My Weather Station

Overview

I live in a rural area where we pride ourselves in knowing how much rain we got with the last bit of weather that rolled through. I always would use one of those free glass rain gauges that our local electric cooperative would give out each year. This past year, I forgot and left the gauge out after the first freeze and it busted. This spring, I decided I wanted to upgrade my rain gauge to a more accurate one. Being the computer nerd that I am I thought it would be cool to have a rain gauge that would keep a tally of all the rain I received throughout the year. So, I set out to build something that would do just that. One thing led to another and before I knew it, I had built a nice little weather station.

Parts

- Particle Photon
- Argent Wind/Rain Sensor Assembly
- Adafruit AM2302 (wired DHT22) temperature-humidity sensor
- Adafruit BMP280 I2C or SPI Barometric Pressure & Altitude Sensor
- Solar Panel
- Solar Charger Controller
- Rechargeable 12V battery

I wanted to use the Particle Photon microcontroller because I had such good luck with it on my last project. The board costs around $20 and has several great features that I wanted, several analog and digital I/O pins, WIFI, over the air updates, good online documentation, and a web-based development environment.

https://www.adafruit.com/product/2721

While searching the internet for ideas on the rain gauge, I was worried about having to go out and dump the rain gauge once it was full. That is where I stumbled across a rather clever way to measure rain. It was an automatic dumping rain gauge (aka tipping bucket).

https://en.wikipedia.org/wiki/Rain_gauge#Tipping_bucket_rain_gauge

A little more searching for one of these devices I ran across one for sale on SparkFun's website:

https://www.sparkfun.com/products/8942

But this setup was more than a rain gauge, it also would allow me to measure wind speed and direction. While I was at it, I decided to throw in a temperature, humidity, and barometric sensors as well:

https://www.adafruit.com/product/393

https://www.adafruit.com/product/2651

This covered me for the basic weather sensing parts, but there were a few other parts that I would need. The weather station would be located in my garden, far away from electricity. So, I decided to power the unit via solar. I had a 10-watt solar panel collecting dust on my shop shelf, so I decided to use it for this project. In addition to this, I purchased a solar charger controller, a 12-volt battery, and a short USB cable.

https://www.amazon.com/gp/product/B000KGUZHW

https://www.amazon.com/gp/product/B01MU0WMGT

https://www.amazon.com/ExpertPower-EXP1270-Rechargeable-Lead-Battery/dp/B003S1RQ2S

https://www.amazon.com/StarTech-com-Inch-Micro-USB-Cable/dp/B003YKX6WM

With the power covered, I started looking for something to house my project in. I had used an enclosure from BUD Industries in the past, so I grabbed a water-proof box from them. I also wanted something to mount the components to, so I ordered some acrylic as well.

https://www.amazon.com/gp/product/B005UPBNWE

https://www.amazon.com/gp/product/B00YV5M7EM

I wondered about placing the temperature sensor directly inside this enclosure. After a bit of research online, I came across a Stevenson Screen. So, I decided to construct one of these myself.

https://en.wikipedia.org/wiki/Stevenson_screen

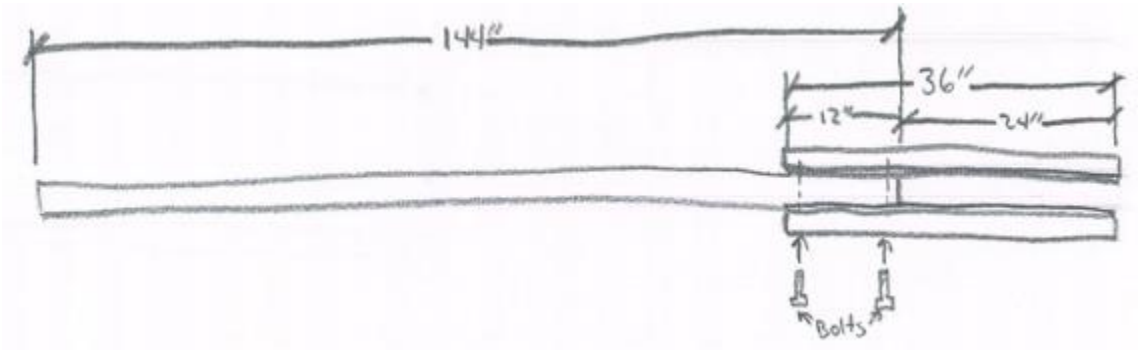
To do this, I ran to Lowes and picked up a single slat of wood fence and a few soffit vents.

