Solar Particle Analyzer

by rabbitcreek

I was at a conference recently in Fairbanks, Alaska where a local Coal company (Usibelli Coal Mine) was sponsoring innovators to think of ways of improving the air quality. Obviously ironic but also really great. It didn't appear to be the research that cigarette companies sponsored to show that their product was good for you or current crop of paid "scientists" that deny climate change or evolution, but a way of dealing with an unfortunate combination of factors that makes Fairbanks air less than ideal in the winter when thermal inversion, cold temperatures, cars, and home heating with wood causes the particulate count to go over EPA limits. This stew is not good for your health--the best place to start if you have an interest in this is Wikipedia:
https://en.wikipedia.org/wiki/Particulates

If you look far down in the article you can see the map of the U.S. and areas that exceed EPA limits which include a tiny part of Alaska--Fairbanks. This may not be the only place where the air in winter could be bad--The North Slope where oil and gas production involves burning lots of hydrocarbons has been under scrutiny. It's strange to think of these tiny pristine villages in the arctic suffering from air more commonly found in urban China. But what to do about it? One innovative idea is to get more people interested in the problem which this local Coal company is doing. My project involves making these monitoring devices more palatable to home use--cheap, solar powered, an App on your phone for output and easy on the eyes.

Step 1: Gather Your Supplies

1. The most obvious get is that large shell in the photo! Luckily these are available at a lot of home furnishing stores or on the web for less than $20.(or print it...**https://www.instructables.com/id/Giant-Analog-CO2-Meter**/) Its got a wonderful shape for gathering the wind and enclosing the working of the particle sampler and computer and protecting the bug-wired construction from rain, snow and whatever.

2 Solar cell--ALLPOWERS 2.5W 5V/500mAh Mini Encapsulated Solar Cell Epoxy $8.00

3. TP4056 Charging Module with Battery Protection 18650 BMS 5V Micro USB 1A --nearly $0

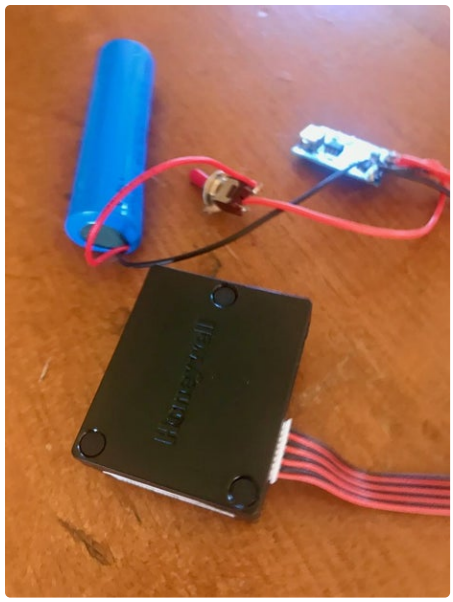
4. Adafruit ESP32 Feather--$19

5. Generic 18650 Lipo Battery $3

6. Adafruit (PID 2030 PowerBoost 1000 Basic - 5V USB Boost @ 1000mA from 1.8V+ this thing is great because it has an enable pin which you need $10

7. Adafruit TPL5111 Low Power Timer Breakout--brilliant little timing device $6.00

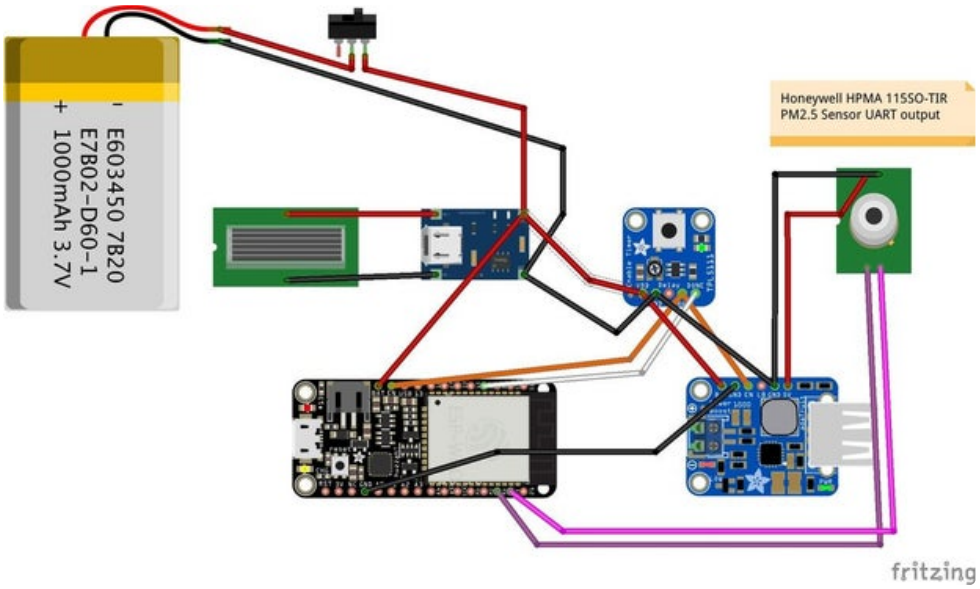
8. HONEYWELL HPMA115S0-TIR PM2.5 Particle Sensor laser pm2.5 air quality detection sensor module Super dust sensor PMS5003 $18

