INDOOR AIR QUALITY MONITORING SYSTEM CONTROL

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Abstract – **In this project report, sensitivity detection of various smells in the room is discussed by using air sensor MQ-2. People do not perform well on their job when they are uncomfortable. Suitable air sensor circuit is which to detect the smells will be presents on this paper. In order to display the output results from the sensor, screen monitor was used. Programmable Interface Controller (PIC) 16F877A was used as the intelligent system that connected between the air sensor circuit and screen monitor which present the output of the room's conditions. Visual Basic is used to display the three different colors for the output. Red, yellow and green were the chosen colors to indicate danger, warning and safe conditions. Serial port communication is used to interface with PIC16F877A.The hardware and software is implemented in this system modeling and experimental results are presented.**

Keyword - Indoor Air Quality (IAQ), Peripheral Interface Controller (PIC) and Visual Basic (VB).

I. INTRODUCTION

One of the greatest concerns of today's facility managers is the health and safety of the occupants of their building. Indoor Air Quality is a key factor. Technology now exists to allow continuous monitoring to help control the air quality of a facility. Air quality sensors can be placed in individual rooms and in air ducts and can send data directly to the building management system. This type of "on-line" monitoring system offers a number of important benefits like improved our comfort, identified early before they reach a critical stage or energy savings through demand-based control of outside air intake [1].

Indoor environments are highly complex and building occupants may be exposed to a variety of pollutants from office machines, cleaning products, construction activities, carpets and furnishings, perfumes, cigarette smoke, water-damaged building materials, microbial, insects, and outdoor pollutants. Other factors such as indoor temperatures, relative humidity, and ventilation levels can also affect how individuals respond to the indoor environment [2].
Improving IAQ can help:

- Reduce absenteeism
- Improve people concentration
- Improve people productivity and performance
- Decrease IAQ-related health risks from exposure to indoor pollutants
- Reduce environmental triggers of asthma
- Reduce respiratory illness

MQ-2 gas sensor has high sensitivity to LPG, i-butane, propane, methane, alcohol, Hydrogen and smoke, it is with low cost and suitable for different application. The application of this gas sensor is domestic gas leakage detector, industrial combustible gas detector and portable gas detector [3]. A microcontroller is a small computer on a single integrated circuit consisting internally of a relatively simple Central Processing Unit (CPU), clock, timers, input or output ports, and memory [4]. The type of microcontroller used in this project is PIC type. PIC16F877A is used to interface between air sensor and computer.

Figure1 shows the block diagram for the indoor air quality monitoring system control. The special of this circuit is the sensor can detects several of smells and displayed the output on the screen monitor.

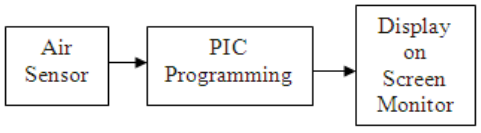

Figure 1: Block diagram of the indoor air quality monitoring system control.

II. METHODOLOGY

Flowchart below shows the flows of the project for Indoor Air Quality Monitoring System Control from start until the end the project to be done successfully.

