

ElectroCap



Monitoring Air Quality in AC Units

Group 18

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Advisors and Mentor

- Scientific Advisor: Prof. Luís M. Correia
- Coordinator: Prof. Luís M. Correia
- Co-coordinator: Prof. João Felício



Problem definition

- Lack of Monitoring Devices for Air Conditioning Units
- Importance of Indoor Air Quality Monitoring
- Need for Real-time Assessment and Intervention
- Selection of Key Pollutants for Evaluation (CO₂, NO₂, TVOC and PM₁₀)
- Adaptation of Existing Air Quality Index



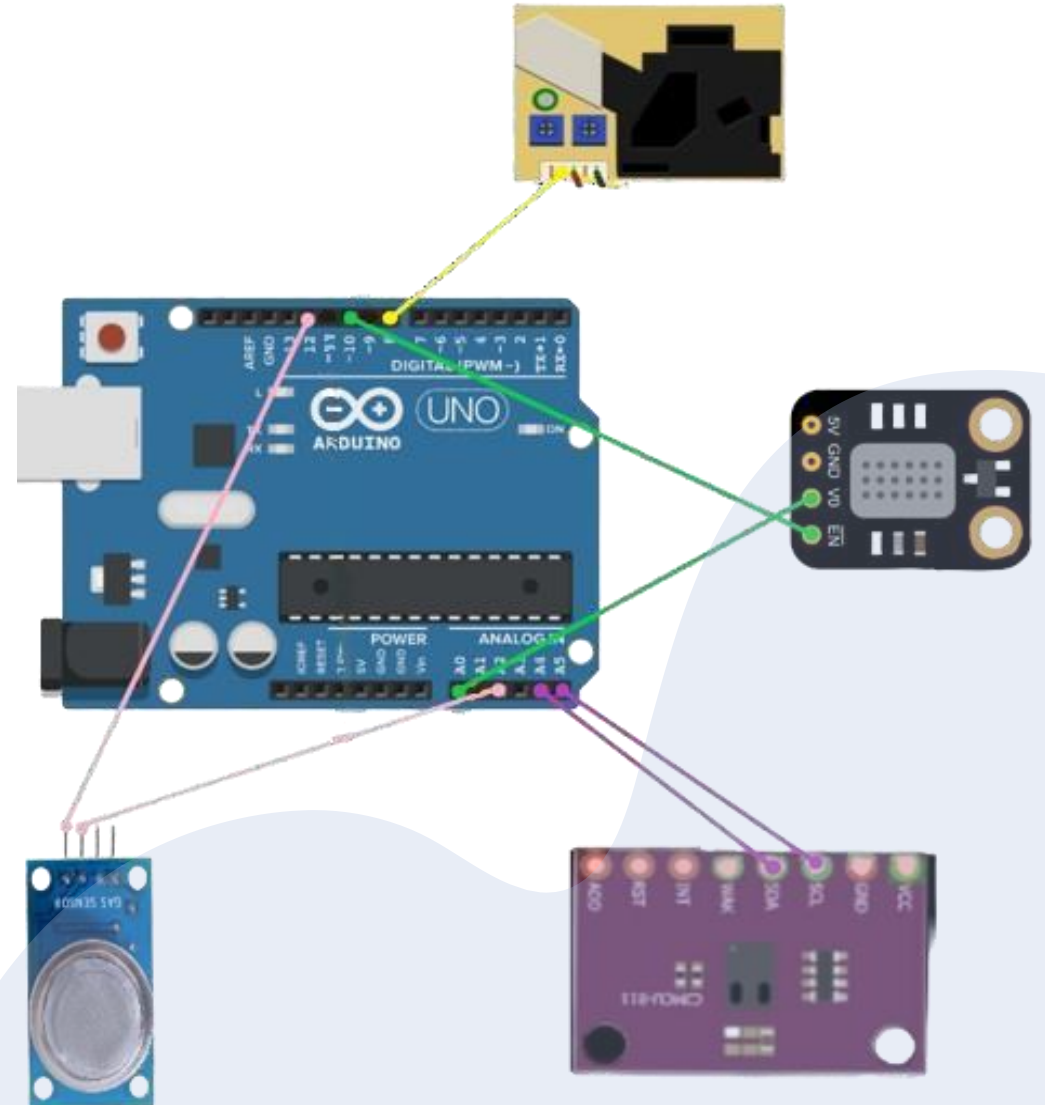
Solution/Product





Technological solution

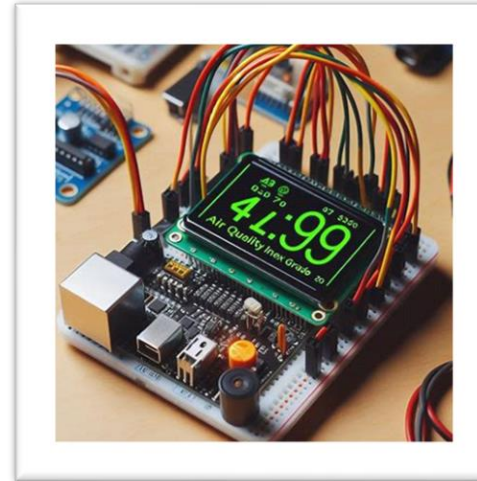
- PPD42NS: PM10
- MiCS-2714: NO2
- CCS811: CO2 and TVOC
- BME280: Temperature and Humidity
- MQ-2: Gas Leakage





Technological solution (II)

- The user will obtain from our solution the following data:
 - Air Quality Index (AQI)
 - Presence of flammable gases
 - Air temperature
 - Relative air humidity