https://www.lowes.com/pd/Severe-Weather-Natural-Cedar-Fence-Picket-Common-19-32-in-x-5-1-2-in-x-6-ft-Actual-0-59-in-x-5-5-in-x-6-ft/4323595

https://www.lowes.com/pd/Air-Vent-8-in-L-White-Aluminum-Soffit-Vent/3122213

I also repurposed an old self-closing cabinet hinge I had for this task. (one like these: https://www.lowes.com/pd/Style-Selections-10-Pack-2-3-4-in-x-1-3-4-in-Satin-Nickel-Self-Closing-Flush-Cabinet-Hinges/50419386)

All of this would be mounted to a 2" square tube steel pole I had that was 12' long. I also used 6' of 2" angle iron. The angle iron is what was cemented into the ground. I sandwiched the steel tube in between the two pieces of angle and drilled out and placed two bolts though it all. This allows me to remove the top bolt and swing the entire thing down to the ground for any maintenance tasks that may be needed.

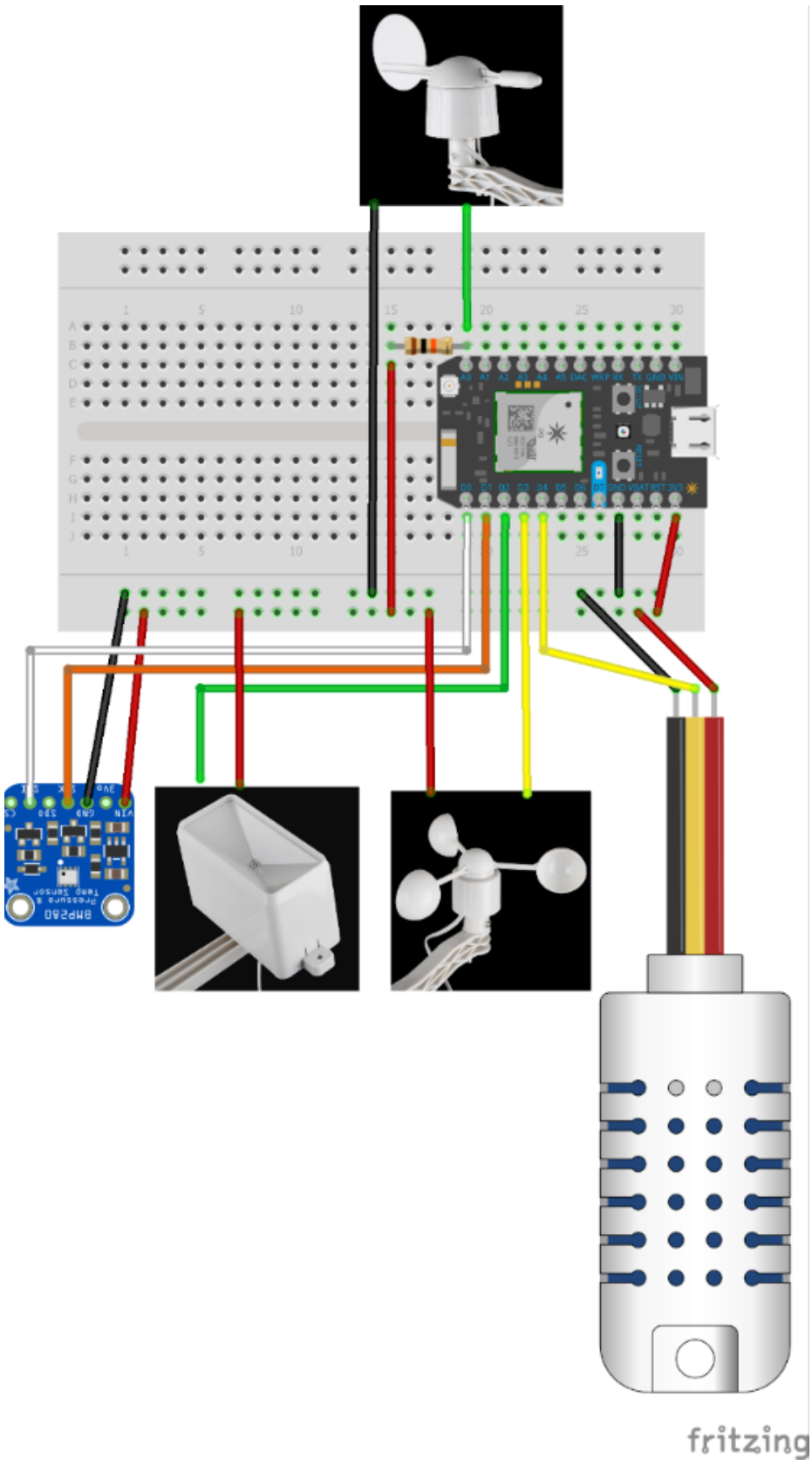


Sketch of pole used to mount weather station

A few more miscellaneous parts that were used were:

- Plastic zip ties (https://www.harborfreight.com/11-in-black-cable-ties-100-pk-60277.html)
- Thermostat wire (https://www.lowes.com/pd/Southwire-50-ft-18-AWG-5-Conductor-Thermostat-Wire-By-the-Roll/3128633)
- Hose clamps (https://www.harborfreight.com/automotive-motorcycle/hoses-lines/20-pc-large-hose-clamp-assortment-63280.html)
- Hookup wire (https://www.adafruit.com/product/3111)
- Breadboard (http://www.gikfun.com/electronic-pcb-board-c-60/3x-solderable-breadboard-gold-plated-finish-proto-board-pcb-p-725.html)

