# In-Space Robotics Assembly Infrastructure Development

## 2021 Engineering Design Project: ME 4015-4016

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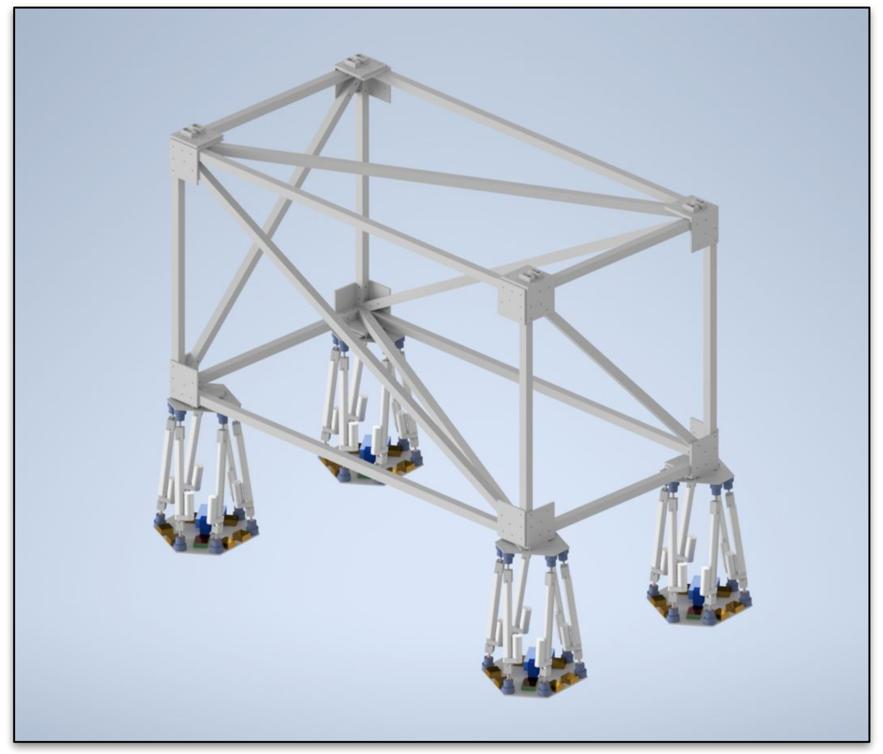
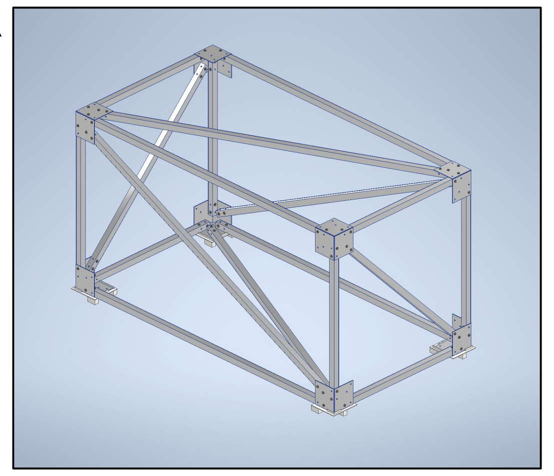
## Problem Statement

Design and construct 4 parallel robots with 6 degrees of freedom that will be used for the construction of an original truss infrastructure design that could be assembled and used on non-uniform Lunar or Martian environments.



## Infrastructure Design Data

The truss assembly measures one meter tall by two meters long. Trusses are versatile and robust structures with countless applications making them useful for Lunar and Martian construction.



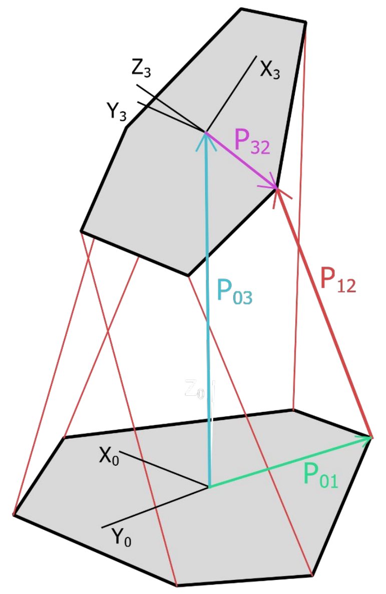
Full CAD assembly of the infrastructural truss

