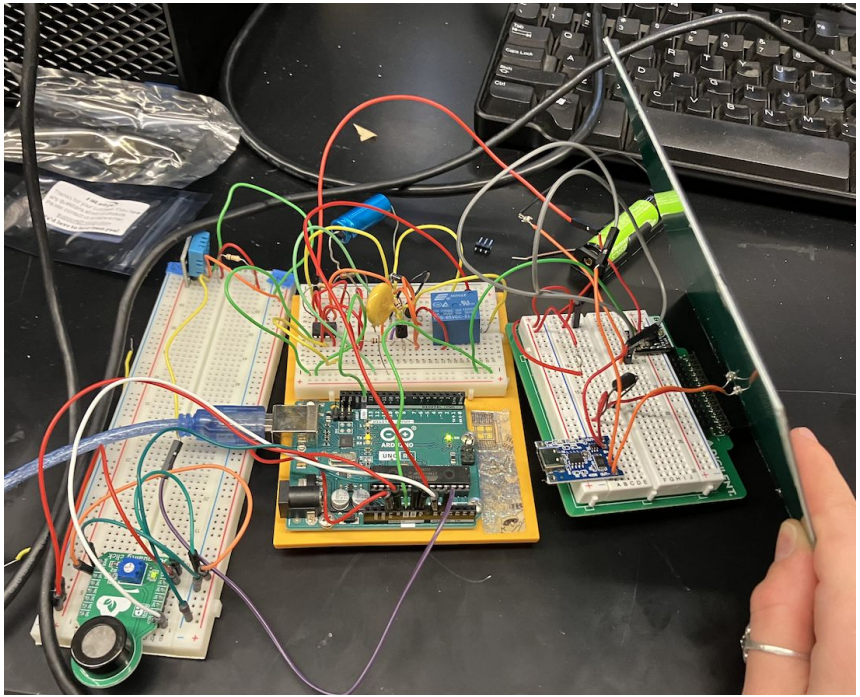
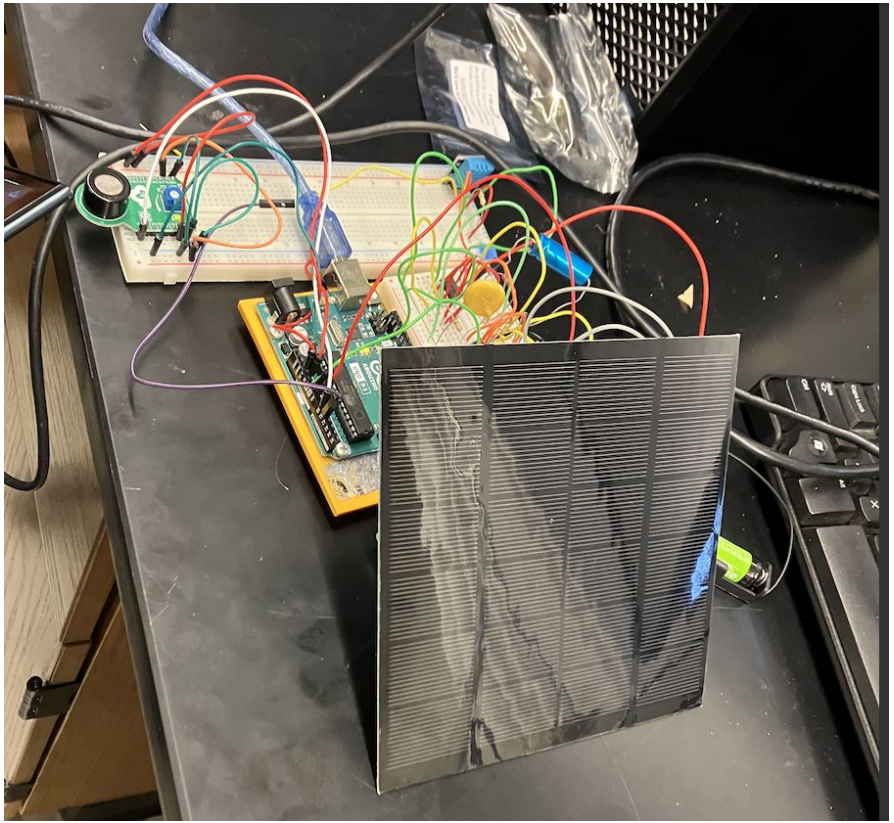
Singing Satellite Project

