Gas Detector

Table of Contents

I. Executive summary

In this assignment, the team decided to develop an application that applies Arduino with the use of C programming language. Our main goal is to build a project that challenges our knowledge and urges us to learn beyond what we already knew.

The team started off with a basic idea which was building a gas detector system with appropriate actions based on different gas levels in the atmosphere. Due to the simplicity of the initial plan, the team wanted to add more features and enhance the creativity of the project. Based on the recommendations from the professor, the server side of the system was included as an online monitor which informs the status of the gas level. Hence, the final project is composed of a LED, a fan, and a buzzer which will be activated when the gas value read by the gas sensor reaches a certain level. Besides that, the web server will receive real-time data and check whether the current situation is safe or dangerous.

To finalize this project, the team went through many stages including forming idea, changing components, researching, building circuit, and writing source code. At the beginning, the team chose to apply Raspberry Pi to the project since all the members were comfortable with Python language. The team spent a lot of time to learn how to make gas detector with Raspberry, but we met some problems with analog input and resource shortage. Therefore, we decided to switch from Raspberry to Arduino, and quickly adjusted the idea to be suitable to Arduino. Thanks to the tutorials in class, all members already had a fundamental knowledge of how to build the circuit, so we could build successfully the electrical circuit for our project. In terms of the source code, since all members were not familiar with C language, available source code examples were the essential guide to write the program in C, especially C in Arduino. In addition, in order to develop the server side, the knowledge from the Data communication and Web Programming courses were applied and fostered in an advanced way. With all the advantages and useful resources, the team quickly finished the program without any severe problems.

Our management approach is that we often had group meetings outside class to build the the circuit, write the source code, and have discussions about the project. The part related to the web server was assigned to a team member who has knowledge about networking and server development, and she would explain the implementation to the rest of the team. After the project was accomplished, it was tested often by the member who kept the components. For the report, each member was responsible for one section, and the team leader would revise all the parts at the end for better quality.

II. Table of Content

a. Introduction

It is undeniable that gas leak is one of the most common factors which causes fire and explosion. Instant alert and immediate actions must be executed to prevent those incidents from happening. Based on that concept, the project was built to serve as part of a safety system by using Arduino and C language. In general, the team developed a gas detector system that instantly and automatically turns on the buzzer, the LED, and the fan when meeting certain gas values. The gas value can be also monitored on the web server to check the status of the environment. To be specific, the fan will be turned on in order to decrease the gas amount, and the LED will be also brightened to notify people when the gas level in the atmosphere reaches 200. Then, if the gas value exceeds 350, the buzzer will be activated to give an emergency alert as the gas value cannot be reduced by the fan. In addition, the web server is also provided to display the gas level in every second and determine if the situation is safe or dangerous. When gas value is over 200, the website will change the state of the environment from “Safe” to “Dangerous”.

b. Project Implementation

i. List of Equipment/Components and specification

1. **Arduino Uno**

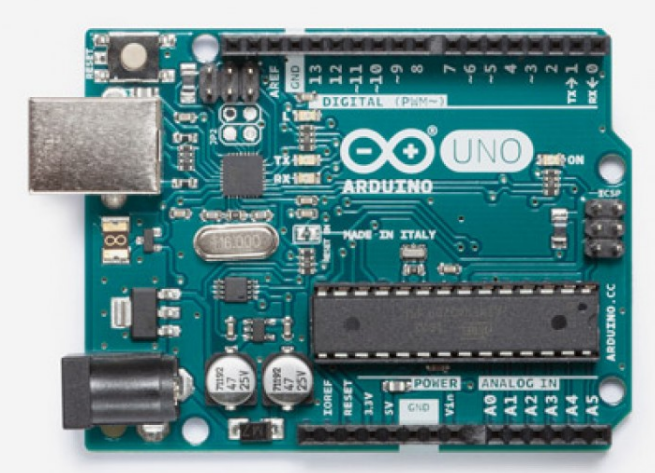

Figure 1. *ARDUINO UNO REV3*

Reproduced from Arduino n.d

❖ **Specification**:

*** According to Arduino (n.d)

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm

Weight	25 g

Table 1: *Arduino Uno Specification*

❖ **Justification:**

- According to Arduino (n.d), Arduino Uno is a microcontroller board, and it has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.
- To start using Arduino Uno, the user just needs to use a USB cable to connect it to a computer.

