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Remarks on Recognition of Aromas from Tea Sources Using MQ3, MQ5, MQ7 Sensor Signal

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ABSTRACT

This study investigated the capacity of a deep neural network to distinguish tea sources based on their aromas. The data set of aromas from tea sources, which contained sensor responses measured with a gas–sensing system using a mass–sensitive chemical sensors namely MQ3, MQ5, MQ7, was used to evaluate the recognition accuracy. To define the input vectors of the deep neural network in aroma recognition experiments, frequency analysis using a continuous wavelet transform, with the Morlet function as the mother wavelet, was used to extract features from the sensor signals of the data set. The deep neural network achieved a recognition accuracy of 100% for the tea sources and the base gas of de humidified indoor air. Comparing the recognition accuracy of the deep neural network to that obtained from other pattern recognition methods, such as naive Bayes and random forests, the experimental results demonstrated the effectiveness of applying a deep neural network to this task.

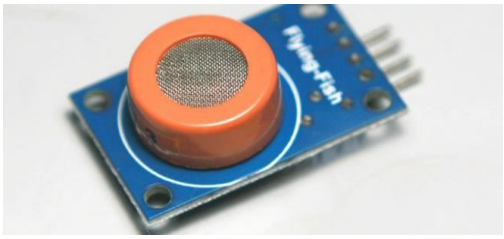
Keywords : MQ3, MQ5, MQ7, Morlet Function, The Recognition Accuracy

I. INTRODUCTION

An electronic device system is a smart instrument developed for detecting, analyzing, discriminating and recognizing complex odour by imitating the principal mechanisms and functions of biological olfactory systems. Its applications dealing with real–world problems related to odour are anticipated in various disciplines, such as environmental monitoring, food and beverage evaluation, flavour and fragrance testing, medical diagnoses, sending user messages, drug detection and robotics. To support this demand and develop a high–performance electronic device system, many studies on sensor devices, system integration of sensors and signal processing algorithms have been conducted. In an electronic device systems, a popular methodology uses a sensor device that transducers the response related to the

concentration change of the sample gas molecules that constitute odour into an electrical signal, signal processing that extracts the statistical or temporal features from the sensor signal, and an appropriate pattern recognition technique, such as cluster analysis, multilayer perceptions, neural networks, support vector machines and ensemble learning, that classifies the sensor response using the extracted features and identifies the type of sample gas. Neural networks that use deep learning Techniques have recently been attracting increasing attention in several fields and have been successfully used to solve intractable problems in image and speech recognition. The application of neural networks trained with deep learning techniques to an electronic device system may therefore be allow for recognition tasks to improve the recognition performance.

Tea is one of the most popular beverages around the world and can be roughly classified into two types based on the manufacturing process: fermented and unfermented. Each has its own unique aroma; for instance, fermented tea reflects a mix of chemicals produced by the enzymatic oxidation of tea polyphones during fermentation. The use of aromas to categories of tea sources, discriminate its grade and evaluate its quality has become an emerging application of electronic device systems from the viewpoint of scientific interests and industrial demands; therefore, many studies have focused on recognizing the aromas of tea sources, such as black tea, Japanese green tea and Chinese tea. In currently we are using three sensors namely MQ3, MQ5andMQ7 showed in Fig-1 (a), (b), (c) and applied it to the identification of tea types based on their aroma. Furthermore, the deep neural networks demonstrated a high recognition rate against the tea–type classification where the base gas was considered as recognition class because determining whether the sample gas exists is also an important basic function of the gas–sensing system. In this study, we conducted the recognition of aromas from tea sources using a deep neural network and compared the recognition performance with that obtained by other pattern recognition methods, such as naive Bayes and random forests, to clarify the effectiveness of using the deep neural network for this application.



(a)

(b)

(c)

Fig-1: (a),(b),(c)

II. DATA SET OF AROMAS FROM TEA SOURCES

To conduct experiments of aroma recognition, the sensor response data set of the aromas from tea sources, which was constructed by acquiring sensor responses with a gas–sensing system, was used. As shown in Fig-2,the gas–sensing system is switched on, then next step is 1) detecting the aromas using sensors that is sensor is convert the physical signal into its equivalent electrical signal, 2) then the detecting aroma signals are converted it into the digital signal, 3)the chip on the board plugs straight into your computer as a virtual serial port through this port data has been transfer to the computer,4)this system also

include the GSM module for transferring the message to the customer, i.e. type of tea, it is healthy or unhealthy etc. The materials of the sensorMQ3 are detecting the alcohol, Benzene content.MQ5 Sensor detecting the High Sensitivity to LPG and Natural Gas, Flat Response, Stable and Long Life, Both Digital and Analog Outputs On-board LED Indicator. Applications are Domestic gas leakage detector, Industrial Combustible gas detector, Portable gas detector, Gas leak alarm, Gas detector. MQ7 Sensor detecting the high sensitivity to carbon monoxide.