Unda, Madeleine, and Anatalya

Cite: Astronomy pic of the day sometime in 2020 maybe? It's NASA

The Satellite





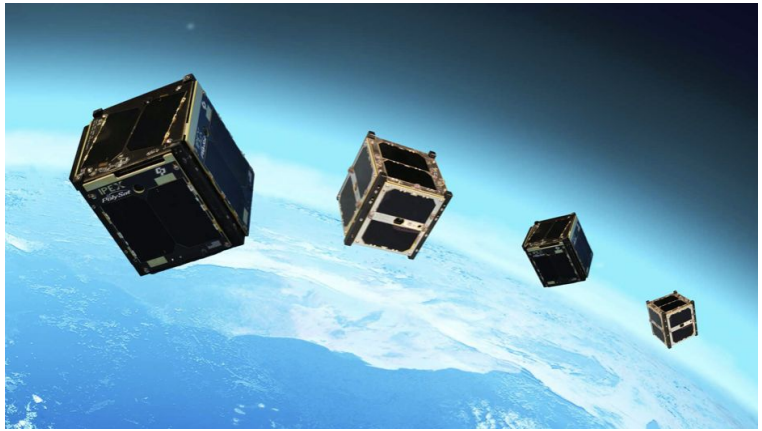
Why???

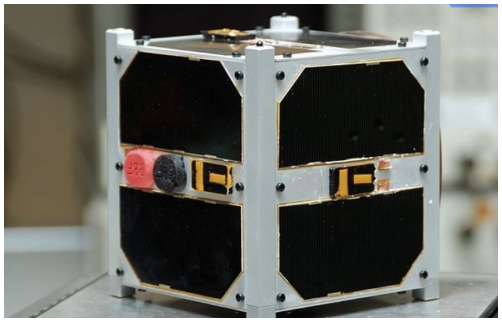
Because they are cost efficient and accessible!

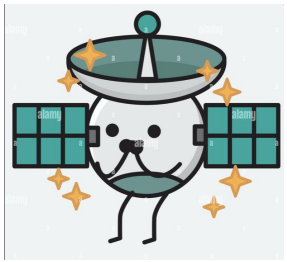
They can also talk to each other and

everything is more powerful in numbers!

Also they are fun and cute and small…





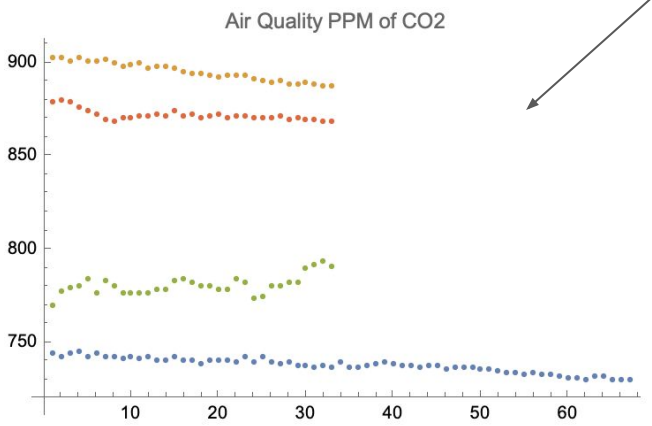


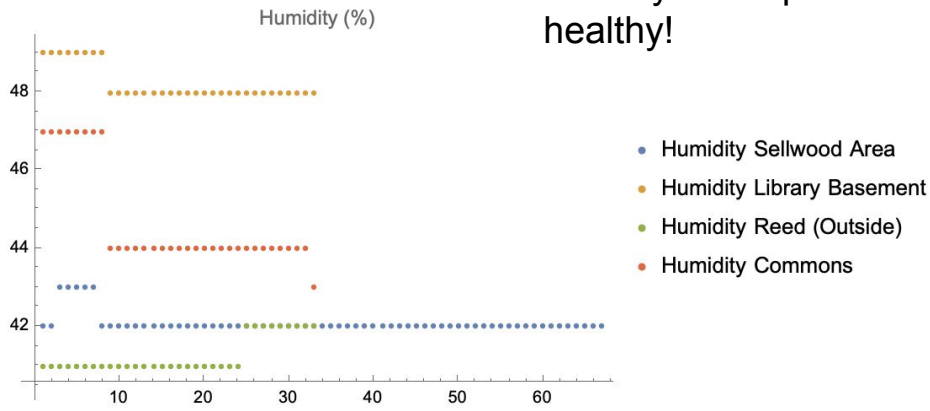
Data?? Actually yes.

