JabTen

JabTen Pro Air Quality Monitor

model No. dg783csx23

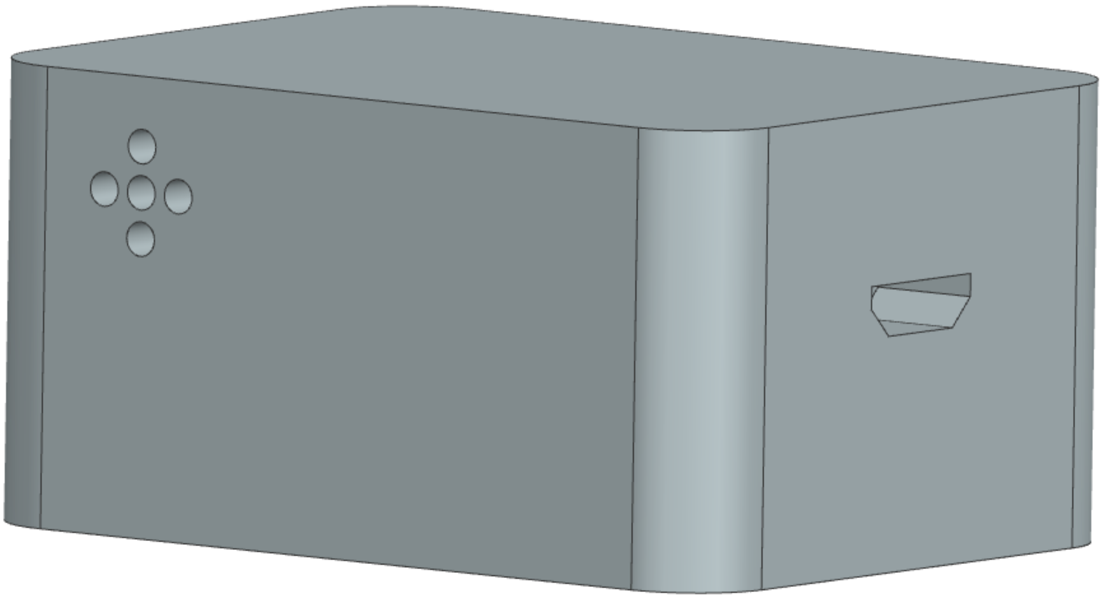

Image 1. Jabten Pro air quality monitor

Contact:

- jjablonski@student.agh.edu.pl
- dtendera@student.agh.edu.p

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1. Problem described

Air pollution is a serious problem, especially in larger cities. In the long term, smog can cause many health problems, such as respiratory diseases and even cancer. Household air pollution was responsible for about 3.2 million deaths in 2020. The combined effects of ambient air pollution and household air pollution are linked to 6.7 million premature deaths annually. Therefore, it's good to know whether or not the air we breathe is polluted in order to prevent its effects. We came up with the idea of creating an affordable air pollution sensor to monitor the air quality around users.

2. The environment in which the device will work.

The device should operate indoors under stable conditions. For best results, it should be placed in a place from where air enters the room, such as near a window or air conditioning. The device should not be touched or moved while taking readings. It should be protected from all liquids. It can be set up outdoors, but must meet certain requirements, such as a dry environment and temperatures ranging from -10°C to 60°C.

3. Minimum functionality and design assumptions.

Minimal functionality:

➔ The device should measure air pollution, and display the measurement on the screen.

Design assumptions:

➔ low cost
➔ easy to set
➔ low power consumption
➔ high efficiency
➔ user friendly
➔ included driver

4. Solutions from the market (pros, cons, cost of the device and maintenance).

Pros:

- ➔ it is easy to set, the only thing users have to do is simply turn on the device
- ➔ user-friendly interfaces
- ➔ build-in battery, so it does not need to be powered by a charger
- ➔ it uses little space
- ➔ it's portable

Cons:

- ➔ there are many different devices, so it can be difficult to decide which device is appropriate for the user.
- ➔ they can be very expensive
- ➔ varying accuracy of measurement
- ➔ only one particle size is measured
- ➔ some air purity meters have additional functions that are not necessarily needed by the user
- ➔ many kitschy-looking devices
- ➔ cost of the device oscillates from 200zł to 1100zł

Maintenance:

- ➔ manufacturers usually provide a 2-year warranty
- ➔ in general, the products are small and closed, so it may be difficult or even impossible to repair them yourself.

