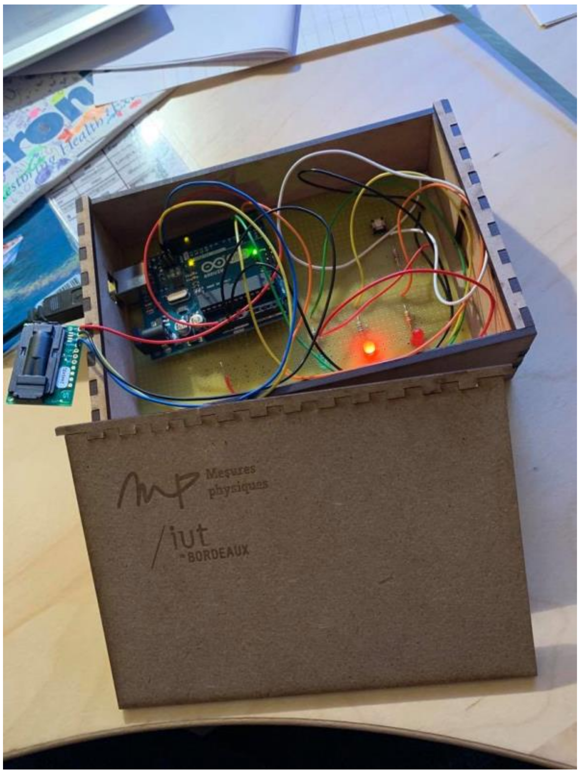
Intermediate report tutored project



Louis BROCCA
Florian CASTERMANS
Liam CHAUMETTE
Paul SAUVAUD
Tutored project S3 2020-2021
Tutor : Thomas ZIMMER

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Introduction

In this perturbed context, a new subject has been proposed by our tutor Thomas ZIMMER : Make a CO_2 sensor.

The objective was the following: Enforce a system able to detect and warn concerning the level of CO2 in the air. This device has for goal to help to aerate classroom to respond to current sanitary requirements. (COVID-19)

In order to work efficiently, we have decided to organise ourselves as a team. One leader has been nominated: Louis Brocca and two groups have been formed.

One was focused on the programming and the other had to design the prototype's package.

The purpose of this report is to retrace our progress on the project by answering the following question:

How to make such a device and design it?

In a first part, we will talk about the research done concerning the sensor's operation and in a second part, we will introduce to you the device's design.

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1 Ownership of the topic

1.1 Search for the functioning of the sensor: the heart of the prototype

At first glance, it may seem difficult to design such a device. The CO_2 being colourless, tasteless, and odourless, we must find a specific way to detect it.

Three types of sensors exist: The MOX (metal-oxide), Electrochemical, NDIR (Non-Dispersive Infra-Red). Let’s have a look concerning their functioning.

The MOX: the sensor has a metal strip (substantial portion) which is heated directly exposed to the air. When the gas interacts with this substantial portion, it can absorb or release electrons (according to the gas) Thus, the measure current will change and permit to deduce the CO_2‘s concentration.

The Electrochemical: the principle is directly linked with reduction and oxidation. We choose two conductive substances that are sensitive to the $CO_{2.}$ Thus, we can deduce thanks to the variation of current the real concentration in $CO_{2.}$

The NDIR: the sensor will emit an infrared beam which the wavelength is defined as a function of the Gas. Then, the measured intensity will vary depending of the concentration of CO_2 (the higher the concentration, the lower the intensity)

1.2 Selection of the elements required for the prototype

The Appropriation of the different sensor has allowed us to make a choice concerning our prototype. Indeed, we would a reliable sensor with a long lasting able to work between 600 and 2000 ppm.

Here is a comparative between sensors:

	NDIR	Electrochemical	MOX
Advantages :	Long lasting; No interferences with other substances; Work well around 1000 ppm	Little influenced by temperature and humidity	Easy to use
Drawbacks :	Affected by humidity and temperature	Other substances can throw off readings Do not last as long as NDIR sensors The sensor can “drift,” or lose accuracy	Affected by humidity and temperature Other substances can throw off readings Work well around 2000 ppm

So the Mox wasn't very appropriate because of its work area. Finally, we have chosen the NDIR sensor (scd30). It was reliable, worked around 1000 ppm and do not drift or lose any accuracy.

To finalize the prototype, we also needed an Arduino board necessary for the programming, 3 leds (indicators of the Co_2 levels), connector wires and a test board.

2 The realization of the device

2.1 Programing

Before coding the Arduino card, we took the stepwise CO2 values specified by the scientists. Below 1000ppm, the CO2 level is good, between 1000 and 1500, it is quite good but it is advisable to ventilate the room, and above 1500, it is urgent to ventilate because the level is much too high.

For coding, the Arduino library codes "<Wire.h>" and "<SparkFun_SCD30_Arduino_Library.h>" are included for the operation and reading of the SCD30 CO2 sensor. The setup loop is used to configure the ports of the Arduino board, as well as to display an error message on the computer screen if the sensor is read incorrectly.

In the loop, the "CO2_rate" value is set, which will be the support for the CO2 rate value in the rest of the program. With the function "airSensor.getCO2" (or getTemperature or getHumidity), the CO2, temperature and humidity values can be read when the sensor is connected to a computer. Then an IF loop is integrated in order to switch on the green led if the CO2 level is good (<1000ppm), the orange led if the CO2 level is way (between 1000 and 1500), or the red led if the level is bad (>1500ppm).