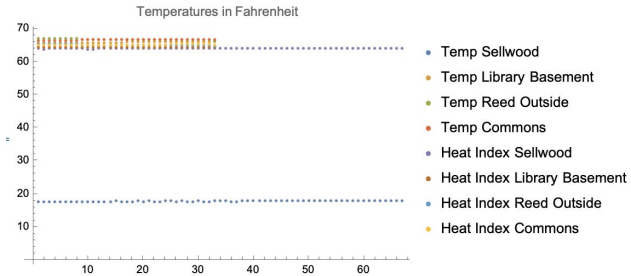
The PPM of CO2 and humidity correlate!!

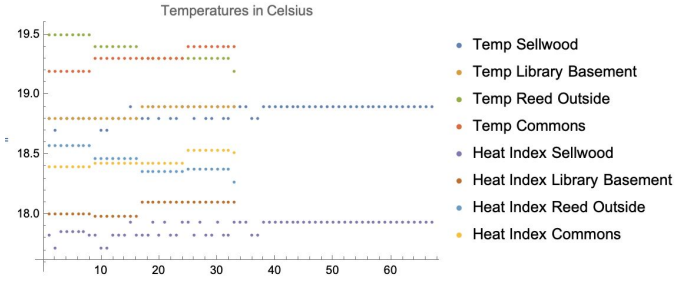
But don't worry, there are worse things ☹

The lib basement is actually not super healthy!





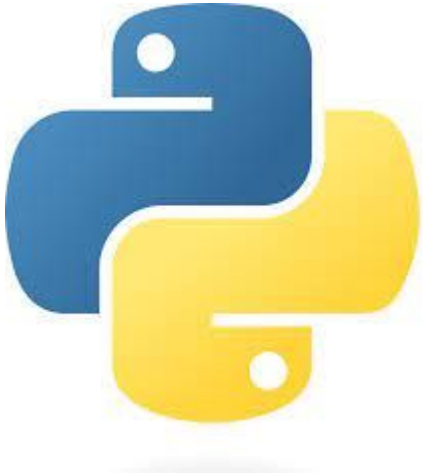




The temperature graphs are small because it's not interesting

How we did it!!

- Arduino to Excel
- Excel to Mathematica for easy analysis
- Python: the missing link
- Data collection took 8 seconds!
- Issues: Bluetooth connection, data cleaning



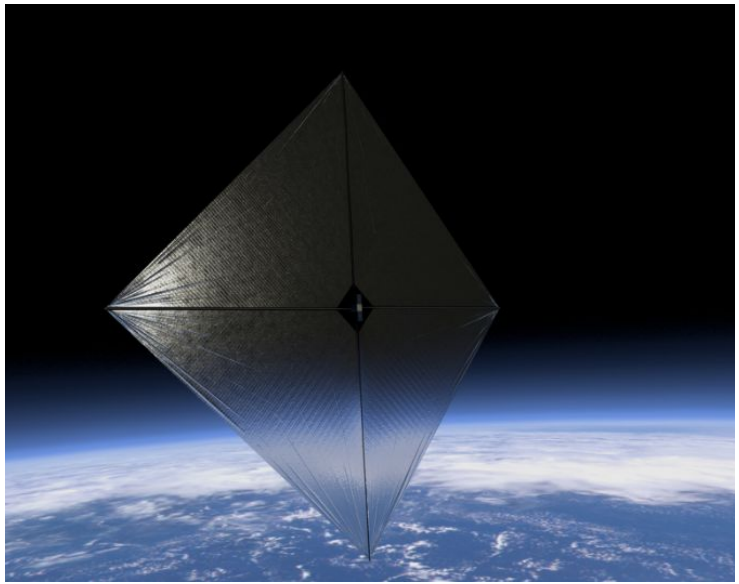
Did it work?

It would have been cool to have a transceiver, and maybe more sensors, but it works!

Extensions??

