Active Reflector Surface Shaping

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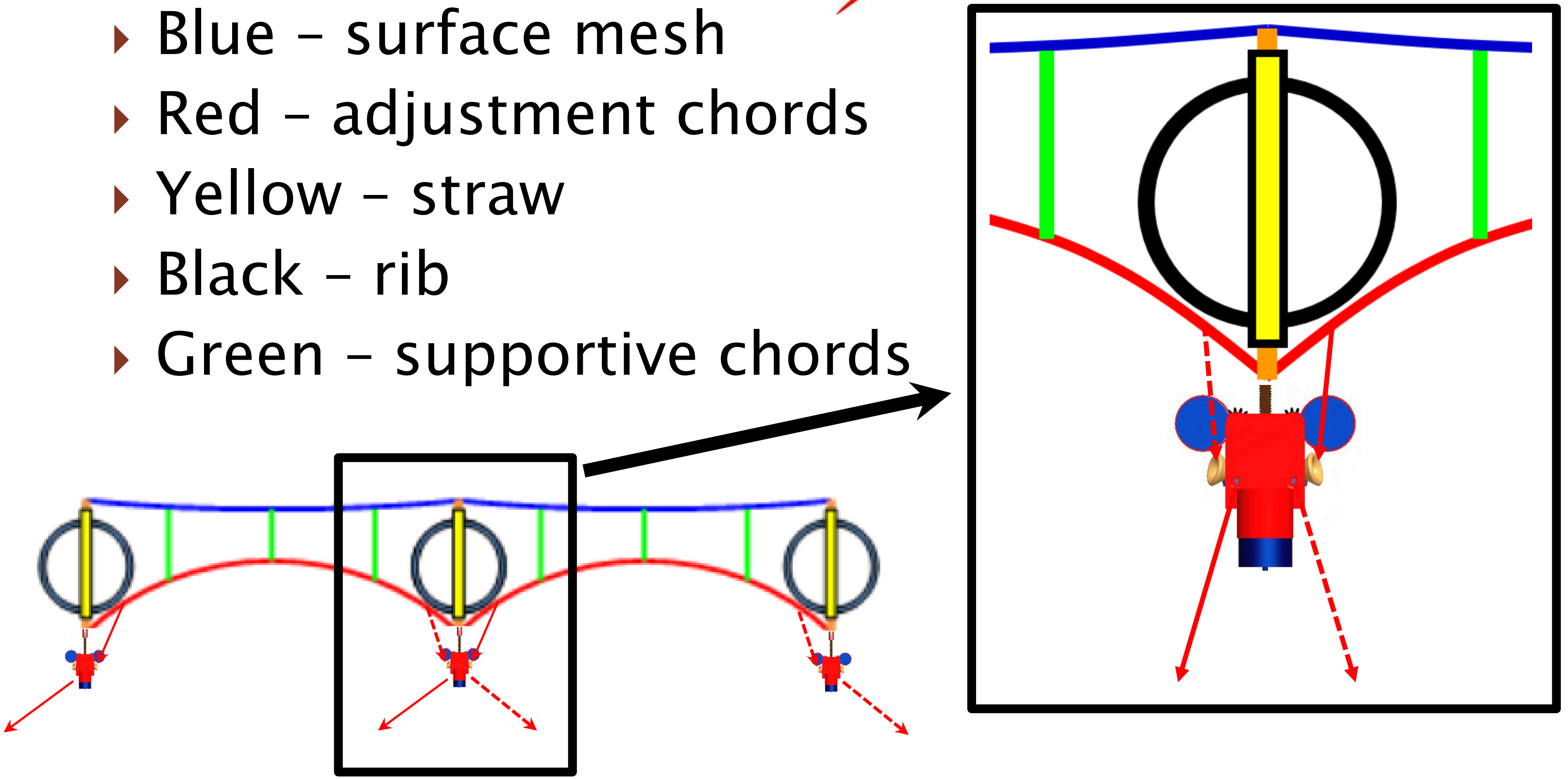
Background

- Mesh reflectors
  - Pull chords and straws to adjust shape
  - 8 ribs, 17 per each rib, 136 total adjustment points