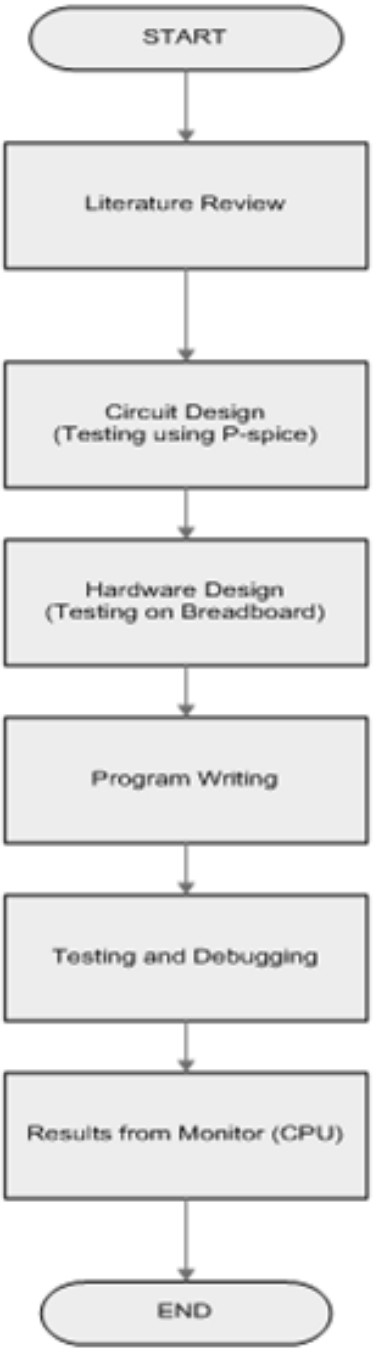

Figure 2: Project Flowchart

A. Hardware Design

Figure 3 shows the hardware implement in this project for IAQ system. The system are consists of air sensor, microcontroller (PIC), Universal Asynchronous Receiver-Transmit (UART), screen monitor and input 5V. Before build up the hardware, the circuit simulation had been done by using P-spice simulation to check the voltage required to estimate the minimum and maximum output limit for this system to operate.

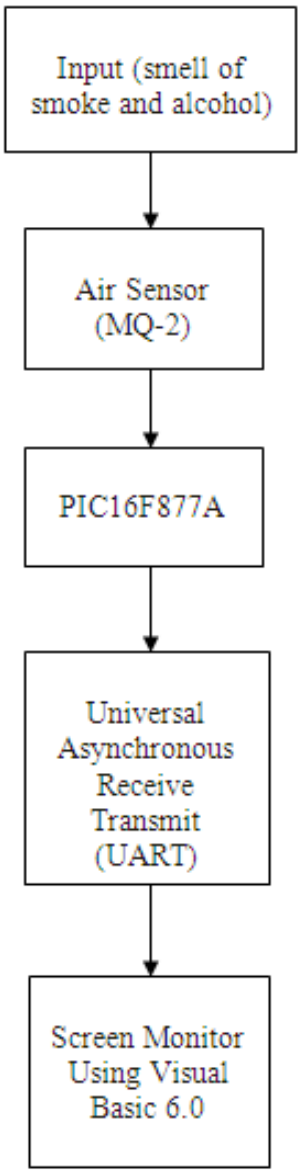

Figure 3: Block Diagram of the Project

Figure 4, shows the complete of sensor circuit. The objective for designing this circuit is to supply 0V-5V in-circuit serial programming for PIC16F877A [5].

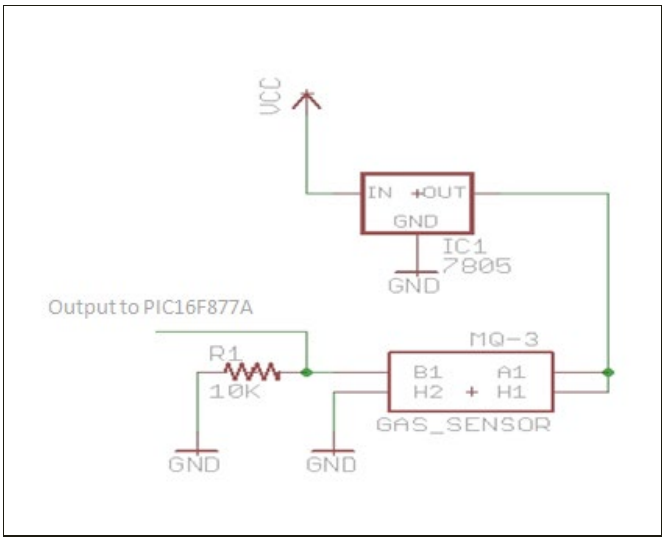

Figure 4: Complete sensor circuit.

B. Software Design

The software develop in this project is to be embedded in the PIC16F877A microcontroller to control the output voltage according the signal from the input. It is easy to use PIC16F877A and FLASH memory technology because of its flexibility. MPLAB software is used to program the PIC. PIC16F877A have 40 pin by 33 path of input or output [6]. Figure 5 shows the enhanced 40pins PIC start-up kit and USB IC PIC programmer V2010 that use to interface output of the circuit and computer.

