REEF Subsonic Wind Tunnel Articulating Robotic Arm

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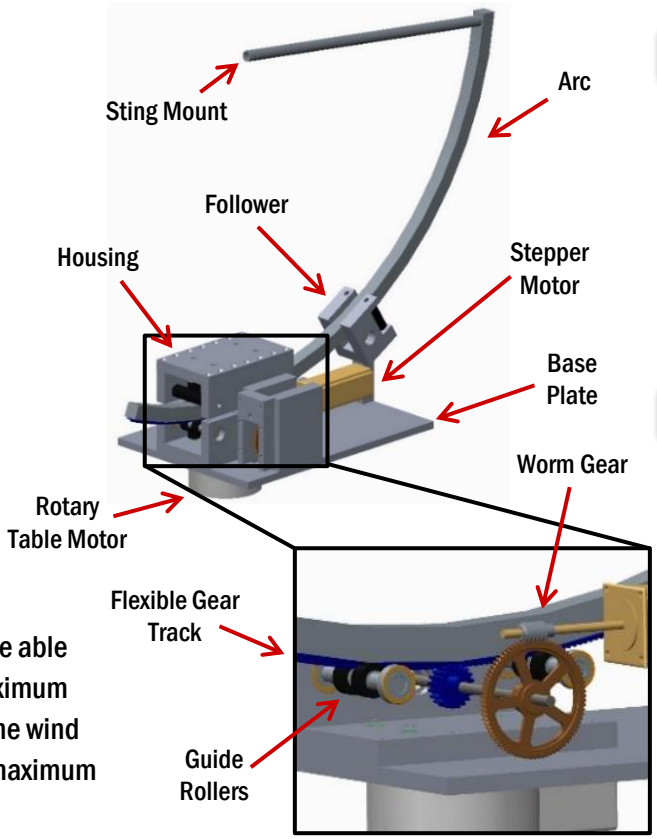
Purpose

Design and produce a cost effective mechanism that can maintain and adjust the orientation of a test specimen in a subsonic wind tunnel.

Background

- A wind tunnel is a research tool used to recreate flight conditions in a controlled environment
- It provides a cost effective method of testing by using models scalable through the use of dimensionless properties



Software

- LabVIEW for user interface
- DMC (Digital Motion Controller) code for motor initialization and commands
- Controller programs written in GalilTools
- Shared library enables software communication

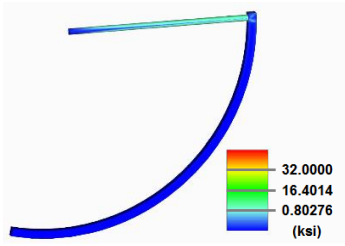
LabVIEW

GalilTools

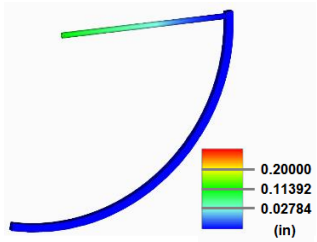
Hardware

- Velmex stepper motor rotary table with magnetic reed homing switch
- Anaheim Nema-23 stepper motor with encoder
- Galil DMC-4040 Motion Controller

Design and Analysis



VonMises Stress Analysis



Displacement Analysis

Objectives:

- The structure must be able to withstand the maximum force generated by the wind tunnel which has a maximum velocity of 22 m/s
- The specimen must remain in the center of flow
- The specimen must have an adjustable angle range of -5° to +20° for pitch and ±10° for yaw

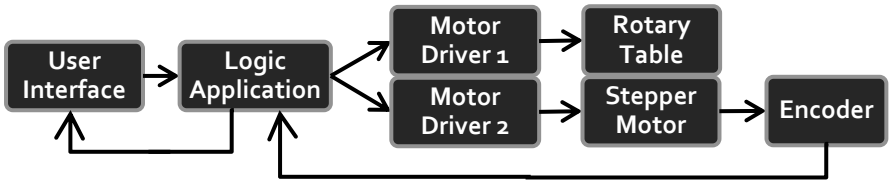
Testing Assumptions:

- Maximum coefficient of drag and lift on arc are CD=1 and CL=2
- Maximum allowable flow blockage is 10%*Tunnel Area
- A multiplier of 1.5 is applied forces to account for unsteady loading
- Testing loads were applied to the end of the sting mount

Design Specifications:

- The arc has a radius of 25in.
- All components excluding gears, rollers, shafts, bolts, and screws are machined from aluminum 6061

System Operational Flow



Future Improvements

- Redesign the base plate with a shaft to fit in the rotary table and add an absolute encoder to the base
- Add a gyroscope (or similar sensor) to the sting for more accurate feedback of actual specimen position
- Incorporate sensors for testing needs in the system and user interface