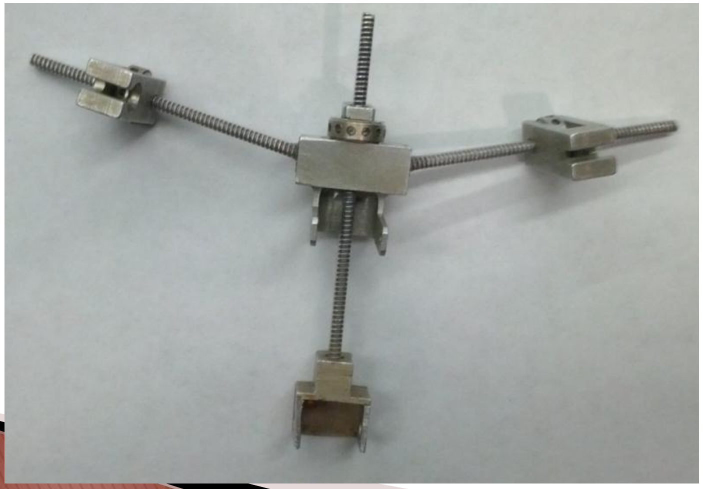
Chord Configuration

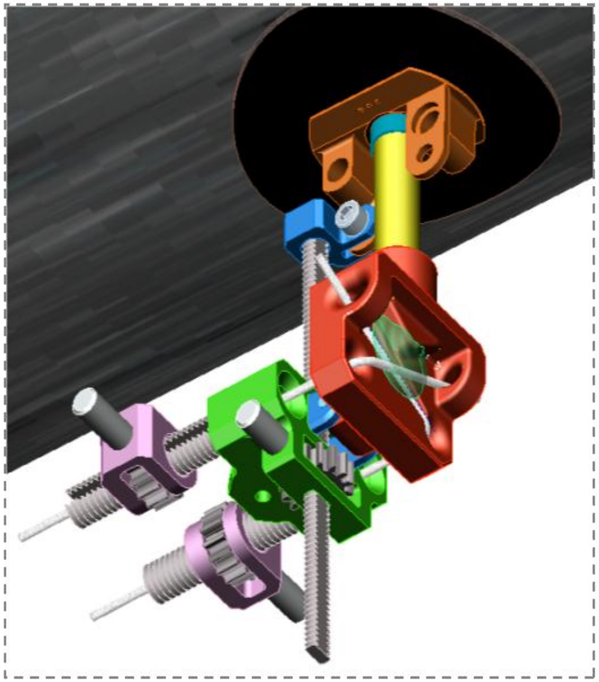
- Blue – surface mesh
- Red – adjustment chords
- Yellow – straw
- Black – rib
- Green – supportive chords



Previous Mechanisms

- Manual adjustment mechanisms
  - Time consuming
  - Motors would be non-stationary
- Angled to parallel pull configuration
  - Interference with adjacent components when stowed
  - Independent of chord pull angle





Customer Needs

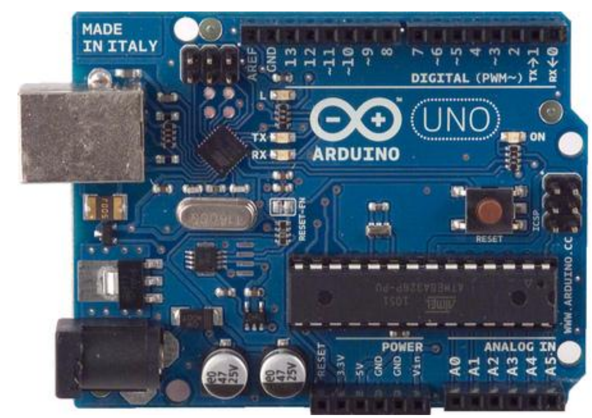
- Main Goal:
  - Build one automated high precision adjustment mechanism
  - Tabletop visual demonstration
  - Ability to measure accurate displacement
  - Lightweight as possible
  - Minimal cost, preferably under $800 per unit
- Secondary Goals (if weight allows):
  - Wireless system
  - Integrated power supply

Constraints

- Budget of total project: approximately $2,500
- Lightweight as possible, preferably under 80 grams
- Linear resolution 0.001" = 0.0254mm
- Total linear range of ±0.100" = ±2.54mm
- Life of 10,000 linear inches = 254m

Componentry

- 3 - Micro stepper motors
- Microcontroller (possibly Arduino Uno)
- 3 - Linear Variable Diff. Transformer (LVDT)
- Computer interface
- Power supply (integrated if weight allows)
- Wireless (budget/weight tolerance permitting)



