ISSN 2229-5518

Design and Development of A Formalin Detection System Using IoT

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Abstract— We designed and develop of a detector that can sense the presence of formaldehyde in air which is measured in Parts Per Million (ppm). The prototype used a storage device (SD) technology to save real time data and an android application so that the user can be sent message along with the location. The objective of the study was to design and develop a system that can detect formaldehyde concentration and indicate if the reading is below or above the permissible level of formaldehyde.

Index Terms— Detection, formaldehyde, fluorescence, real-time, IoT, Terms—Formaldehyde detector, SD technology, gas detector, air quality monitoring, android application.

1 Introduction

Formaldehyde (HCHO) is a toxic substance which can cause adverse effects on human health. It can cause burning sensation in the eyes, nose, and throat, damage the central nervous system, and even cause immune system disorders (Wongniramaikul, 2018). The liquid form of formaldehyde (35-40% aqueous solution) known as formalin is widely used as a precursor in chemical industries due to its high reactivity and relatively low cost and as a preservative in medical laboratories (Wongniramaikul, 2018). But, formaldehyde has been identified as a carcinogen and mutagen in laboratory animal testing and has been banned from use as a food additive (Chaiendoo, 2018).

Considering the increasingly alarming abuse of formalin and lack of portable, user-friendly, and effective detecting kits, we realize the necessity to an electronic device that can detect formaldehyde in edible products instantly and correctly. The main purpose of this device is to sense the presence of formaldehyde concentration, whether it is below or over the limit of toxicity that the body can only tolerate. Usually, formaldehyde detectors are based from the principles of gas sensors and microcontrollers. Most gas detectors follow five functional components which are the transport of air samples, the analysis of these air samples, the identification of the target gas concentrations, the comparison of the read gas concentrations to set the alarm levels and the actions to these alarm conditions. Light Emitting Diodes (LED) and alarm buzzers were the common alarm actions of most gas detectors. This project presents the development of a gas detector that can sense the presence of formaldehyde in an indoor environment and display will its concentration in ppm.

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A mobile application is also designed to display results on smart-phones. The app user can show data or information about formaldehyde presence, level of formaldehyde and location to the end user by sending massage.

2 Procedure for Paper Submission

2.1 Review Stage

Already several initiatives have taken to detect formalin in Bangladesh. At present there are two ways to detect formalin in our country. One is chemical based test which is difficult for general people to understand how to use it and other is formalin detection device which is very costly. Formaldehyde Meter Z-300 (BC Group International, 2019) had been widely used in Bangladesh for detecting formalin in food markets. But in 2015, according to the report of Bangladesh Council for Scientific and Industrial Research (BCSIR), it was found inappropriate for detection as Z-300 machine's reading of formaldehyde in soaked and fresh fruits varies depending on time, temperature and moisture. So the kit's reading of formaldehyde level were not found to be accurate if fruits were kept in warm temperature (The Daily Star, September 24, 2014).

2.2 Final Stage

Two students of Dhaka University have made a breakthrough innovation in the formalin detection mechanism arena by developing portable formalin detection device called Food Alytics. Swapnil Sayan Saha, a fourth-year student of the Department of Electrical and Electronic Engineering (EEE), and third-year student Sadman Siraj, have deftly developed a cheaper formalin detection kit by working relentlessly on this research project for an entire year. (Dhaka Tribune, 24 October, 2018)Some students of Department of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology, Bangladesh developed a formalin detector project that can detect formalin in fishes. In this method, formalin is detected within 30 seconds which is a chemical based test. But the use of this kit is little complicated and many people don't understand how to use this kit. (IEEE paper, 2016)

There is a wide range of proposals on how formaldehyde can be detected in contaminated foods so, that is why we want to develop a formalin detector device by using IoT which will

ISSN 2229-5518
be much more cost efficient.

3 Objectives

The project has aimed to develop a system to achieve the following sub objectives:

1. To design automatic IoT based device to detect formalin/formaldehyde that applied
   In foods, vegetables and fishes.
2. To develop an android application that can notify formaldehyde status and location.