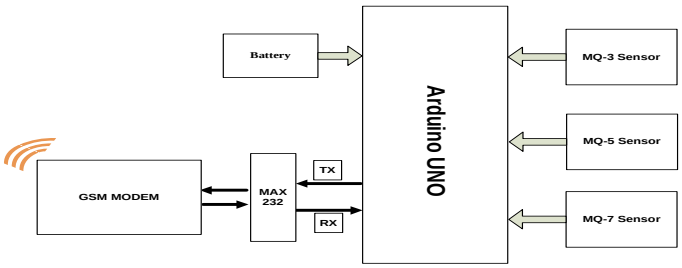


Fig-2 : Block diagram of gas–sensing system.

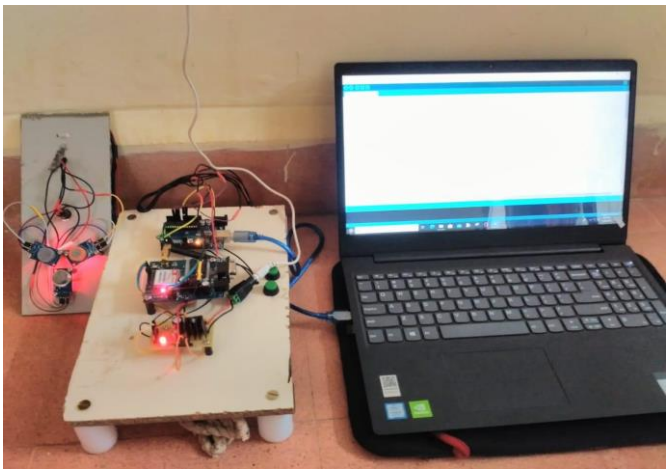


Fig-3 : Electronic device gas sensing system.

To collect the sensor responses, different types of tea sources were used as the sample gas source. The Fig-3 shows the Electronic device gas sensing system, it has combined the three different sensors in one board and detect the different gas features according to the variation of the data result will be decided.

1. Arduino module:

Arduino is an open-source platform for embedded and used for building embedded electronic projects. Both the physical and programmable pin to burn the IC is present in Arduino and run the program using IDE (Integrated Development Environment) that runs on computer, used to write and upload computer code to the physical board. As a platform Arduino becomes much popular with people just who are new to Embedded, and for good reason. The Arduino does not need separate part of hardware.

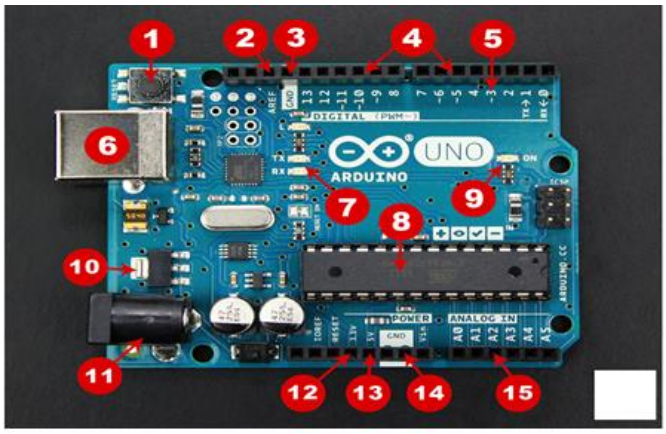


Fig-4 : ARDUINO UNO

Here are the components that make up an Arduino board and what each of their functions are.

- **Reset Button** – This will restart any code that is loaded to the Arduino board.
- **AREF** – Stands for "Analog Reference" and is used to set an external reference voltage.
- **Ground Pin** – There are a few ground pins on the Arduino and they all work the same.
- **Digital Input/Output** – Pins 0-13 can be used for digital input or output
- **PWM** – The pins marked with the (~) symbol can simulate analog output
- **Buss Connection** – Used for powering up your Arduino and uploading sketches.
- **TX/RX** – Transmit and receive data indication LEDs.
- **Microcontroller** – This is the brains and is where the programs are stored

- **Power LED Indicator** – This LED lights up anytime the board is plugged in a power source
- **Voltage Regulator** – This controls the amount of voltage going into the Arduino board
- **DC Power Barrel Jack** – This is used for powering your Arduino with a power supply**3.3V Pin** – This pin supplies 3.3 volts of power to your projects
- **5V Pin** – This pin supplies 5 volts of power to your projects
- **Ground Pins** – There are a few ground pins on the Arduino and they all work the same
- **Analog Pins** – These pins can read the signal from an analog sensor and convert it to digital

