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Detection of Volatile Organic Compound using Electrochemical Sensor

B.Uma Maheswari, T.Mangayarkarasi, G.Jayanthi, L.Karthick, R.Karthikeyan

Abstract— : Food is essential for every living creature. Food consist of many nutrients such as vitamins, minerals, carbohydrates, fats or proteins. These nutrients present in food are partaken by an organism that forms energy for inciting growth and for process of metabolism. Food chemistry mainly deals with a range of chemical processes and synergies between biological and non-organic components. Preservatives are used in the food to increase its usability and retains its consumability. These may have some serious effects. Many of the chemicals VOCs are controlled and eliminated while detecting. These usages can be extended from environmental monitoring to test the emission of materials. These VOC detected can be detected by using gas sensors and the consumed level these VOC was already stored in Rasberry Pi development board and concentration is proportional to the small change in current value.

Keywords: Preservatives, VOC, Consumability, Gas sensors, Rasberry Pi

I. OBJECTIVES

1.To detect the VOCs using electrochemical sensor in fruits.

2.Certain VOCs like nitrogen, hydrogen, acetylene and propane are detectable above threshold level using sensors.

3.The value can be stored and retrieved from in raspberry pi development board.

4.The concentration of the gas is proportional to threshold current.

II. EXISTING SYSTEM

Organic substances and chemicals are analyzed using analytical instruments such as spectroscopy methods such as IR or UV Spectrophotometer, gas chromatography, liquid chromatography and high-performance liquid chromatography. This device is highly costly and requires training and therfore can detect the non – charged agriculture chemicals in less time with high sensitivity. On the other hands, immunoassay method can easily to detect agricultural chemicals, but the disadvantage present in this method was less accuracy.

III. INTRODUCTION

A diffusion barrier , a sensing electrode and a counter-electrode and an electrolyte are present in an electro chemical sensor. The chemically reactive gas is admitted through the thin layer also known as diffusion barrier it oxidizes. Oxygen is intermingled with another substance into the cell at environment in free condition with the help of chemically reactive gases. As soon as oxygen is diffused into the cell it is being adsorbed by both the electrodes.

Because of this, a potential is formed between the electrodes and there will be no current flow theoretically. When a chemically reactive gas is sent through the layer which is very thin or diffusion barrier it gets either oxidized (gives up electrons or accepts oxygen) or reduced (accepts electrons or gives up oxygen), depending upon the gas. A current will be induced in between the two electrodes due the potential difference.

At present cells containing poisonous gases uses a third electrode which is also called reference electrode which grasp the stable potential due to this, no current can be drawn. Its main objective is to remove interference from side reactions with the counter-electrode at the same potential and also it holds the current across these electrodes. Extended storage comprises a short link which is connected between the reference and sensing terminals. These storages were required to maintain the electrodes at the same potential and to hold current across cell.

The electrochemical cell has a casing and it comprises of an electrolyte gel and three electrodes. Gas permeable membrane and gas capillary are placed at the top of casing. The electrodes are mounted in such a way that it provides more sensitivity and more life time by electrode construction that allows larger surface area for quick response and permits a smaller volume of electrolyte compared to large sensors.

In order to make the cell more specific each of them is constructed using special filters, electrodes, and electrolytes. Provision for appropriate bias current to eliminate interfering gas sensitivity must be made.

