CubeSat Wildfire Prevention

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Project Background and Objective

In recent years wildfires in California have been increasing at an alarming rate. Current preventions do not mitigate the problem enough. Fire prediction will help decrease the number of acres burned each year. Our project objective is to design and analyze a 3U CubeSat for the purpose of detecting hot and dry zones that pose a wildfire risk. The CubeSat must meet launch provider and NASA requirements such as Mission-Specific Interface Control Documents, Launch Services Program, CubeSat Design Specifications, Dispenser Standard Specifications, Federal Statutes, Range Safety Requirements, and more.

System-Level Requirements

Structural Requirement	
Stress	The stress of the CubeSat can not exceed the yield strength of Aluminum 6061 T6 (259MPa)
Displacement	Displacement must be less than 1mm
Natural Frequency	First Natural frequency must be greater than 100hz along the axial and lateral direction

General Requirement	
Mass	1.33 kg per U
Temperature	-40°C to 85°C
Size	10cm x 10cm x 10cm per U
Input Power	6.9W per panel

Results

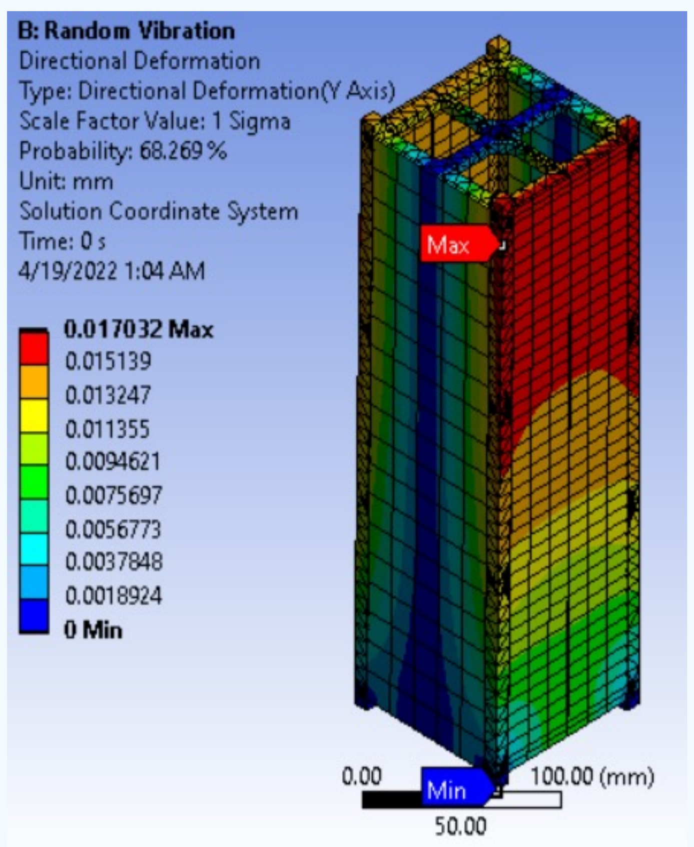


Figure 5: Total Deformation Random Vibration Ansys Model

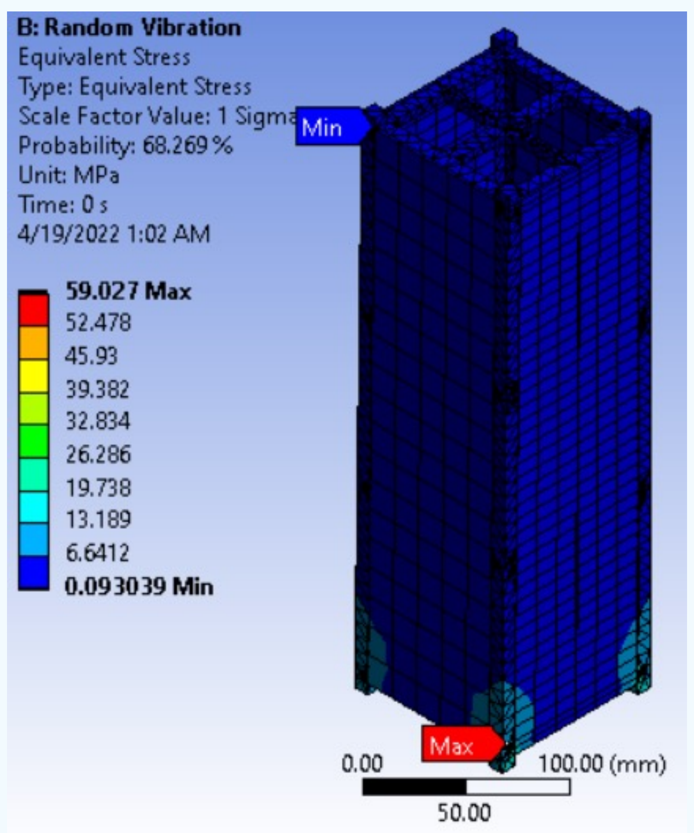


Figure 6: Equivalent Stress Random Vibration Ansys Model

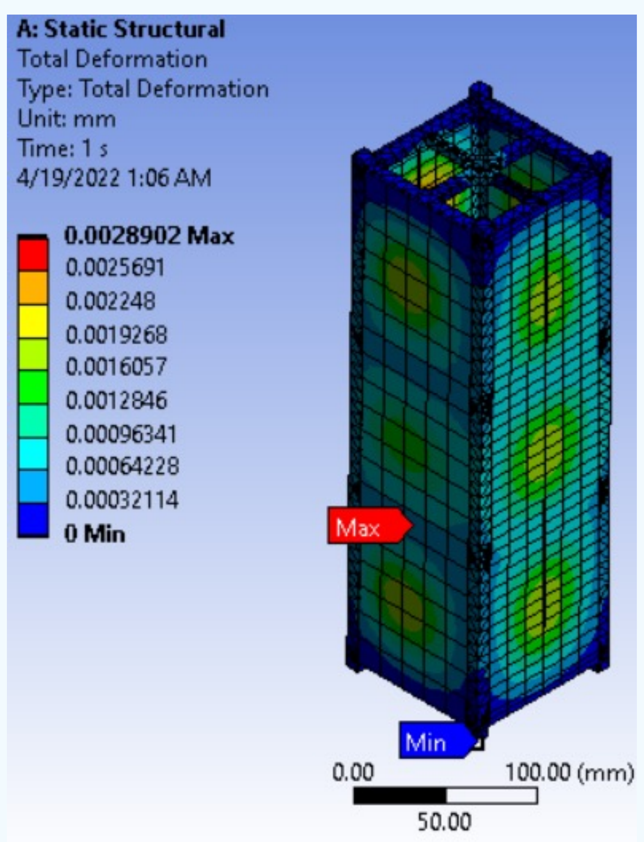


Figure 7: Total Deformation Quasi-Static Ansys Model

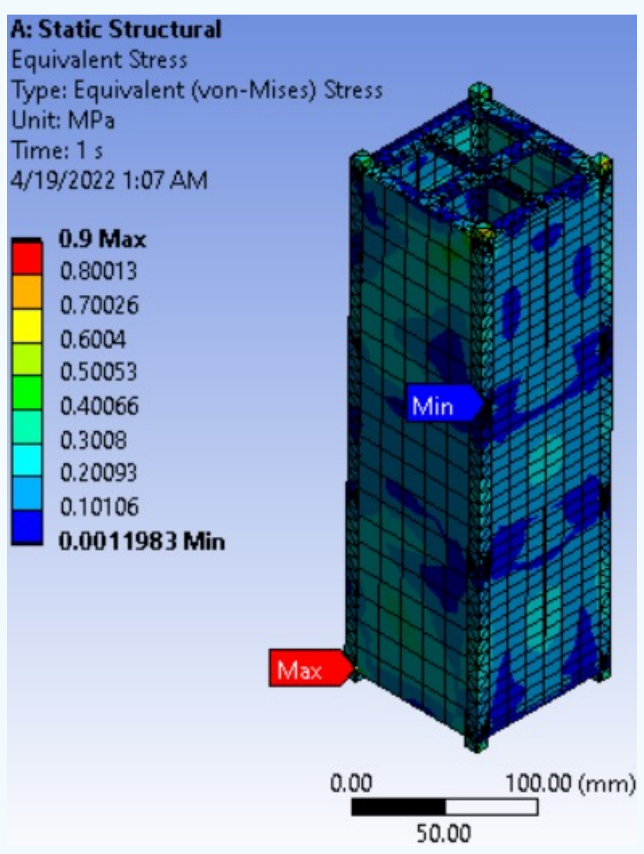


Figure 8: Equivalent Stress Quasi-Static Ansys Model

Parameters	Quasi-Static Analysis	Random Vibration Analysis
Maximum Von Mises stress (Mpa)	.9	59
Maximum Displacement (mm)	.003	.017