2. Sensors

2.1 MQ3 gas Sensor:

1) Features of MQ-3 Alcohol Sensor:

- Sensor Type - Semiconductor
- Easy SIP header interface
- Compatible with most of the microcontrollers
- Low-power standby mode
- Requires heater voltage
- Good sensitivity to alcohol gas
- Fast response and High sensitivity
- Long life and low cost
- Requires simple Drive circuit

2) Specifications of MQ-3 Gas Sensor

- Power requirements: 5 VDC @ ~165 mA (heater on) / ~60 mA (heater off)
- Current Consumption: 150mA
- DO output: TTL digital 0 and 1 (0.1 and 5V)
- AO output: 0.1- 0.3 V (relative to pollution), the maximum concentration of a voltage of about 4V
- Detecting Concentration: 0.05-10mg/L Alcohol
- Interface: 1 TTL compatible input (HSW), 1 TTL compatible output (ALR)
- Heater consumption: less than 750mW
- Operating temperature: 14 to 122 °F (-10 to 50°C)
- Load resistance: 200kΩ
- Sensitivity S: Rs(in air)/Rs(0.4mg/L Alcohol)≥5
- Sensing Resistance Rs: 2KΩ-20KΩ(in 0.4mg/l alcohol)
- Dimensions: 32 x 22 x 16 mm

2.2 MQ5 Sensor:

Gas Sensor (MQ5) module is useful for gas leakage detection (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer.

Features:

- Wide detecting scope
- Stable and long life
- Fast response and High sensitivity

Applications:

- Gas leakage detection.
- Toys.

2.3 MQ7 gas sensor:

MQ-7 Semiconductor Sensor for Combustible Gas Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. It make detection by method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). The sensors conductivity is higher along with the gas concentration rising. When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature. Please use simple electro circuit, Convert change of conductivity to correspond output signal of gas concentration.MQ-7 gas sensor has high sensitity to Carbon Monoxide. The sensor could be used to detect different gases contains CO; it is with low cost and suitable for different application.

3) Characters:

- High sensitivity to Combustible gas in wide range
- High sensitivity to Natural gas
- Fast response
- Wide detection range
- Stable performance, long life, low cost
- Simple drive circuit

3. GSM modem:

GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates.

Fig. 5. GSM Modem

There are various cell sizes in a GSM system such as macro, micro, Pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, Pico and umbrella cells. The coverage area of each cell varies according to the implementation environment.

Time Division Multiple Access:

TDMA technique relies on assigning different time slots to each user on the same frequency. It can easily adapt to data transmission and voice communication and can carry 64kbps to 120Mbps of data rate.

GSM Architecture:

A GSM network consists of the following components:

- **A Mobile Station:** It is the mobile phone which consists of the transceiver, the display and the processor and is controlled by a SIM card operating over the network.
- **Base Station Subsystem:** It acts as an interface between the mobile station and the network subsystem. It consists of the Base Transceiver Station which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the Base Station Controller which controls the Base Transceiver station and acts as a interface between the mobile station and mobile switching centre.
- **Network Subsystem:** It provides the basic network connection to the mobile stations. The basic part of the Network Subsystem is the Mobile Service Switching Centre which provides access to different networks like ISDN, PSTN etc. It also consists of the Home Location Register and the Visitor Location Register which provides the call routing and roaming capabilities of GSM. It also contains the Equipment Identity Register which maintains an account of all the mobile equipments wherein each mobile is identified by its own IMEI number. IMEI stands for International Mobile Equipment Identity.

Features of GSM Module:

- Improved spectrum efficiency
- International roaming
- Compatibility with integrated services digital network (ISDN)

- Support for new services.
- SIM phonebook management
- Fixed dialing number (FDN)
- Real time clock with alarm management
- High-quality speech
- Uses encryption to make phone calls more secure
- Short message service (SMS)

The security strategies standardized for the GSM system make it the most secure telecommunications standard currently accessible. Although the confidentiality of a call and secrecy of the GSM subscriber is just ensured on the radio channel, this is a major step in achieving end-to- end security.