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Code of the Arduino card

Code_arduino

```
#include <Wire.h>


#include <SparkFun_SCD30_Arduino_Library.h>
SCD30 airSensor;

int ledR=2;
int ledO=3;
int ledV=4;

void setup()
{
  pinMode(ledR, OUTPUT);
  pinMode(ledO, OUTPUT);
  pinMode(ledV, OUTPUT);
  Serial.begin(9600);
  Serial.println("capteur");

  Wire.begin();

  if (airSensor.begin(Wire)==false)
  {
    Serial.println("capteur non détecté. Veuillez verifier la connexion.");
    while(1);
  }
}

void loop()
{
  int taux_co2;

  if(airSensor.dataAvailable())
  {
    taux_co2=(int)airSensor.getCO2();
    Serial.print("co2(ppm):");
    Serial.print(taux_co2);

    Serial.print(" temp(C):");
    Serial.print(airSensor.getTemperature(),1);

    Serial.print(" humidity(%):");
    Serial.print(airSensor.getHumidity(), 1);
```

```
    Serial.println(taux_co2);
    if(taux_co2<1000)
    {
      digitalWrite(ledV,HIGH);
      digitalWrite(ledO,LOW);
      digitalWrite(ledR,LOW);
    }
    else if (taux_co2>=1000 && taux_co2<1500)
    {
      digitalWrite(ledO,HIGH);
      digitalWrite(ledV,LOW);
      digitalWrite(ledR,LOW);
    }
    else if (taux_co2>=1500)
    {
      digitalWrite(ledR,HIGH);
      digitalWrite(ledO,LOW);
      digitalWrite(ledV,LOW);
    }
  }
  delay(500);

}
```

2.2 Case design

The conception of the box was realized in two steps:

-First, we have decided to make a first sketch (fig 1) to have an idea of the global shape of our prototype. By the same time, it has allowed us to think about the layout of the model. We have chosen to stack the elements on the box to minimise the space occupied.

Other adjustments have also been made to allow for optimal operation such as:

- A hole for the board power cable
- A Sliding cover revealing the colour of the LEDs and allowing sufficient ventilation during measurement

-After conceptualising the box, we modelled it on Inscape (fig 2). This software is compatible with the laser cut-outs available at the Fablab. This method is faster and more accessible than 3D printing.

Concerning the box itself, we have used glued wood, an ecological and more aesthetic material.

Conclusion

To conclude, this project can be summarised in three main stages. The first was the creation of the model by selecting and purchasing the components necessary for its proper functioning. The second was the programming of the prototype, an essential step for carrying out and interpreting measurement results. Finally, our project became a reality through the material design of the box to house the sensor. (fig3)

Obtaining a device that fully meets the requirements set would require concrete efficiency and uncertainty tests to ensure the reliability of the system. Other objectives could also be defined as points for improvement in order to correct any defects in the CO_2 sensor.

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Annex

Louis Brocca
Florian Castermans
Liam Chaumette
Paul Sauvaud

Fig1

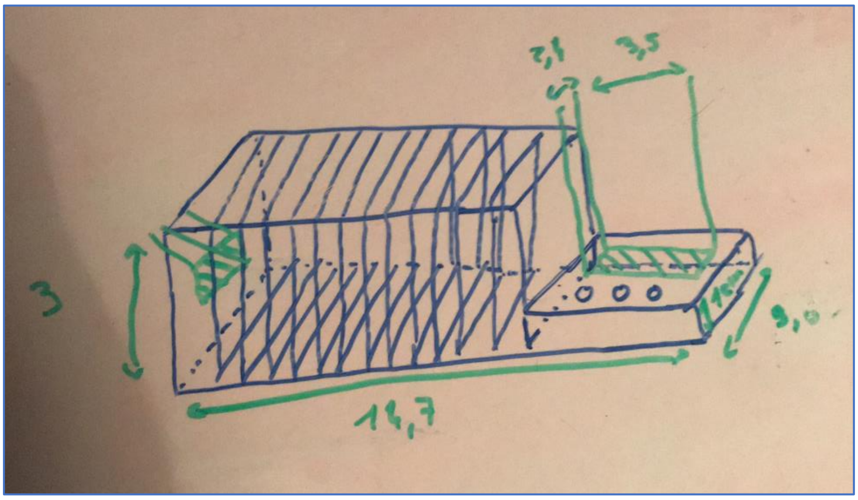

Fig2

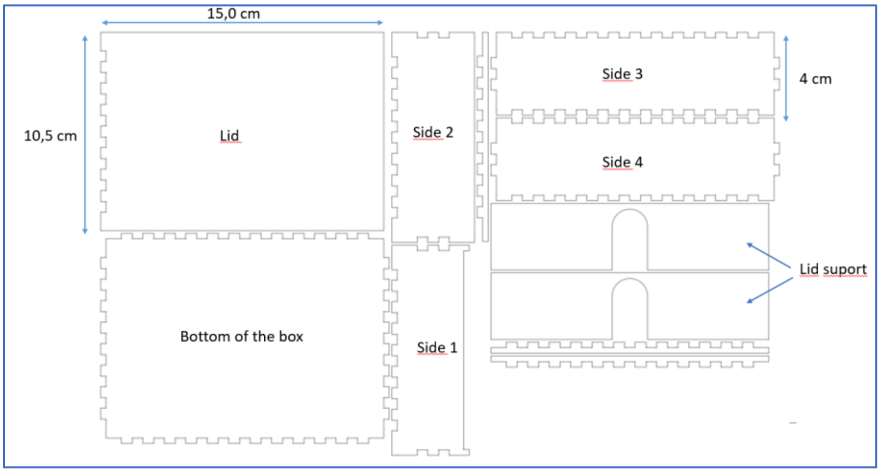

Fig3