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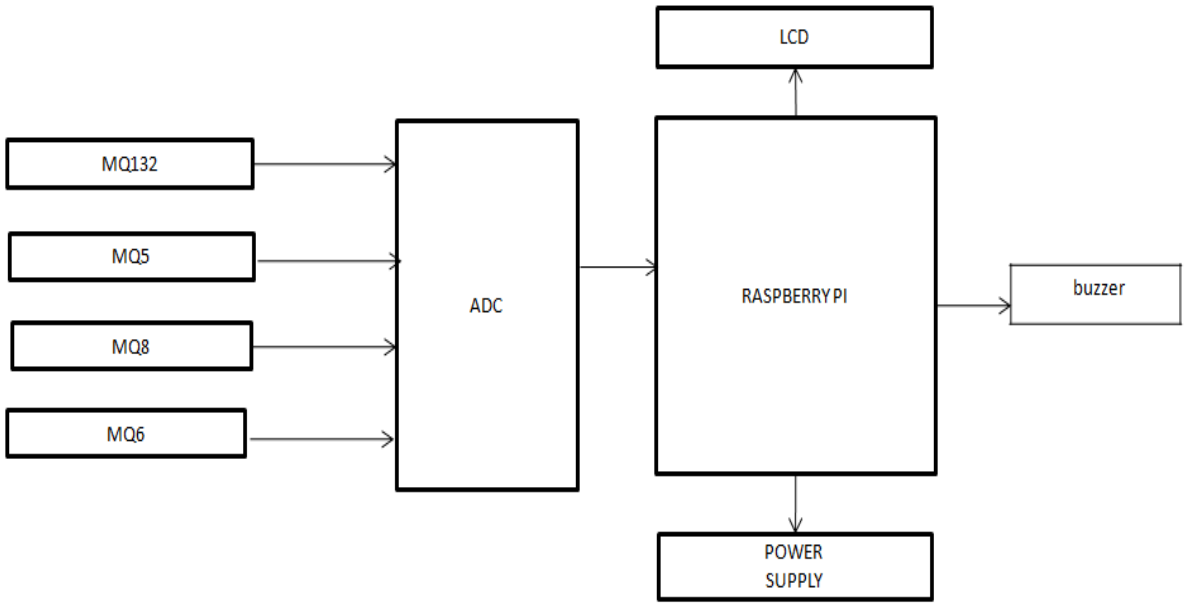
* Correspondence Author
B.Uma Maheswari*, Asst Prof, Instrumentation and Control Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India
(Email: maheshwari.ice@sairam.edu.in)
T.Mangayarkarasi, Asst Prof, Instrumentation and Control Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India
(Email: hod.ice@sairam.edu.in)
G.Jayanthi, Asst Prof, Instrumentation and Control Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India
(Email: jayanthi.ice@sairam.edu.in)
L.Karthick, Student, Instrumentation and Control Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India.
(Email: e7ic028@sairamtap.edu.in)
R.Karthikeyan, Asst Prof, Instrumentation and Control Engineering, Sri Sairam Engineering College, Chennai, Tamilnadu, India.
(Email: karthikeyan.ice@sairam.edu.in)

IV. METHODOLOGY

Whenever a gas reacts with an electrochemical sensor the ions gets separated into constituents, then the adsorption takes place with the help of sensing electrode. This adsorbed gas develops a potential difference across the sensing element which is been sending to the processor unit in form of either oxidized or reducing manner depending on the gas that we sent into the cell therefore a current is induced or produced between the two electrodes because of potential difference. A steel skeleton covering is present in the gas sensor that actually houses the sensing element. Then that element is being exposed through connecting leads by passing current. This phenomenon is called as heating current. This adsorption of gases made the resistance of that element to change the current direction which is going out of it. The analogy values from the electrochemical sensor were send to the MCP3008(analogy to digital convertor) which the data lines and clock pins of the mcp3008 connected to spi pins of raspberry pi to get the converted digital output.

V. BLOCK DIAGRAM



5.1.Raspberry PI:

Scientists namely Eben Upton,Rob Mullins, Jack Lang and Alan Mycroftat at Cambridge's University of computer laboratory invented a small computer for kids in 2006 which is known to them. In that period, the computers were so costly There was a situation where computers had become so expensive and kids couldn't learn the programming and experimentation. The idea behind this discovery was to improve the skill levels of the kids so that they can easily understand, read the computer science well in manner.

This made them to come with the plan of inventing a device where even children could be more affordable to easy for the children to learn programming on raspberry pi. A several number of designs and prototypes was created during the period from 2006 to 2008using raspberry pi. This is small sized computer which has been embedded on single board or chip.

5.2.SOC:

A system on chip (SoC or SOC) is an integrated circuit that integrates all components of a computer or other electronic system ,in which each and every component are embedded into a single chip. Basic small computers such as Smart phones and tablets which requires almost the same components found in a typical computer or a desktop. Many prominent SoC manufacturers, like Qualcomm, Nividia or Texas Instruments, have the potential to place those components on a single chip which in turn powers smart phones.

