M.A.R.S

Aaron Jarmusch, Jacob Stafford,
Joel Huffman, Ethan Conway

Northrop Grumman

- Company we are working with throughout the year.
- American multinational aerospace and defense technology company.
- Working with Andrew Meyer, John Stolan, and other Northrop Grumman engineers.

The M.A.R.S Problem

Rocket Launch to Mars

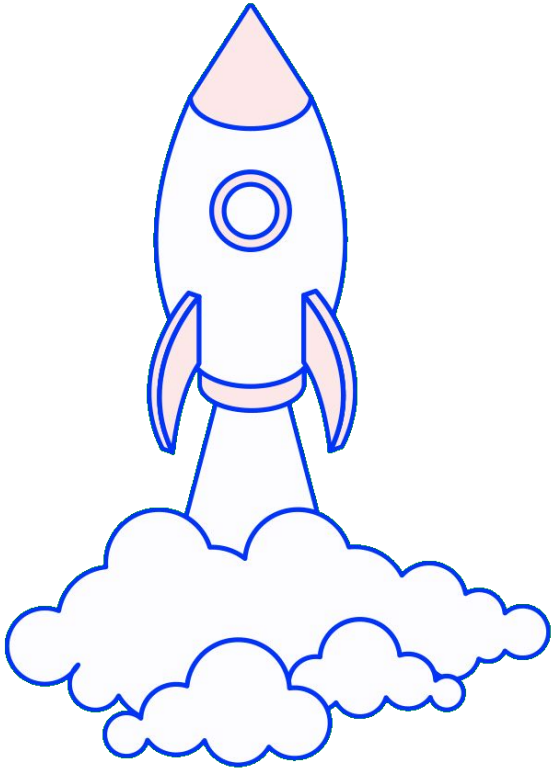
- Expected Launch in 28’

Electronic System

- Moving Platform for Space Exploration

Noise Experienced

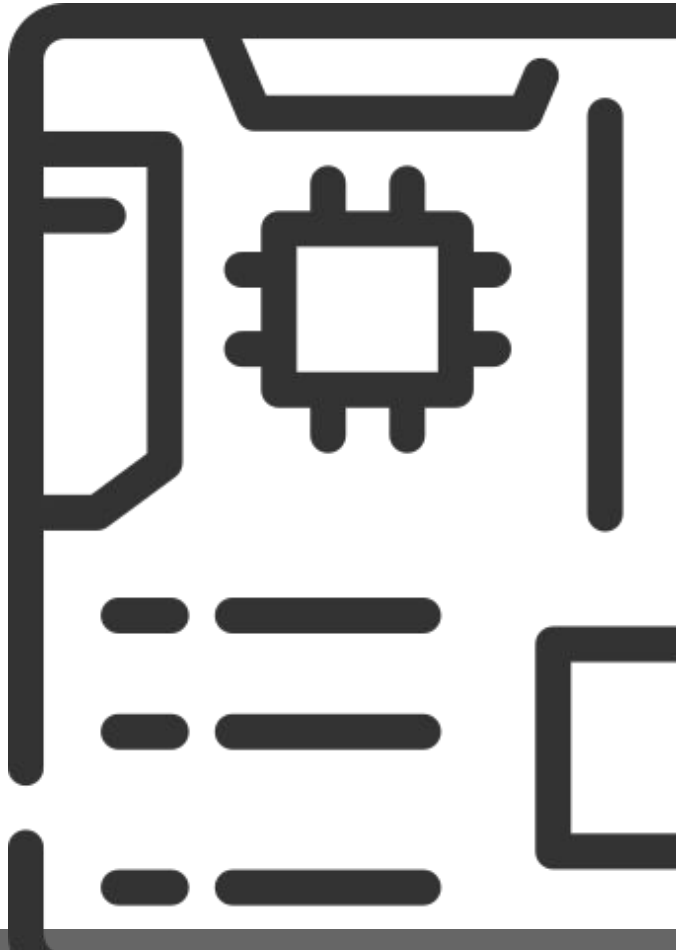
- Electromagnetic Interference
- Thermal Noise
- Mechanical Noise