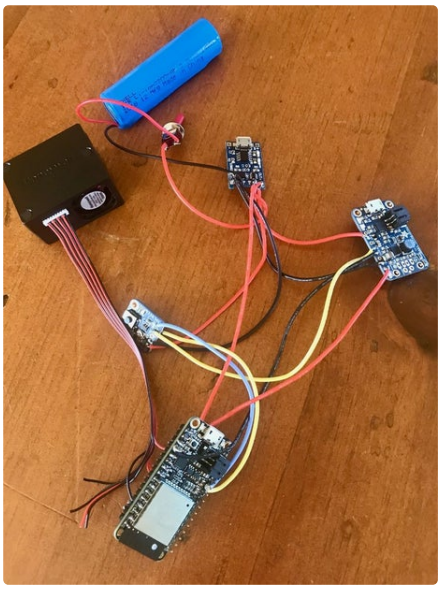


Step 2: Wire It

The wiring is very straightforward. The Fritzing diagram has all the details. The Honeywell unit has a lot of wires coming off the back connector but this information sheet should help you if need more details: https://sensing.honeywell.com/honeywell-sensing-p...

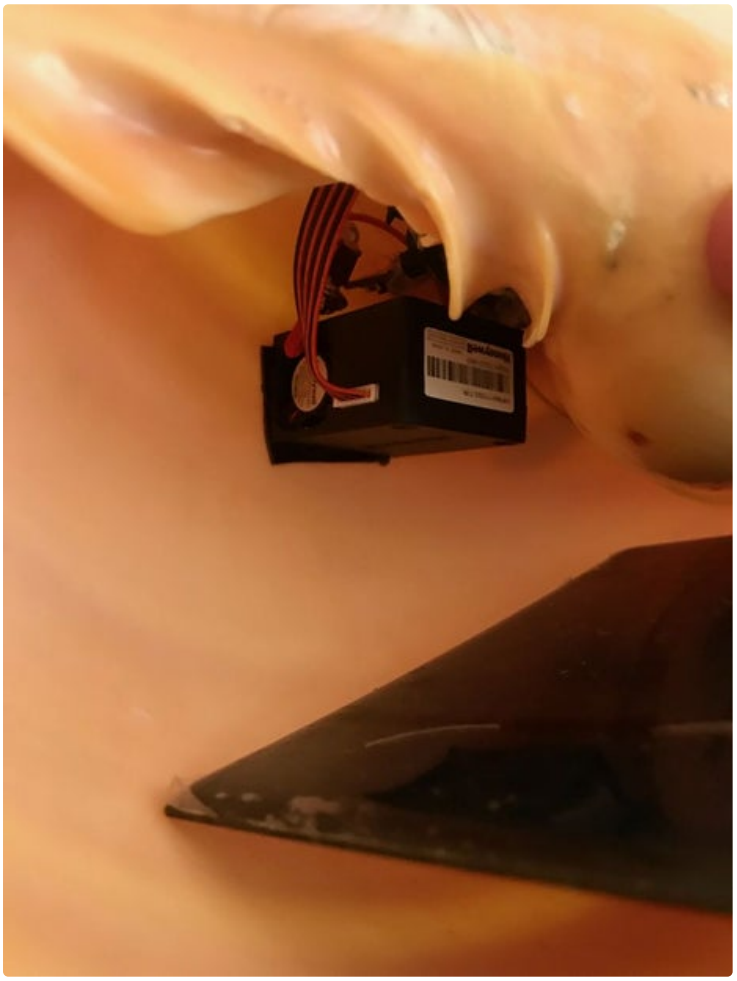
It is a UART connection to the ESP32 which has two serial ports and should be connected to the RX and TX pins on the development board. The power has to come from the boost unit which takes the lipo battery voltage up to 5V for the sensor. The logic on the sensor output is 3 volts so you don't have to mess with it. The wonderful little timing unit from Adafruit (I get no money from any manufacturer...) the TPL5111 uses the enable pins on both the Boost unit and the ESP32 board to turn the unit on every two hours. This is adjustable with a tiny variable resistor on the board from every second up to two hours. You can also replace this with a fixed resistor--you can find the chart on the Adafruit web site. The TPL has a quirk in it that requires you to depower whenever you change this Ohm reading for the timing to obtain the new timing. The wiring requires a constant supply of power to this timer. The solar power and battery charging is done by the TP 4056 just connect the solar cell to the input side. A slide switch is also nice between the battery and the TP input to fully turn the unit off.