The Raspberry Pi is definitely a best platform which is suitable in all home automation systems. A Raspberry pi should be used as a 'hub' which can be used to connect other open source platforms to utilize it to the fullest. It supports all the features required by the proposed system. GPIO pin was connected to the switch.

Rasberry Pi consists of High Definition Media Interface, 512mb RAM, RCA ports for display, ARM v6 Processor,2 USB and an Ethernet port,3.5mm Audio jack, SD card slot which is bootable (which starts the system it is turned on), General purpose I/O pins, runs on 5v. The speaker is connected and supplied by a USB power source which is directly plugged into audio jack which is of dimension 3.5mm. The webcam is connected to one of the USB ports available on the board.

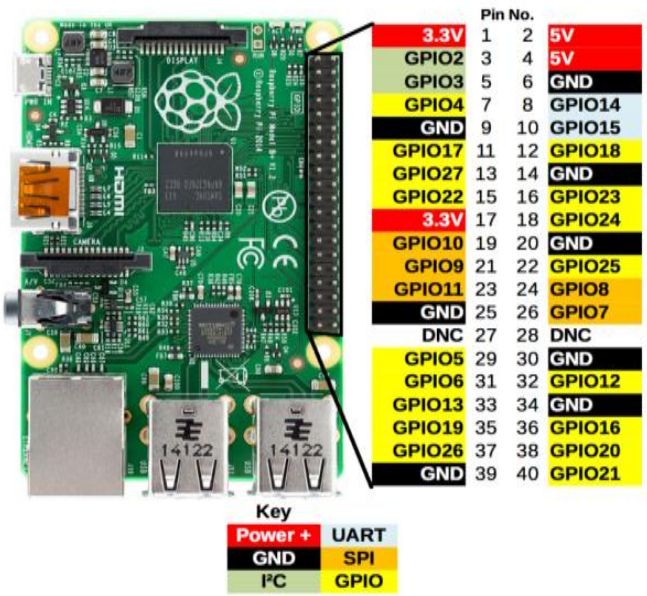
ARM CPU/GPU is a Broadcom BCM2835 system on a chip which is made up of ARM central processing unit and video core and also the graphics processing unit. The purpose of CPU is to make arithmetic computations like taking input, doing calculations or evaluations and processing output and also promotes graphic output. The real hardware was allowed by General Purpose input/output connection points. The GPIO pins present on board can be programmed using Python.

The operating system used in Raspberry pi was Linux kernel. Kernel performs and runs from the SD card. No external memory other than the internal ROM is made use of. SD cards up to 32 GB are compatible for the SD card slot. For switch on and switch off an electro-valve is used. It is connected with GPIO pins with the help of transistor and relay. Decoding their function, they are generally switches which can operate on the outputs. The board consists of totally 26 pins. In this project to control three devices 3 pins have been used which have been represented by 3 LEDs. The switching signals are tested by using these LED's. For control purpose the raspberry pi and device is interfaced with relays

The pins are programmed for their interaction. Inputs can be anything such as switches or even signals obtained from a sensor. For turning on an LED for transmitting a signal or data to another device these outputs can also be used.

5.3.Additional Components:

- Display Serial Interface (DSI) connector for LCD.
- Stereo audio output is provided by using a standard 3.5mm TRS connector.
- 5 Status LEDs.
- CSI – Camera Serial Interface is used for the sake of digital camera interfacing.
- Ethernet and USB ports.
- Joint Test Action Group(JTAG) for test point access issue on PCB.

