Temperature Tuned FOSS Software

JOHN STRENIO

AFRC-540 SENSORS & SYSTEM DEVELOPMENT

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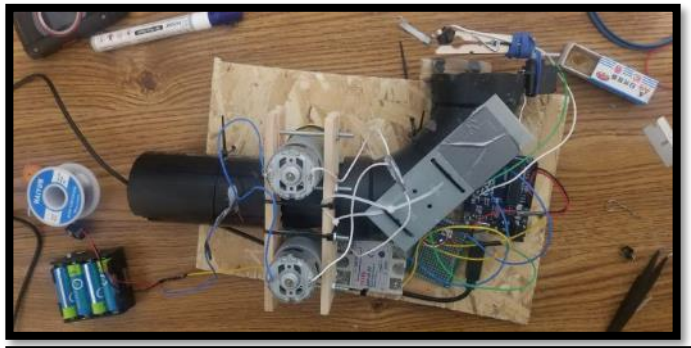
Other Projects:



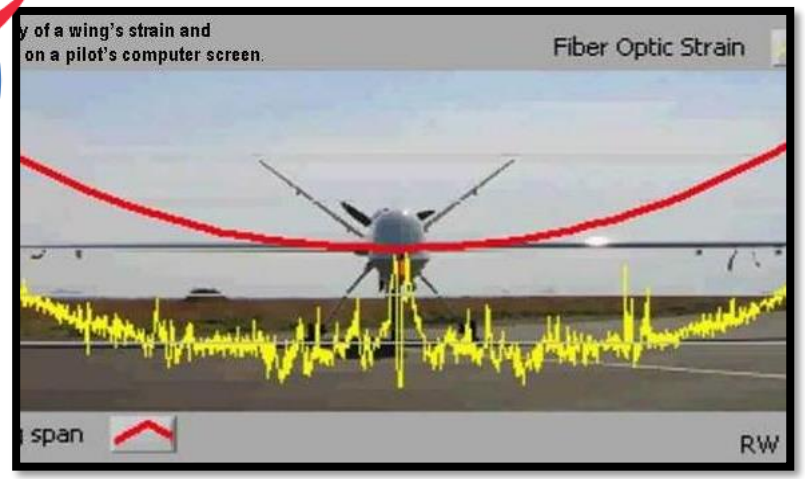
Arduino tennis ball launcher

Unity based video game

Hobbies:

Skiing

Surfing



Fiber Optic Sensing System (FOSS)

- A new technology for an essential system

- Strain, real time structural health monitoring

- New applications: shape, deformation, temperature, liquid level, operational load

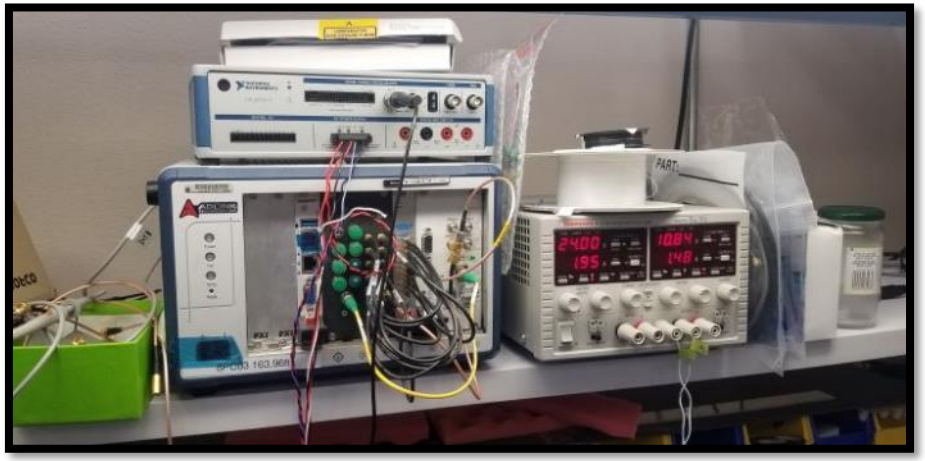
- Utilizing Optical Frequency Domain Reflectometry (OFDR)

