Ping Pong Robot

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Utah Valley University Mechanical Engineering Capstone

UVU MECHANICAL ENGINEERING
UTAH VALLEY UNIVERSITY

Purpose

To design, manufacture, assemble, and program an autonomous ping pong robot.

Customer Needs

By meeting with UVU faculty and the Provo Canyon Ping Pong Club the customer needs were defined, and metrics were set to guide the design process.

- The robot must be able to reach any point on its side of the table and return a hit.
- The robot must be modular to facilitate easy assembly and disassembly.
- The robot must be scalable. Improvements to the robot can be added by future Capstone teams.

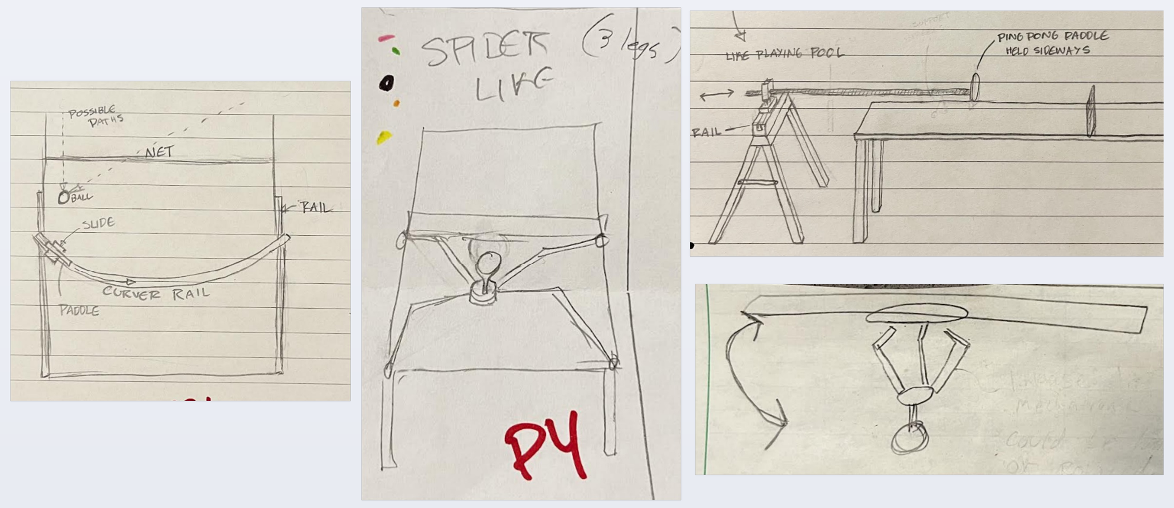
Metrics

The customer needs were then converted into quantifiable performance metrics.

Metric	Units	Goal
Image Processing Time	s	0.1
Mechanical Settling Time	s	0.5
XYZ Paddle Coverage	ft*ft*ft	6*5*1.5
X Speed	ft/s	6
Y Speed	ft/s	5
Z Speed	ft/s	1.5