Bill of Materials

Component	Purpose	Weight	Cost
Arduino Uno	Microcontroller	30g	29.99
Arduino Wifi Shield	Wireless Control	36g	83.99
Al6061 Body	Assembly body	23.42g	N/A
ABS plastic body	Assembly body	12.6g	N/A
Faulhaber AM1524 Motor x 3	Stepper motor	36g	360
400mAh Lithium polymer ion	Integrated power supply	9g	7.95
Total with Uno and Wifi			482.00
Al6061 body ABS body		134.42g 123.6g	←

Torque Requirements

$$T_{raise} = \frac{Fd_m}{2}\left(\frac{l + \pi\mu d_m}{\pi d_m - \mu l}\right) = 4.23\text{mN} * \text{m}$$

d_m = mean diameter
μ = coefficient of friction
l = lead = #of Starts * Pitch
Pitch=1/threads per inch

$$\text{T} = \text{kFd} = 5.06\text{mN} * \text{m}$$

k = fitting factor

Motor Selection

Faulhaber AM1524 motor

- Micro stepper motor
- Weight – 12 grams
- Rated torque is 6 mN*m
- $120 each after university discount
- Encoder not utilized due to weight constraints and radar scan monitoring

Linear Resolution

$$Required\ step\ angle\ from\ motor\ to\ obtain\ .001"\ resolution:$$

$$\frac{0.025"}{360deg} = \frac{0.001"}{x} \Rightarrow x = 14.4°$$

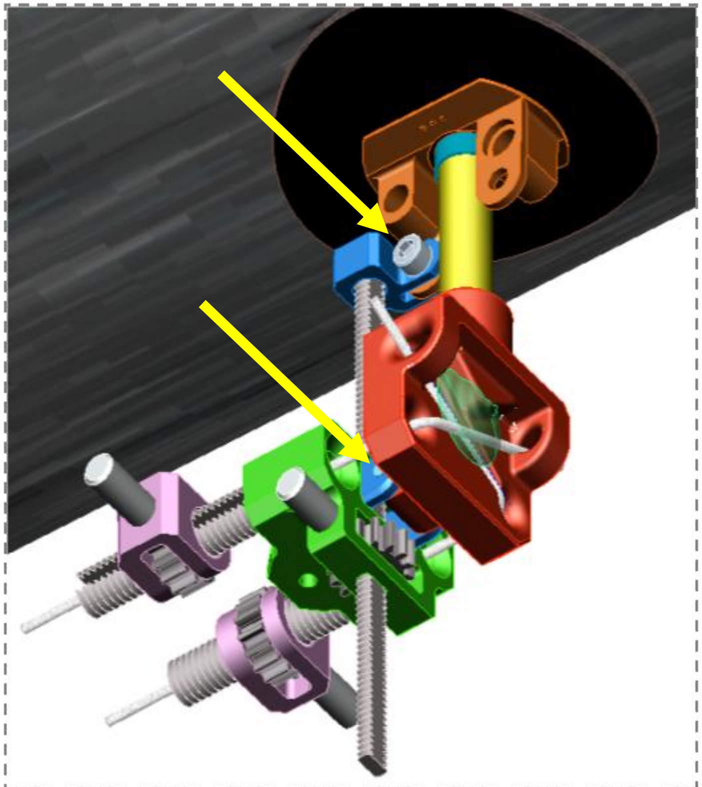
$$Actual\ step\ from\ Faulhaber\ AM1524\ motor:$$