Temperature Tuned FOSS

The same FOSS (mostly) you know and love for new applications

A little slower, no moving parts and LOT cheaper

Perfect for liquid gauge readings and temperature measurements



Narrowband laser

coupler

Optical network

Optical amplifier board → Analog Digital Converter → Micro-controller → CPU

Key application: NASA Cryogenic Fluid Management. Robust with high measurement density

Temp Tuned Software

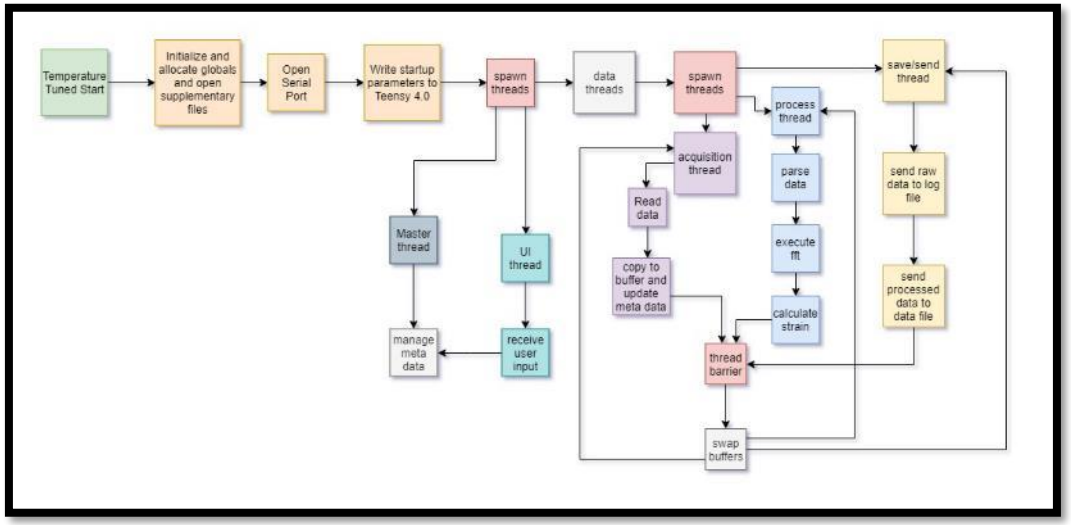
Implementing Temp Tuned Software

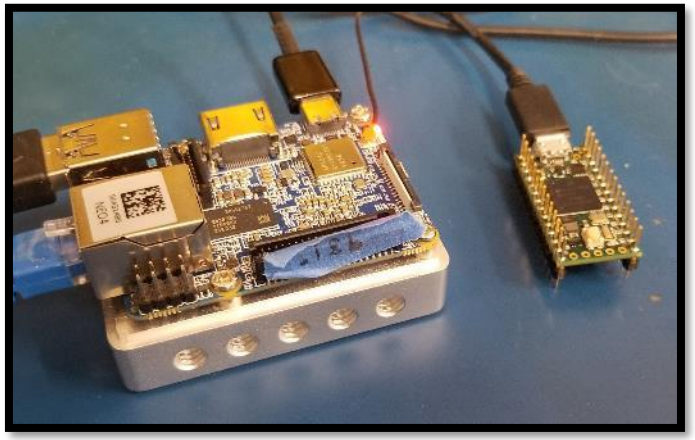
Establish Serial Connection with Arduino Teensy 4.0