The Current Solution

Northrop Grumman

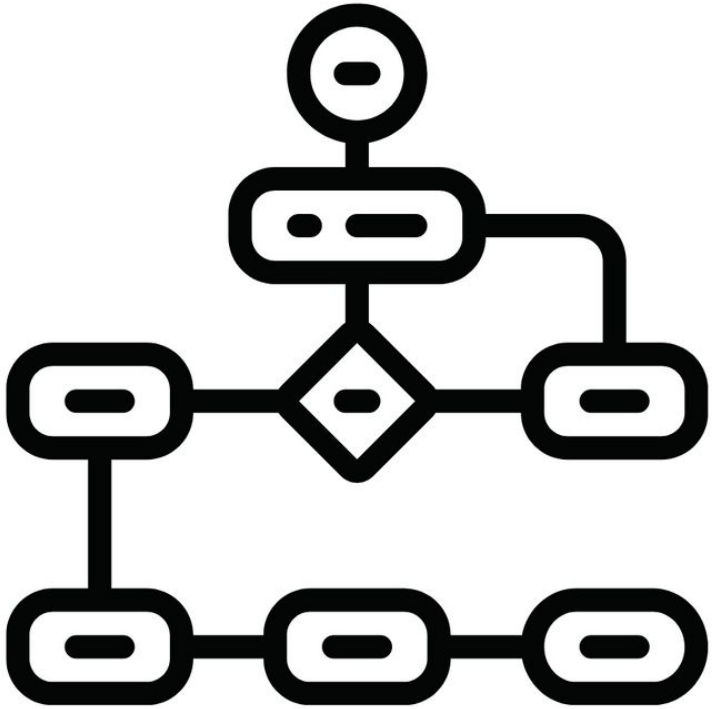
- Current Implementation
- Self-Developed Microcontroller Board
    - Reduces Weight
    - Test Multiple Algorithms
- Current Algorithm
    - Similar to a Phase Locked Loop



Our Solutions

Matlab Simulink

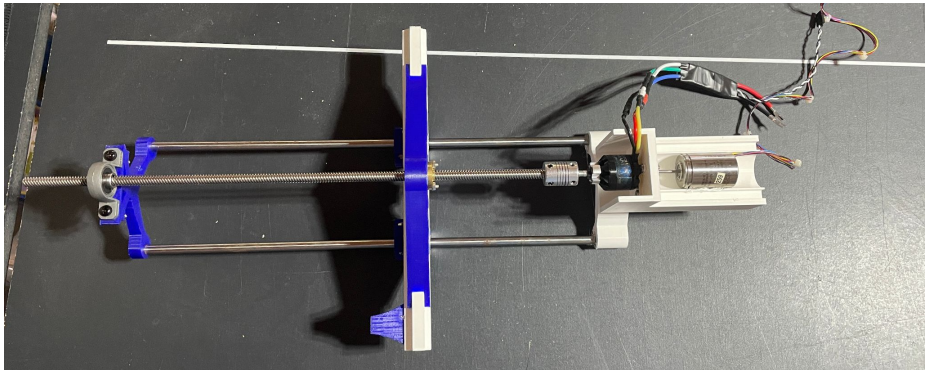
- Physical Build of Resolver and Resolver Encoder
- Phase Locked Loop (PLL)
- Third-Order Rational Polynomial (3-ORP)
- S-Transform (S-T)
- Recurrent Neural Network (RNN)



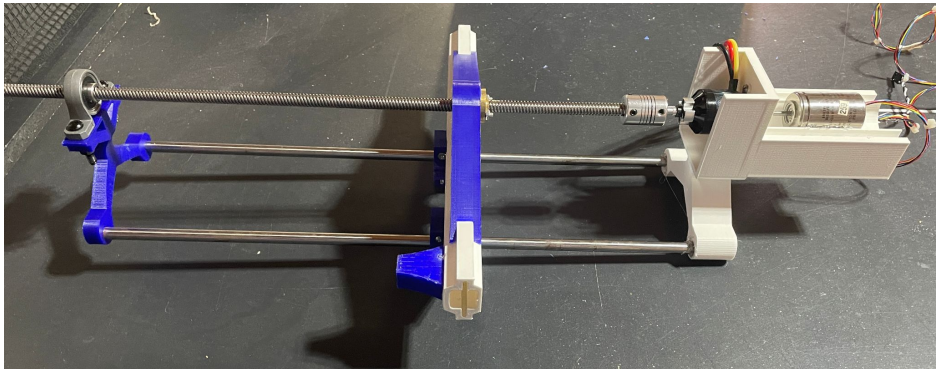
Physical Apparatus

The apparatus consists of:

- Brushless motor
- Resolver
- ESC
- Two couplers
- Threaded rod
- 3D printed stand



Top View of Apparatus



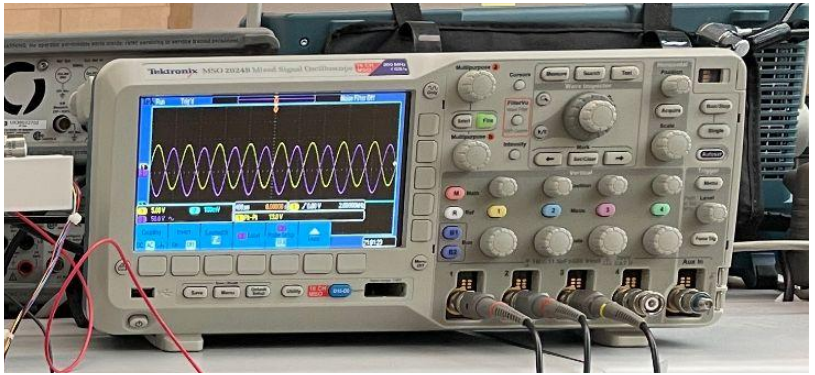
Side View of Apparatus

Physical Apparatus (cont)