2. Ethernet Shield

Figure 2. *Arduino Ethernet Shield*

HobbyTronics n.d

❖ **Specification**:

*** All information below belongs to HobbyTronics (n.d):

- Supports TF card up to 16GB
- Uses standard Arduino Ethernet drivers
- The Arduino Ethernet Shield supports up to four simultaneous socket connections
- The on-board micro-SD card slot can be used to store files for serving over the network.

❖ **Justification:**

Ethernet Shield allows the Arduino Board to connect to the Internet by Ethernet library and send data to the web server by HTTP methods. In order to have the network connection, the user could use CAT6 cable with RJ45 connectors to connect the Ethernet Shield to the router (LAN port).

3. Breadboard

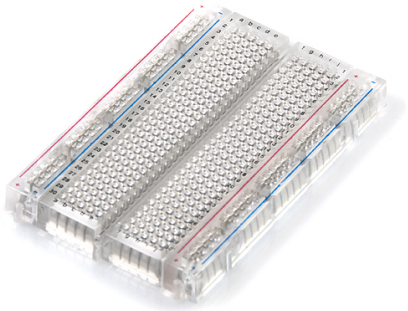

Figure 3. *Breadboard - Translucent Self-Adhesive (Clear)*

Reproduced from sparkfun n.d

❖ **Specification**:

*** According to sparkfun (n.d)

Power Buses	2
Columns	30
Rows	10 - a total of 400 tie in points
Space between 2 Pins	0.1"
Dimensions	3.29 x 2.15 x 0.33" (83.5 x 54.5 x 8.5mm)

Table 3: *Breadboard Specification*

❖ **Justification:**

The breadboard is used to connect the Arduino board to other hardware components by using specific types of jumper wires. It is considered as a tool to create prototypes of circuit.

4. Gas Sensor MQ2

Figure 4. *MQ-2 Gas Sensor*

Reproduced from Amazon n.d

❖ **Specification**:

*** According to Amazon (n.d)

Power	2.5V ~ 5.0V
Dimension	40.0mm * 21.0mm
Mounting holes size	2.0mm
Sensitive for	Propane, Hydrogen, Methane (CH4), etc.
Terminals	VCC, A0, GND

Table 4: *Gas Sensor MQ2 Specification*

❖ **Justification:**

The MQ2 sensor detects the flammable gas in the environment, and it can output both analog and digital voltage.

5. LED

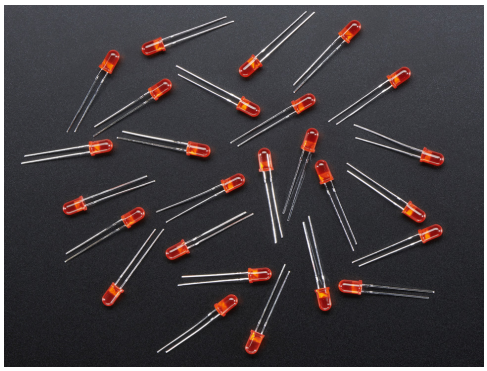

Figure 5. *Red LED*

Reproduced from adafruit n.d

❖ **Specification**:

*** According to adafruit (n.d)

Diameter	5mm
Wavelength	660 nm
Forward Voltage	1.85-2.5V
Typical Brightness	250 mcd

Table 5: *Red LED Specification*

❖ **Justification:**

The LED is used as an indicator which can be turned on and off very easily.

6. Buzzer

Figure 6. *Buzzer 3W*

Reproduced from Hshop n.d

❖ **Specification**:

*** According to Hshop (n.d)

Diameter	4 cm
Width	2 cm
Operating Voltage	3W
Resistance	4 ohm
Sensitivity	100db/W

Table 6: *Buzzer 3W Specification*

❖ **Justification:**

The buzzer is used for making sound when meeting certain conditions. Its tone can be set with parameters such as pin, frequency, and duration in the program.