5. Idea compared with the competition.

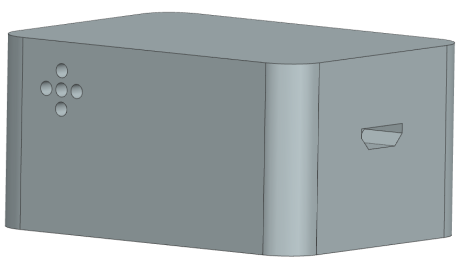
The device is very inexpensive, twice as cheap as the lowest-priced devices on the market. What's more, the measurement is very accurate with a maximum consistency error of ±10μ g/m³ in the 0~100μ g/m³ range and ±10% in the 100~500μ g/m³ range. The sensor is capable of collecting data on three particle sizes PM 1, PM 2.5, PM 10. Two variants are available, one with cable and the other with WiFi connection, which, combined with its small size (6cmx8cmx4cm), ensures that the air quality monitor is portable and won't stand out in a home environment. The device is very easy to maintain, and all components are accessible. In case of any malfunction, the user can replace the damaged part and repair the device privately.

Advantages over competition:

- ➔ much lower price
- ➔ very high accuracy of measurements
- ➔ three most important particle sizes measured
- ➔ possibility of own low-cost repair
- ➔ small size
- ➔ no flashing lights or displays

6. Project description

Our air purity sensor is built from a programmed arduino nano board connected to plantower's PMS5003 sensor. Everything is enclosed in a printed box with holes for airflow and a micro USB input used to power the device and transfer data. The culmination of the working system is a prepared interactive interface in labview in which graphs of particle concentrations in μg/m³ are drawn. In the program, it is possible to increase or decrease the frequency of measurements (the default setting is measurement every second), zoom in and out on the graphs, and pause measurements



Specification

- Supply voltage: 4.5 V to 5.5 V
- Low consumption current: under 100 mA
- Measuring range:
  - from 0.3 μm to 1.0 μm
  - from 1.0 μm to 2.5 μm
  - from 2.5 μm to 10 μm
- Sensitivity:
  - 50% for 0.3 μm
  - 98% for 0.5 μm and larger
- Response time: less than 10 seconds.
- Operating temperature: -10°C to 60°C
- Box size: 50 x 70 x 40 mm

Technical Index

Parameter	Index	unit
Range of measurement	0.3~1.0; 1.0~2.5; 2.5~10	Micrometer（μ m）
Counting Efficiency	50%@0.3μ m 98%@>=0.5μ m	
Effective Range（PM2.5 standard）	0~500	μ g/m^3
Maximum Range（PM2.5 standard）*	⩾1000	μ g/m^3
Resolution	1	μ g/m^3
Maximum Consistency Error (PM2.5 standard data)*	±10%@100~500μ g/m^3 ±10μ g/m^3 @0~100μ g/m^3	
Standard Volume	0.1	Litre（L）
Single Response Time	<1	Second（s）
Total Response Time	⩽10	Second（s）
DC Power Supply	Typ:5.0 Min:4.5 Max: 5.5	Volt（V）
Active Current	⩽100	Milliampere（mA）
Standby Current	⩽200	Microampere（μ A）
Interface Level	L <0.8 @3.3 H >2.7@3.3	Volt（V）
Working Temperature Range	-10~+60	℃
Working Humidity Range	0~99%	
Storage Temperature Range	-40~+80	℃
MTTF	⩾3	Year（Y）
Physical Size	50×38×21	Millimeter（mm）

Note 1: Maximum range means that the highest output value of the PM2.5 standard data is not less than 1000.

The connected device sends data using the UART serial communication. These are three numbers separated by a space, representing the concentration of the particle in µg/m³, respectively PM1, PM2.5, PM10. After connecting the device, you need to check what serial port it was connected to (in our case it was COM6), then you need to set this port in the labview application and run the program.

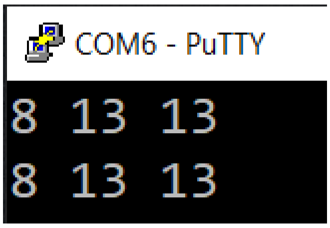


Image 2. Console serial readings

7. Tests

Our device gave very similar results to nearby independent sensors . That said, their results are averaged and the distance matters on dust concentrations, so such small differences in values can be ignored and we conclude that the device is working correctly