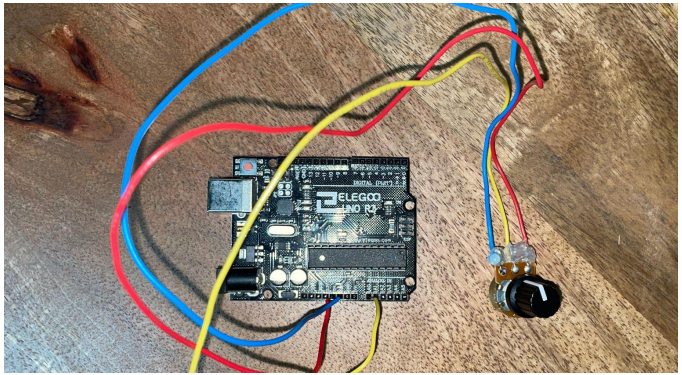
Also included:

- Arduino
- 10k Potentiometer
- Power Supply
- Oscilloscope
- Waveform generator

We can use the data from the oscilloscope and feed it into our various algorithms.

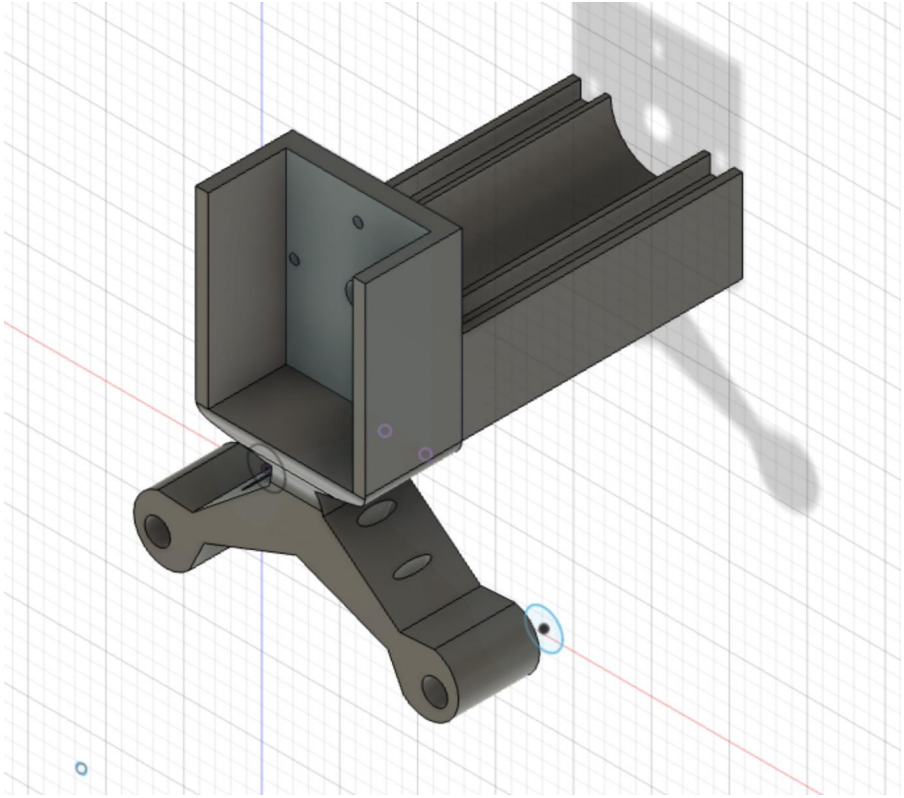


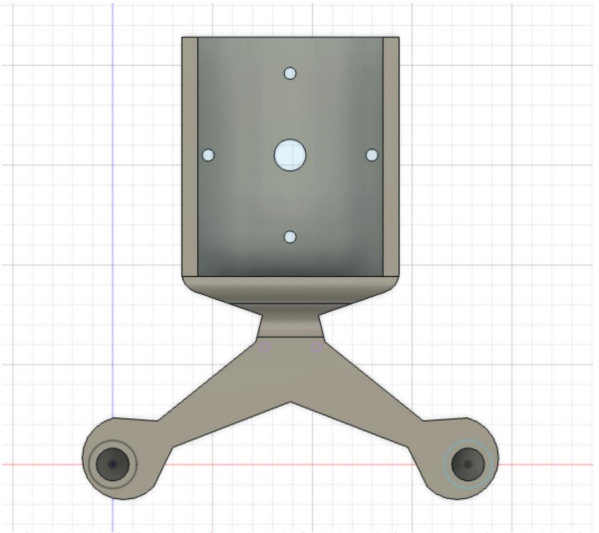
Oscilloscope to measure resolver. Sine (Yellow), Cosine (Purple).