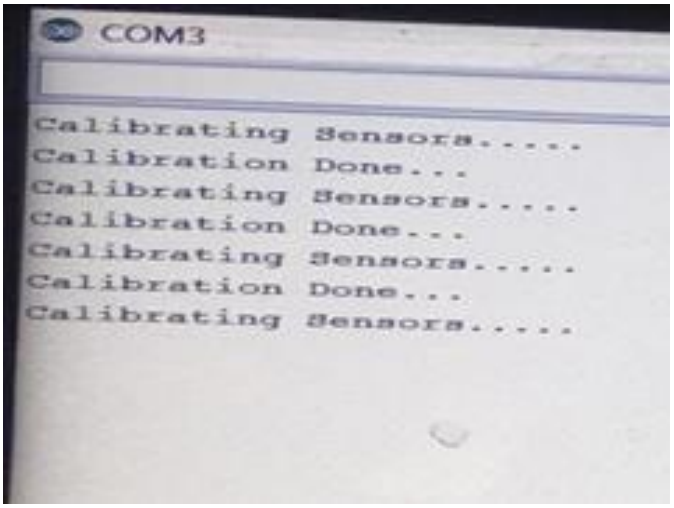
Working of GSM Module:

GSM modem duly interfaced to the MC through the level shifter IC Max232. The SIM card mounted GSM modem upon receiving digit command by SMS from any cell phone send that data to the MC through serial communication. While the program is executed, the GSM modem receives command 'STOP' to develop an output at the MC, the contact point of which are used to disable the ignition switch. The command so sent by the user is based on an intimation received by him through the GSM modem 'ALERT' a programmed message only if the input is driven low. The complete operation is displayed over 16×2 LCD display.

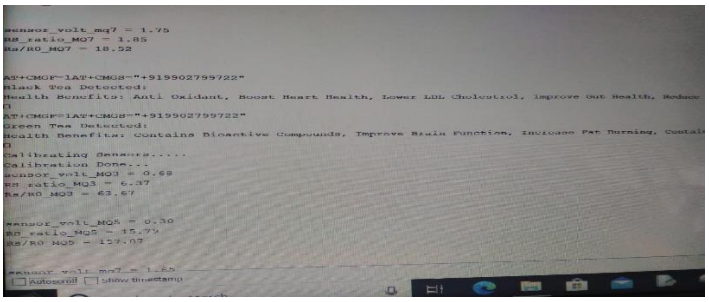
III. EXPERIMENTS and RESULTS

An Electronic device gas sensing system, the time domain features extracted from time–series data of sensor responses, such as features are affected by variations in the temperature and humidity of the gas. To guarantee robustness against dynamic changes in the concentration of the sample gas and its humidity, the frequency domain features extracted from sensor signals using a short–time Fourier transform has been proposed. Consequently, in this study, the feature vector v used for aroma recognition consisted of the frequency domain features obtained from the continuous wavelet transform using the Morlet function as follows: v = pT 1 pT 2 pT 3 pT 4 pT 5 pT 6 pT 7 pT 8, where the component of pi ∈ RN (i =1, 2,⋯,8) is given by the mean of the power obtained in the frequency domain in the measurement period of the sample from each sensor.

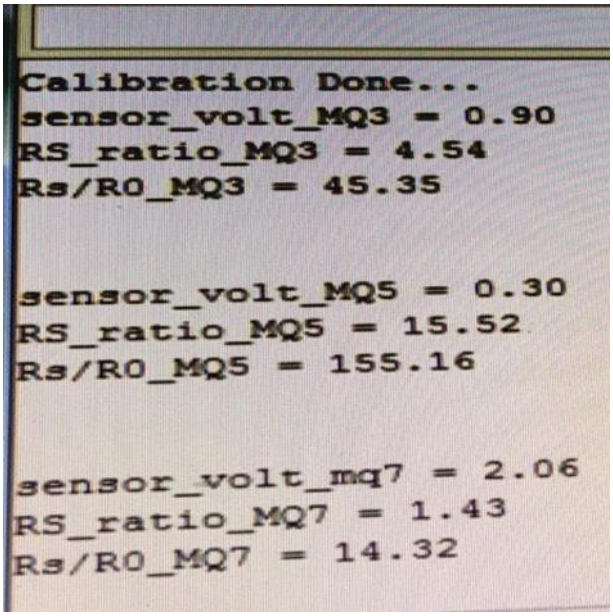
Electronic device gas sensing system is first calibrating the sensors, once the calibration is done next step sensing the aromas and detecting the features of the aromas then send to the outside of the users. If the values are varied minutely the tea-sources were good and healthy and detecting data is varies more than previous value the tea source is not good or unhealthy for drinking. The data set values are simultaneously giving the same values that tea-sources were good for customers. In this system we also generate the user message for customers. Sample output and values are showed in below screenshot images.



Calibration-



User message and detected data-



III.CONCLUSION

In this study, we evaluated the capacity of a deep neural network for recognizing aromas from tea sources, where the data set of aromas was obtained by using a gas–sensing system. The input vector of the deep neural network consisted of frequency domain features that were extracted from the sensor signals using a continuous wavelet transform. Experiments of aroma recognition were conducted and a recognition rate of 100% for all the tea sources types and the base gas was achieved. Comparing the recognition accuracy

Of the deep neural network to that obtained from other pattern recognition methods, such as naive Bayse and random forests, the effectiveness of the proposed method for this task was confirmed.

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