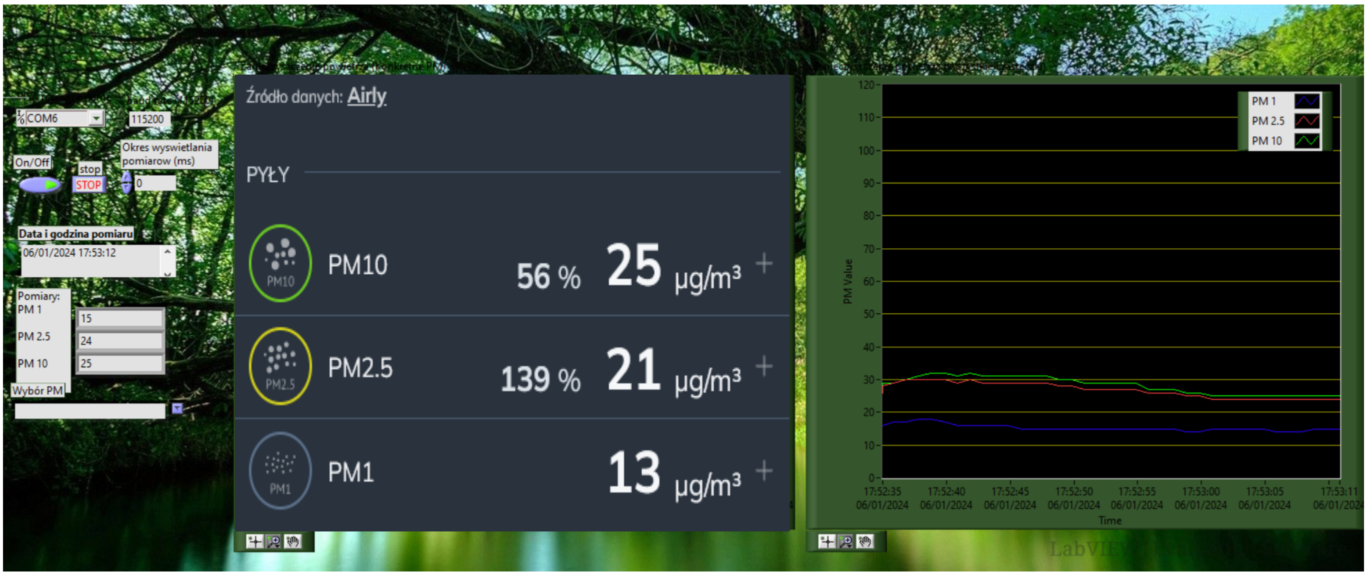


Image 3. Device readings compared

On the graphs you can see µg/m³ on the vertical axis and time with date of the measurement on the horizontal axis.

