FINAL REPORT

AirFlow-3000

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2CI

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PROJECT PROPOSAL

1. Summary

Students and teachers spend about 30-35% of the day at school. Therefore, it is particularly important to ensure good air quality in the classroom and to ventilate more often. The concentration of the students suffers from the bad indoor air and they tire more quickly.
Our project is a mock-up model of a room composed of a wooden panel and four plexiglass walls with a window that opens and closes automatically. We use a ESP32 Arduino microcontroller to control the servo motor that opens the window when the gas senor measures the CO_2 level that surpasses the limit of 1000 PPM (parts per million). Studies show that the ideal indoor climate should be between 500 – 1000 PPM. As the CO_2 level rises, so do other pollutants (bacteria, virus). The LCD display shows the CO_2 level in real time.

2. Resources

- ESP32 microcontroller (Arduino)
- Servo (motor)
- LCD (liquid crystal display)
- MG811Gas Module Air Quality Sensor
- Plexiglass
- Wooden panel

3. Phases / Deliverables

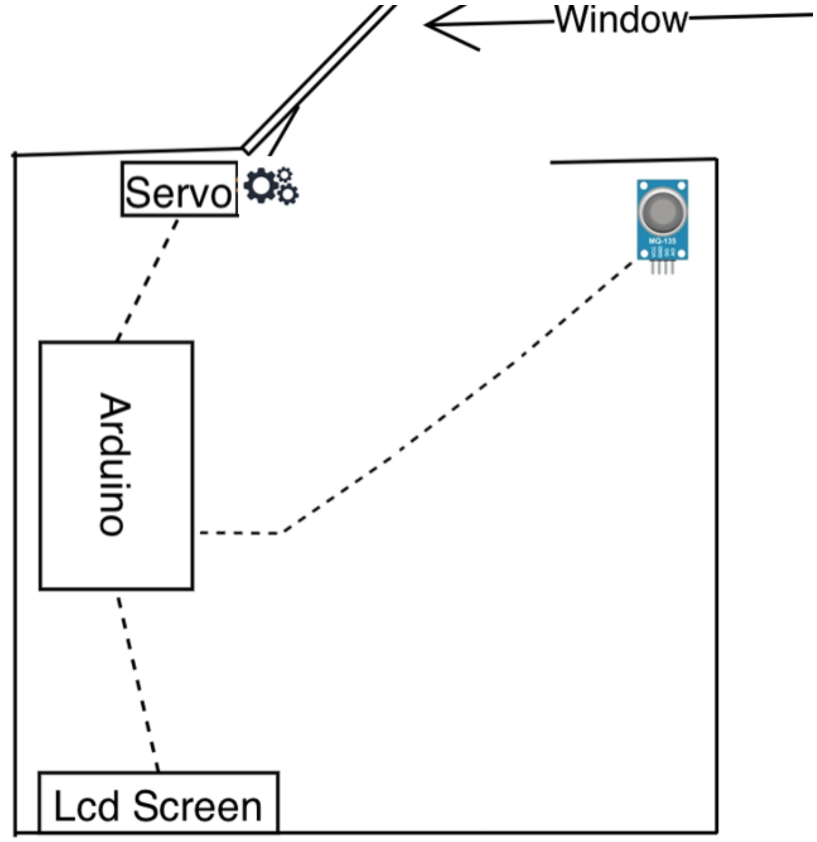
Phases	Description	Estimation (d/h)	Deliverables
Buy material	Purchase the missing parts: - MG811 Gas Module Air Quality Sensor - Plexiglass - Wooden panel The Arduino kit that includes the microcontroller ESP32, the servo,	1h	

	the LCD display and the wirings are provided by school.		
Hardware	Assembly of electronic parts	2h	Hardware of our project
Build the model room	Construction of our model room with a wooden floor and plexiglass walls	5h	Mock-up model room
Program the microcontroller	Development of the code that allows the microcontroller to function as intended	7h	LCD display shows the CO_2 level and the servo moves if the gas sensor measures a value that reaches the limit.