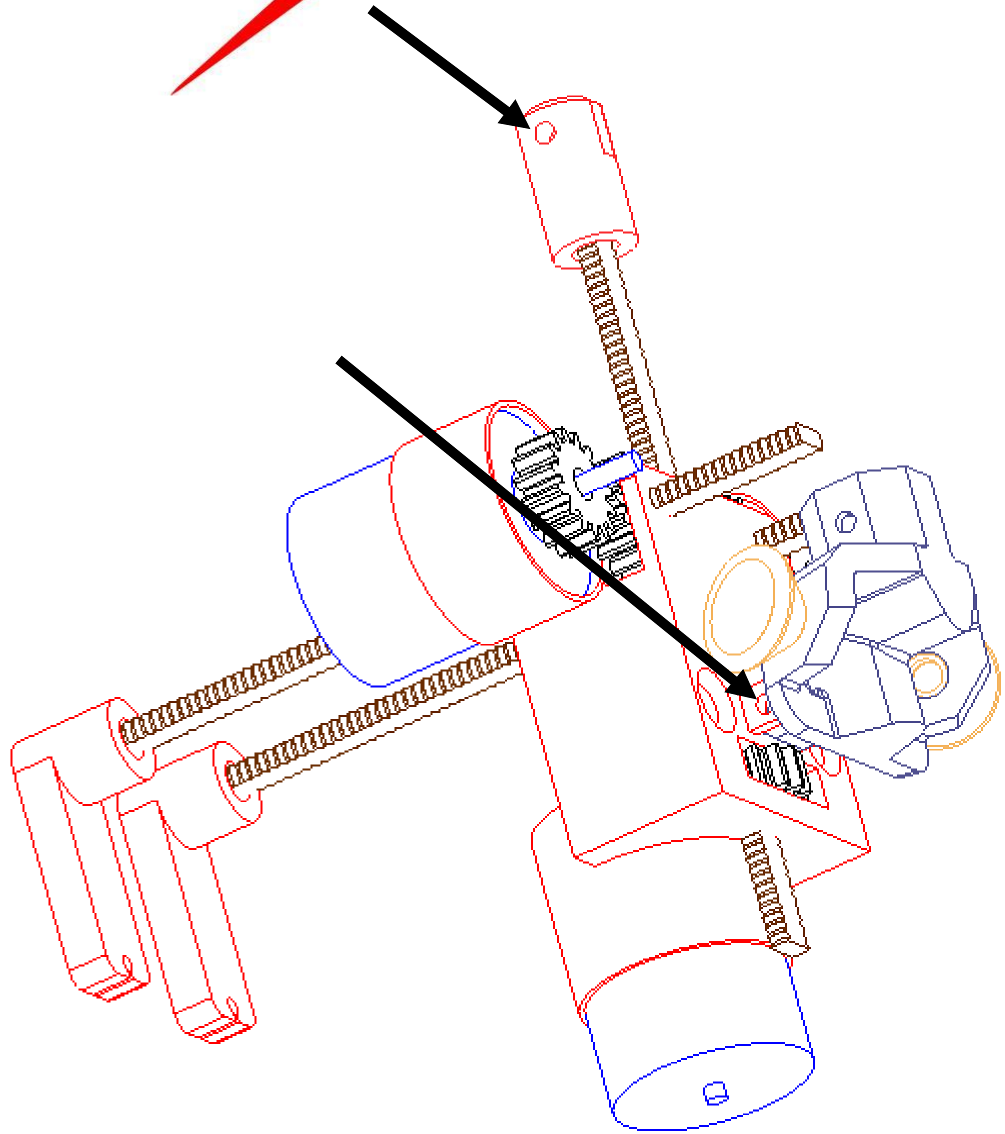
$$\frac{0.025"}{360°} = \frac{x}{15°} \Rightarrow x = 0.00104"\ linear\ resolution$$