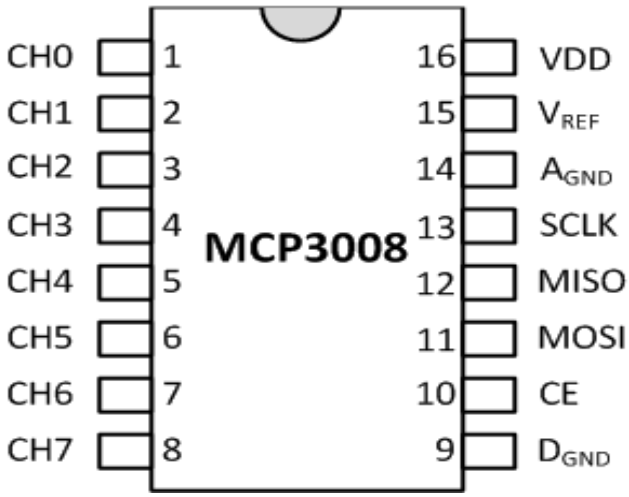


- HDMI – High Definition Multimedia Interface for connecting HDMI screens.

5.4 Analog To Digital Convertor (ADC)

In electronics, an ADC is a system that converts an analog signal, such as music and video signals, into digital signals. It can also provide a digital manipulation of the measured analog signal in the form of magnitude of current or voltage. In simple, it is an electronic integrated circuit which converts along to digital form signals are measured directly.

An ADC converts a continuous time signal and continuous amplitude analog signal to discrete time amplitude digital signal. Its output is a sequence of binary digit. As it primarily involves quantization process it will definitely introduce a finite amount of noise.



5.5.Electrochemical Sensor

An electro chemical sensor is a device which transfers information or data. Two basic components usually construct the sensor, now-a-days a chemical (molecular) recognition system is the very essential part of a sensor and the physicochemical transducer is a device that converts the chemical response(non electrical quantity) into a signal(electrical) which is been detected by modern electrical instrumentations. These construct the sensing electrode. A reference electrode is also suitable for the measurement purpose. The best type of chemical sensors are biosensors in which the recognition is made by certain biochemical mechanism depending on the process.

5.6.INPUT SENSORS:

MQ-5 Nitrogen sensor

Features:

Sensitive gas	Liquefied gas, natural gas and coal gas
Boost converter chip	PT1301
Operating voltage	2.5V-5.0V
Dimensions	40.0mm*21.0mm
Fixing hole size	2.0mm

Operating principle:

The sensing material used in this sensor is SnO2 which has lower conductivity especially in clean air.mq-5 plays an important role in detecting butane, propane and methane present at a same time and it is also very sensitive to natural gas. It also have the ability to detect inflammable gases which is of low cost and it also a best choice for different application of detection of gases.

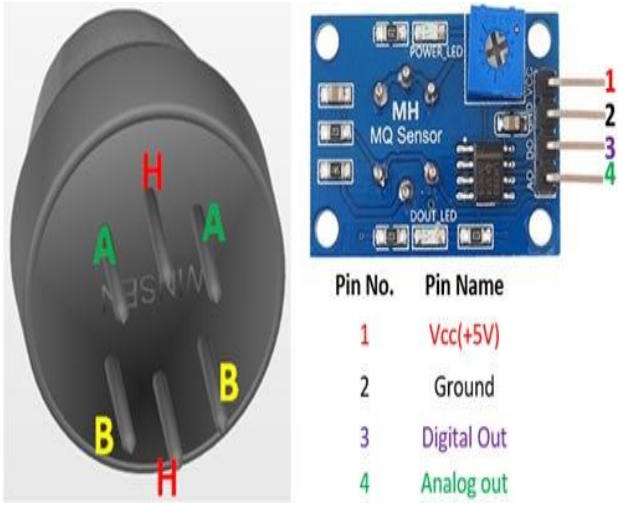
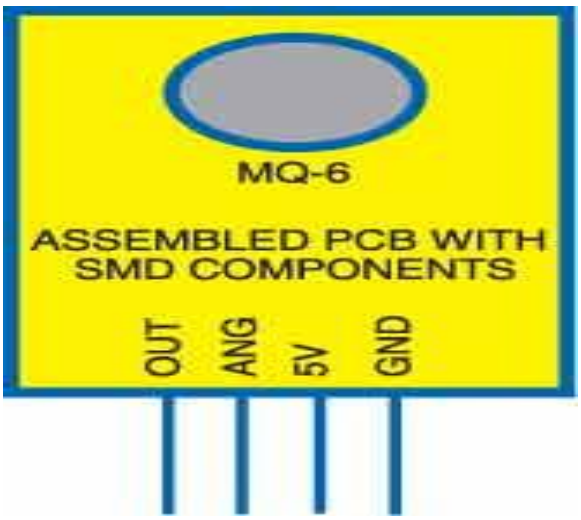