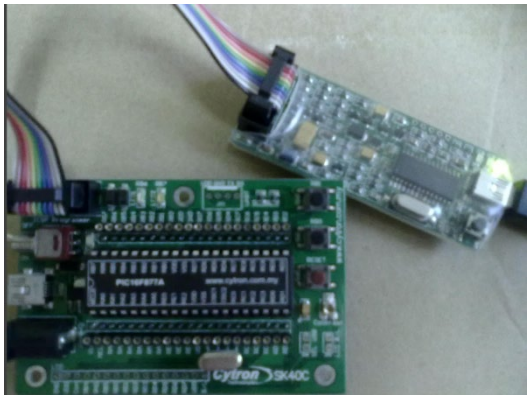

Figure 5: Enhanced 40pins PIC Start-up Kit and USB IC PIC Programmer V2010.

Visual Basic 6.0 is used to display the results of the data. Visual Basic (VB) is the third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its Component Object Model (COM) programming model [7].

Figure 6, shows the flow of program using MPLAB software. For this project, less than 1.5V is at safe condition, between 1.5V and 2V is at warning condition and greater than 2V is set as danger condition.

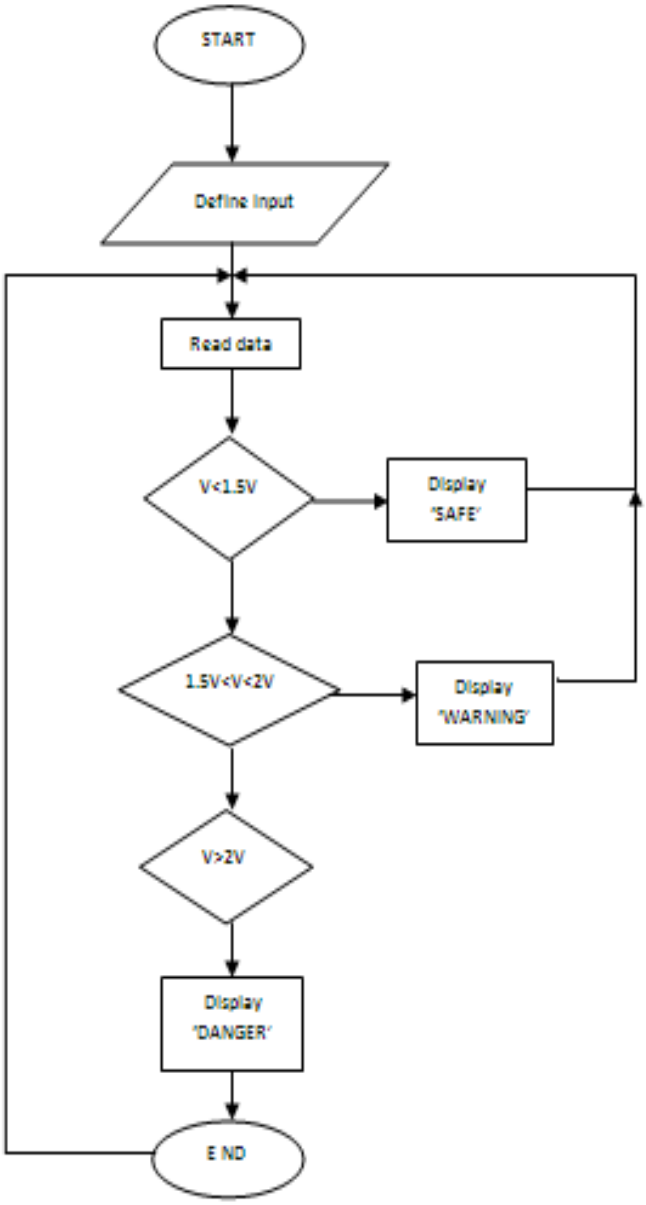

Figure 6: Flowchart for the program (PIC16F877A).

III. RESULT

There are different types of smells to make the sensor sensitive. For this project, alcohol and smoke is used. This is because MQ-2 gas sensor can detect LPG, i-butane, propane, methane, alcohol, hydrogen and smoke [8]. All the results are recorded using oscilloscope and represented in graphical form as shown in Figure 7 to 12.

