sensor provides an analog resistive output based on alcohol concentration. The drive circuit is very simple, all it needs is one resistor. A simple interface could be a 0-3.3V ADC.

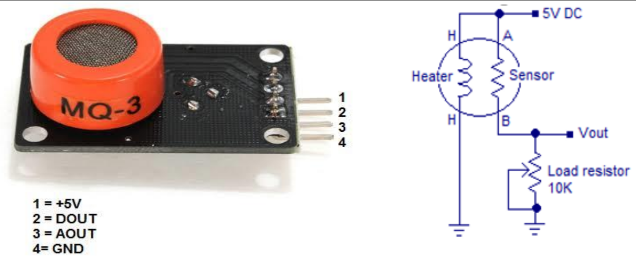

Fig- 4 MQ-3 Alcohol Detection Sensor

3.4 MQ-6 Sensor

Sensitive material of MQ-6 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, The sensor's conductivity is more higher along with the gas concentration rising .It is simple electronic circuit, that convert change of conductivity to correspond output signal of gas concentration.MQ-6 gas sensor has high sensitivity to Propane, Butane and LPG, also response to Natural gas. The sensor could be used to detect different combustible gas, especially Methane, it is with low cost and suitable for different application.

Features of MQ-2 sensors are as follows:

- Good sensitivity to Combustible gas in wide range
- High sensitivity to Propane, Butane and LPG
- Long life and low cost
- Simple drive circuit

Fig- 5 MQ-6 Smoke(LPG) Detection Sensor

3.5 MQ-135 Sensor

Sensitive material of MQ135 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, The sensor's conductivity is more higher along with the gas concentration rising. There is change of conductivity to correspond output signal of gas concentration.MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benzene steam, also sensitive to smoke and other harmful gases. It is with low cost and suitable for different application.

Features of MQ-2 sensors are as follows:

- Good sensitivity to Harmful gases in wide range
- High sensitivity to Ammonia, Sulfide and Benzene

Fig- 6 MQ-135 Combustion Detection Sensor

3.6 RS-232

This port configuration is used to transmit the data serially to PC for further processing. For this purpose it require a RS-232 port and DB-9 connector.

Fig- 7 RS-232 port and DB-9 connector

3.7 CP-2120 USB driver

The CP2120 is a highly-integrated SPI-to-I2C Bridge Controller with an SPI interface that provides a simple and reliable method for communicating with I2C devices. The CP2120 includes a 4-wire serial peripheral interface(SPI), a serial I2C interface, 256 byte data buffers, an internal oscillator, eight input/output port pins, and one pin configurable as an edge-triggered interrupt source in a compact 4x4 package .It passes the data from circuit to PC.

Fig- 8 CP-2120 USB driver

3.8 Working of System

In the hardware architecture, the PIC18F4520 is used for the processing the data and controlling different functions. The MQ-series sensor array is connected to the microcontroller using the port A as they work using analog signals. The 10-bit 12 channel ADC converts the analog data odor in ppm(parts per million) to digital data.

This data is displayed on LCD display and transmitted serially using RS-232 IC using RS-232,port DB-9 and CP-2120 driver to PC where data is given to LABVIEW which plots it amplitude vs. time variation of the signal .According to the received data system can be monitored and measures could be taken to regulate pollution control ,breath analyzer or alcohol control and combustion control.