Send initialization commands to Teensy

Receive serial input from Teensy

Perform an FFT on the data and calculate the strain





Nanopi Neo 4 & Teensy 4.0

Record Data

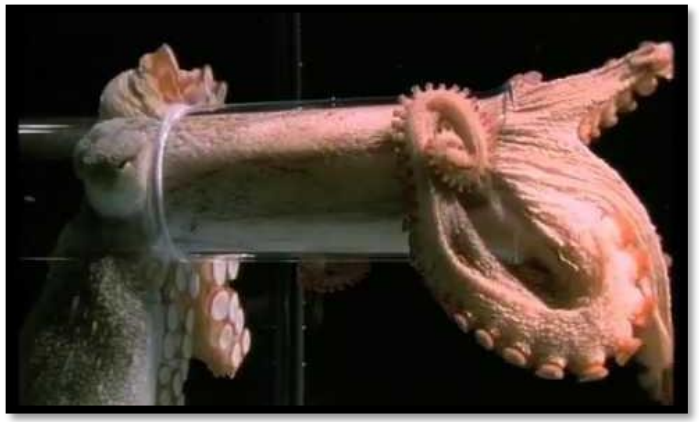
Transmit Data

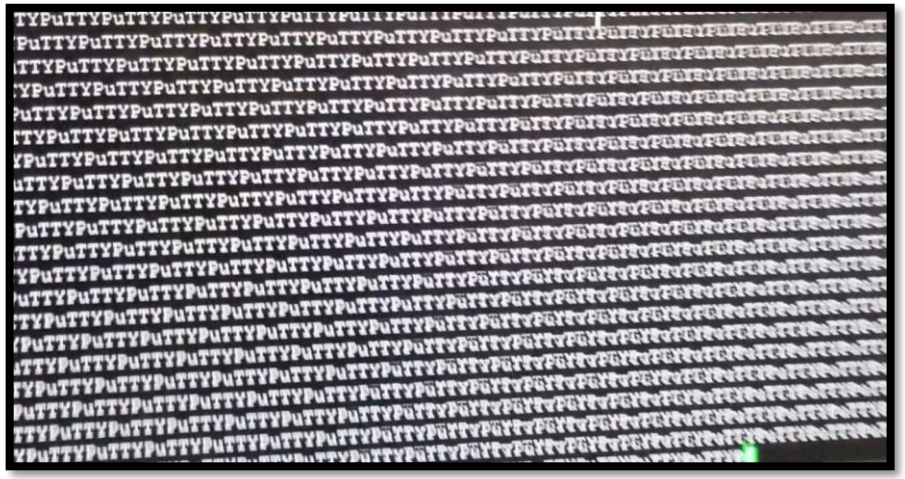
Use multithreading to make it fast, efficient and function continuously

Serial Communication

Goals:
- Establish serial connection with device in C
- Send initialization parameters to device
- Implement alternating buffers to continuously receive input

Challenges:
- Termios settings are esoteric and critical for proper data transfer
- Serial communication involves sending lots of data fast which is difficult to error check
- Loss of even a single byte can corrupt all subsequent data
- Lots of settings work most of the time, but still may cause errors





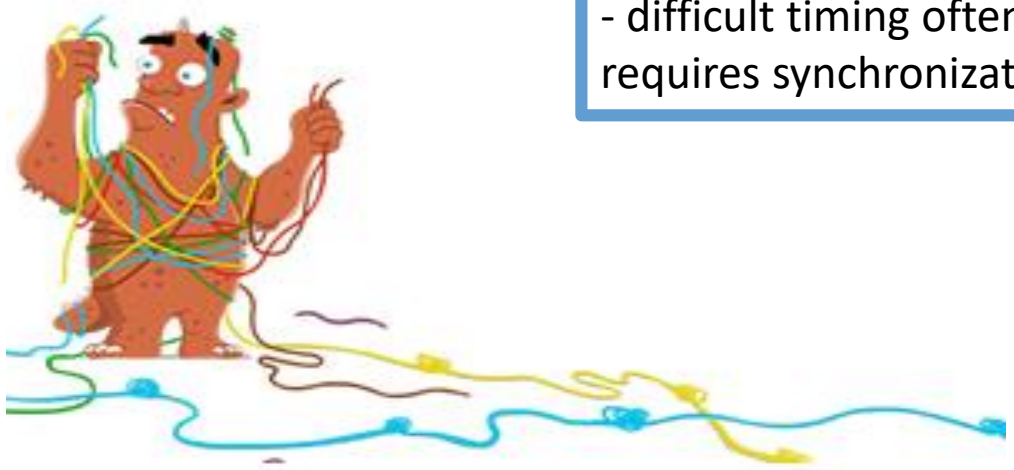
Solutions:
- Utilize Termios serial framework in C
- Rigorous error checking, Isolate errors, progress incrementally
- Write robust test code that covers ALL test cases