A. Sensor Circuit Testing

The output of sensor produces small value of voltage when in initial condition. When smoke and smell of alcohol get near to the sensor, the values of output voltage keep increasing. The output voltages keep increasing and the input voltage remains constant when the amount of smells increases. Figures 7-12 shows the differences of voltage output.

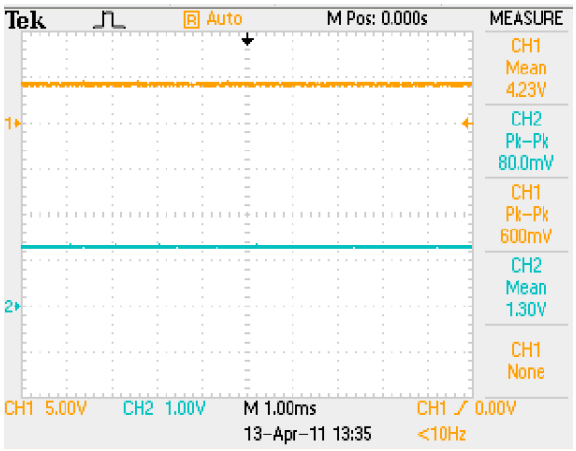

Figure 7: Conditions when no alcohol smell detected at 1.3V.

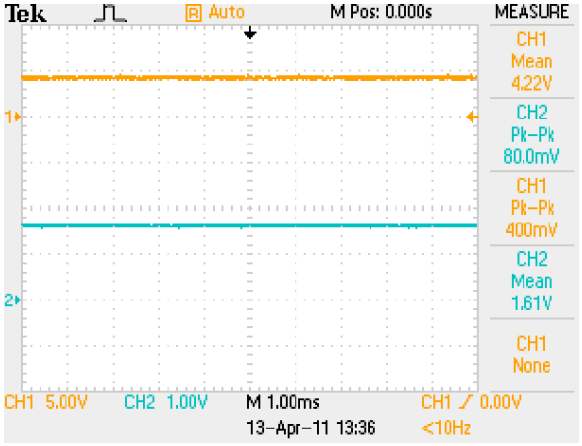

Figure 8: Initial response to the smell of alcohol at 1.61V.

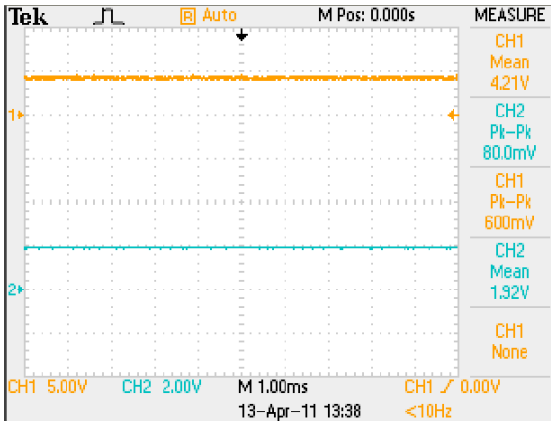

Figure 9: Maximum response to the smell of alcohol at 1.92V.

Channel 1: Voltage input of sensor (Vin)
Channel 2: Voltage output of sensor (Vout)

TABLE 1 show the result of output voltage for alcohol and TABLE 2 are for smokes. Input voltage (Vin) is constant while the output voltage (Vout) is kept increasing when the sensor kept detecting the smell of smokes and alcohol. This shows that when increasing the smell of smokes and alcohol, the output voltage will also increase.

TABLE 1:
INPUT AND OUTPUT VOLTAGE RESULTS BY USING ALCOHOL.

Alcohol	
Vin	Vout
4.19	1.49
4.19	1.56
4.19	1.62
4.19	1.75
4.19	1.84
4.19	1.92
4.19	2.02
4.19	2.09

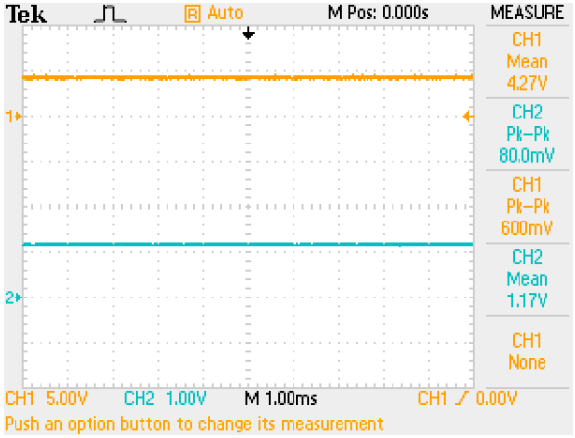

Figure 10: Condition when no smokes detected at 1.17V.