7. Fan

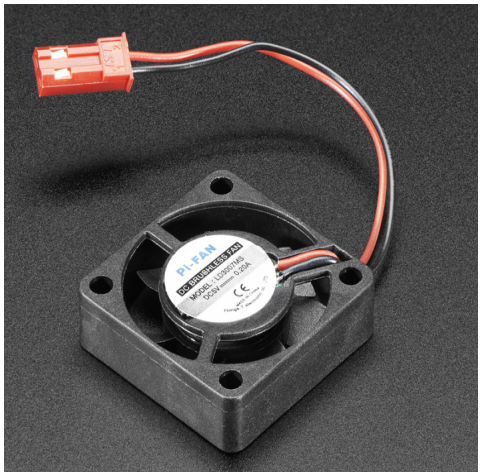

Figure 7. *Miniature 5V Cooling Fan*

Reproduced from adafruit n.d

❖ **Specification**:

*** According to adafruit (n.d)

Operating Voltage	5V
Current	0.2 A
Fan dimensions	30mm x 30mm x 8mm
Wire length	3.25" / 80mm
Fan weight	6.2g / 0.22oz

Table 7: *Miniature 5V Cooling Fan Specification*

❖ **Justification:**

The fan is used for cooling and preventing overheating, and in this project, its function is reducing the gas level.

8. Resistor

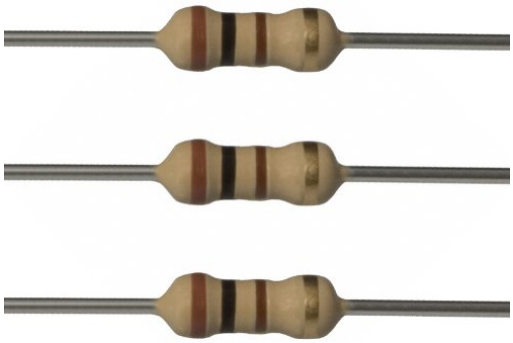

Figure 8. *Resistors*

Reproduced from Amazon n.d

- **Specification**:

*** According to Amazon (n.d)

Item Weight	0.64 ounces
Watt	¼ Watt
Material	Carbon

Table 8: *Resistors Specification*

- **Justification:**

The resistor is used for adjusting signal levels and divide voltage.

9. CAT6 Cable

Figure 9. *CAT6 Cable*

Reproduced from Telco Antennas n.d

❖ **Specification**:

*** According to Telco Antennas (n.d)

Conductor Material	Bare Copper 243AWG
Insulating Material	HPDE
Outer Shield Material	Aluminium Foil
Outer Jacket Material	Blue Polyvinyl Chloride PVC
Connectors	50µ Gold Plated Modular 8P8C Male

Table 9: *CAT6 cable Specification*

❖ **Justification:**

CAT6 supports high-speed data transfer, which is 10 Gigabit speeds. Also, it has short delay times compared to other types of cables because two-way communication between each pair of wires is available. It can be used to connect the Ethernet Shield to the LAN port through the RJ45 connectors in order to have the Internet connection.

10. Male/Male Jumper Wires

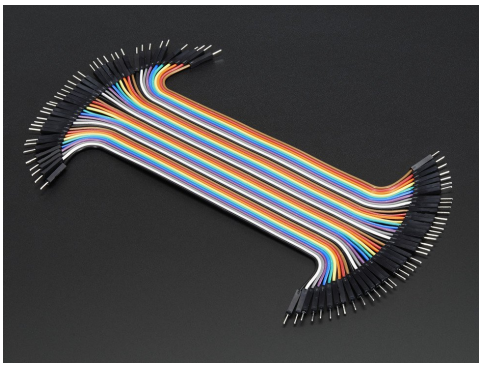

Figure 10. *Male/Male Jumper Wires*

Reproduced from adafruit n.d

❖ **Specification**:

*** According to adafruit (n.d)

Length	6" (150mm)
Material	Durable hard plastic and copper wire
Connectors	1pin-1pin male to male header

Table 10: *Male/Male Jumper Wires Specification*

❖ **Justification:**

Male/Male jumper wires are used to connect hardware components to Arduino board's ports.

ii. Software (attached in the group folder)

- **Technologies used:**

  + Programming languages: C and JavaScript

  + Server Frameworks: Node.js and Express.js

  + Hosting Service: Amazon EC2

iii. Circuit Design (HD image link)

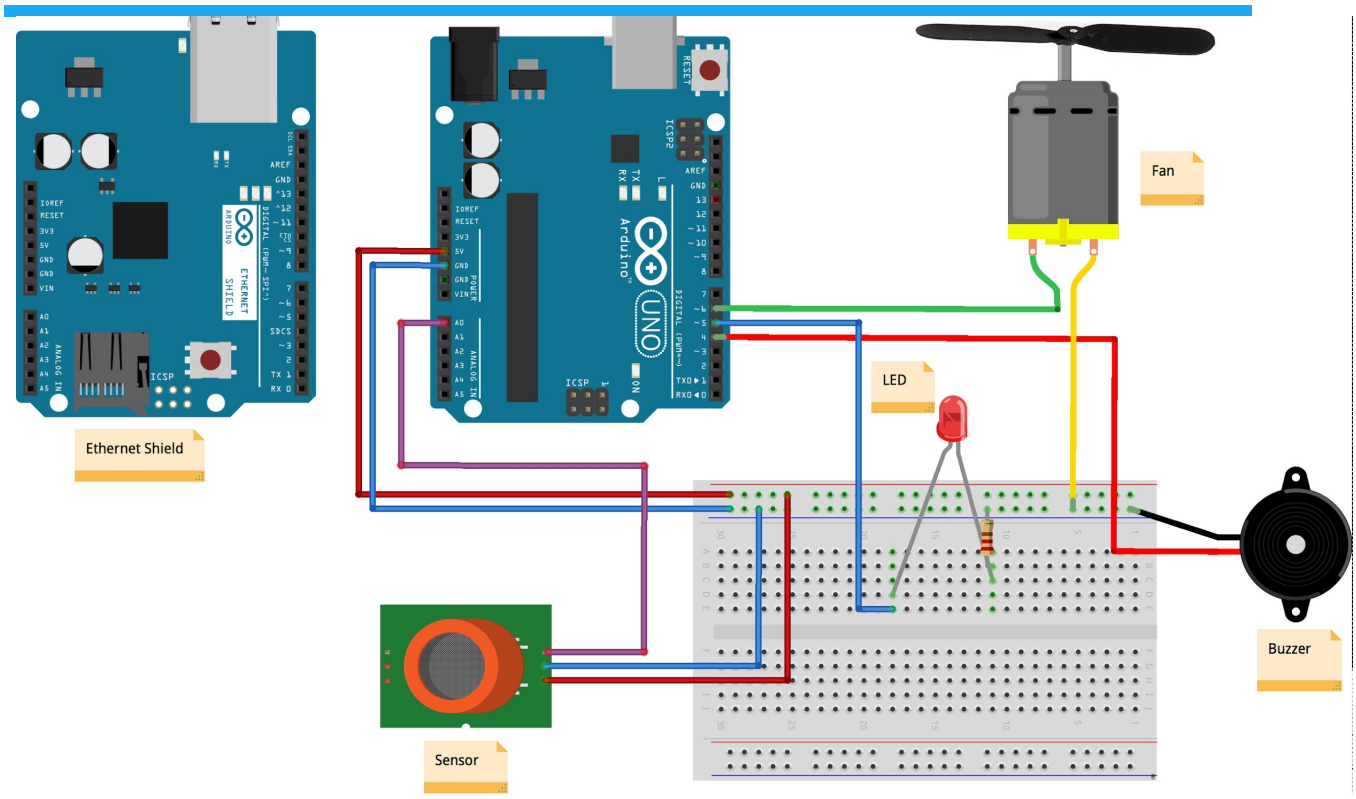

Figure 11: *Gas detector circuit using one Sensor MQ2, one Fan, one Buzzer, one LED and one Ethernet Shield*

iv. Procedure

These steps are followed to build Arduino gas detector circuit:

Step 1: Import the Ethernet Shield
The Ethernet Shield is put on the top of the Arduino board.