$$Using\ 2:1\ gear\ ratio:$$

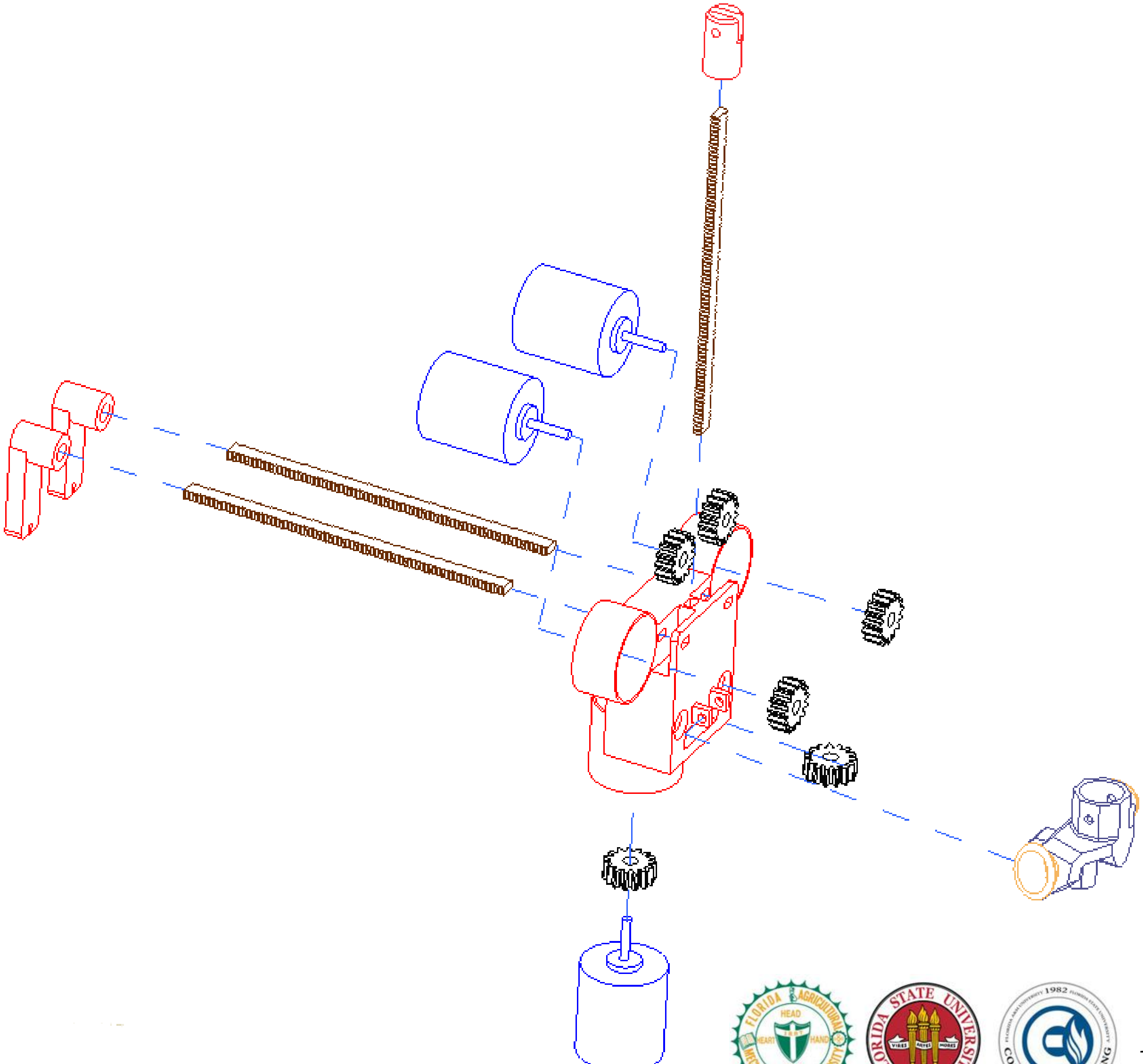
$$\frac{0.025"}{360°} = \frac{x}{7.5°} \Rightarrow \mathrm{x} = 0.000521\text{” linear resolution}$$

