DESIGN AND PROTOTYPE OF ARDUINO BASED SMARTWATCH FOR ALERGENIC PARTICLE DETECTION WITH BLUETOOTH LOW ENERGY TECHNOLOGY

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Abstract: *This document illustrates the technologies used and the building processes for a Smartwatch with a particle sensor and a BLE module. All the data is processed by an Arduino Pro Mini. The device analyses particles in air suspension, giving the user feedback and alerts via Smartphone when the environment is contaminated or below a certain level. While in idle mode, it will display the time and date, performing analysis at regular time intervals and alerting the user with a Bluetooth text message sent to his/her Smartphone. This document reviews the Hardware, Software and technologies used for the development of this device. As final considerations, there are changes that could improve the user experience.*

Key-Words: *Smartwatch, Arduino, Allergy, Detector, Bluetooth*

1 INTRODUCTION

This device was developed as a dissertation for the Telecommunications Engineering Bachelor at the Universidad Miguel Hernández de Elche.

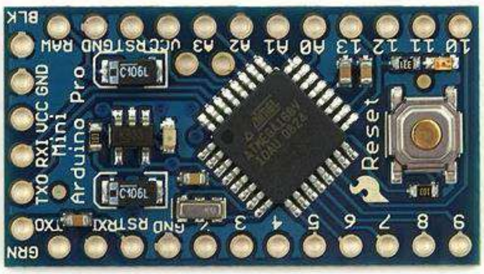
The objective is to help individuals who suffer from pollen or dust allergies to keep track of their immediate environment. This is done by analysing the surroundings with an air quality sensor, alerting the user when certain a threshold has been surpassed. At regular intervals, the device will perform analysis by itself, alerting the user if it surpasses the threshold. This limit can be set by the end user.

2 METHODOLOGY

2.1 Arduino Pro Mini

Arduino Pro Mini is a microcontroller based on Atmega328, a controller chip design by Atmel. It has 14 IN/OUT pins. Six of them can be used as PWM or Pulse Width Modulation. There are two types of this processor, depending on the voltage, 3 V or 5 V. For this project, it's recommended to use the 3 V.

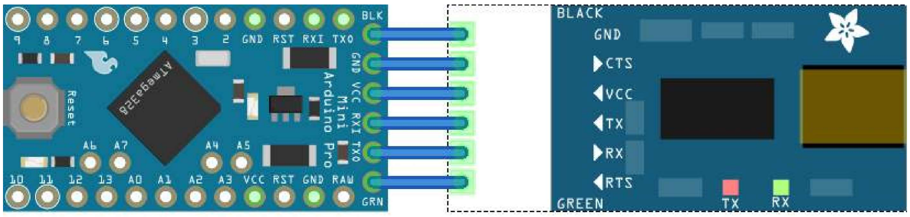
Figure 01 – Arduino Pro Mini



Source: Arduino

To load software into the Arduino, it's required to download Arduino IDE, which can be found at **https://www.arduino.cc/en/Main/Software**. It also needs an FTDI board for USB interfacing with the computer.

Figure 02 – FTDI connexion to Arduino Pro Mini

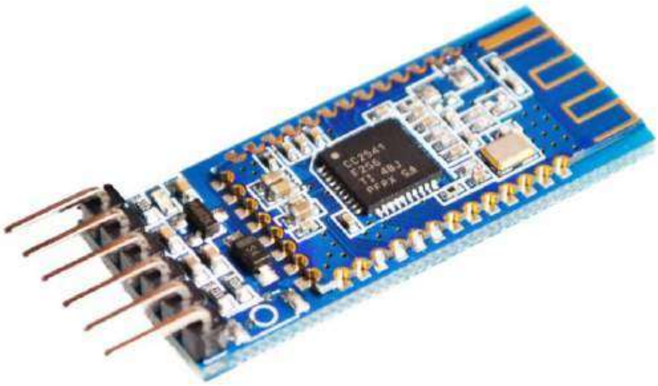


Source: Fritzing

2.2 HM-10 Bluetooth Module

The HM-10 module is a device that allows BLE (Bluetooth Low Energy) communication with other devices that have the same technology.

Figure 03 – HM-10 Module



Source: Seedstudio

BLE or Bluetooth v4 is a WPAN (Wireless Personal Area Network) that, compared to classical Bluetooth, has an important reduction in power consumption. The simplicity for configuring it, the reliability and the low power consumption make the HM-10 very adequate for a wearable device.

