Embedded System for Detecting Cigarette Smoke Indoors using STM32 Microcontroller

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Abstract. In everyday life, smokers are often found around us. As we know, a lot of losses caused by cigarette smoke and cigarette smoke itself can also disturb the people around us. In order not to disturb the health of others, there are restrictions in certain rooms for smoking by giving a sign that smoking is prohibited. But some people sometimes ignore the ban. In this study, our system was embedded to give warnings to people who smoke in rooms that cannot smoke. The system will sound the siren if smoke is detected. This system is designed using a STM32 microcontroller and MQ-2 sensor to detect cigarette smoke. From the results of testing the system will work well by directly giving a signal when there is cigarette smoke.

1. Introduction
In everyday life, many smokers are found around us. As we know, there are so many losses caused by cigarette smoke and cigarette smoke itself can also disturb people around us. Besides disturbing, cigarette smoke can also harm our health, but many people do not care about their health. Every human being tends to want to get pleasure in his way even though it is not good. Cigarettes have become part of all walks of life ranging from children who are not old enough, young children, adults both men and women, even seniors. Of course, cigarette smoke disturbs the surrounding environment for people who don't smoke. According to experts, cigarette smoke is more dangerous when inhaled by people who don't smoke [1–3]. Cigarettes will produce cigarette smoke as a result of burning tobacco so that it can interfere with people who don't smoke. Because of the bad factors brought about by cigarette smoke, in certain areas, some restrictions do not allow someone to smoke. For example, in hospitals, theatres, air-conditioned rooms, and elsewhere. This is done so that the smoke generated does not interfere with other people around him.

Along with the development of embedded system technology, there has been a lot of designing smart equipment systems [4–6]. Intelligent equipment and can work automatically are increasing, in addition to the way it works carefully also does not need to be monitored every time, simply by activating the equipment and set it as desired, then the equipment will work by the programs that have been given. Based on the above problems we will design an embedded system that can detect cigarette smoke in the room by using a smoke sensor, which can notify the occupants who are smoking. The purpose of cigarette smoke detection systems is to detect cigarette smoke in the room so that smokers can be given a warning or warning not to smoke in certain rooms.

This research is based on several previous studies on automatic monitoring of room conditions and air quality. Previously we have designed a system to detect air quality remotely using UAV with the ZigBee protocol [7]. Also, we have designed a system to monitor temperature and humidity in the server.
room [8]. Apart from the research, we have done, this research is also based on other research on smoke detection [9–11].

2. Method

2.1. System overview

The initial stage of this research is to design a system process that is built. The general description of the system designed process can be seen in the flow diagram in Figure 1. From Figure 1 it appears that the system designed has the following process:

- The MQ-2 sensor will send a signal to the ARM STM 32 microcontroller if it detects fire smoke.
- When the ARM STM-32 microcontroller gets a signal and will send the signal to the buzzer and the LED.
- The buzzer will make a sound when getting a signal from the microcontroller is in a state of moderate conditions.
- LED will light when getting a signal from the microcontroller.

2.2. System design

The system is built using the STM32 microcontroller as the central control of the system. STM32 is a 32-bit processor-based microcontroller. This microcontroller has a high clock frequency, generally in the range of 72MHz or more. Internally, each microcontroller consists of a processor core, static RAM,

Figure 1. System process flow chart.
flash memory, debugging interface[12,13]. The form of the STM32 Microcontroller can be seen in Figure 2. The use of STM32 microcontrollers is done because the price is cheap for a type of microcontroller with a 32-bit processor core[14,15].

![Figure 2. STM32 microcontroller.](image)

To detect cigarette smoke we use the MQ-2 gas sensor. MQ-2 gas sensor is a sensor that is useful for detecting gas leaks both at home and in industry. This sensor is very suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane[16,17]. Because of its high sensitivity and fast response time, measurements can be made quickly. Sensor sensitivity can be adjusted with a potentiometer. The image of the MQ-2 gas sensor is seen in Figure 3. The MQ-2 gas sensor has the following specifications[18]:

1. Heating power supply: 5V AC / DC
2. Circuit power supply: 5VDC
3. Measurement range:
   - 200 - 5000ppm for LPG, propane
   - 300 - 5000ppm for butane
   - 5000 - 20000ppm for methane
   - 300 - 5000ppm for Hydrogen
4. Output: analog (voltage change)

![Figure 3. MQ-2 gas sensor.](image)

In addition to controller and sensor components, this system also uses LEDs and buzzers as smoke detector output signals. The entire component is arranged as shown in Figure 4.

![Figure 4. Schematic circuit system](image)
From Figure 4 it appears that the MQ-2 sensor is connected to the PA3 pin on STM32. The PA3 pin is chosen because the MQ-2 sensor is an analog sensor and the PA3 pin on the STM32 is a pin that can accept analog input. As an output signal, Buzzer is connected to the PB7 pin on STM32. While the two LEDs (green and red) are each connected to pin PB8 and PB7 on STM32.

3. Results and discussion
The results of the design carried out experiments to test whether the system can work well or not. The test was carried out 11 times by putting the system built in a closed room. In the first experiment, the system was run for 5 minutes in a smoky room. In the system, a green LED lights up indicating that no smoke has been detected.

In subsequent experiments, the room was given cigarette smoke to test whether the system could detect or not. Within a few seconds, the green LED on the system is off and the red LED is on. Also, Buzzer also makes a sound that indicates the system detects smoke. Then do the smoke exemption in the room by opening the room so that the smoke will switch out of the room. After a few seconds the room was not smoking Buzzer and the red LED went out and the green LED flashed again. In some experiments, there was a system error where Buzzer and red LED were lit even though there was no smoke in the room. Details of trial data during smoking rooms can be seen in Table 1.

Table 1. Data trials.

| Experiment | Time Detecting Smoky Rooms (seconds) | Time Detecting Non-smoking rooms (seconds) | Information |
|------------|--------------------------------------|--------------------------------------------|--------------|
| 1st        | 4                                    | 7                                          | Succeed      |
| 2nd        | 4                                    | 8                                          | Succeed      |
| 3rd        | 7                                    | 9                                          | Succeed      |
| 4th        | 0                                    | 8                                          | Buzzer and Red LED are on before the room gets smoke |
| 5th        | 6                                    | 10                                         | Succeed      |
| 6th        | 8                                    | 9                                          | Succeed      |
| 7th        | 5                                    | 10                                         | Succeed      |
| 8th        | 0                                    | 10                                         | Buzzer and Red LED are on before the room gets smoke |
| 9th        | 7                                    | 9                                          | Succeed      |
| 10th       | 5                                    | 9                                          | Succeed      |

From the data in Table 1, it can be seen that from 10 smoking room trials there were 8 successes. Then from that data, the success rate can be calculated as follows:

\[
\text{Level of success} = \frac{\text{Number of successes}}{\text{Number of Trials}} \times 100\% = \frac{8}{10} \times 100\% = 80\%
\]

4. Conclusion
From the experiments performed, the system can work to detect smoke in a room with an 80% success rate. There were several errors in the experiment, namely the system detected smoke while the room was not smoking. This is because the MQ-2 gas sensor is too sensitive.

5. Acknowledgment
We thank the Universitas Sumatera Utara for supporting us in conducting this research. We are also grateful to all staff at the Computer and Regulatory Laboratories, Department of Electrical Engineering, Faculty of Engineering, Universitas Sumatera Utara, who have helped with this research.
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