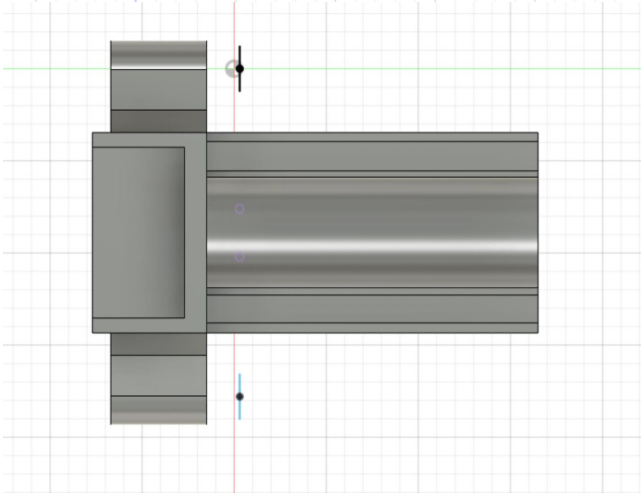


Arduino to send PWM signal and potentiometer to control motor.

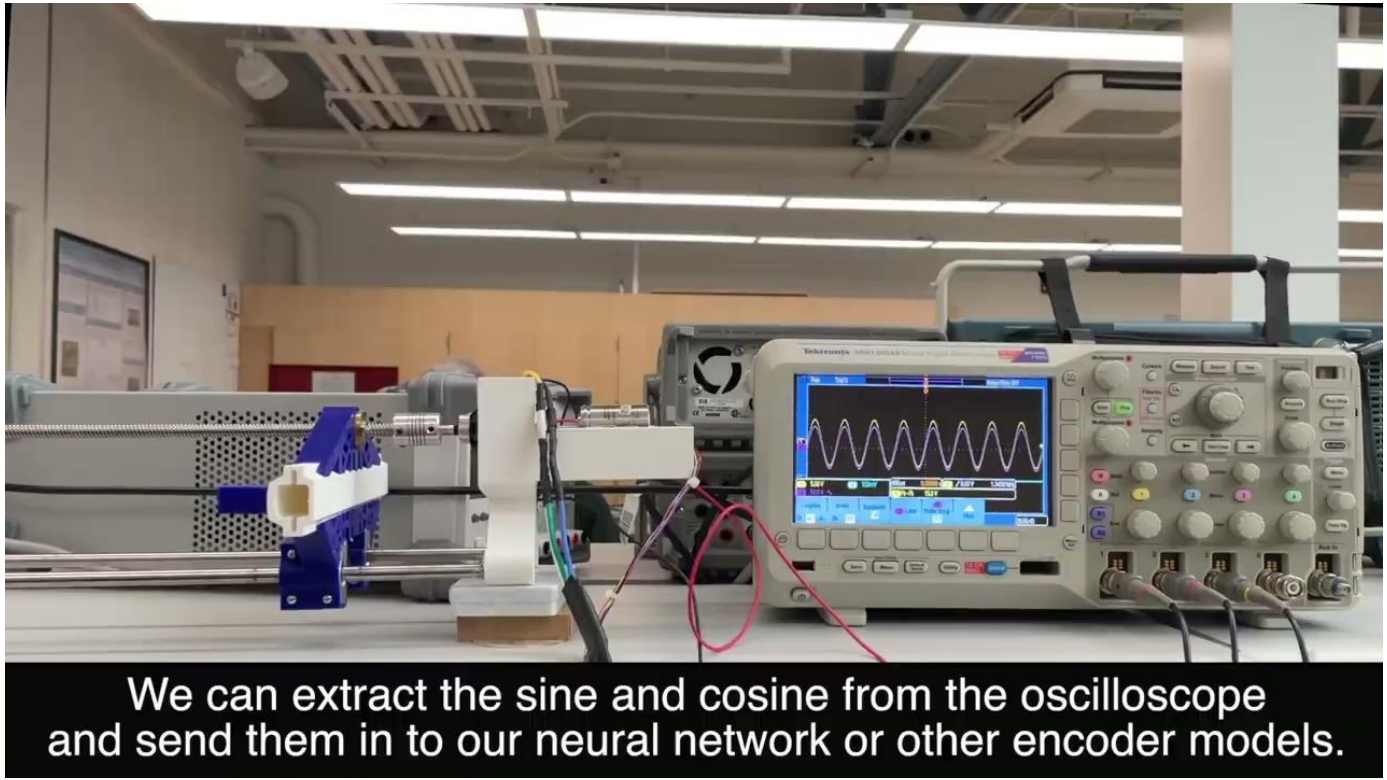
3D Printed Apparatus Piece



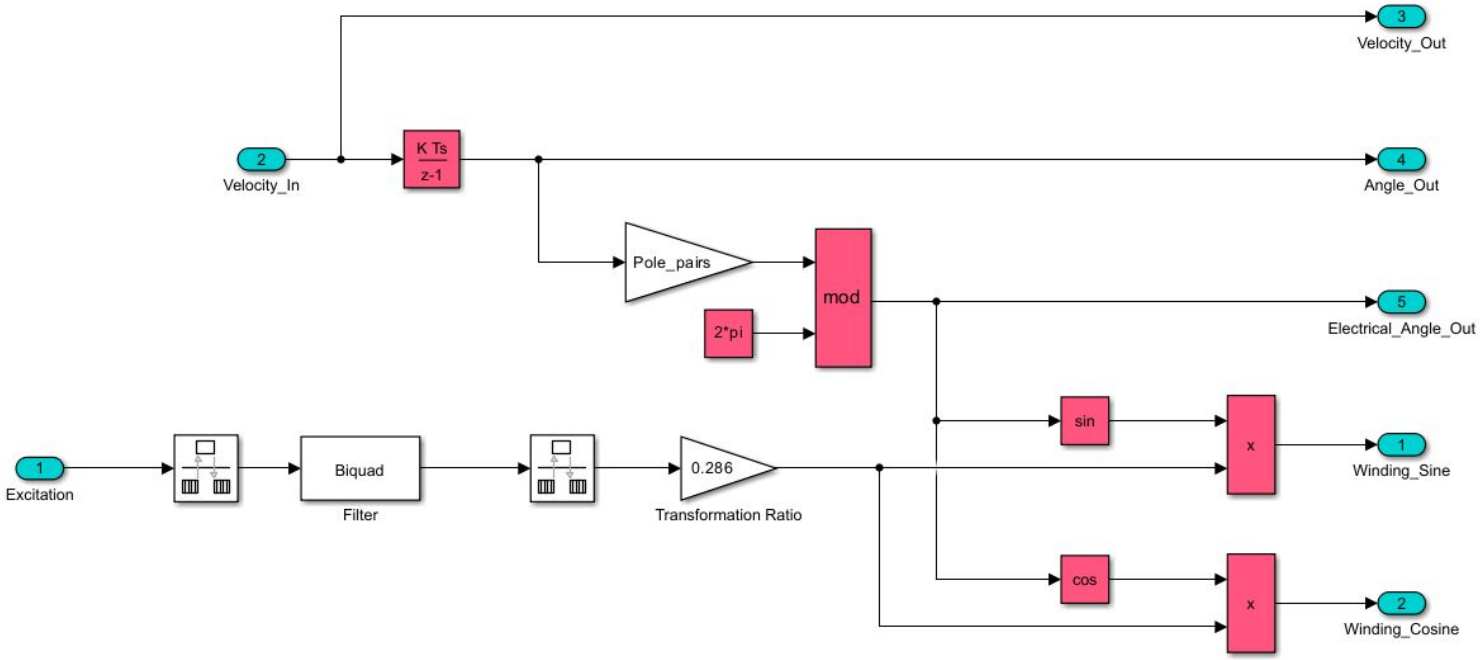




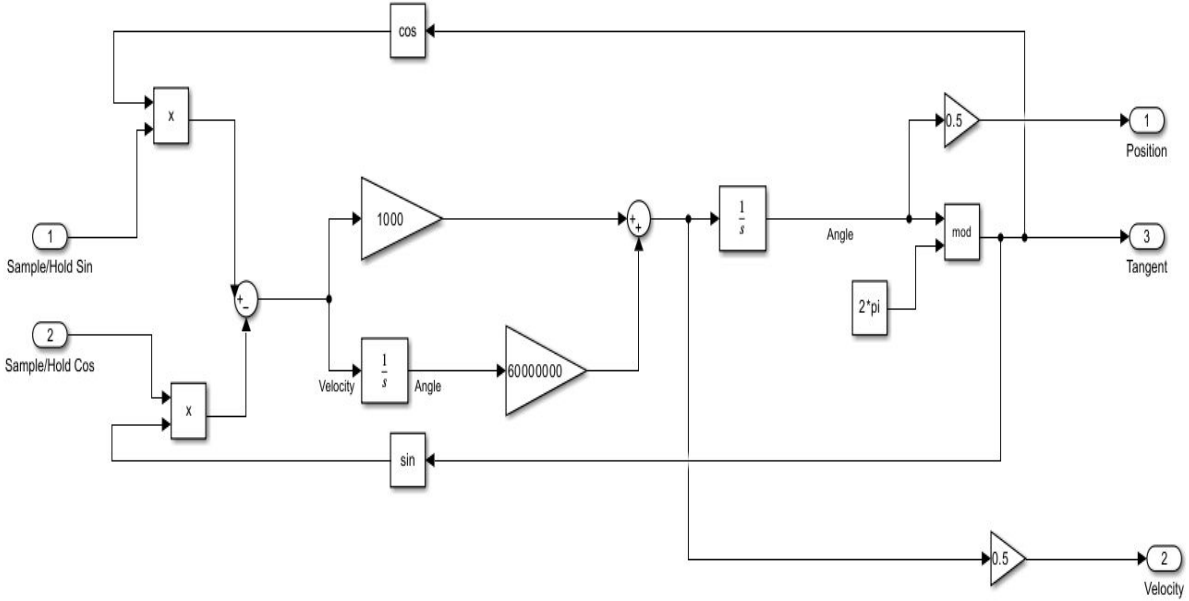
Apparatus Demo

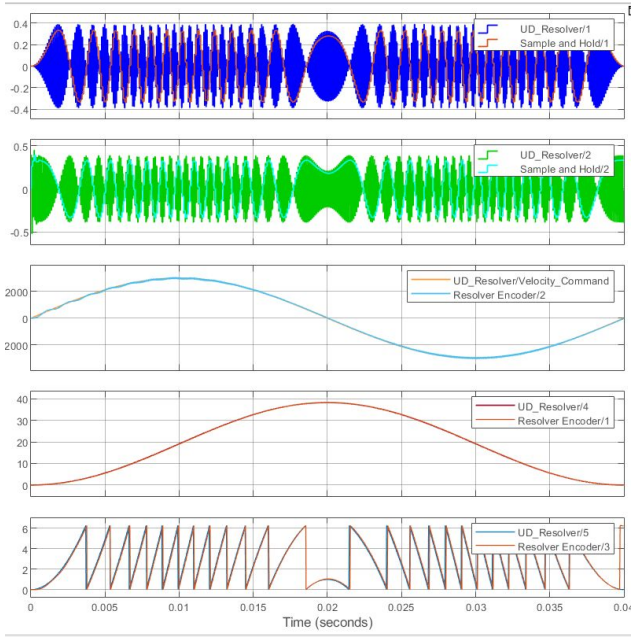


Resolver with Simulink

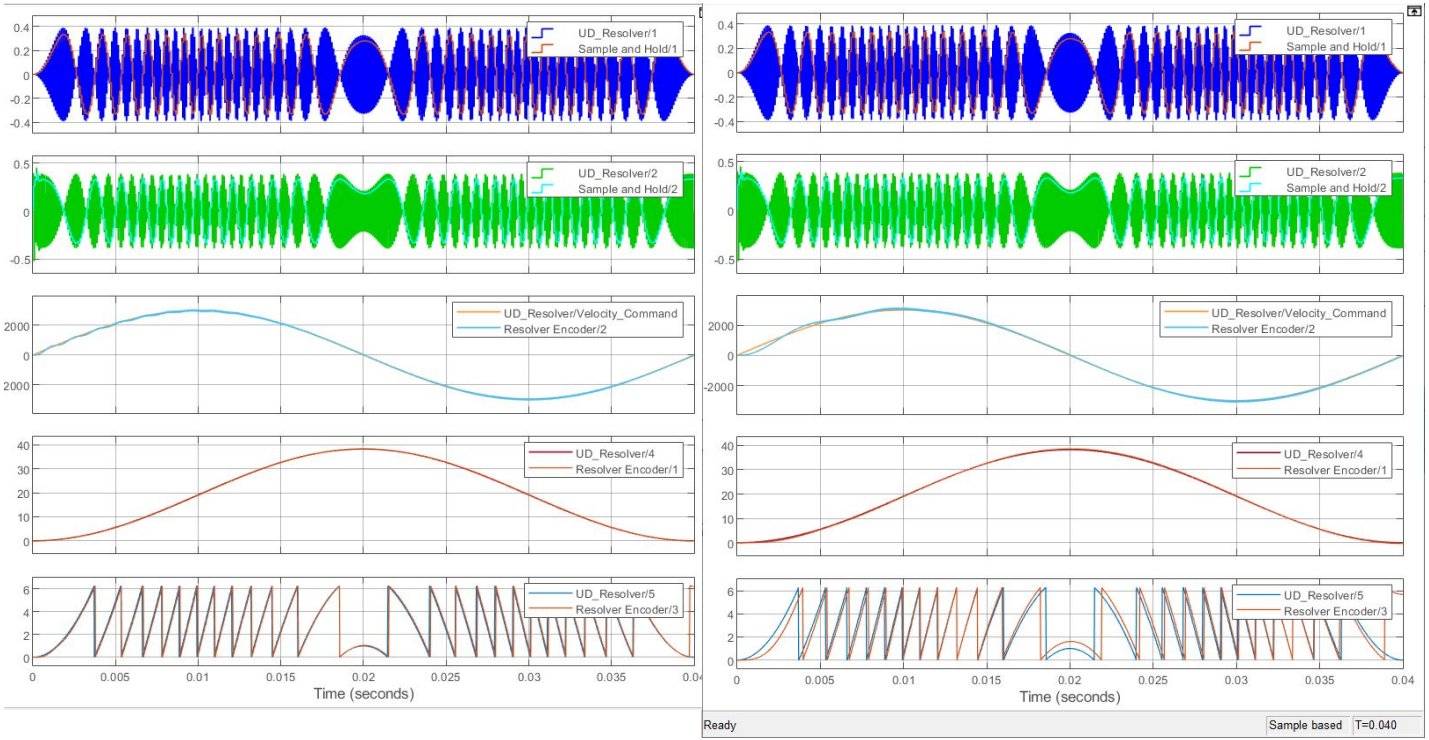