Overall Design Approach

The first task of the design process was to research and build off the CubeSat design specification. Initially, a solid structure was made that fit the CubeSat specification, and it was broken down in a manner that was more practical to manufacture. Then, the structure was put through FEA to reduce the weight of the structure and meet all the thermal requirements. and a prototype of the deployed solar panel system was designed. Lastly, a sketch for the deployable solar panel setup was integrated with the design

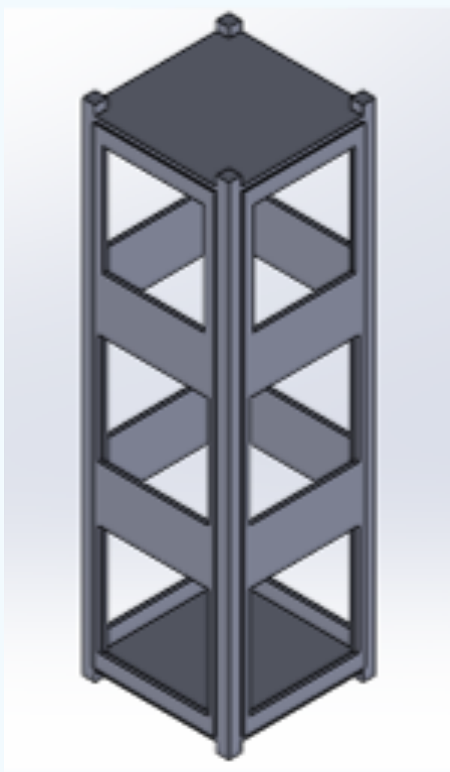


Figure 1: Stage 1 Design

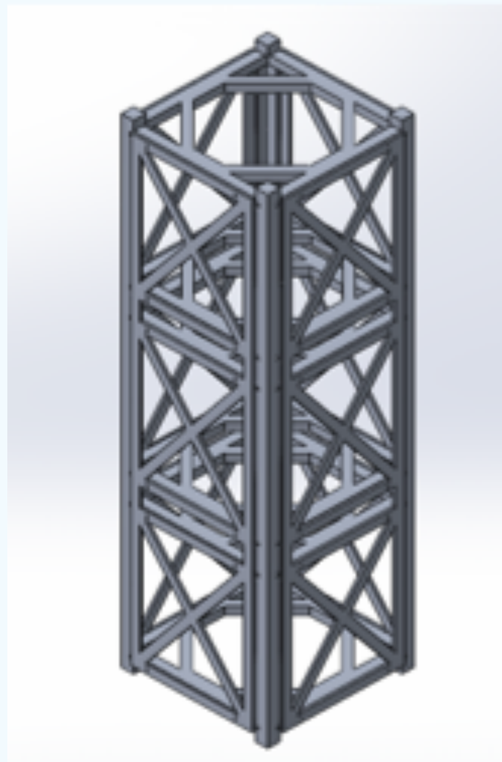
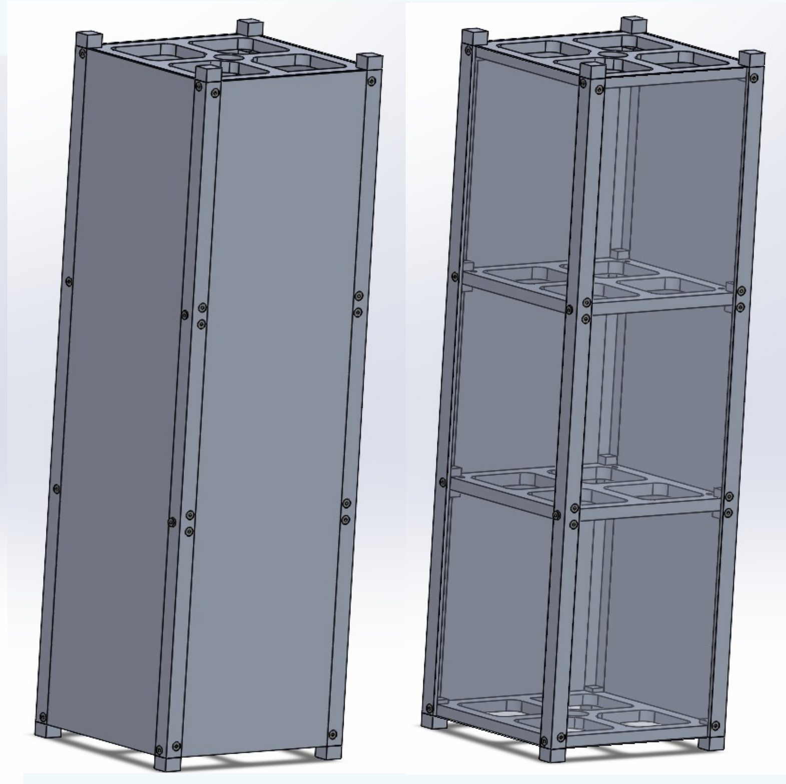