4. Evolution Plan

- We could add a DHT11 sensor to control the room temperature and humidity, as these two measuring values are also important to guarantee the well-being in the classroom.
- In case, we finish the basics of our project earlier than expected, we could add a few more details or decorations to our model room. We could add a wallpaper to the plexiglass, as well as a lamp to illuminate the room to make it look more realistic.

5. Sketch



SPECIFICATIONS

1. Introduction

1.1 Purpose of the document

The purpose of this document is to describe the project “AirFlow-3000”, a small model house, equipped with a CO_2 sensor as well as a servo motor, opening a window, when the CO_2 level reaches 1000 ppm (parts per million).

1.2 Recipients

This document is intended for the teachers of the "Lycée des Arts et Métiers" linked to the “Maîtrise d’ouvrage” lesson, as well as all people, who want to have an automatic system, which controls the CO_2 level and closes or opens windows automatically.

1.3 Scope

- Assembly and programming of the Arduino, so that when the CO_2level gets too high, the servo motor opens a window, and then closes it when the CO_2 level is under a certain value.
- Include the hardware in the model house.
- LCD display shows the CO_2 level in real time. The display’s background is green when the CO_2 level is under 1000 ppm and it turns red when the carbon dioxide level is above 1000 ppm.

1.4 Out of scope

- For the moment our project only measures the CO_2 level and not the temperature or humidity.
- A solar energy station charges the batteries, which power the electric system.

2. Needs and requirements

2.1 Request description

First, we need a CO_2 sensor (MG811) and all the necessary parts to control an Arduino ESP32 microcontroller. To program the Arduino, we need a Laptop or a PC, on which a specific software is installed.

- Arduino IDE (https://www.arduino.cc/en/software)

2.2 Requirements

2.2.1 Functional requirements

ID	Description
FR-01	**Provide the Arduino ESP32 microcontroller with wires**
FR-02	**Program the Arduino**
FR-03	**Connect the CO_2 sensor and the servo motor to the Arduino**
FR-04	**Include the hardware in the model house**

Table 1 – Functional requirements

2.2.2 Non-Functional requirements

ID	Description
NFR-01	**Model house**
NFR-02	**Add comments to the code**
NRF-03	**Show CO_2 level on LCD screen**

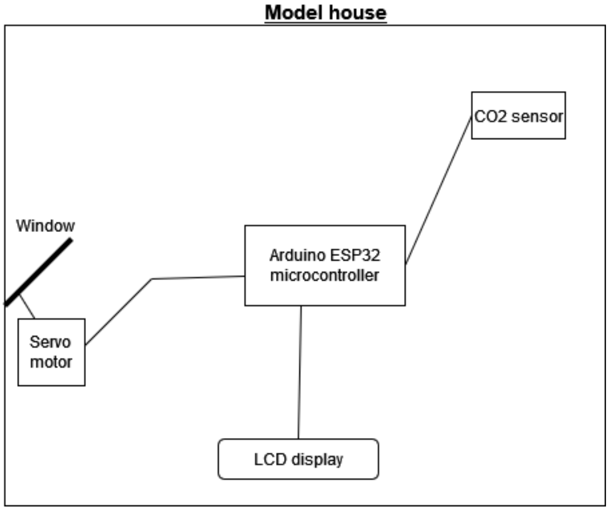
Table 2 – Non-functional requirements

2.3 Restrictions

ID	Description
R-01	**Access to a power source must be guaranteed**
R-02	**CO_2 level have to vary so that our demonstration can work**

Table 3 – Restrictions

2.4 Use case



3. Detailed description of the project

During the pandemic of Covid-19, the Luxembourgish government bought CO_2 measuring devices for school classes to improve the indoor air quality and to limit the propagation of Covid-19. It is scientifically proven that the concentration of viruses and carbon dioxide is related. Nowadays, in almost every classroom there is a CO_2 sensor, beeping as soon as the CO_2 level surpasses a certain value. Then a window has to be opened, so that the CO_2 level decreases and the sensor stops beeping. In winter, when it is cold outside, it is especially uncomfortable when the window is still open, even though the CO_2 level already has dropped to a healthy level.

Our idea for this project was, not to have to open the window manually, but to connect a motor to a microcontroller, that opens the window when the CO_2 level is getting too high and afterwards closes the window when the CO_2 level is beneath 1000 ppm.