2.3 Sharp Dust Sensor

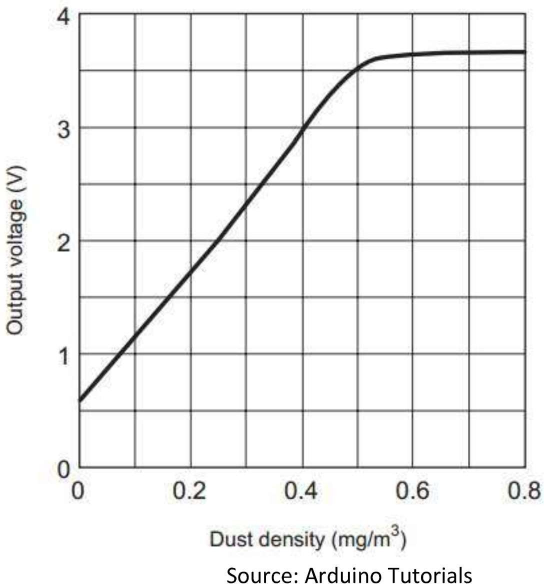
This sensor, developed by Sharp, is capable of detecting traces of fine particles floating in the air using an infrared diode and a detector that captures light reflected by the particles. It needs to be connected to one of the Arduino's analogue pins to be able to send modulated pulses to the emitting led. It measures the air pollution in mg/m^3.

Figure 04 – Sharp Dust Sensor

Source: Sparkfun

The most important factor when dealing with the Sharp Dust Sensor is that the Output voltage (or the data we are looking for) grows linearly with the dust density, as shown in the next diagram.

Figure 05 – Relation Output Voltage, Dust density



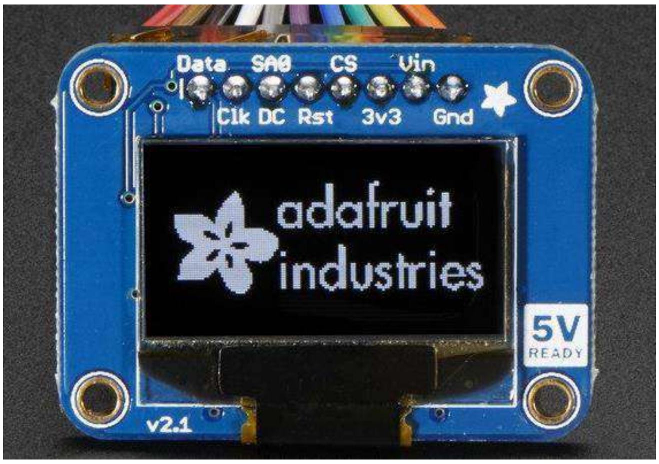
Source: Arduino Tutorials

As a result of this, the signal that the Arduino receives must be altered by a factor of 3.3/1024,0. 3.3, as the voltage we are powering the sensor with is 1024 for the integers that the sensor is able to map.

2.4 Adafruit OLED 128x64 Display

This element is a 38 mm x 29 mm OLED Display made by Adafruit, with a 128x24 pixel resolution. This makes it easy to read up to 2 meters away.