 - Total Volatile Organic Compounds (TVOC) concentration (PPB) in the air.



Technological solution (III)

- Carbon dioxide (CO₂) concentration (PPM)
 - Nitrogen dioxide (NO₂) concentration (PPM)
 - Particle matter with a diameter of 10 micrometers (PM₁₀) concentration (µg/m³)
- The user can access this data from our website

Air Quality Index (AQI)

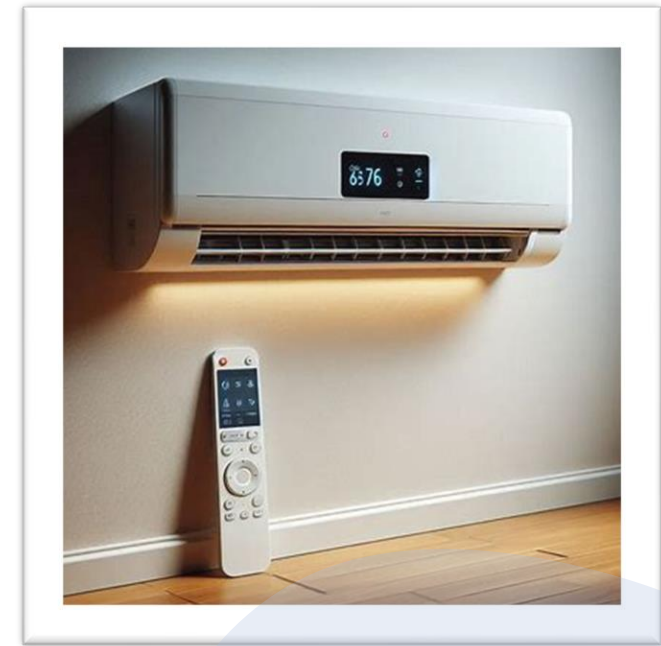
Rating	PM10 [$\mu\text{g}/\text{m}^3$]	NO2 [PPM]	CO2 [PPM]	TVOC [PPB]
1 – Very poor	101 – 1200	>0,3	>1800	>2200
2 – Poor	51 – 100	0,2 – 0,3	1101 – 1800	1431 – 2200
3 – Moderately polluted	36 – 50	0,15 – 0,2	801 – 1100	661 – 1430
4 – Satisfactory	21 – 35	0,1 – 0,15	601 – 800	221 – 660
5 – Good	0 – 20	0 – 0,1	0 – 600	0 – 220

- AQI gives a grade to the quality of the air based on the worst concentration of one of these 4 parameters



Solution beneficiaries

- People with an air condition unit or heat pump ✓
- Any individuals that suffer from allergies or asthma ✓
- Crowded establishments ✓
- Industrial companies that produce toxic fumes ✓