PLL Resolver Encoder with Simulink

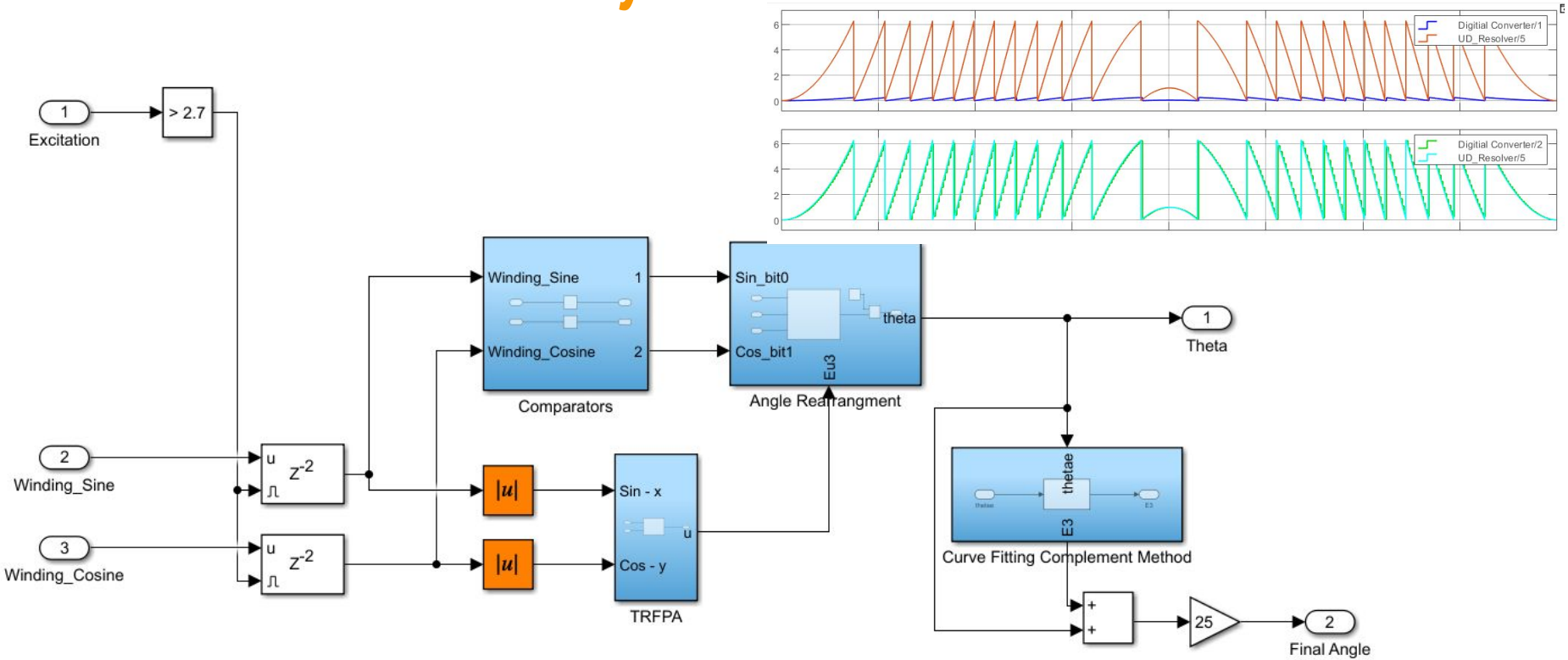




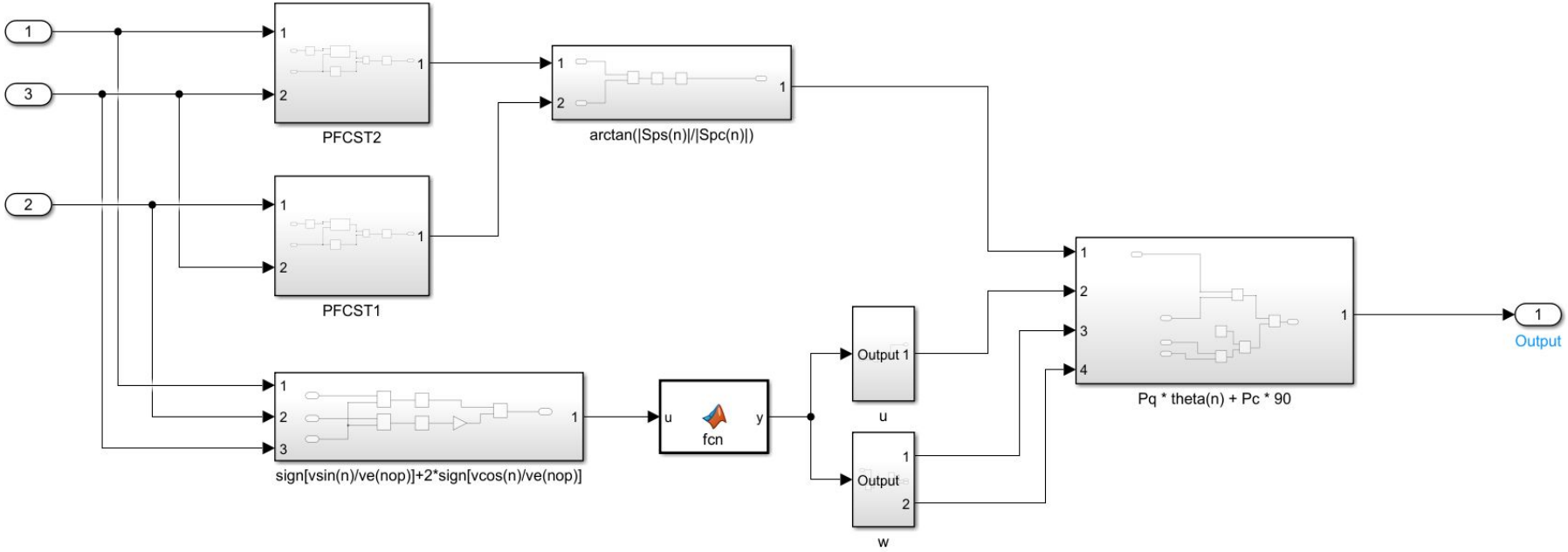
PLL Resolver Encoder with Simulink



Third-Order Ration Polynomial



S-Transform Resolver Encoder with Simulink



How did these help with our project?

Apparatus:

- Gives us a physical model to help us generally understand what the real world application is for this project, and