4 Design & Development

Hardware Requirements: Node MCUESP-12, Display 16*2, 12C LCD, CJMCU-1100 Sensor, Battery-18650, Holder, Charger+ Booster, Buzzer, Pull up, Pull down Resistor

Software Requirements: Operating system windows 8 or any windows, Language C, Kodular Creator, cloud computing

Proposed system model

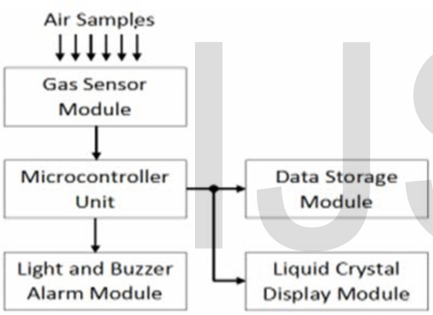


Fig 1: Design and Development Diagram

Gas Sensor Mechanism: The sensor has a built in variable resistor that changes its value according to the concentration of gas. If the concentration is high, the resistance decreases. If the concentration is low, the resistance increases. Besides the built in resistor, it is necessary to include a load resistor. This resistor serves to adjust the sensor's sensitivity and accuracy Calculation of gas concentrations from the variation of resistance is given below:

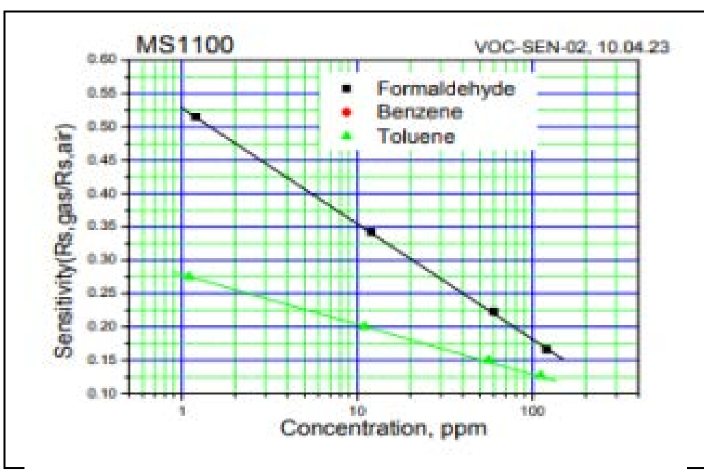
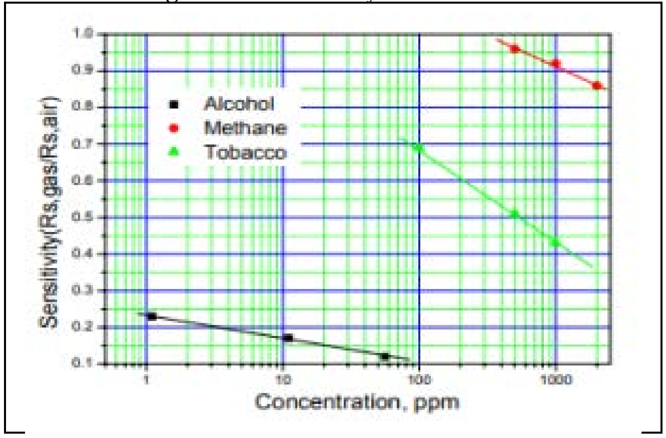


Figure 2.1: Sensitivity Characteristics



The scale of the graph is log-log. This means that in a linear scale, the behavior of the gas concentration with respect to the resistance ratio is exponential. The data for gas concentration only ranges from 1 ppm to more than 100 ppm. The formula we will be using is the equation for a line, but for a log-log scale. The formula for a line is: y = mx + b Where: y: X value x: X value m: Slope of the line b: Y intercept For a log-log scale, the formula looks like this: log(y) = m*log(x) + b Note: the log is base 10. Okay, let's find the slope. To do so, we need to choose 2 points from the graph. In our case, we chose the points (1.2,0.51) and (120,0.14) from the Formaldehyde line. The formula to calculate m is the following: m = [log(y) - log(y0)] / [log(x) - log(x0)] If we apply the logarithmic quotient rule we get the following: m = log(y/y0) / log(x/x0) Now we substitute the values for x, x0, y, and y0:

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ISSN 2229-5518

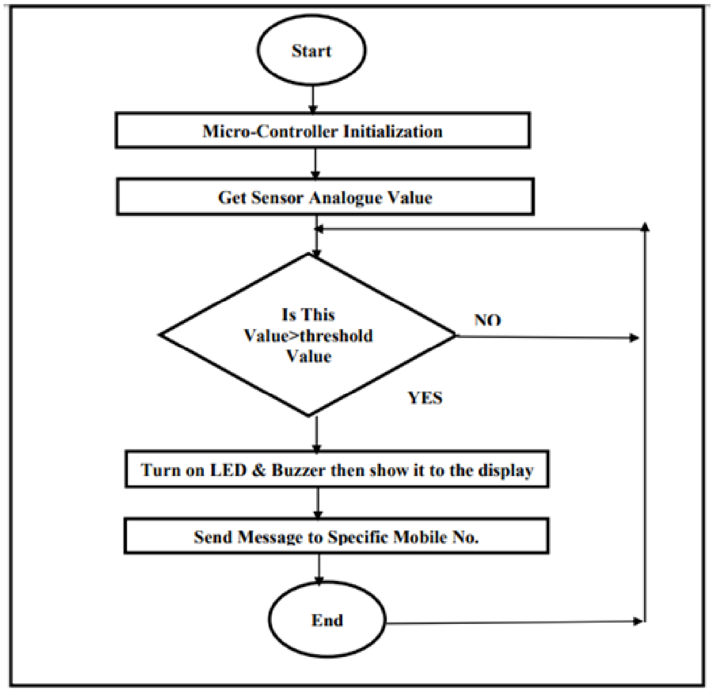

Fig 3: Flow Chart

Circuit Diagram

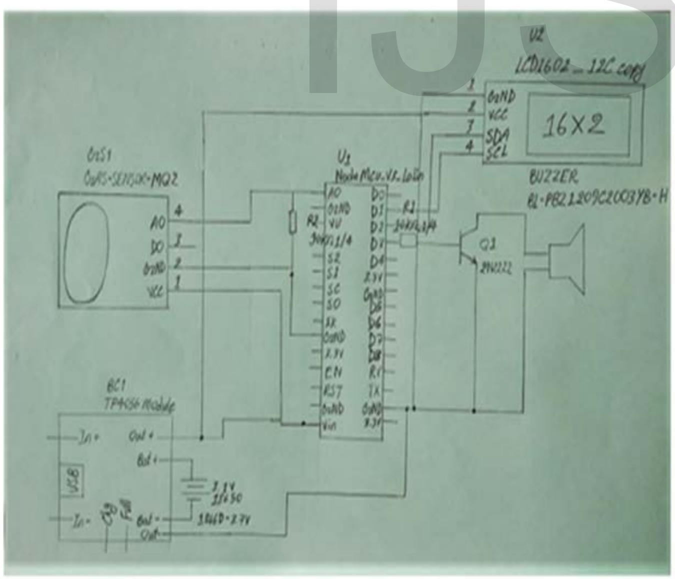

Fig 4: Circuit diagram

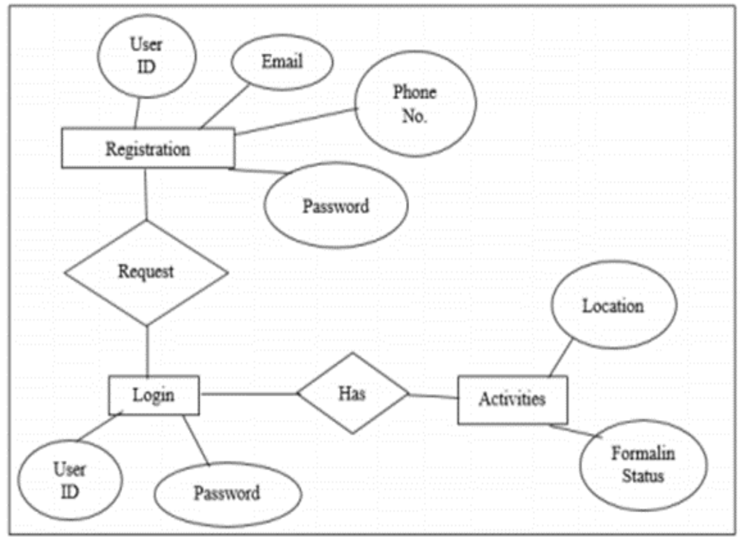

Fig 5: E-R Diagram of Database

7 Project Description

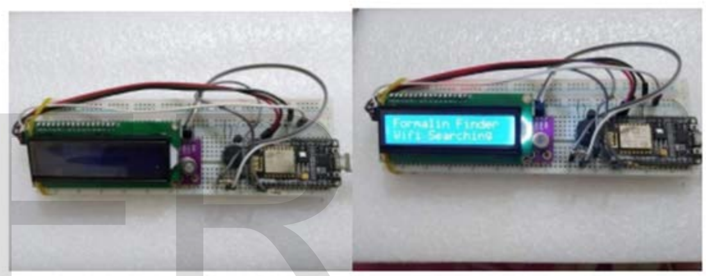

Fig 6(a): When device is offline Fig 6(b): When device is online

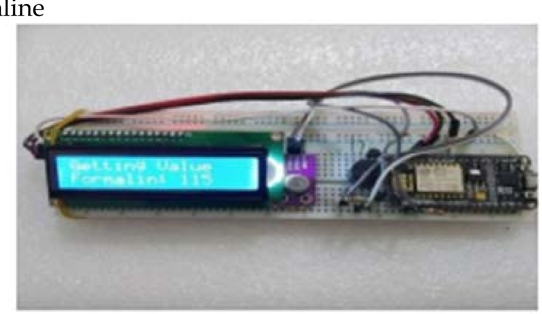

Fig 6(c): during getting Readings

Calculating ppm: The microcontroller converts the resistivity (ρ) to its ppm value as. To convert in ppm, resistivity was multiplied with the quotient of the input voltage (Vi) over 1023.

Equation for ppm: ppm = ρ (Vi/1023) Input voltage of the sensor is at 3.3Vdc and 1023 was set as conversion constant of byte reading of the microcontroller unit. The concentration reading of formaldehyde will be displayed next to the 4×20 LCD attached to the microcontroller unit.

5 Interface of Mobile Application:

Interface Look and Feel:

Fig7(b): Registration Interface

Fig7 (b): Help Interface

Data collection: To determine the accuracy of the device, it was subjected to a box. We conducted test on several food which available in the market. We also tested the food by added different concentration of formaldehyde. So, we could understand the accuracy of the device. As the formaldehyde concentration in the food is decreased by added water, the sensor value is also decreased as it should be. It is to be noted that, the sensor does not display the percentage concentration of the formaldehyde in which we generally measure, rather its unit is in parts per million (ppm)

TABLE I: DETECTOR READINGS WITH THE PRESENCE OF FORMALDEHYDE

Food	Status	HCHO Level
Green Apple	0	Null
Red Apple	1	0.22
Orange	1	0.19
Banana	0	Null
Barry	1	0.28
Rui Fish	1	0.31
Guava	0	Null
Apple with 40% HCHO	1	0.33
Apple with 20% HCHO	1	0.12

6 Conclusion

By analyzing and researching on the collected or gathered data we have completed our whole project using IoT. Our device makes use of a volatile organic compound (VOC) gas sensor which can reliably detect concentration of formaldehyde presence in edible products. Experimental results show that the kit can successfully detect formalin in samples/solutions prepared in the laboratory containing different concentration levels. It will also show the level(amount) present in the samples. The level/concentration of formalin can be shown in ppm (parts per millionIn this prototype we used an android application along with the device to save real time data so that the user can be sent message along with the location.

7 Limitations

The limitation of the work is there must be internet connection between application and the device. Device should be placed within a closed area so that it can produce exact result. The application is needed to develop more.

8 Future Scope

Greater portability through miniaturization will be a key feature for future development. In adopting the device for commercial applications, it will require reproducibility and robustness. Specialized industrial processes will be needed to develop for 28 reproducibility. The application will be made available for downloading from the app store. Much of the focus will be on improving the Android application. The application is in receiving mode now. Some useful features will be added to the android application. These are the further improvements we need to work on. This device can be used by consumers to ensure food safety for their families. This device can also be used reliably by government officials or mobile court for conducting safety operation in various fish markets, fruit shops etc

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