4. Planning

Task	Duration	Start date	End date
Order of the CO_2 sensor	1h	13/04/2022	03/05/2022
Assembly of the parts (Servo, Sensor, LCD display, ESP32)	2h	04/05/2022	06/05/2022
Coding of the Arduino	7h	04/05/2022	01/06/2022
Last changes to improve the functionality	2h	01/06/2022	06/06/2022
Inclusion of the hardware in the model house	1h	07/06/2022	09/06/2022

Table 4 – Planning

5. Budget & resources

Resource	Quantity	Unit price	Total	Comment
CO_2 sensor	2	40.00€	80.00€	MG811 Carbon Dioxide Gas Sensor Module
Arduino ESP32	1	/	/	
Arduino UNO R3	1	/	/	We used the 2nd Arduino for power supply.
LCD Display	1	/	/	
Potentiometer	1	/	/	
Servo Motor	1	/	/	
Wires	±10	/	/	
Model House	1	50.00€	/	Already in possession

Table 5 – Budget

REPORT

6. Description of the final product

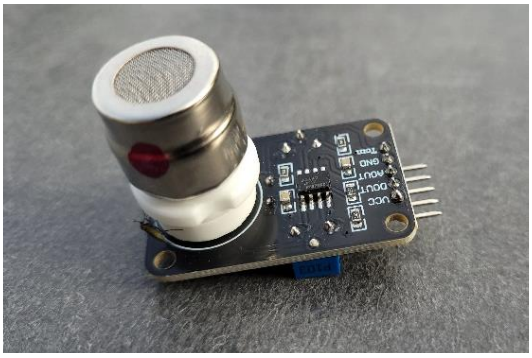
The model house[1], was included in a scientific kit. The plexiglass window had to be resized to fit in the window frame. To avoid wasting too much time cutting the plexiglass, we simply used a piece of cardboard as a window. Even though we have to submit the final report, we are not finished with our project. We spend too much time trying to figure out how the MG811 sensor works, so that in the end we had not much time left to build a system that opens the window with a servo motor. Therefore we decided to build the holder for the servo out of Lego bricks.

6.1 How does the MG811 sensor work?

The MG-811 sensor is an electrochemistry sensor and is basically a cell which gives an output in the range of 100-600mV (400—10000ppm CO_2). The output voltage of the sensor in clean air (400ppm CO_2) is in the range of 200mV-600mV and is defined as “Zero Point Voltage” (V_0). The higher the CO_2 concentration, the lower the output voltage. And with a few complicated calculations, the output voltage is converted to ppm. To explain how it works in detail, we lack the necessary background knowledge in chemistry and electronics.

For more detailed information :

- https://sandboxelectronics.com/files/SEN-000007/MG811.pdf
- https://sandboxelectronics.com/?p=147



MG811 Carbon Dioxide Gas Sensor

[1] https://www.ideeundspiel.com/p/kosmos-625825-geolino-power-house/KOSMOS625825

7. Retrospective

The first problem was our budget. CO_2 sensors are in general quite expensive and cost up to 200€. Nevertheless, we found a cheaper variant (MG811) and ordered one on Amazon. But then we received an E-mail saying that this sensor could not be shipped. We then decided to order another CO_2 sensor on the platform eBay. A few weeks later, the CO_2 sensor from Amazon arrived even though we were told that it would not. So we tried to cancel the order on eBay, but it was already too late. Long story short, we now have two CO_2 sensors and we tried to make them work.