how the work that we're doing in simulink factors into the real application.

Simulink:

- Main thing NG partnered with us to create. Gives us a virtual model that allows us to test and change values without having to adjust anything physically.

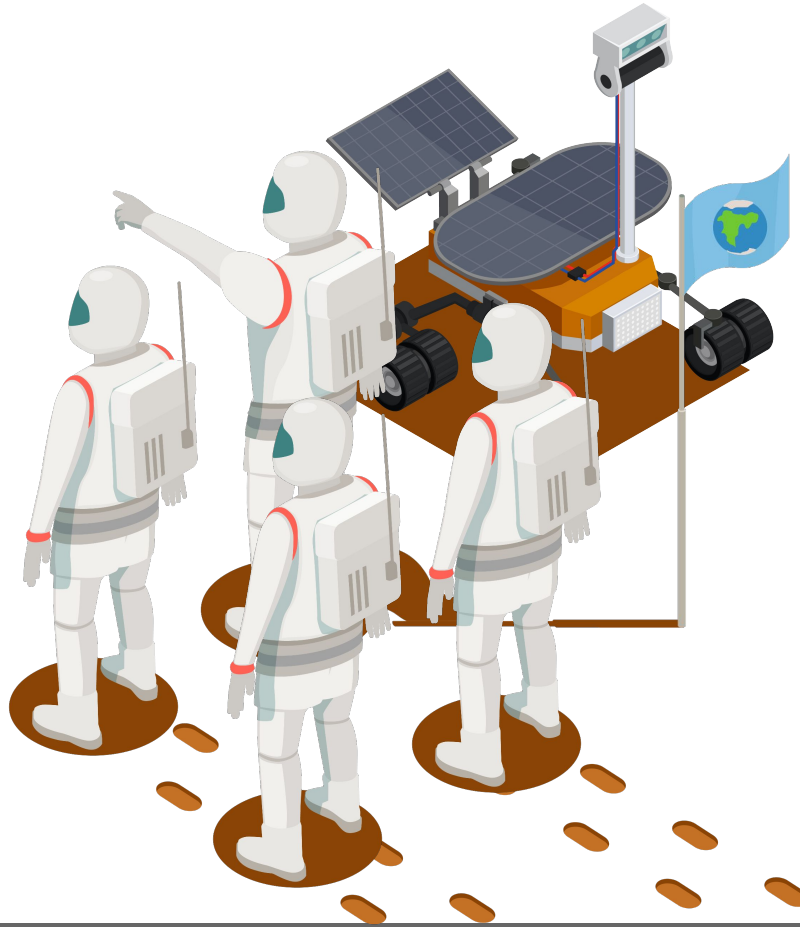
Working with a third party

- Process of getting started on the entire project was slow
    - NDA wasn't signed until the end of the first semester, didn't know what was expected of us, didn't know the scope of the project
- Once regular meeting times were established, ended up getting a lot of work done with the help of NG
    - Utilized research papers given by NG to work on resolver encoder simulations
    - Continued work on physical apparatus
    - Explored neural networks

Where would we go from here?

- Expand the amount of Simulink models
  - 3 models were built and tested for the project, testing more could potentially lead to a better output.
- Continue work on the neural network
  - Neural network was tested, but not one of our goals to complete given by NG. Has the potential to work better than a simulink model, but would need more work and training.

Questions?



NORTHROP GRUMMAN