Figure 2: Stage 2 Design



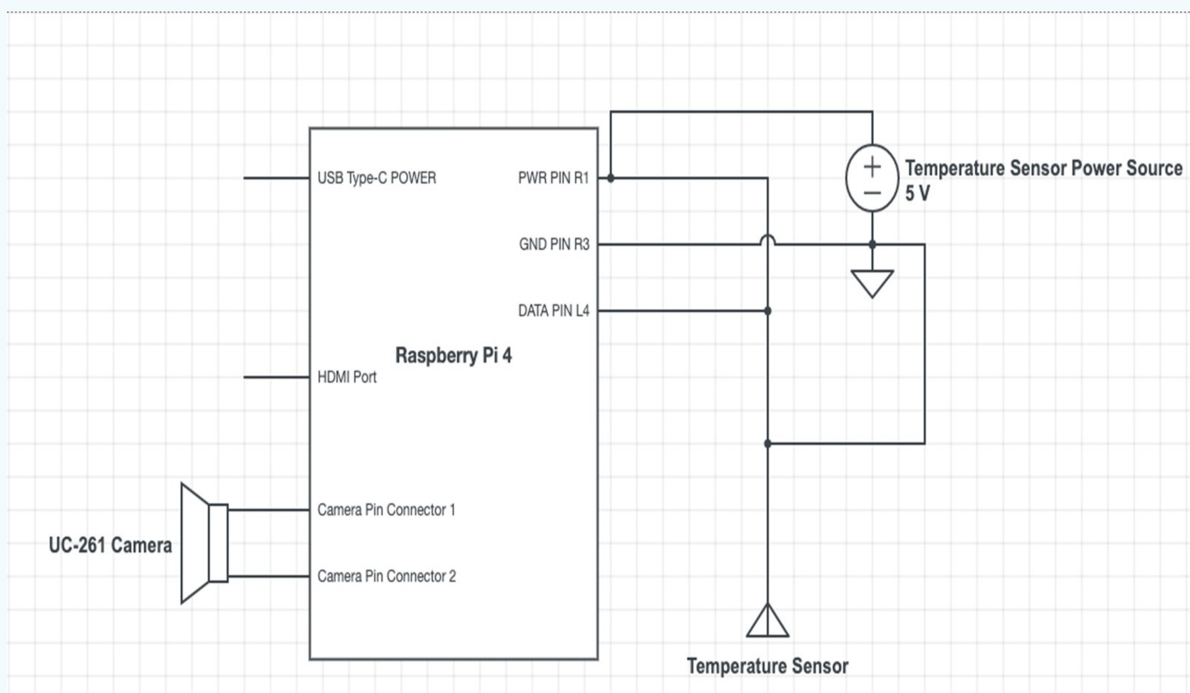


Figure 4: Raspberry Pi/Camera Block Design

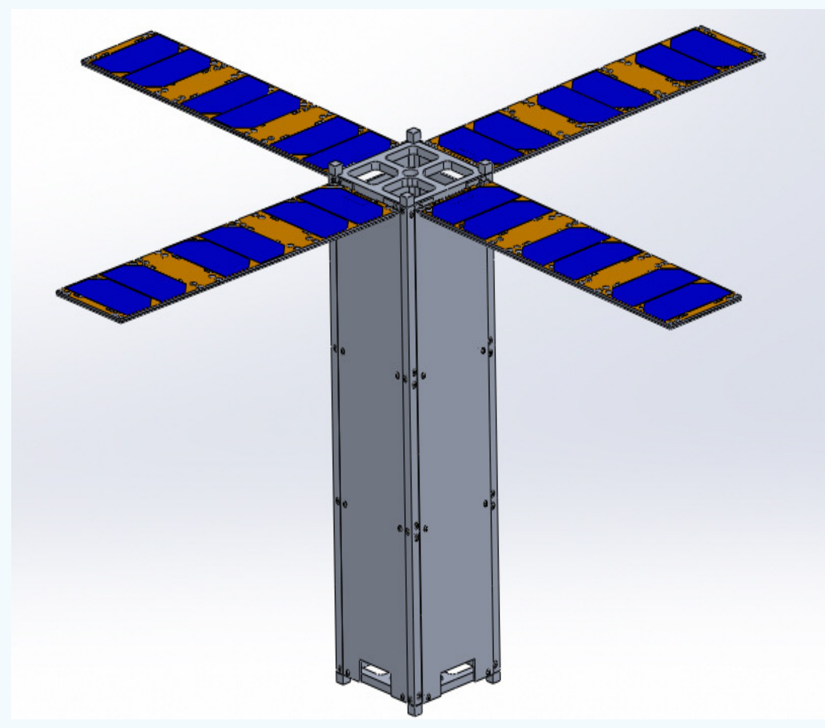


Figure 3: Stage 3 Final Design

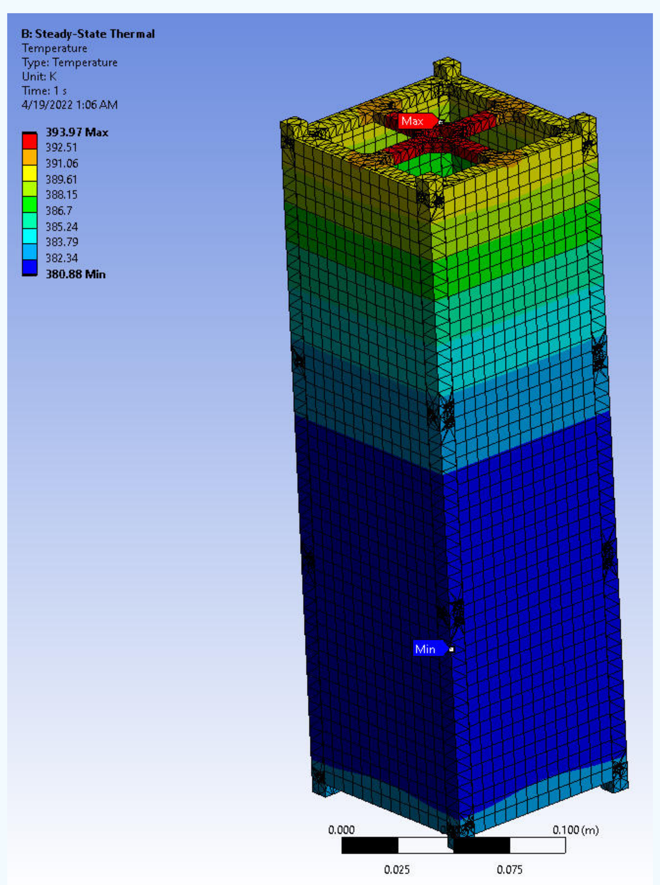


Figure 9: Steady State Thermal Ansys Model

Major Conclusions/Findings

Due to the power system having a 13.4-hour active lifetime per day, conserving energy where there is a low wildfire risk will be implemented. Static Structural and Random Vibration analysis proved that the designed CubeSat could withstand the acceleration loading and random vibrations due to launching loads. The maximum determined stress in either analysis is significantly smaller than the yield strength of 259 MPa of the Aluminum 6061 T6. From the modal analysis, the first natural frequency passed the requirement of being greater than 100hz in both the longitudinal and longitudinal directions ensuring no resonance occurs. Major locations to place the MLI insulation will be the top/bottom plate and corners of the CubeSat. Overall, the designed CubeSat can withstand the launching loads making the design suitable for launch.

Temperature Distribution: 381 K ≤ T ≤ 394 K	
Conditions In Orbit	
Emissivity of Al 6061-T6	0.1
Ambient Temperature (Kelvin)	3
Solar Flux ($\frac{W}{m^2}$)	1394.76
Albedo Flux ($\frac{W}{m^2}$)	410.1
Planetary Flux ($\frac{W}{m^2}$)	239.22