

Intermediate project

Work Conditions Monitoring Device

Magdalena SAŁĘGA

24.10.2021

Instructor:

PhD Witold Paluszyński

Faculty of Electronics, Photonics and Microsystems

Wrocław University of Science and Technology

The purpose of the project was to build a device that uses sensors to monitor conditions of the environment like temperature, humidity, concentration of CO₂ and air purity. Assuming that work is in an office or home office setting. Constructed physical device shown on picture 2 is fully operational, regularly reads and displays sensor data and sends data to web user interface. In user interface history of recent readings is available.

Wrote programs and note how to run them are available in GitHub repository: *Work-Conditions-Monitoring-Device*.

1 Introduction

The purpose of the project was to build a physical device that uses sensors to monitor conditions of the environment like temperature, humidity, concentration of CO₂ and air purity. Additionally it displays current readings from sensors on LCD display in different colors depending on whether the value is within the acceptable or optimal limits. Values of acceptable and optimal values are defined based on assumption that device is used in an office or home office.

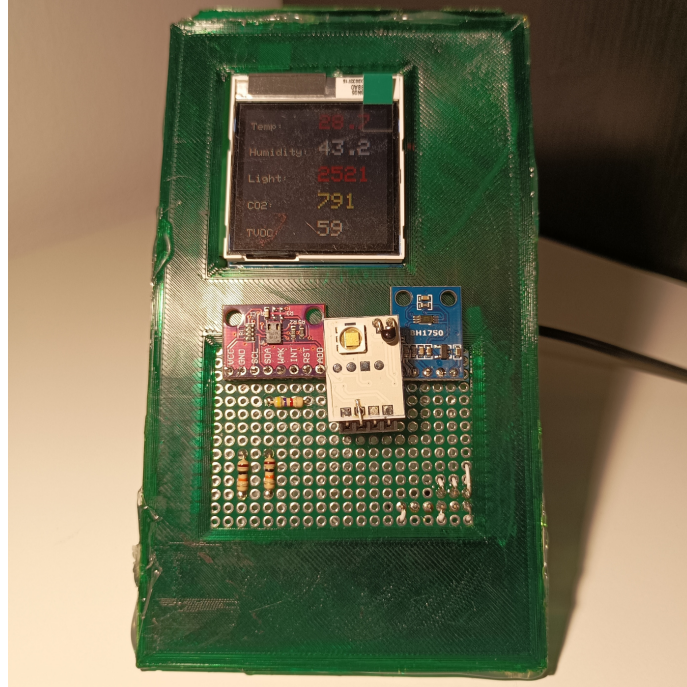


Figure 1: Physical appearance of the monitoring device

The acceptable and optimal values of work conditions were obtained basen on aricles [4], [2], [1] and [3] articles.

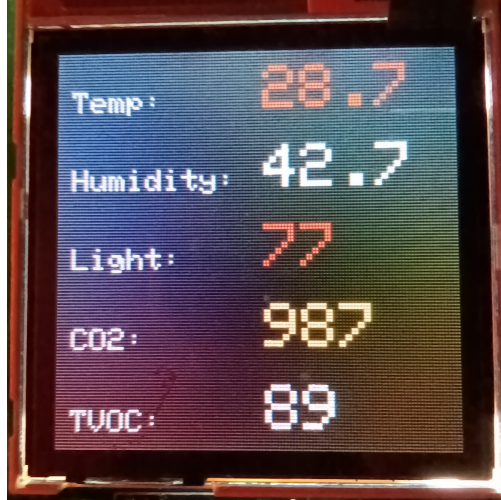


Figure 2: LCD display during operation

2 Electronic part

Sensor used in project to measure temperature and humidity is DHT22 [8], to measure light intensity – BH1750 [6], and sensor used to measure concentration of CO₂ and air purity is CCS811 [7].

Reading data from sensors was handled by Raspberry Pi 0 and used communication protocols are I²C and UART. An Arduino Nano microcontroller was used for communication via SPI interface with the LCD display. The information exchange between Raspberry Pi 0 and Arduino Nano uses USB communication interface. In the picture 3 is shown electronic scheme created in KiCad, where are marked all electronic components, connections and used ports.

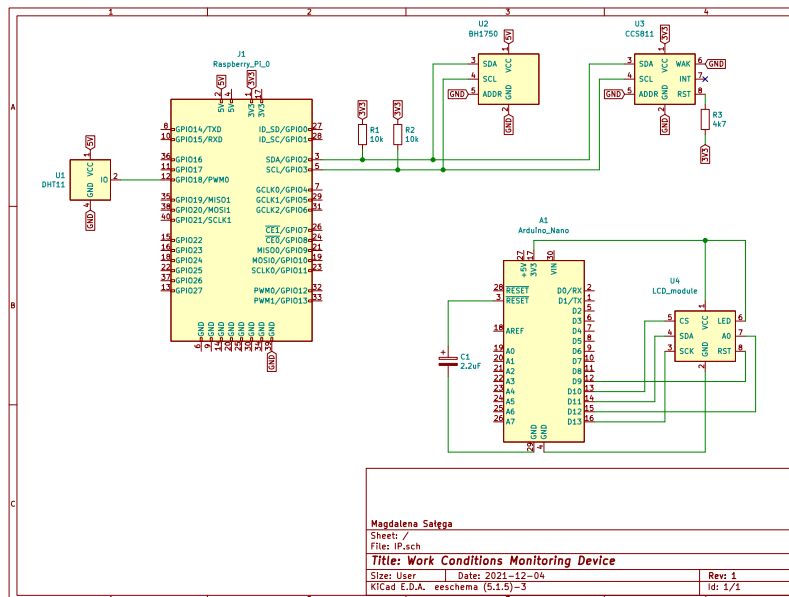


Figure 3: Electronic scheme

3 Case of physical device

The case was designed in Autodesk Fusion 360 as a 3D model and printed on 3D printer with PET-G filament. Result case is shown in the figure 4.