Circuit

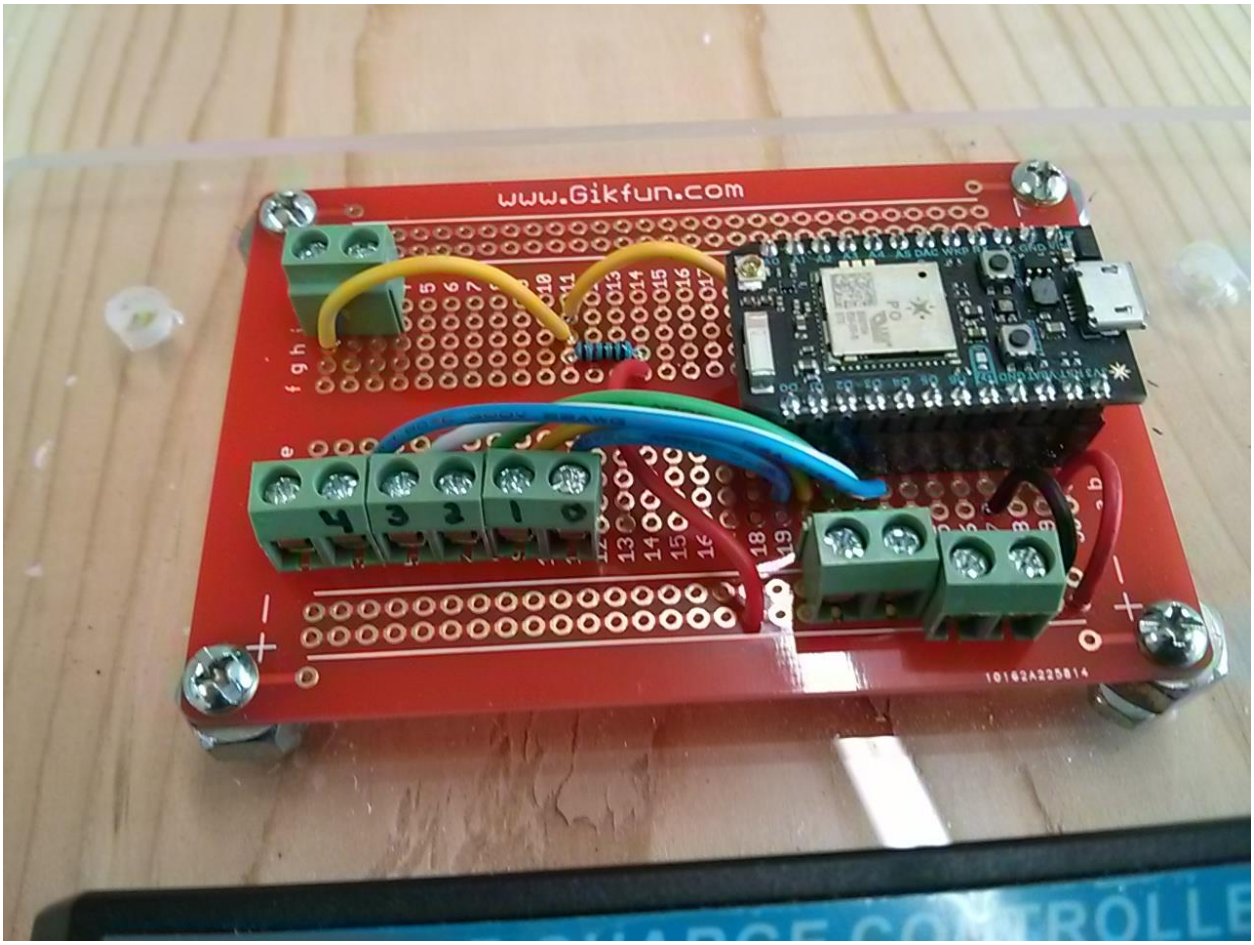


Code

The code is posted on my GitHub feed: https://github.com/okie1/weatherstation

Assembly

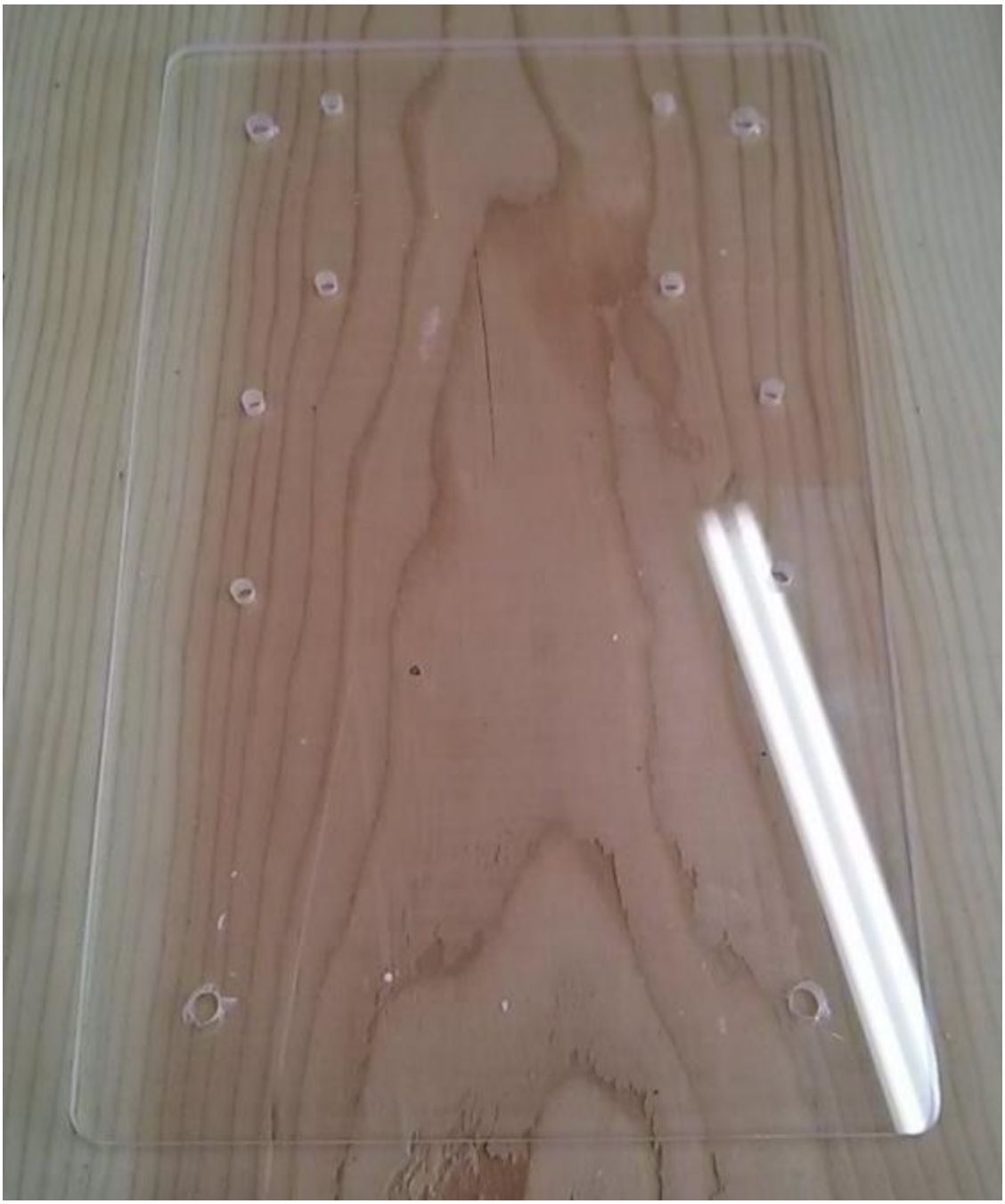
I assembled the circuit board as per the Frtizing diagram above. The only difference was that the wire terminals I had on hand actually covered 4 holes on the PCB board. This is why I did not mount them directly below the photon as I did want to retain access to all of the pins on the microcontroller.