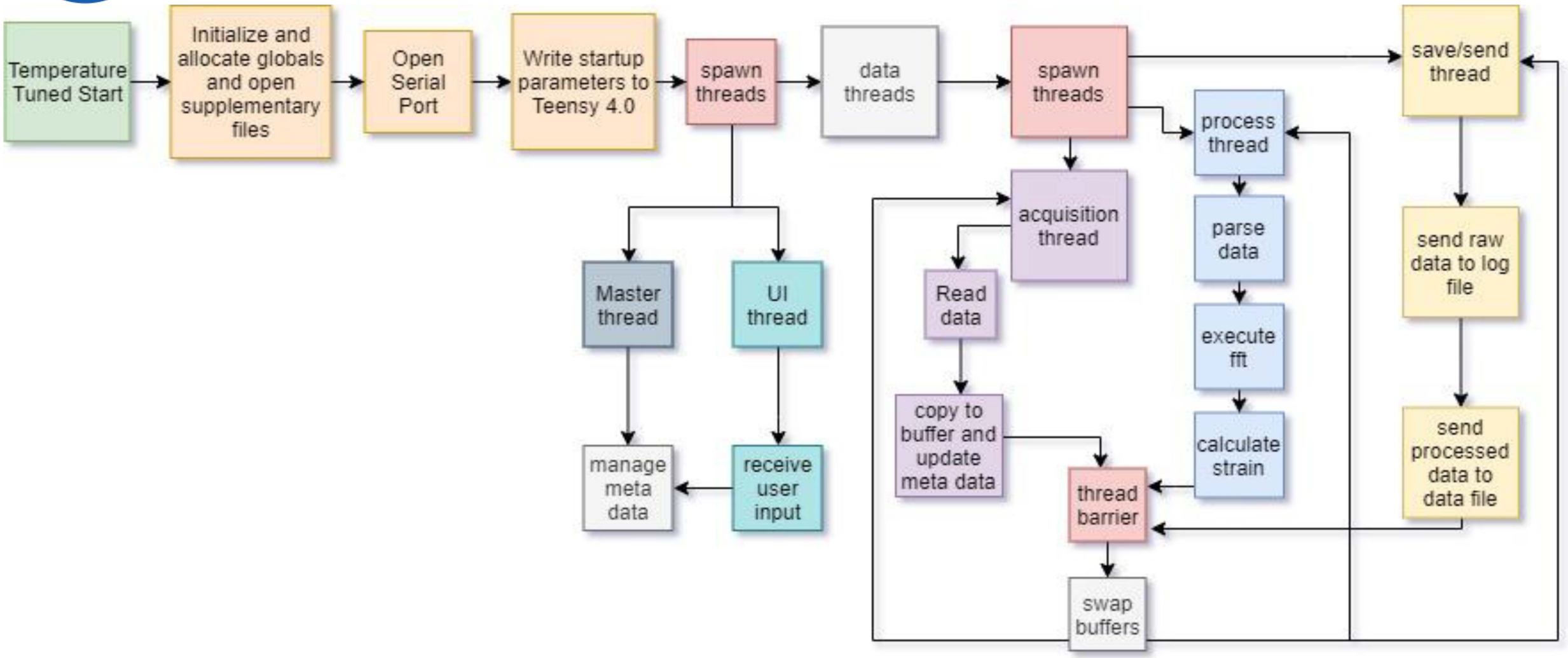
Multithreading

Goals:
Use parallel programming for concurrent and continuous data acquisition and processing

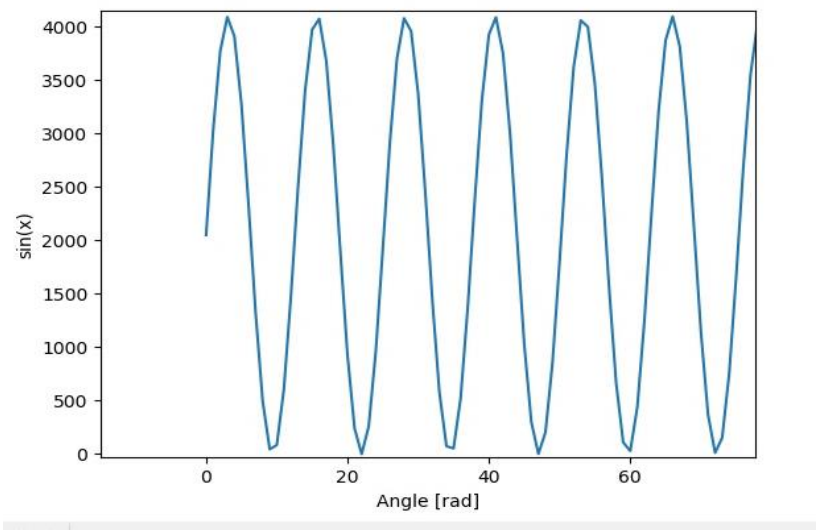
Challenges:
- nondeterministic, susceptible to unreproducible bugs
- lots of moving parts leading to propagation of errors
- difficult timing often requires synchronization