Finished infrastructure truss loaded with potential external applications

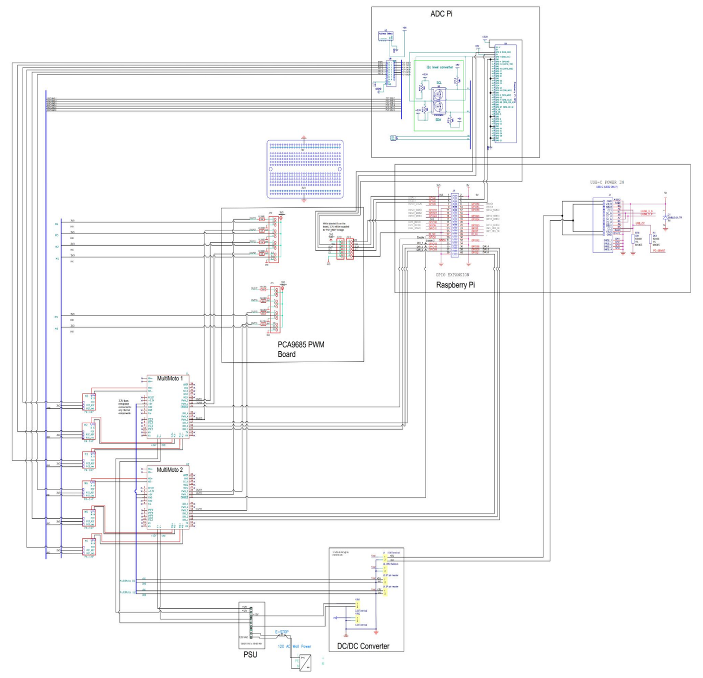
## Stewart Platform Design Data

Stewart platform CAD model

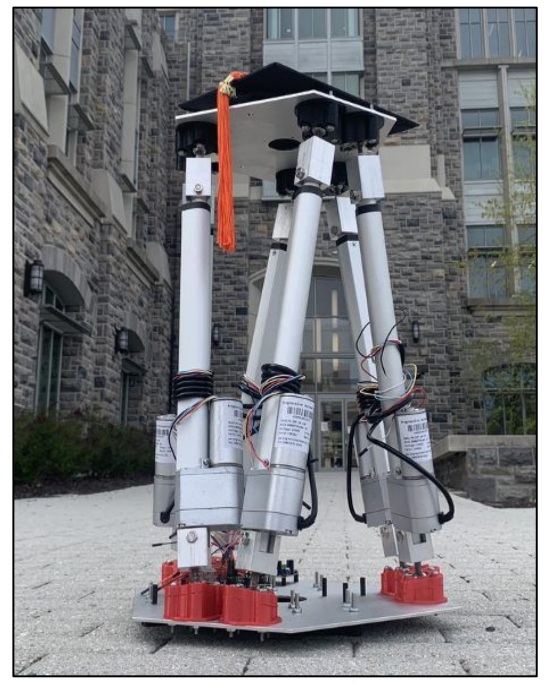
Mathematical model used for inverse kinematics




- Move in six degrees of freedom
- Parallel design is geometrically strong and moves with precision during intricate tasks
- Consists of six linear actuators attached to two plates
- Additional end-effector can be added based on task at hand and mission requirements
- Can be stacked on top of each other
- Capable of working in coordination with each other and additional robots to accomplish complex tasks



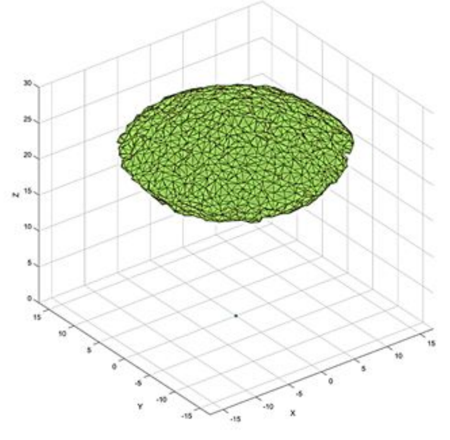
Full wiring diagram



Finished Stewart platform

## Stewart Platform Evaluation

- Exceeds range of motion targets with a translation of 10” in all dimensions and rotation of at least 48° about all axes
- Requires further testing of angular/linear precision
  - Model error will need to be evaluated
- Exceeds lifting force target of 34 lbs
- Ball Joints, most vulnerable part, can withstand maximum loading conditions of 200 lbs
- Weight below target at 22 lbs
- Stands 21.625” fully retracted and 32” fully extended



Theoretical workspace of Stewart platform (when level)

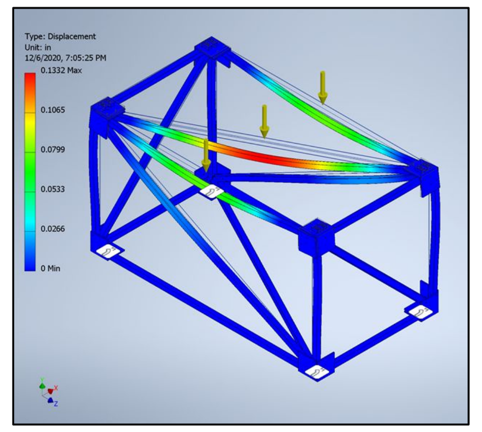
Rotation range measured with a digital angle meter

Two stewart platforms stacked on top of each other

Lifting force exceeds 140 lbs in pure vertical movement

## Infrastructure Evaluation

- Supports a load of 500 pounds, exceeding the ideal specification
- Designed to be assembled autonomously on the Lunar or Martian surface
- Capable of supporting solar arrays, satellite dishes, communication antennas
- Light enough for individual bays to be manipulated robotically



## Self Assessment of Design and Future Work

- Stewart platform met and exceeded all but one target specification
- Global camera tracking system used in the future to optimize movement precision and reduce model error
- Add internal computer vision to improve precision and autonomous stacking capability
- Needs an algorithm for pure Z-axis rotation
- Develop a server system to communicate with all four stewart platforms