Temperature Tuned FOSS Software

JOHN STRENIO
AFRC-540 SENSORS & SYSTEM DEVELOPMENT
MENTOR: ALLEN PARKER
John Strenio
Portland State University
Computer Science
Junior

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

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

Narrowband laser
coupler
Optical network
Optical amplifier board
Analog Digital Converter
Microcontroller
CPU

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

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
FFT & Strain Calculation

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
- Fast is slow, slow is fast
- Prioritize and compromise, don’t lose sight of the bigger picture
- Plan, execute, test repeat
- Read the man pages
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
Lisa Illowsky
Shideh Naderi
Paul Bean
Skyler Szot
Patrick Chan
Jonathan Lopez
John Rudy
Phil Hamory
Adam Curry
Frank Pena
Richard Hang
Jody White
Questions?

Microsoft Data Link

Unexpected Error. Please Investigate.

OK

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