Solutions:
- Implement as late in the process as possible
- Use of semaphores to ensure proper thread syncing
- Create a well documented plan before implementation

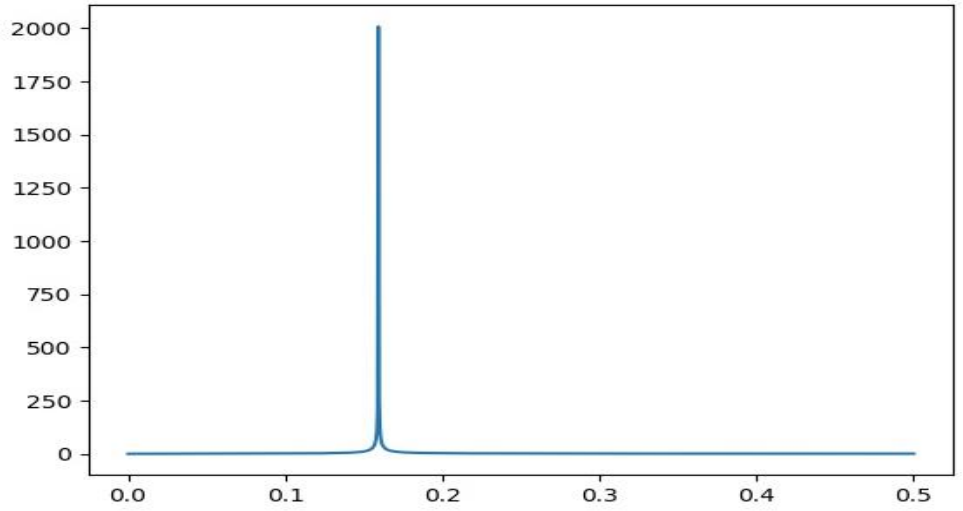



Temperature Tuned Start
Initialize and allocate globals and open supplementary files
Open Serial Port
Write startup parameters to Teensy 4.0
spawn threads
data threads
Master thread
UI thread
manage meta data
receive user input
spawn threads
acquisition thread
Read data
copy to buffer and update meta data
thread barrier
swap buffers
process thread
parse data
execute fft
calculate strain
save/send thread
send raw data to log file
send processed data to data file

FFT & Strain Calculation



FFT



Goals:
- Parse Data
- Perform FFT
- Calculate Strain

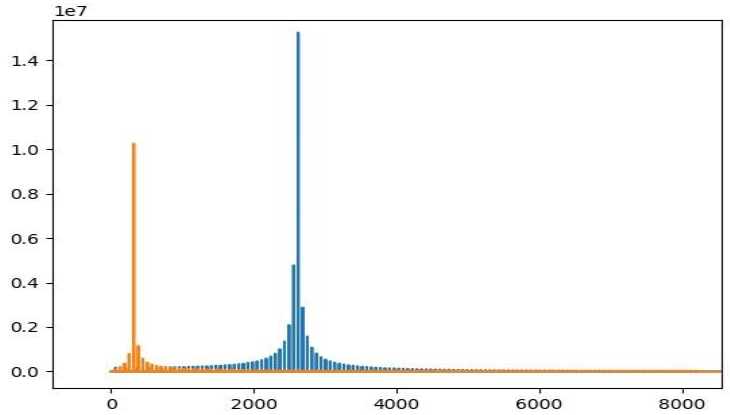
Challenges:
- Implementing algorithm without real data
- Generating illustrative test data

Solutions:
- Reading man pages and careful execution of algorithm

Side Projects

Git Repository:
- Created a git repo for the lab
- Placed the repo on the network on a single board computer, while the actual data is stored on a mounted server
- ensured it doesn't require data being stored at an external location such as a website
- Included documentation for the entire setup process for posterity

Soldering Certification:
- Learned proper soldering techniques for integrated components



Python, bash scripting and Plotting:
- Learned basic python to utilize popular plotting libraries for FFT visualization
- Wrote basic bash scripts to create a real time graphing of raw data vs processed FFT