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Application interface description

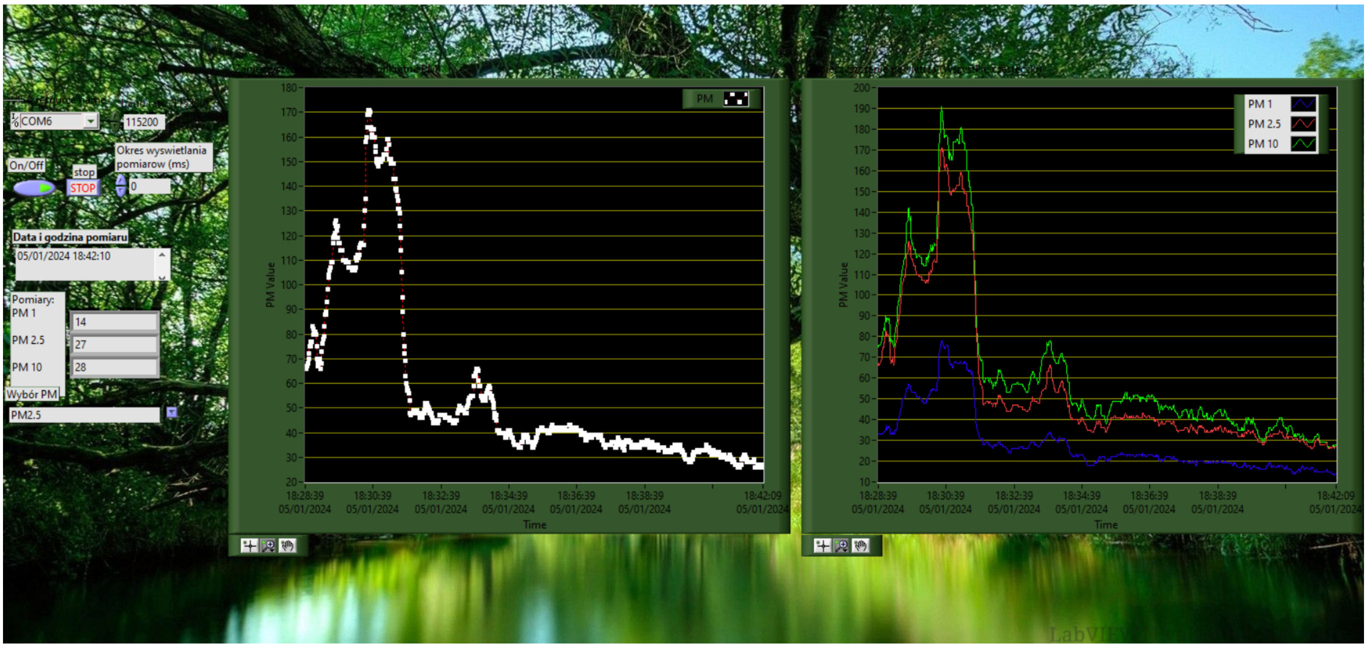
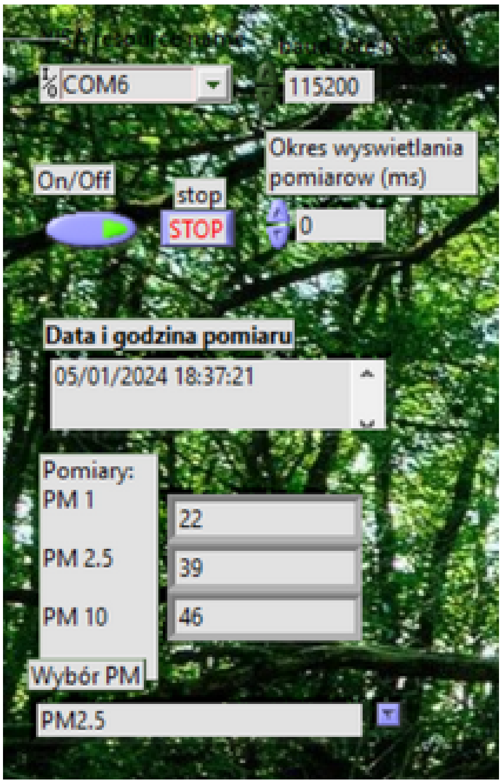