Figure 06 – OLED Display

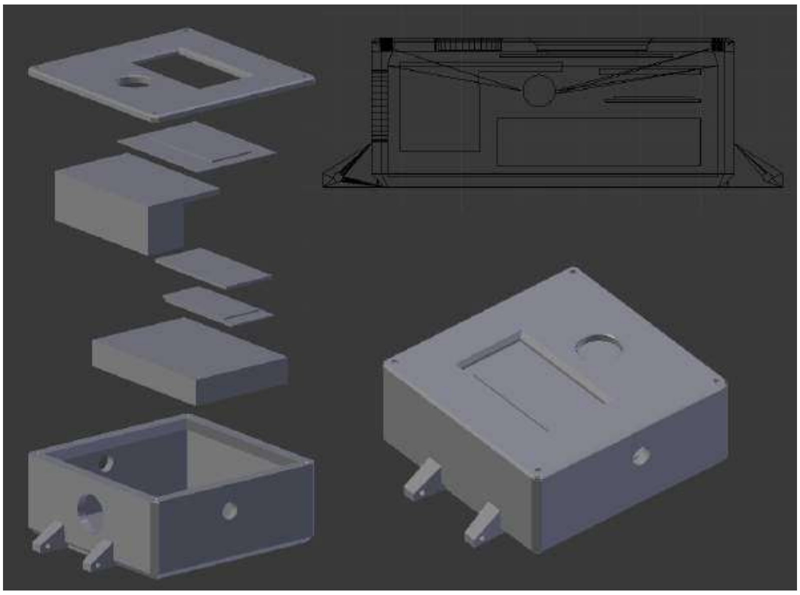


Source: Adafruit

2.5 3D-Printed Casing

The plastic casing was designed with Blender and printed with a 3D Printer. In the following images the process is displayed.

Figure 07 – 3D Design including all the Hardware used. (Top to bottom: Top Casing, Display, Sensor, Arduino, BLE **Module** and 3.7 V LiPo Battery, Bottom Casing)