Step 2: Connect Power Rails
By using the male - male jumper wires, connect the power (+) rail in red color of the breadboard to the 5V port of the Arduino, and connect the ground (-) rail in blue color to the GND (ground) port of the Arduino.

Step 3: Connect the gas sensor (port A0)
Connect the Gas sensor (MQ2) into the Arduino through female - male jumper wires. The VCC pin of the sensor is connected to power (+) rail on the breadboard, GND pin is connected to the ground (-) rail on the breadboard, and the A0 (Analog) pin is connected to port A0 of the Arduino. (We use Analog port instead of Digital port to read the exact value of the gas level.)

Step 4: Connect the Fan (port 6)

The positive terminal of the Fan will be connected to port 6 and the negative terminal is connected the ground (-) rail on the breadboard through male - male jumper wires.

Step 5: Connect the LED (port 5)
Connect the LED's positive terminal (long leg) to port 5 of the Arduino by male - male jumper wire, and install a resistor from the LED's negative terminal (short leg) to the ground (-) rail on the breadboard.

Step 6: Connect the Buzzer (port 4)
Connect the Buzzer's positive terminal to port 4 of the Arduino, and negative terminal to ground (-) rail on the breadboard. Set up the tone through the source code.

Step 7: Connect cables
Connect Arduino board to the computer and Arduino IDE by USB cable, and connect Ethernet Shield board to the LAN port by CAT6 cable.

Step 8: Verify and import the code
Verify and upload the source code to the Arduino board.

Step 9: Testing the system and debug

- **Description:** To run the system, one person need to release the flammable gas such as Hydrogen and Methane (CH4) near the MQ2 gas sensor. The gas sensor will read the gas value as an analog input, and the application will compare it to the defined ranges and activate certain actions. Those actions in different gas levels are listed below:
    - If the gas value is below 200, the Fan, the LED and the Buzzer will be off, and the button on the web server displays "Safe" in green color.
    - If the gas value is above 200, the Fan and the LED will be turned on, and the button on the web server will be changed to "Dangerous" in red color.
    - If the gas value is above 350, together with the Fan, the LED and the Buzzer will be turned on, and the button on the web server will remain "Dangerous" in red color.

III. Reference

adafruit (n.d), '*Diffused Red 5mm LED'*, image, *adafruit*, viewed 8 January 2018, <https://www.adafruit.com/product/299>.

adafruit (n.d), '*Diffused Red 5mm LED'*, *adafruit*, viewed 8 January 2018, <https://www.adafruit.com/product/299>.

adafruit (n.d), '*Miniature 5V Cooling Fan for Raspberry Pi (and Other Computers)'*, image, *adafruit*, viewed 8 January 2018, <https://www.adafruit.com/product/3368>.

adafruit (n.d), '*Miniature 5V Cooling Fan for Raspberry Pi (and Other Computers)'*, *adafruit*, viewed 8 January 2018, <https://www.adafruit.com/product/3368>.

adafruit (n.d), '*Premium Male/Male Jumper Wires - 40 x 6" (150mm)'*, image, *adafruit*, viewed 8 January 2018, <https://www.adafruit.com/product/758>.

adafruit (n.d), '*Premium Male/Male Jumper Wires - 40 x 6" (150mm)'*, *adafruit*, viewed 8 January 2018, <https://www.adafruit.com/product/758>.