Lessons Learned

-Computer Science is often an applied field

- Plan, execute, test repeat

-Fast is slow, slow is fast

-Read the man pages

-Prioritize and compromise, don't lose sight of the bigger picture

Next Steps

-Parallel processing of all 8 channels

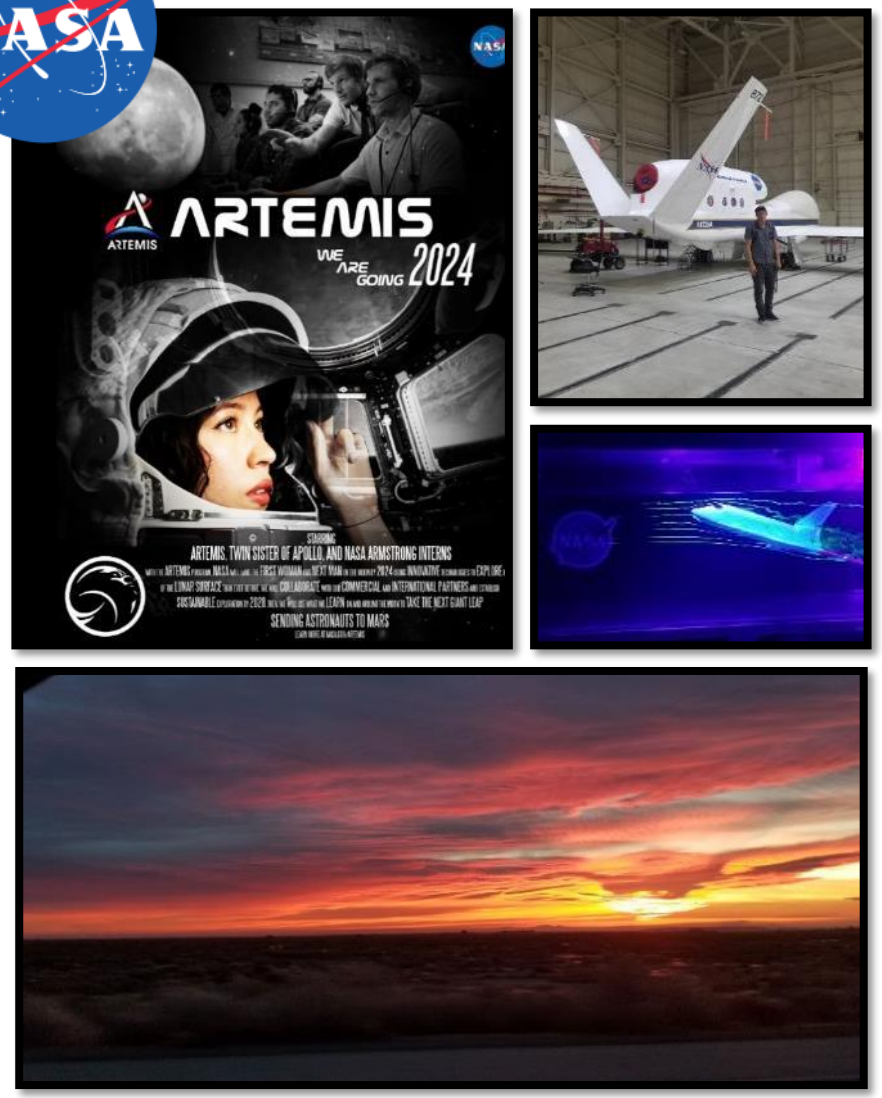
- Testing of software with real data

- Further development of graphing and output of data

- Potential further optimization via parallelizing code

Future Work

Beginning MS in computer science at Portland State University machine learning and A.I. track



Internship Experience

- Aerospace is awesome
- There are lots of facilities in and around NASA doing really cool things
- The desert has beautiful sunrises
- NASA employees are passionate

Acknowledgements

Allen Parker
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Paul Bean
Skyler Szot
Patrick Chan
Jonathan Lopez
John Rudy
Phil Hamory
Adam Curry
Frank Pena
Richard Hang
Jody White

Questions?

```
Segmentation fault (core dumped)
makefile:39: recipe for target 'all' failed
make: *** [all] Error 139
```