Stationary Motor Design

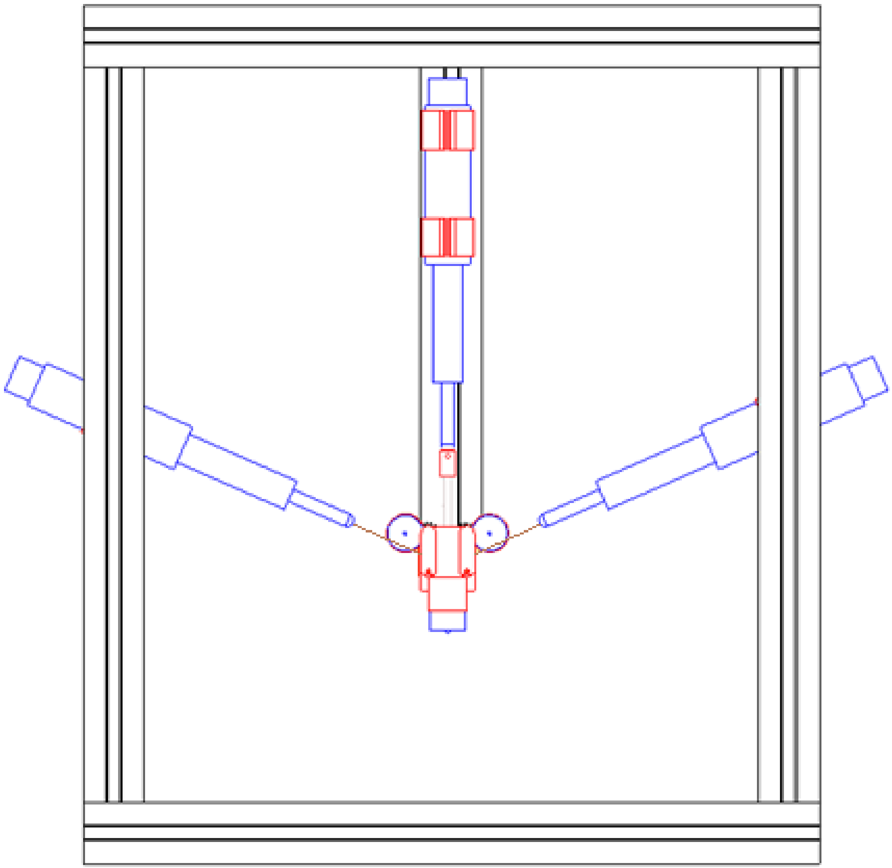


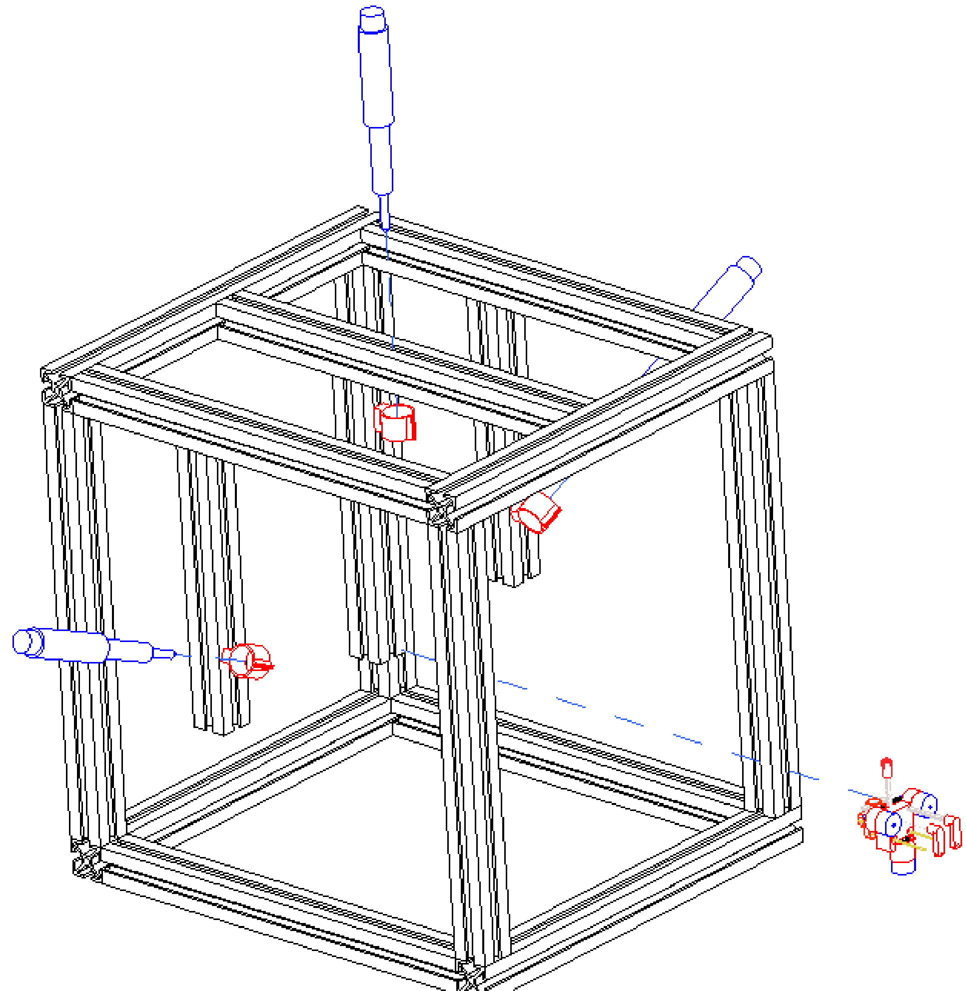


Exploded View



Visual Demonstration





Moving Forward

- Finalize electrical and control components
- Order hardware
  - Stepper motors
  - Microcontroller
  - LVDTs
  - 80/20 Structure material
  - Gears – Exploring delrin (decreased friction)
- Rapid prototype structural components
- Visit Harris Corp. facilities in Melbourne, FL

Q & A

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References

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