11. Sensor on Perf Board

Purpose: Build an instance of the sensor circuit onto a perf-board.

Goal: Make a small-ish version of the ATTiny84 sensor processor and transmitter circuit that I can use in a real-world planter to better guage the performance of various capacitor-sensor designs.

Key References --

Sensor Design Article: This is interesting for sure. Notice how this sensor is made from two rings of copper, wrapped around PVC tubing. And they are then inserting the sensor down into another (wider) PVC tube and it is sensing (forming) capacitance through the insulating PVC tubing. I do note here, however, that they are sensing capacitance via the high-frequency pulsing/waveform method. So now I wonder if that approach does yield greater sensitivity and dynamic range. I may have to test this out.

A Portable Pull-Out Soil Profile Moisture Sensor Based on High-Frequency Capacitance @ https://www.mdpi.com/1424-8220/23/8/3806

Esp this photo: @ https://www.mdpi.com/sensors/sensors-23-03806/article_deploy/html/images/sensors-23-03806-g006.png

To Modify RPi side .cpp code --

Use Kate on my desktop.

Then copy to the RPi using below command:

```
scp /home/jroc/Dropbox/projects/MoistureSensor/CapSensor
/RPi/RPi_CapDataReceive.cpp pi@192.168.1.118:/home/rf24libs
/RF24/examples_linux/
```

Then on the RPi, cd into the build directory and execute 'make'

BUT if this is the first iteration of the program, you need to first add it to CMakeLists.txt in the examples_linux directory (above the build directory).

NOTE: All the code is under git version control. So the executables for both the ATTiny and RPi are on my desktop.

Raspberry Pi Login --

Pi user is: pi. So SSH login is:

`ssh pi@192.168.1.118`
password: `pi9012`

And then once in, get into the working directory for the nRF24 utilities and programs:

```
cd /home/rf24libs/RF24/examples_linux/build
```

The run the RPi receiving program:

```
./RPi_CapDataReceive
```

Next Step: Three next steps. One, Fabricate a few different capacitor sensors to test. Two, modify code to measure and TX moisture (capacitance) data once/hour instead of continuously. Three, setup sensor in a real flower/plant pot in my house and run field tests on the sensors.

6/26/2023 --

Results: **Success**. Created power supply for the mobile sensor-circuit of 6/20/2023.

Build: Used a 5.5V wall-wart I had laying around. It's output actually read 6.0V. Created a voltage regulator circuit using an LD1117S33TR voltage regulator that I also had on hand.

> Note: Per the Observation discussed below I increased the input cap value on the regulator from the recommended 0.1uf to 1.0uf to improve noise filtering. This did improve the ACK-back success rate from the RPi back to the ATTiny84's nRF24 module.
>
> See photo at: /ProjectLog/MS11_b_Photo_SensorCircuit_PowerSupply.jpg

Observation: The nRF24 is sensitive to power supply noise. Up to now I've been powering it from a bench power supply. And the perf-board circuit reported back very, very, few acknowledgement errors; meaning the soldered in perf-board circuit was more stable and reliable than the breadboad circuit - which is not surprising. I initially used an 'active' LM2596 variable DC regulator to power the perf-board. When I did that I got a 100% acknowledgement error rate. Tho interestingly the RPi was receiving data from the ATTiny84 fine, it was only the ACKs from the RPi back to the ATTiny84's nRF24 that weren't making it through. When I put some extra capacitance on the DC output of the LM2596 board I got about a 25% success rate. When I put my old Radio Shack multimeter in-circuit to measure the current consumption of the sensor circuit I got a nearly 100% success rate - which I have put down to (inadvertent) noise suppression/smoothing caused by the meter. So then I powered the ATTiny84 sensor circuit using the same wall-wart, but with the passive 3.3V LD1117S33TR regulator. Using the recommended 10uF cap on the output, and the recommended .1uF cap across the input I got about a 50% acknowledgement error rate (multimeter not in-circuit). Using the recommended 10uF cap on the output, and increasing the input cap to 1.0uF I am now getting about a 30% acknowledgement error rate. So clearly power supply noise is an important consideration.

> * Ultimately I plan to power the ATTin784 sensor circuit with a battery, so hopefully this will be a moot point. But it is interesting to see noisy power affects the radio reliability.
>
> * I don't have an oscilloscope so I can't actually visualize the noise to understand it better.
>
> * And I don't know what the noise is actually doing to cause the errors.
>
> * I do have the wall-wart about 3 feet from the sensor circuit board, and the power regulator is about 6 inches from the sensor-circuit.

6/20/2023 --

Results: **Success**. Built the ATTiny84 sensor circuit onto a small perf-board. Have tested it an it is working.

NOTE: In fabricating the perf-board circut I did (of course!) make an incorrect connection - I mixed up the pin connections for the red error LED and the capacitor lead. Fortunately both those pins only need to be regular digital pins so I was able to simply swap those pins in the Arduino code to correct the error. From this point forward this correction is the 'official' pin mapping for sensor-capacitor connections to the ATTiny84.

The error was that I connected the cap lead to physical pin#3, and the red LED to physical pin#5; which was the opposite of how I had the breadboard circuit wired. So I reqired the breadboad circut to match, made the change in `tiny84_pfCapMeasureAndTx.ino`, uploaded the revised sketch to the ATTiny84 chip, tested it, and all was well.

Photos of Perf-Board: See /Physical-Construction/Sensor/SensorCircuit_On-perfBoard_Photo.jpg.