Step 3: Build It

Truly simple build for this outing. The shell forms the case of the whole unit--waterproof and a good air gathering station! Make sure you hot glue all the wires to their attachment points on the various boards to make them tougher to handle. The Honeywell unit was affixed to the inside of the shell with outdoor level serious double sided tape--otherwise the rest of the pile was just tossed into the shell housing where gravity held it. A hanger bracket is glued to the back with either silicon or Goop brand adhesive. The solar panel is clipped to the front of the cell with a go-pro clip mount which is nice so you can adjust the angle to the sun when it is hanging. The solar panel was glued with Goop to the mount.

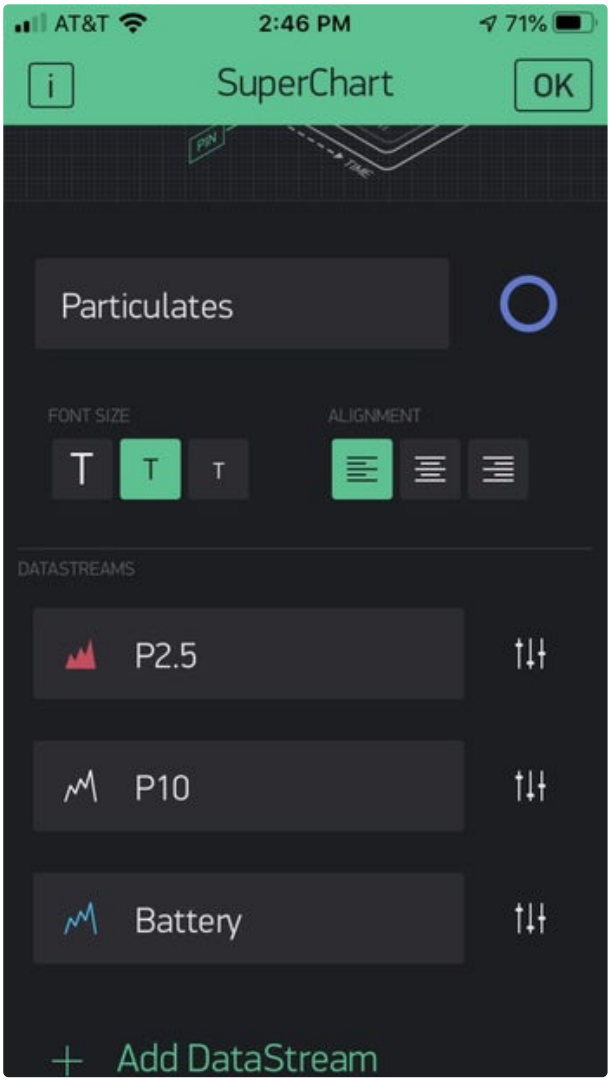


Step 4: Program It

Here is the repository for the software:**https://github.com/rabbitcreek/solarParticleAnalyz...**

There is a library for this Honeywell unit and it seemed to work well when connected to the computer but as soon as it was on battery control it failed. So the program just takes apart the UART communication to get the data and sum check it. To get the data out of the unit and onto your phone requires the services of the Blynk app. If you haven't used Blynk before it is dead simple IOT system that requires minimal programming and works forever with no issues. I have had several Blynk IOT systems running for years on Non Tech savvy peoples phones with no issues. The system requires you to download the Blynk app and set up an account--all free so far.

You have to set up a new program on your phone that asks what system you are using (ESP 32) and supplies you with a Key that you can email to yourself when setting up the code. You then need to set up a super chart taking three inputs from virtual pins V4 Battery level, V5 PM 2.5, and V6 PM10. There are many tutorials on the Blynk site that can talk you through it but it is very simple. The other changes in the program are to insert the name of your wifi network and the password. The software first turns on the sampler and waits ten seconds for the particle data and if ok sends it on to the Blynk server which then sends it to your phone. The DONEPIN code raises the level of the pin on the TPL5111 to make everything go to sleep with the enable timer. The battery voltage is taken off the A13 pin.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71%
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Particulates
FONT SIZE
ALIGNMENT
DATASTREAMS
P2.5
P10
Battery
Add DataStream

Step 5: Using It

Hang this device where the sun does shine and near enough that it picks up your wifi signal to communicate with the Blynk server. There are a surprising number of things that cause small particles. Toast! (**https://www.instructables.com/id/Toast-Talker/**) Who knew? I guess the newest research posits that toast particles get into your brain and cause depression.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6085...

https://www.ncbi.nlm.nih.gov/pubmed/30719959

Well the magic of statistics enables the publication of lots of correlations but causation is a little more difficult to prove. This neat device will at least enable you to follow the dance of particles in your life that you never worried about before. The solar battery charging needs a good steady sun supply which should also help your depression.