Assembled circuit board

I started with a blank sheet of acrylic and cut it on my table saw for height and width such that it would fit precisely in the back of my project box. I had to also round off the corners as well. Once this was done, I drilled holes to mount the circuit board and solar controller. I also drilled 4 holes to mount the acrylic to the project box.

Acrylic Before Photo



Acrylic sized and drilled for components

I used 4 nuts as stand-offs for my circuit board. I mounted the solar controller directly to the acrylic and then bolted the acrylic to the project box. I left enough room at the bottom for the 12V battery. I went ahead and attached the solar controller and the microcontroller via a USB cable.

Major components inside of project box

I drilled a hole in the bottom of the project box to run the wires through (back left corner). I wired everything as per the fritzing diagram above.

Components mounted and wired

I did not take any good photos of the build of the Stevenson's style box that houses the temperature, humidity, and barometric pressure sensors. It is just a wood box with vents on the left, right, and front that allow air to freely flow in and out but keep the sensors nice and dry. It is also made of wood and painted white to reflect the sun's heat.

I dug a 24" hole at the location where I wanted my weather station. I placed the angle iron end of the assembly into the hole and cemented it in making sure to hold the pole nice and plumb. Once the concrete dried, I could remove the top bolt and swing the entire station to the ground for any future maintenance.

Photo of pole once cemented into ground

Here is a photo with the pole in the maintenance position with all of the components mounted.

Everything mounted to the 2" steel pole

***** never mind last year's decapitated scarecrow in the background ****

Results

I can now check the weather at my house no matter where I am:
https://www.wunderground.com/personal-weather-station/dashboard?ID=KOKHULBE3&cm_ven=localwx_pwsdash

Aside from 2 lockups, I am pleased with the results. The unit faithfully reports to weather underground every 15 seconds. I need to do some more work setting the time zone for when the rain fall data is zeroed out (does so at midnight, local time). I have had to go out twice and cycle power on the board as the microcontroller locked up. I am still chasing those bugs in my code.

Credits/Sources

- WIMP Weather Station – I referred to this project often while constructing. https://github.com/sparkfun/Wimp_Weather_Station
- Particle.io – Documentation for all things Particle Photon https://www.particle.io/
- Adafruit .com
- Sparkfun.com
- Fritzing.com
- GitHub.com

Hindsight's

This is a list of things I ended up redoing or things I wish I did differently….

- Barometric sensor – I did not originally purchase a barometric sensor. Had I purchased the temperature, humidity, and barometric sensors all together, I may have been able to find a single sensor board that did all three as opposed to two separate boards that had some overlap. (both boards will measure temperature).
- Combine temp sensors and brains into single box – I think I could have saved quite a bit of money had I built a larger wooden box and housed all the electronic components inside of it.
- Overkill on power – The 10-watt solar panel is overkill. It was a leftover from my electric gate opener. You could very likely get by with a 3-5-watt unit on this build. This would cut cost as well.
- Don't mount tipping bucket directly above electronics…. It dumps water on all your sensors. I ended up swinging the rain gauge 180 degrees to dump on the solar panel instead.
- Rollover bug? I'm not sure if this was the source of my lockup or not, but I have fixed a few spots in the code where the problem would happen.
- Wire terminals…. I wish I would have purchased some that better fit my breadboard. Then I would not have had to do the funky offset thing.