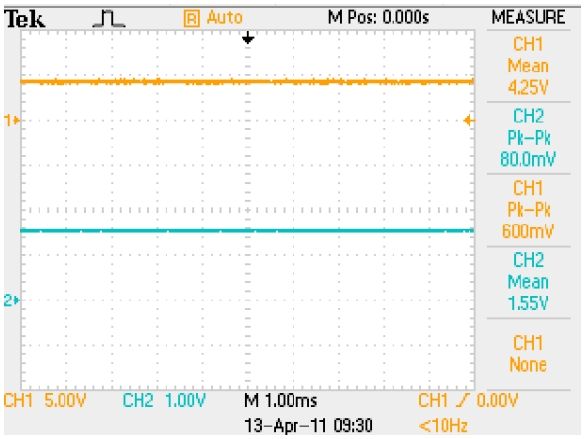

Figure 11: Initial response to the smell of smokes at 1.55V.

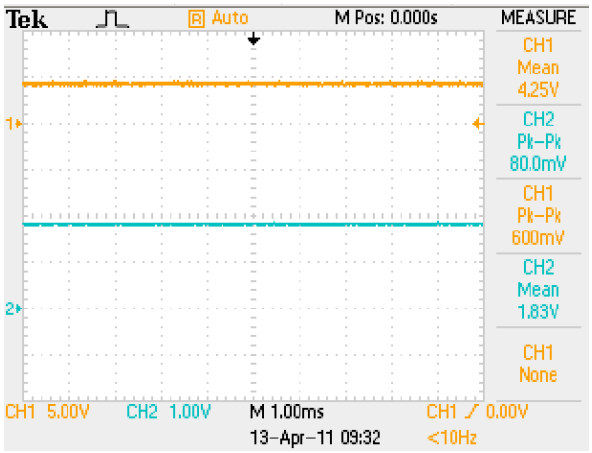

Figure 12: Maximum response to the smell of smokes at 1.83V.

Channel 1: Voltage input of sensor (Vin)
Channel 2: Voltage output of sensor (Vout)

TABLE 2:
INPUT AND OUTPUT VOLTAGE RESULTS BY USING SMOKES.

Smokes	
Vin	Vout
4.19	1.42
4.19	1.53
4.19	1.57
4.19	1.71
4.19	1.80
4.19	1.85
4.19	1.94
4.19	2.01

B. Screen Monitor Display Testing

To display the output on screen monitor, the circuit should interface with PIC16F877A by using Visual Basic programming. UART is used to connect between PIC16F877A and computer. Since now the technology has advance, so to alert people by using computer is also important. Three output colors are used for indication using computer such that the people will know the quality of air in the building.

Figure 13 to 15 shows the result displayed on screen monitor when detect the values of voltages. Green color shows the condition of the room is safe which the output voltage of sensor is less than 1V. Yellow color to indicate the room is in warning condition where the output of sensor is between 1V and 2V. While for the red color is to indicate the condition of the room is danger when the output voltage from sensor is greater than 2V.

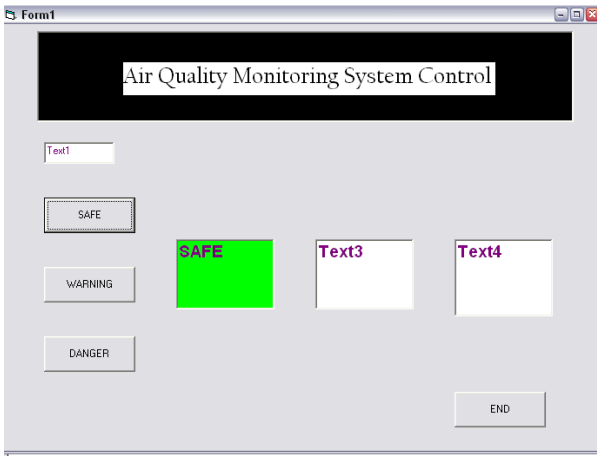

Figure 13: Indicate output voltage less than 1.5V.