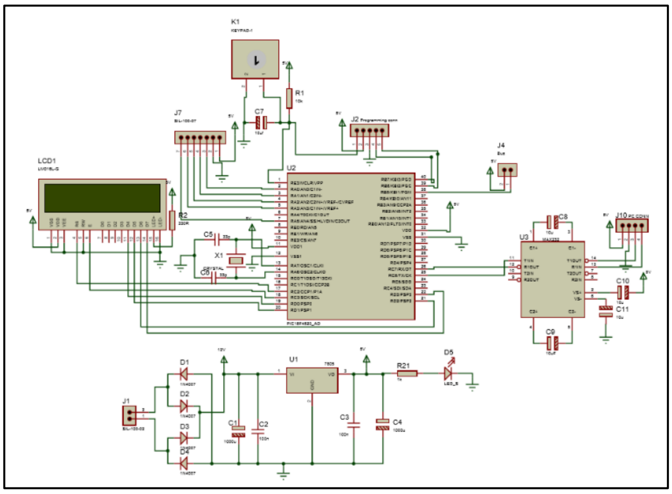

Fig- 9 Hardware Connection

4. Software Architecture

The software of this system is LABVIEW(Laboratory Visual Instrumentation Engineering Workbench) which we are going to use for odor detection using pattern recognition technique. The smell or odor of a sample is sensed by sensors and electrical signal generated by sensors is plotted by LABVIEW in amplitude vs. time. This plotted signal once determined is saved and compared again and again with other successive sample odor, If the new sample odor matches with the saved pattern or the plotted signal then it can be derived that the odors are same.

In this project, this method used is called machine learning which itself compares and derives the result.

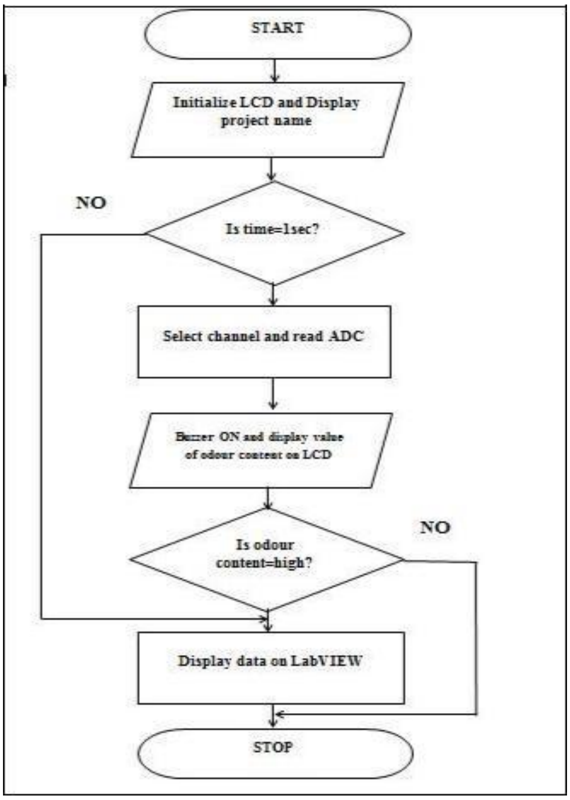

Fig- 10 Flowchart Diagram

4.1 LABVIEW

LABVIEW generates the pattern and plots the signal in amplitude vs. time Depending on the sample odor it give high peaks in amplitude for eg. if alcoholic odor is sensed then the window of MQ-3 alcohol detection sensor detects high amplitude peaks so that control actions are taken.

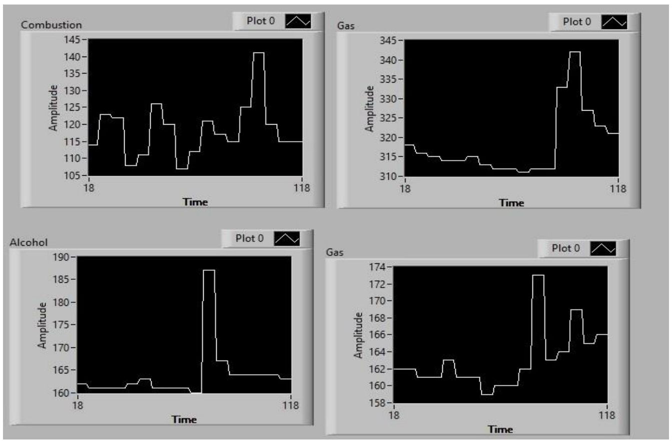

Fig- 11 MOS sensor array data on LABVIEW

5. Result Analysis

It was found that multiple mixed odor detection at the same time can cause confusion for inexperienced users, so we have introduced the specifiers to distinguish between odors. Further for higher sensitivity of sensors we have to switch on the sensors and keep it under monitoring for minimum 3 to 6 hours. Hence we have three modes air pollution control mode, breath analyzer mode and combustion control mode for higher sensitivity and faster response. To avoid the mixing of the odors the inverted funnel model is used for uniform distribution of odors.

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