FIG 3.5.1 Nitrogen Sensor

MQ-6 propane sensor

MQ-6 gas sensor contains SnO2 which is also called as Profile Sensitive material and it has lower conductivity in clean air. The conductivity of the sensing gas increases in the presence of the target flammable gas . As these two parameters are interdependent using a small suitable circuit the proportional output signal can be obtained. It has a very high sensitivity towards propane and can detect all different kinds of flammable gases and with LPG it will give high sensitivity .This sensor is highly economical.



3.5.2:Propane Sensor

MQ-132 Acetylene sensor

This sensor is used for the purpose of detection of acetylene C_2H_2. It range of sensing vary from 500ppm-2000ppm. It has High sensitivity and response time.

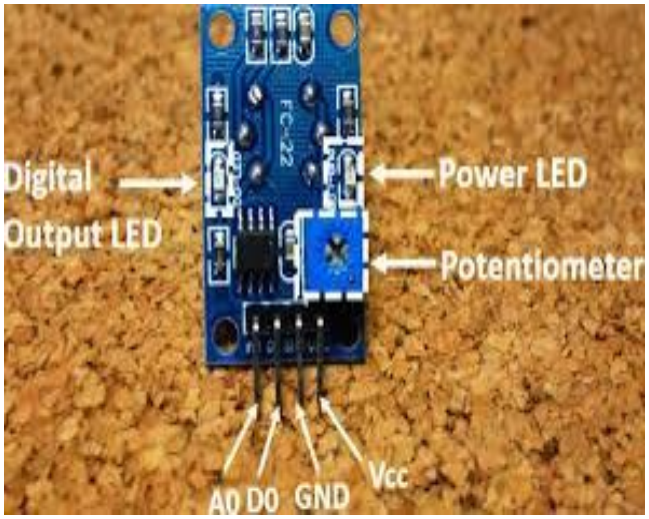


FIG 3.5.3 Acetylene Sensor

MQ-8 Hydrogen gas sensor

The reason of using SnO_2 because it has the low conductivity especially in clean air. If the hydrogen gas is present, the conductivity increases with respect to concentration of gases. It can be converted into output by changing the conductivity by using the necessary circuits. This sensor has significant anti-interference characteristics concerning other gases while being highly sensitive to hydrogen. It also have good sensitivity and it has abundant advantages such as long life ,minimum cost and easy drive circuit.

5.7.Power Supply

Rectifier

A rectifier is a device which is used for the purpose of conversion of alternating current to direct current. They can be used as power supplies and as detecting radio signals.

VI. RESULTS AND CONCLUSION

6.1.Advantages:

1.The volatile compounds can be easily detected without any specialization of the tech.

2.Quick results and accurate percentage rate of each volatile organic chemicals can be obtained.

3.Although organic chemicals are analysed using gas chromatography and high-performance liquid chromatography which has high performance. This equipment are too expensive and the technology prescribed in our paper is comparatively very low and effective.

6.2.RESULT:

The prototype is developed using electrochemical sensors, raspberry pi and interfacing circuits. The volatile organic compounds level present in the food is displayed in the LCD. When the level of organic compound exceeds the threshold level the buzzer alarms.

TABLE:5.2.1 Output Display Table

VOLATILE ORGANIC COMPOUNDS	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4
Nitrogen	25	7	9	15
Hydrogen sulphide	10	15	20	7
Acetylene	3	0	0	1
Propane	14	19	25	7

6.3.Conclusion:

In our proposed system, we found the some volatile organic chemicals in fruits as preservatives. The values have displayed on LCD and raspberry pi used to process the analog values into digital value with the help of MCP3008. If the threshold value is above then buzzer starts alarming.

6.4. Future work:

Here we used four electrochemical sensors to analyse the volatile organic compound. So in our future work, to enhance the proposed system we plan to use a sensor to find the different chemical content in fruits.

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