Competitors

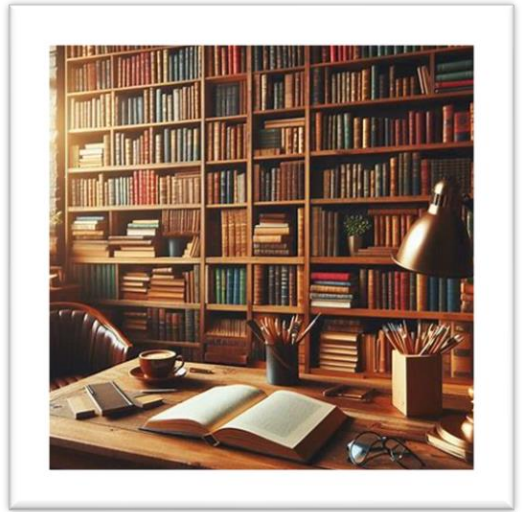
- There are some companies that offer air quality monitoring solutions, such as "Kaiterra," "Elpro," and "Vaisala." These companies provide professional solutions with comprehensive space monitoring, measuring air pollutants and particles to determine Air Quality.
- The solutions provided by these companies are different from ours because they do not measure all the pollutants that our solution measures, and they are not designed for AC units.
- Websites of the companies:
 - <https://www.kaiterra.com/sensedge>
 - <https://www.elpro.com/en/on-site-monitoring>
 - <https://www.vaisala.com/en/industries-applications/hvac-measurement/indoor-air-quality>





Previous work

- Some examples:
 - https://www.youtube.com/watch?v=esY_OtDLv7g&t=320s
 - https://projecthub.arduino.cc/abid_hossain/air-quality-monitor-14f9b4
 - <https://how2electronics.com/measure-co2-tvoc-using-ccs811-gas-sensor-arduino/>
 - <https://www.hackster.io/infoelectorials/project-010-arduino-grove-dust-sensor-ppd42ns-project-ab5f5e>
- These projects are not designed for AC Units because they do not measure AC gas leakage, and some of these projects do not measure the necessary elements to determine whether the AC filter is dirty or not.

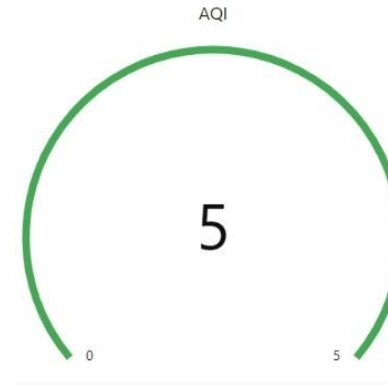




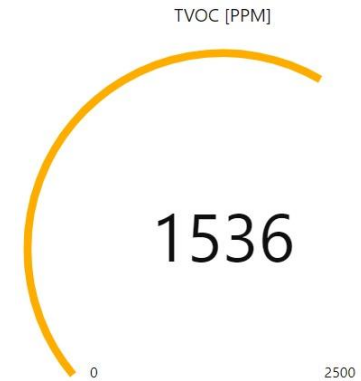
Project changes

- We've decided to not use sensors MQ-135, since it would not give us any useful parameters for our project
- We've changed the sensor ZP07-MP503 with the sensor MQ-2
- Sensor BME280 came in the same board as the CCS811, allowing us to not use DHT22 to measure Temperature and Relative Humidity
- We've added TVOC to the AQI
- Creation of a dashboard, using Node-Red, that allows the user to see different types of graphical outputs and different ways to analyse the data
- Creation and printing of a box that allows the allocation of the sensors, Arduino and enables the air to reach the sensors

AQI (Air Quality Index)



TVOC (Total Volatile Organic Compounds)



Humidity





Testing and validation metrics

To test the sensors, we've conducted some tests:

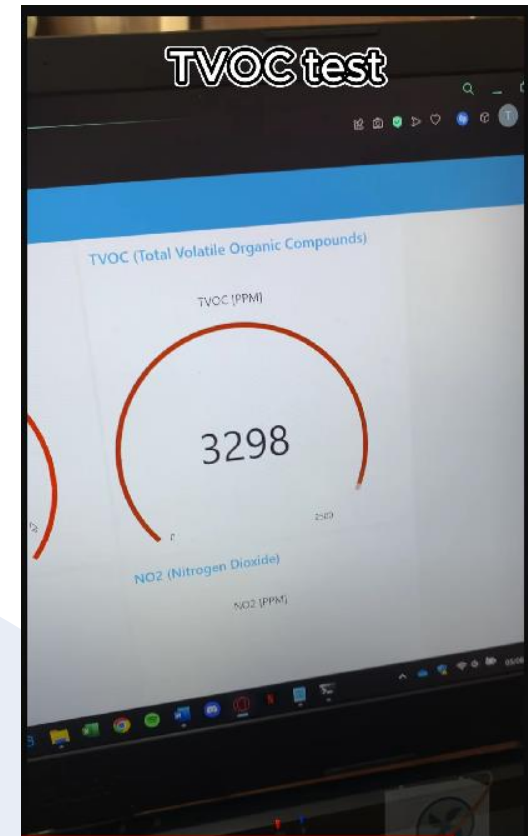
- Using a chalk eraser to test the PM10 sensor
- Lighter near the prototype to test the CO2 sensor and the flammable gas sensor
- Placing the prototype at the car exhaust outlet to test the NO2 sensor
- Using acetone and perfume to test the TVOC sensor



Results

The results for the tests mentioned in the previous slides were:

[PureAir - Air Quality Monitor \(Testing\) - YouTube](#)

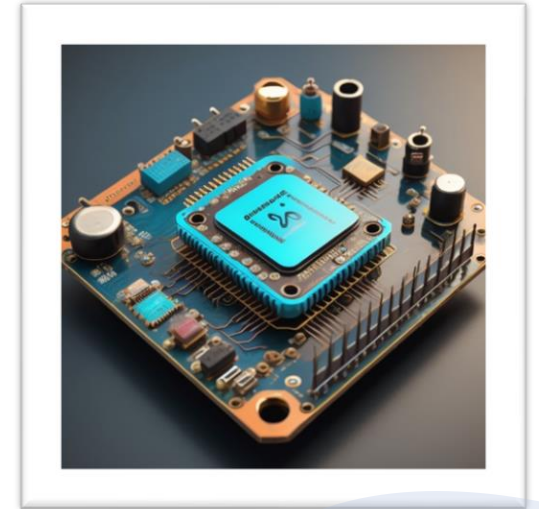




Technical challenges

Technical challenges encountered during our work:

- Ensuring the accuracy of the various sensors
- Learning new programming software's
- Finding the best way to output our data
- Balancing the cost of components and sensors with its accuracy and precision
- Adaptation of our sensors readings to the AQI scale
- The final design of our prototype
- Sensor MiCS-2714 not previously calibrated





Challenges faced by the team

- Difficulty specifying in which situation we will measure air quality
- The proposed solution is too like the existing ones
- Delay in the delivery of the sensors
- There are no sensors in the simulators
- No previous knowledge by the members of the team in the usage of the necessary software
- Balancing this project with the other courses





Contribution of each team member (1)

Afonso Oliveira	Tomás Oliveira	Francisco Oliveira
Project manager	Programmer	Programmer
Sensor research	Sensor testing	Implementation of MICS-2714
Design of prototype	Graphic output	AQI code implementation
Implementation of PPD42NS	Implementation of MQ2	Graphic output
Sampling time calculation	AQI scale adaptation	Testing protocols



Contribution of each team member (2)

João Santos	Miguel Parreira	Gonçalo Mendes
Website and Planning	Designer	Test engineer
Implementation of CCS810 and BME280	Sensor research	Sensor testing
Website creation	Video director and editor	Graphic output
Blog writing	Design of prototype	Poster design
Circuit planner	Presentation preparation	Data analysis

Costs and benefits

- Costs:

Equipment	Price
MiCS-2714	9,90€
MQ2	3,50€
CCS812 + BME280	39,90€
PPD42NS	11,80€
Kit Arduino UNO	19,99€
Filamento 3D	5,00€
Total=	90,09€

- Benefits:

- Solves the proposed problems
- Measures Temperature and Relative Humidity as an extra
- Has a user-friendly dashboard with different types of data outputs

Website

- You can access our website by clicking this link below or by using the QR code:
 - [PIC \(ulisboa.pt\)](http://PIC.ulisboa.pt)
- In our website you can find a brief description of our project as well as a blog that contains our weekly updates of development of our project