Image 4. Application view

On the left we can see the control panel, in the middle there is a graph where we can observe one of the selected particles, on the right there is a graph with all of them at once.



I/O - choice of serial port

Baud raute - it should be set to 115200

On/Off - start/stop the measurement

STOP - end the programm

Period of measurements (default = 1 second)

Date and time of the measurement

Measurements:

values in $\mu g/m^3$

PM choice - select specific PM shown on the graph

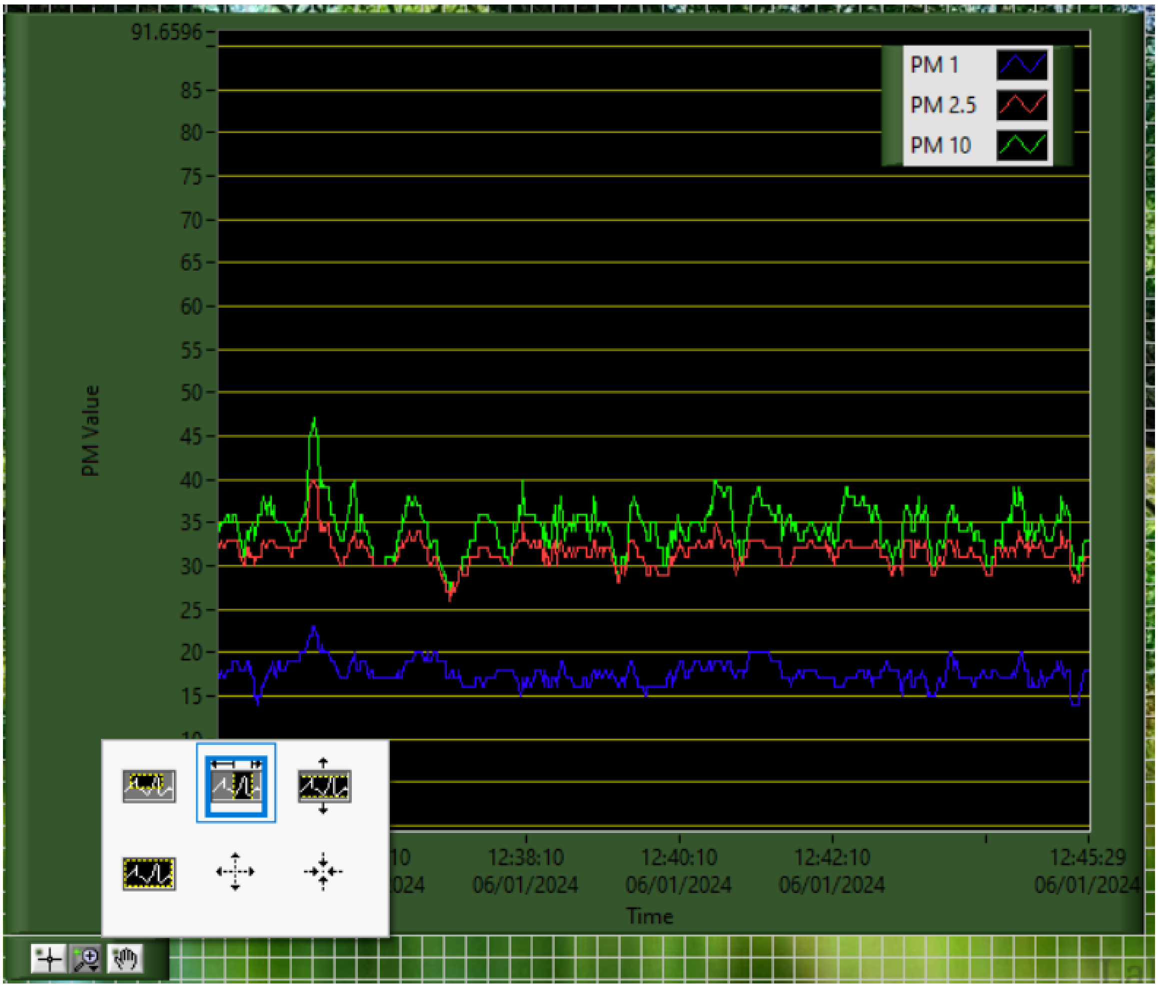


Image 6. Graph zooming options

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8. Prototype

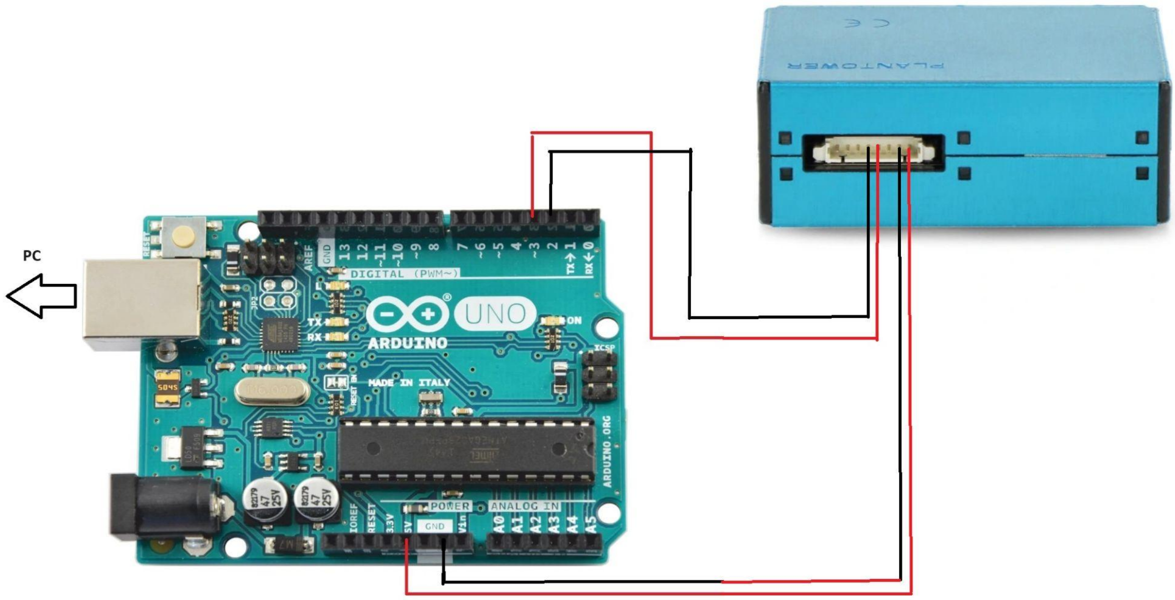

Image 7. pin connection

The prototype uses an Arduino UNO. The microcontroller is connected and powered by a PC. The Sensor is connected to the Arduino just like in Img. 1. When everything is attached correctly, a little fan which is located on the plantower device (sensor) should be spinning. Data is sent to the computer by UART, then the LabView program handles it, and draws graphs of the pollution.