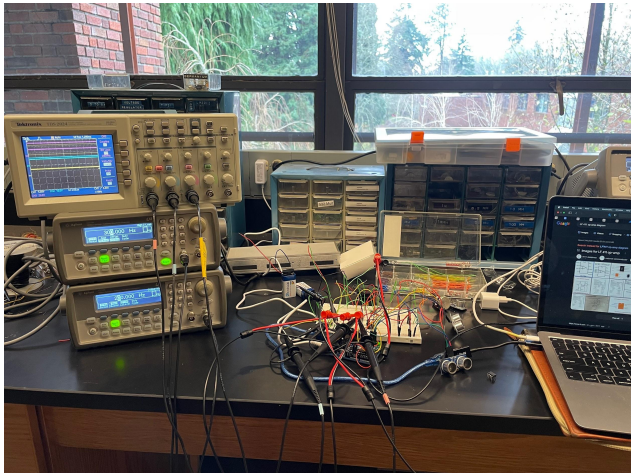
Solar Sail! And working on some cool trajectories!

> A solar sail spacecraft has large reflective sails that capture the momentum of light from the Sun and use that momentum to push the spacecraft forward - The Planetary Society



The Theremin and Motivation

- Taking inspiration from various “multi-voiced” theremin projects (1), we decided to add an additional summing amplifier stage to a digital theremin that used arduino ultrasonic sensors that summed a signal from the theremin with a signal determined from the satellite data.
- This was in the hopes of creating music that indicated air quality.
- We thought it would be interesting to see how the signal with the combined frequencies translated to sound. Would this form chords of sort?



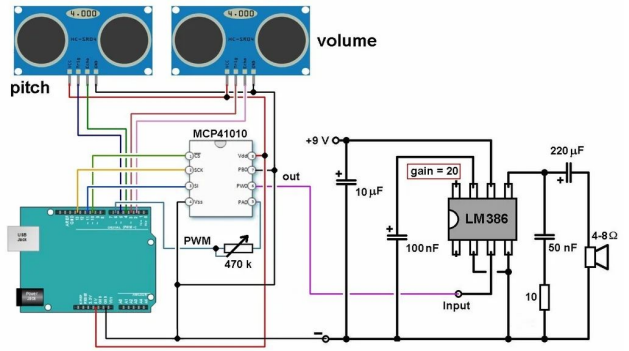
Polyphonic Theremin (3)

An Example of a Polyphonic Theremin

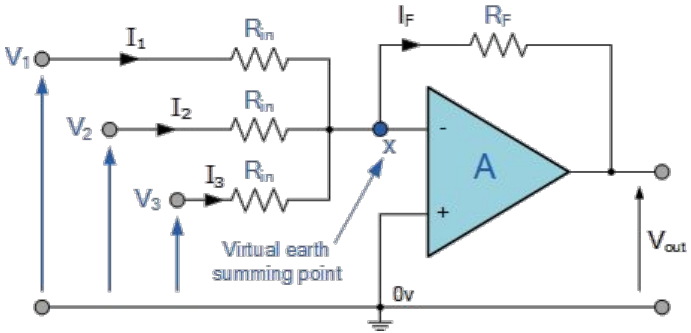
How it worked

- Building off of the usual arduino theremin circuit that many projects use, we added a summing amplifier between the digital potentiometer output and the audio amplifier circuit.
- We only experimented with the signal from the theremin potentiometer and an additional signal from a function generator but we could have experimented with even more signals.

$$-V_{OUT} = V_1\left(\frac{R_f}{R_1}\right) + V_2\left(\frac{R_f}{R_2}\right) + V_3\left(\frac{R_f}{R_3}\right) \ldots . \text{etc}$$



Common Arduino Theremin Circuit (2)



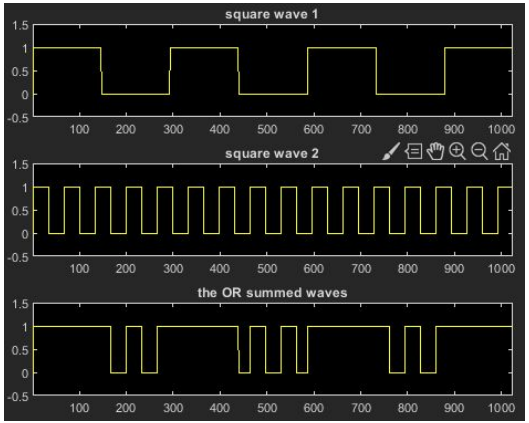
Summing Amplifier (4)

