ROAMX Hover Test and Tensile Pull Test

Report written for the Indiana Space Grant Consortium

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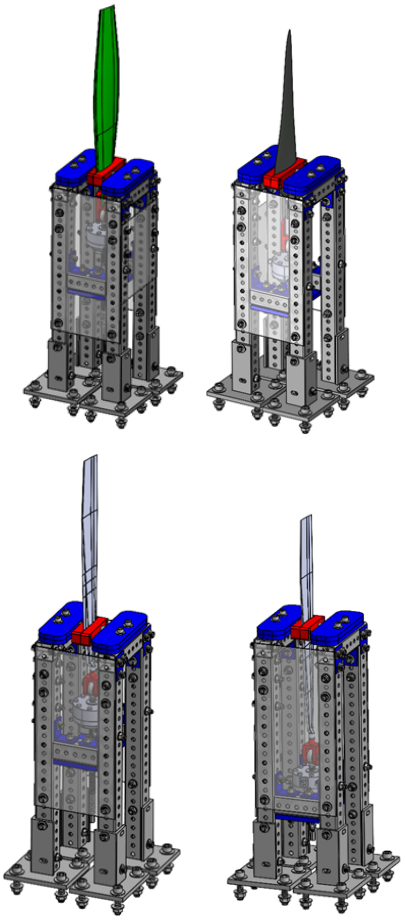
My name is Sajon Seaberg and I am entering my Senior year at Purdue University studying mechanical engineering. This summer I had the opportunity to return to the NASA Ames Research Center in Moffet Field, California. Similar to the Fall of 2022, I once again worked in the Aeromechanics branch under the ROAMX (Rotor Optimization for the Advancement of Mars eXploration) project.

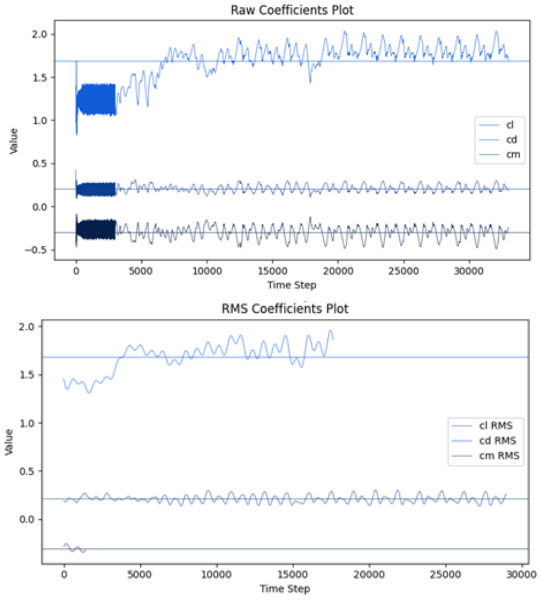
ROAMX seeks to develop new rotor designs to expand current research on high-performance airfoils and blades fit for the Martian atmosphere. With the recent success of the Ingenuity Mars Helicopter, there has been significant interest from the scientific community to develop more capable rotorcraft.

As part of the ROAMX team this summer, significant work was conducted on static tensile pulls for ROAMX, Ingenuity, and Mars Science Helicopter blades. Additionally, I researched and tested methods to optimize Computational Fluid Dynamics (CFD) result generation. Lastly, I designed testing equipment and a calibration stand for the hover test to be conducted in the Planetary Aeolian Laboratory (PAL).

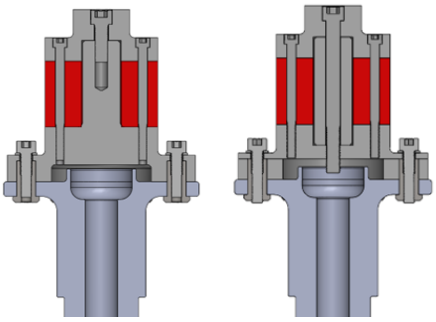
The tensile pull tests are designed to apply a tensile load to a blade, assessing the risk of failure from centrifugal (CF) loading. Due to the reduced density of the Martian atmosphere, rotor blades must spin at a much faster RPM to generate enough lift. Additionally, for the same RPM on Mars and Earth, the tip Mach number is higher on Mars. Therefore, centrifugal or tensile loading is the primary failure mode of concern. The final test stand designs created are shown below.



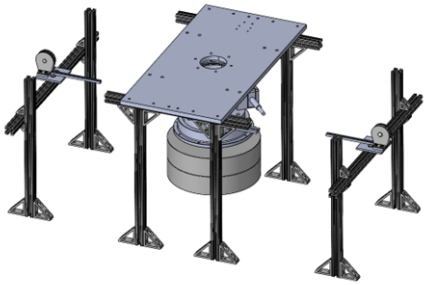
The research conducted on CFD advancements was conducted to increase the efficiency of CFD results produced. Since the team is investigating unconventional airfoils, results from analysis are typically unsteady. My work investigated denoising algorithms and developed methods to optimize results and reduce the time to produce aerodynamic values. An example set of data is below showing raw data and post-processed data.

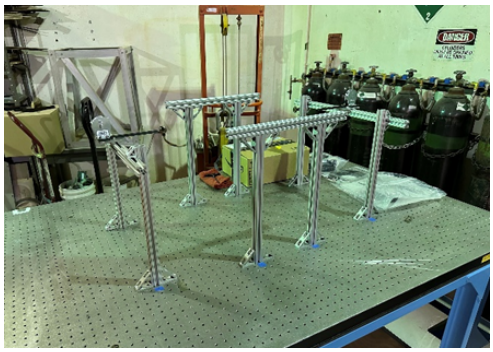


Additionally, I designed, analyzed, and conducted a trade study for a hub adapter to interface the ROAMX hover stand with previously tested blades. This will allow the team to compare previously retrieved data with new data to establish a benchmark for data acquisition. Below is a sub-assembly highlighting the two final adapter hub options from the trade study.

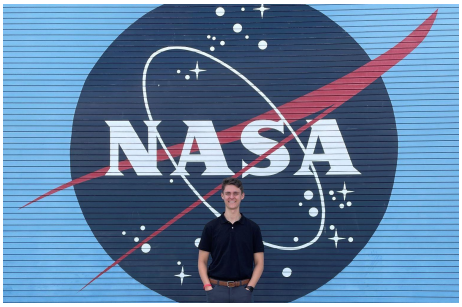


Lastly, a calibration stand was created for sensors that will be integrated into the ROAMX hover test stand. The hardware needs to meet the standards of our test to generate data conforming to our specifications and tolerances. Below is the design and assembled stand in the PAL.





I joined an incredibly welcoming group and was given ample opportunity to learn and develop my professional and technical abilities. From having my own intern to exploring future Mars mission directorates, I have been inspired to continue pursuing these opportunities.



I'd like to thank the Indiana Space Grant Consortium for once again funding my internship experience and allowing me to have an extraordinary experience. It has truly been a dream come true to dive deep into world-class research.