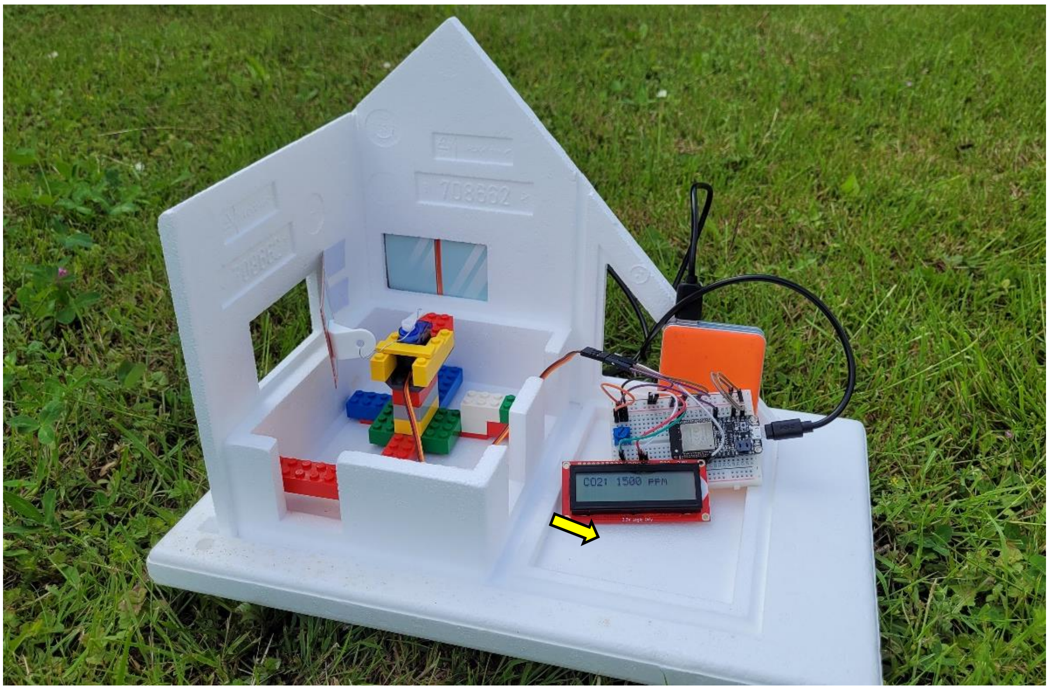
In the time we were waiting for the sensor to be delivered, we worked on the coding of the microcontroller. Our idea was to open a plexiglass window with a servo motor, when the carbon dioxide level exceeds the limit value of 1000 ppm. When the room is sufficiently aired and the CO_2 level has decreased to a healthy level, the window closes automatically. The most difficult functionality of the code was to change the color of the LCD display depending to the current CO_2 level (if the ppm value is greater than 1000 ppm, the display turns red, otherwise the display is green). Another challenge was to program the servo to move smoothly and not abruptly so that the window would not break.

In the beginning we thought that we could simply connect the CO_2 sensor to our Arduino and get instantly the real CO_2 level. However, we had no clue how complicated it would be to set the sensor up and after a few researches we found out that the sensor has to be calibrated. While we tried to obtain more information and visited some websites, we encountered another problem. We found that each website said something different about how long (from 2 hours to 48 hours) you had to "warm up" the senor by leaving it plugged into a power source for a certain amount of time. We also had to use a second Arduino (Arduino UNO R3) to power the CO_2 sensor, because the sensor requires a minimum volage of 5V, which the Arduino ESP32 does not provide. In order to demonstrate our project, our best solution was to use a potentiometer to manually change the values.

Initially, we wanted to display the CO_2 level in real time on our own website. On html5up.net we found a template for our website and with a "GitHub Students Developer Pack" account we got a personalized domain name for free for one year. The website itself is hosted on GitHub, which is also for free. However, it turned out that displaying the CO_2 values in real time, was more complicated than expected. The problem is that on YouTube or on other websites, it always looks a lot easier, as it is in reality. Nonetheless we can use our website airflow3000.live to publish the promotional video and the final report, as well as a short description of our project AirFlow-3000.We used the program Visual Studio Code, a source code editor, to personalize our own website and to add a few functionalities, like buttons which redirects the user to another website. Meanwhile, we also learned a bit of HTML, which is a programming language to develop websites.

8. Improvements for future projects

We spent too much time trying to figure out how the MG811 sensor works, so we ended up with no concrete idea of how to build a system that opens the window with the servo motor. We should have continued working on other parts of the project, although we were blocked by a number of problems. We focused too much on the carbon dioxide sensor, which is the essential “heart” of our project. Next time we should not make the development plan too ambitious. We should work more step by step and continue working on other parts of the projects even if we encounter problems.



Model house with hardware