Issues

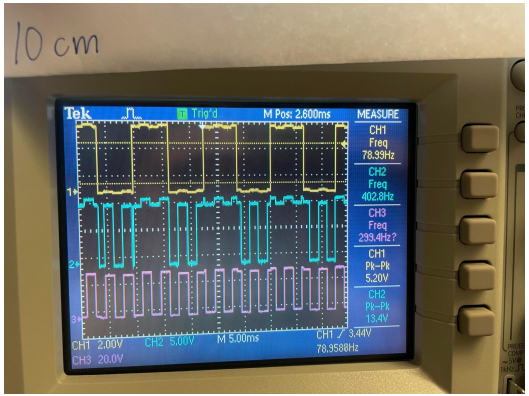
- Timing was the biggest issue in terms of coordination, building things and overlapping the theremin and satellite projects
- We could have worked with multiple signals such as square waves, sensor additions, and sound variations
- Another issue was getting the satellite to connect to the bluetooth for the data acquisition of the satellite.
- Also difficulty getting the tuning the resistor in the summing amplifier to get an output signal with definition between the two frequencies present was difficult. We resulted to setting all the resistors to the same value to create a unity gain inverting adder.
- For the future, we would like to be able to have time to successfully combine and improve upon this project
    - The many signals on the satellite would be interesting to expand upon, gather more data and explore portions of campus with this project for real-world applications

Did it work like we expected?

- The signal output signal definitely matched our expectations but the sound itself what horrendous.
- We didn’t record it because we thought there would be a way to improve it but nothing made it better.
- We were hoping to hear something like chords but only got pulses or beats that made a slight alteration to the pitch.
- The results were similar to the combined signal of two square waves of different frequencies found in other simulations (5), except there was some unwanted square wave behavior at the crest of the larger square wave.

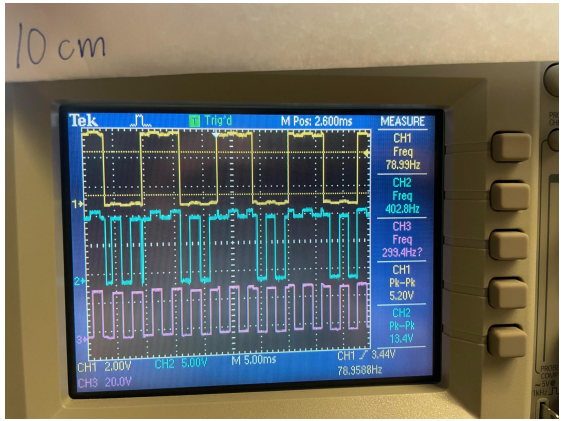


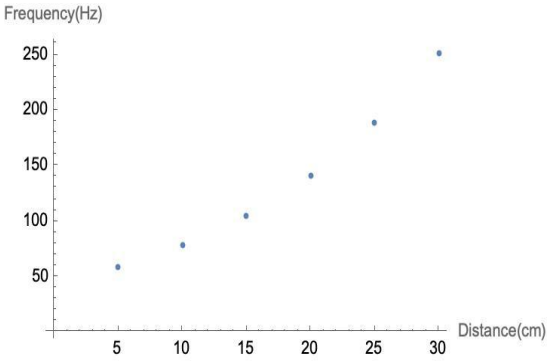
Analogous to the expected output (6)



Data

- The amplitude of the output signal was measured at 12.8 ±0.2 V. This is what we expected from the equation for the summing amplifier output voltage.
- The amplitude of the smaller square waves at the peaks was 0.64V±0.2V. This was not the difference between the two signals as expected.
- The frequency did not increase as linearly as we expected.





- We didn't get a chance to apply Fourier Analysis to the output signal but this could have been interesting.
- The peaks at the top of the larger square wave within the output signal are likely due to amplitude differences between the generator and theremin signals

Conclusions/Implications

- Even though we weren't able to connect the theremin and satellite we thought that the results we got from the theremin with combining signals from the summing amplifier were promising–even if we really weren't pleased with the resulting sound.
- The satellite also showed a lot of promise as a fascination source of data to determine the frequency of input signals for the theremin circuit. There was a wide range of values for humidity, temperature and PPM of CO2 for us use as determinant of the frequency for the other signals.
- What if we enabled the satellite to transmit data in real time to the theremin?
- Could we assign multiple input signals summing amplifier a sensor on the Satellite?
- Also, how would we adjust the notes/chords to be minor or major depending on the air quality parameters?
- Would a multi-speaker setup result in a better sound?

Sources

1. http://www.thereminworld.com/Article/13266/a-multi-voiced-theremin\\
2. https://www.instructables.com/Arduino-Theremin-With-Variable-Pitch-and-Volume/
3. https://www.wired.com/2011/04/polyphonic-theremin/
4. https://www.electronics-tutorials.ws/opamp/opamp_4.html
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