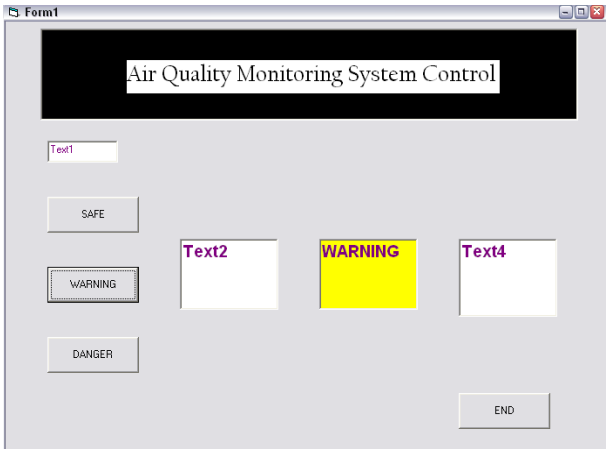

Figure 14: Indicate when output voltage between 1.5V and 2V.

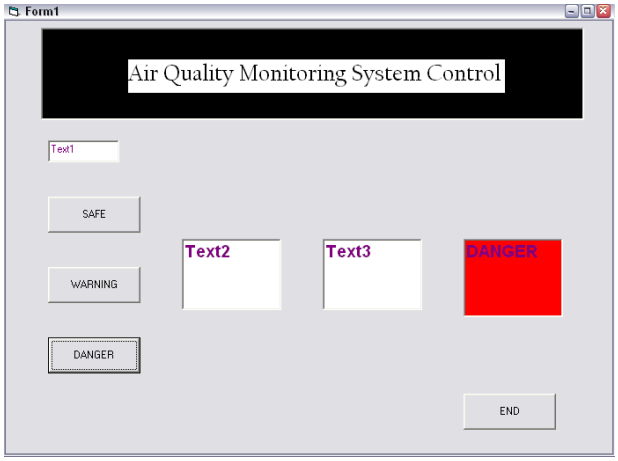

Figure 15: Indicate when output voltage greater than 2V.

IV. DISCUSSION

Indoor air quality monitoring control system is not only applied in a house, but also can be applied in office, school, factory and other buildings. The use of PIC16F877A is to display the output of sensors in screen monitor. MQ-2 sensor is used because it has lower conductivity in clean room and long life use.

Figure 7 and 12 shows the differences of output values before and after applied smell of alcohol and smokes to sensor. TABLE 1 and 2 shows that the output voltages keep increasing when increase the amount of smokes and smell of alcohol. The values of output will be different if applying different amount of fumes to sensor. Output voltage for smoke and alcohol does not have much different. The output voltage of sensor increased rapidly when applied the smell of alcohol. While applied the smell of smoke, the output voltage increased slowly. For this project, different types of smells also can be test.

V. CONCLUSION

The purpose of indoor air quality monitoring control system is to provide a healthy and comfortable environment for the people. The chosen of MQ-2 sensor for this project is because it has fast response and high sensitivity to different types of smells. For this experiment, alcohol and smoke are used to give effect to the sensor. It is difficult to find suitable place to test this experiment, where the smoke make other people in laboratory feel uncomfortable. This project is suitable to apply at home, office or industry. Knowledge of design circuit and programming also needed in this project.

As a conclusion, design of air sensor and convert analogue to digital has succeeded. However, this project needs more improvement and could be used as references for further research and improve the performances of circuit.

FUTURE DEVELOPMENT

This “Indoor Air Quality Monitoring System Control” still needs further improvement in order to increase its efficiency and fulfill the needs and satisfaction of modern people nowadays.

There are some ways that can be done for this system future development as below:

1. Use fuzzy logic controller as the intelligent system where more simple system to rebuild.
2. For future work, connect this project to another system such as blind controller to open the window automatically. This project can be implemented in intelligent home.
3. Design suitable circuit to amplify the output of air sensor.

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