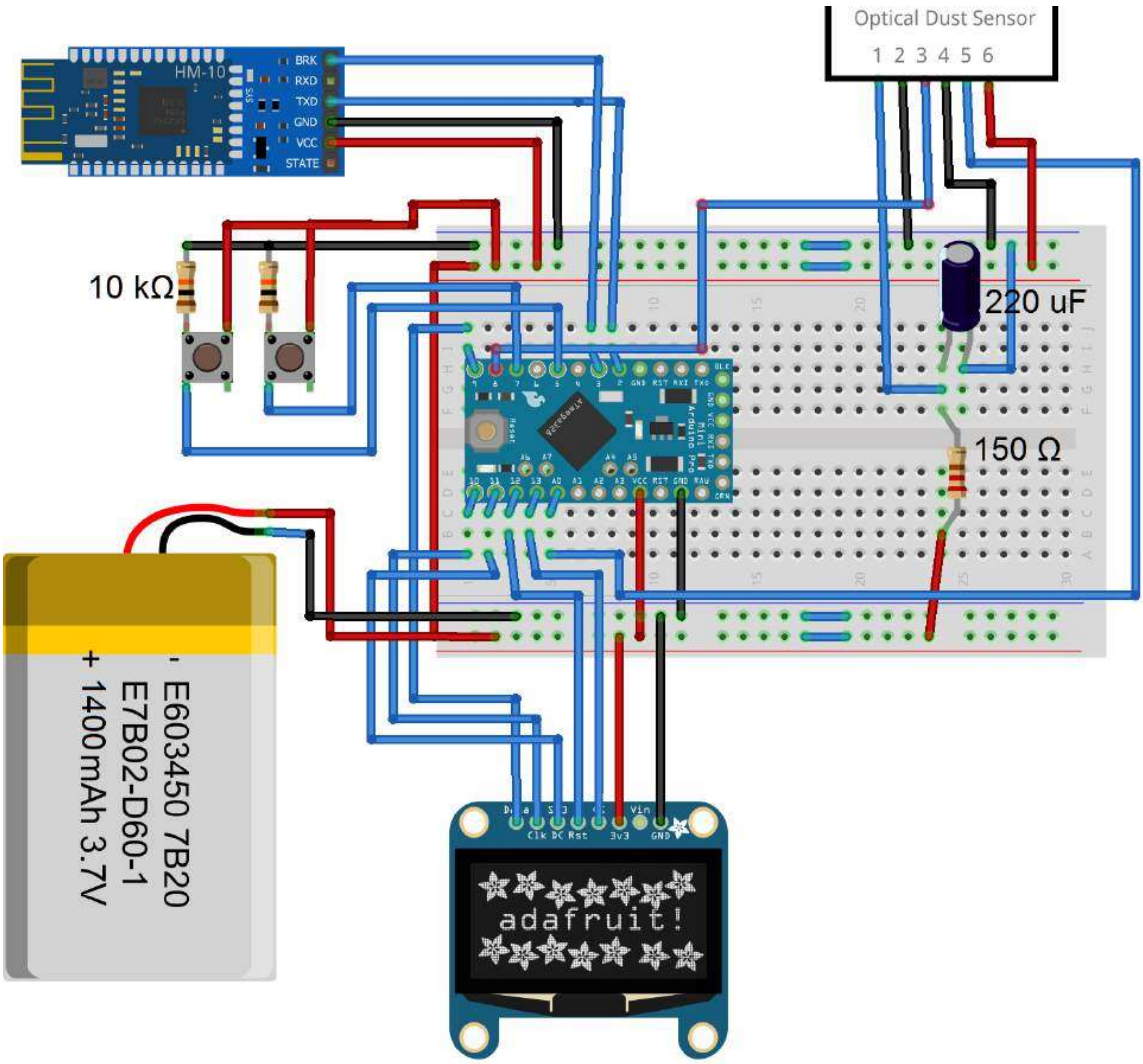


Source: Blender

2.6 Mounting the Prototype

The first thing will be to solder all the elements together. This next image shows how it should be done. Note that we added the two pulsators (with 10 kΩ resistors), a 1400 mAh 3.7 V LiPo battery, a 220 uF condensator and a 150 Ω resistor. None of these elements were mentioned before.

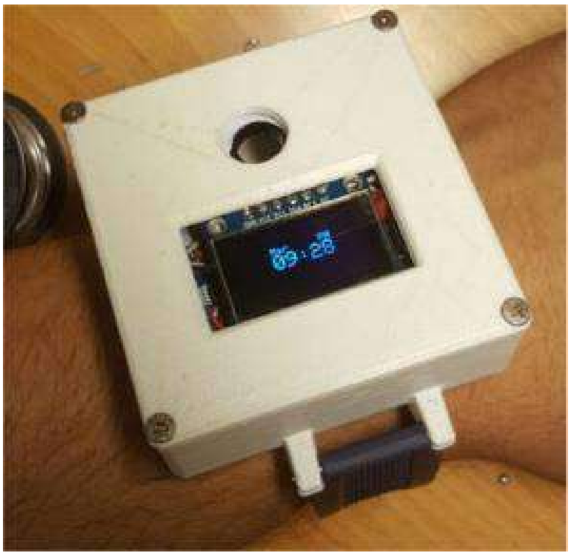
Figure 08– Hardware connections



Source: Fritzing

The last step will be to solder everything together with the shortest connections possible, load the program to the arduino using the FTDI and fit it all into the casing.

Figure 09 – Finished prototype



Source: Self

3 RESULTS AND DISCUSSION

Since using only one analysis is not reliable, the device will perform a total of 50 and then display the average value obtained on the screen and act from this value.

Covering both entrances of the airflow for the sensor makes each analysis gives an average value of around 0.02 and 0.05 mg/m^3. When the airflow is left open and in a standard room it returns a value of 0.1 to 0.4 mg/m^3. When the smoke from a match or a cigarette is close by the values go up to 0.16 to 0.27 mg/m^3.

This test made us confident that the real application of this device is possible and useful. It may also help people detect when the dust density is increasing and let them take action before the allergy effect triggers.

4 FINAL CONSIDERATIONS

Despite the inexistence of dust and pollen sensors that are small enough to fit the requirements to be embedded on a wearable device, the potential of a device that could fully behave as intended is not to be underestimated. While surveying individuals that suffer from allergy problems, the writer encountered an absolute positive feedback on how a device, such as the one described here, could improve their lifestyles.

Improvements that should be considered for future implementations of this device are:

1) Adding a sensor that can distinguish pollen particles from other particles.
2) Design of a more user-friendly interface.
3) Records of past analysis to keep track of variations in the environment.
4) Design a dedicated board to reduce cost and size of the device.

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REFERENCES

Lady Ada, **Monochrome OLED breakouts**, Available at <https://learn.adafruit.com/monochrome-oled-breakouts/arduino-library-and-examples>. Accessed August 12th 2016.

Arduino Team, **Arduino Pro Mini**, Available at <https://www.arduino.cc/en/Main/ArduinoBoardProMini>. Accessed August 12th 2016.

Arduino Tutorials Team, **Standalone: Sharp Dust Sensor**, Available at <http://arduinodev.woofex.net/2012/12/01/standalone-sharp-dust-sensor/>. Accessed August 12th 2016.

Sharp Team, **GP2Y1010AU0F – Sharp Dust Sensor Datasheet**, Available at <https://www.sparkfun.com/datasheets/Sensors/gp2y1010au_e.pdf>. Accessed August 12th 2016.

Arduino Team, **Arduino Pro Mini**, Available at <https://www.arduino.cc/en/Main/ArduinoBoardProMini>. Accessed August 12th 2016.