Amazon (n.d), '*E-Projects 100EP514100R 100 Ohm Resistors, 1/4 W, 5%'*, image, *Amazon*, viewed 7 January 2018, <https://www.amazon.com/gp/product/B00AVSDYFO/ref=s9_acsd_simh_hd_bw_bKlJjn_c_x_w?pf_rd_m=ATVPDKIKX0DER&pf_rd_s=merchandised-search-3&pf_rd_r=M1DYCHRNDWX2ZGCQ2XPD&pf_rd_t=101&pf_rd_p=4783b9b9-c8f8-5fb0-940b-9e469a321bea&pf_rd_i=306804011>.

Amazon (n.d), '*E-Projects 100EP514100R 100 Ohm Resistors, 1/4 W, 5%'*, *Amazon*, viewed 7 January 2018, <https://www.amazon.com/gp/product/B00AVSDYFO/ref=s9_acsd_simh_hd_bw_bKlJjn_c_x_w?pf_rd_m=ATVPDKIKX0DER&pf_rd_s=merchandised-search-3&pf_rd_r=M1DYCHRNDWX2ZGCQ2XPD&pf_rd_t=101&pf_rd_p=4783b9b9-c8f8-5fb0-940b-9e469a321bea&pf_rd_i=306804011>.

Amazon (n.d), '*Waveshare MQ-2 Gas Sensor Module LP,Propane,Hydrogen Detection Sensor Gas Detector Sensor Module for Arduino Raspberry pi'*, image, *Amazon*, viewed

7 January 2018, <https://www.amazon.com/Wavesahre-MQ-2-Gas-Sensor-Detection/dp/B00NJOIB50>.

Amazon (n.d), '*Waveshare MQ-2 Gas Sensor Module LP,Propane,Hydrogen Detection Sensor Gas Detector Sensor Module for Arduino Raspberry pi*', *Amazon*, viewed 7 January 2018, <https://www.amazon.com/Wavesahre-MQ-2-Gas-Sensor-Detection/dp/B00NJOIB50>.

Arduino (n.d), '*ARDUINO UNO REV3'*, image, *Arduino*, viewed 7 January 2018, <https://store.arduino.cc/usa/arduino-uno-rev3>.

Arduino (n.d), '*ARDUINO UNO REV3'*, *Arduino*, viewed 7 January 2018, <https://store.arduino.cc/usa/arduino-uno-rev3>.

HobbyTronics (n.d), '*Arduino Wiznet Ethernet W5100 Shield'*, image, *HobbyTronics*, viewed 7 January 2018, <http://www.hobbytronics.co.uk/arduino-wiznet-shield>.

HobbyTronics (n.d), '*Arduino Wiznet Ethernet W5100 Shield'*, *HobbyTronics*, viewed 7 January 2018, <http://www.hobbytronics.co.uk/arduino-wiznet-shield>.

Hshop (n.d), '*Mini Buzzer 3W'*, image, *Hshop*, viewed 7 January 2018, <http://hshop.vn/products/loa-mini-3w>.m

Hshop (n.d), '*Mini Buzzer 3W'*, *Hshop*, viewed 7 January 2018, <http://hshop.vn/products/loa-mini-3w>.

sparkfun (n.d), '*Breadboard - Translucent Self-Adhesive (Clear)'*, image, *sparkfun*, viewed 7 January 2018, <https://www.sparkfun.com/products/9567>.

sparkfun (n.d), '*Breadboard - Translucent Self-Adhesive (Clear)'*, *sparkfun*, viewed 7 January 2018, <https://www.sparkfun.com/products/9567>.

Telco Antennas (n.d), '*Cat6 SFTP 10m Ethernet Cable - ESD Shielded RJ45'*, image, *Telco Antennas*, viewed 8 January 2018, <https://www.telcoantennas.com.au/site/10m-cat6-sftp-ethernet-cable-esd-shielded-rj45>.

Telco Antennas (n.d), '*Cat6 SFTP 10m Ethernet Cable - ESD Shielded RJ45'*, *Telco Antennas*, viewed 8 January 2018, <https://www.telcoantennas.com.au/site/10m-cat6-sftp-ethernet-cable-esd-shielded-rj45>.