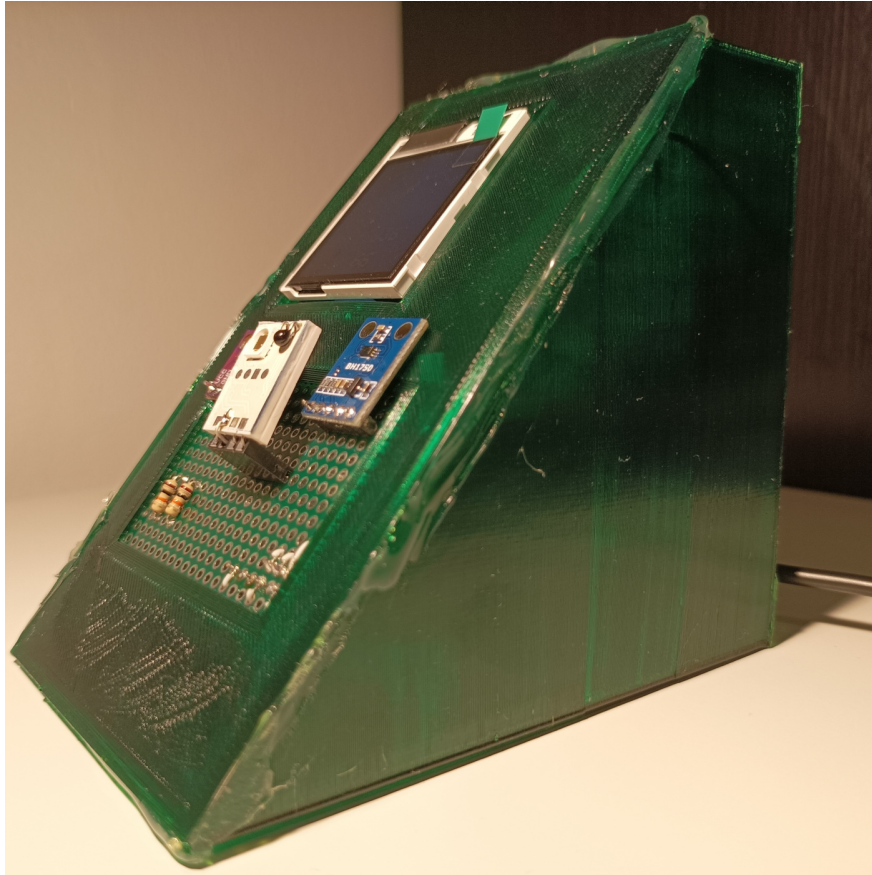


Figure 4: 3D printed case of physical device

4 Programming part

Programming part can be split to two parts: Arduino code for Arduino Nano and Python script on Raspberry Pi 0. All programs, scripts and flows needed to run project are available in GitHub repository: *Work-Conditions-Monitoring-Device*.

First program is responsible for communication via SPI with the LCD display [5], decides about displayed colors based on defined ranges and communicates via USB with Raspberry Pi 0 to obtain values read from sensors.

Python script is responsible for reading values from three sensors, converting values so they can be sent and used in Arduino Nano after receiving them via USB interface. Additionally in background Node-Red is running, where ir written flow that builds dashboard and allows displaying values read from sensors. User interface can be open when Raspberry Pi is running and is under <http://{rpi-hostname}:1880/ui> website.

5 User Interface

The user interface is designed in a web application Node-Red as live data dashboard and allows to see on graphs the history of values read from sensors. In the figure 5 is shown user interface with displayed read measurements. User interface can be open when Raspberry Pi is running and is under `http://{rpi-hostname}:1880/ui` website.



Figure 5: The appearance of the working user interface

References

- [1] Description about optimal CO₂ levels. <https://www.osstf.on.ca/services/health-safety/information-bulletins/inadequate-ventilation-and-high-co2-levels.aspx>.
- [2] Description about optimal humidity levels and dependencies with temperatures. https://www.ohsrep.org.au/offices_temperature_and_humidity_-_what_are_the_rules.
- [3] Description about optimal light intensity depends of environment. https://www.engineeringtoolbox.com/light-level-rooms-d_708.html.
- [4] Description about optimal temperatures. <https://www.tuc.org.uk/sites/default/files/Temperature.pdf>.
- [5] LCD display user manual documentation. http://www.lcdwiki.com/res/MSP1601/1.6inch_SPI_Module_MSP1601_User_Manual_EN.pdf.
- [6] Library to BH1750 sensor. <https://learn.adafruit.com/adafruit-bh1750-ambient-light-sensor/python-circuitpython>.
- [7] Library to CCS811 sensor.
- [8] Library to DHT22 sensor. <https://learn.adafruit.com/dht/dht-circuitpython-code>.