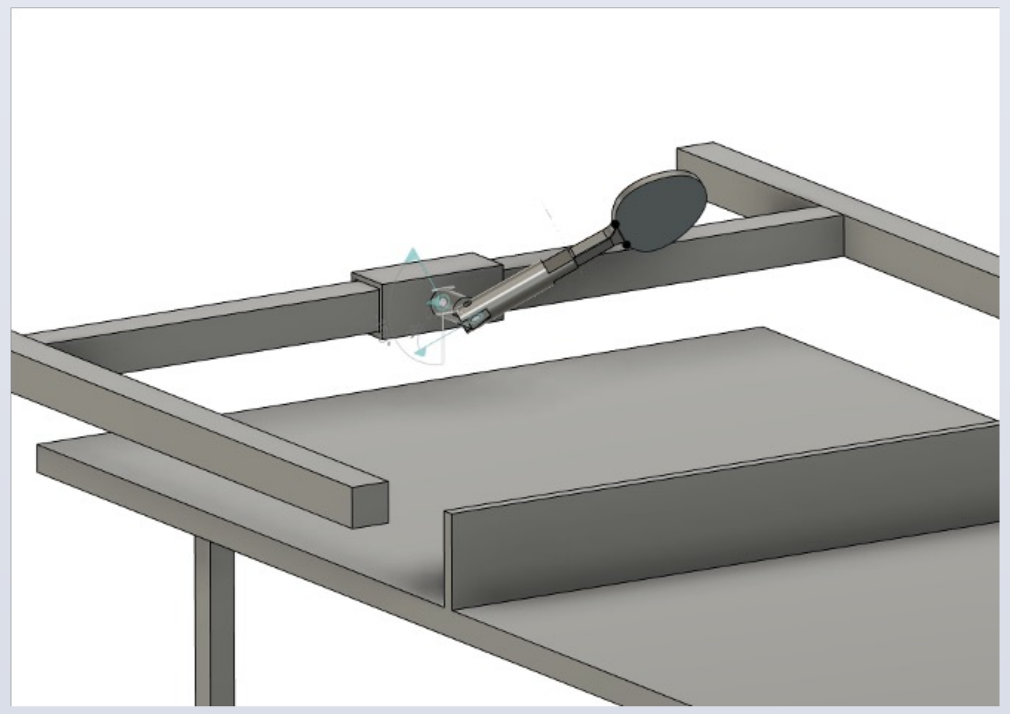
Concept Generation

100+ unique concepts were created using a variety of methods. Gradually these were ranked and eliminated leaving the most viable designs for prototyping.



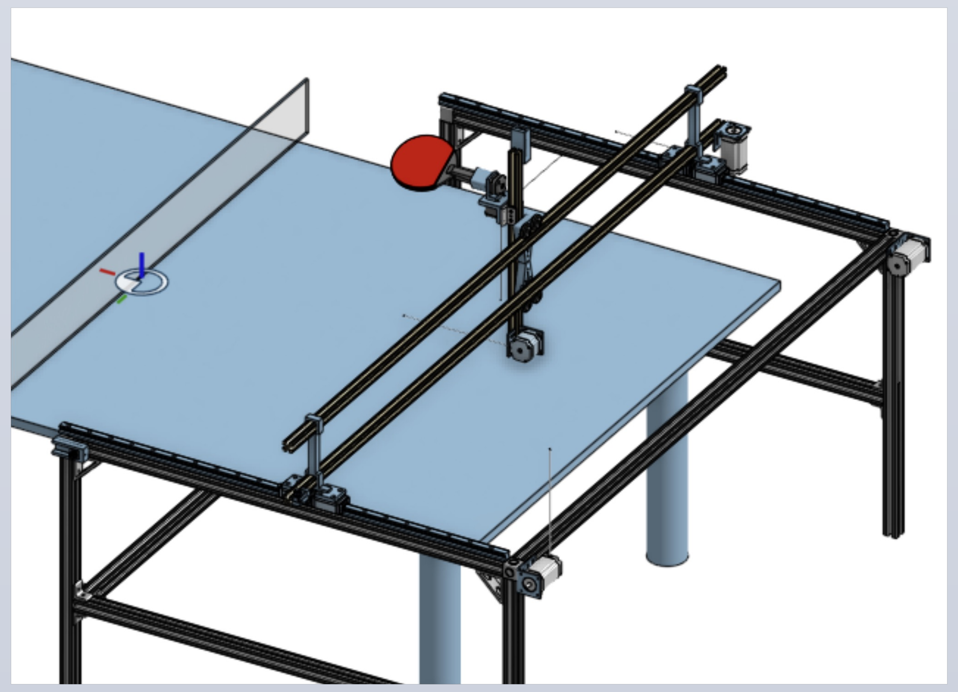
Potential concept designs, from left to right: Curved wall paddle, Spider robot, Jousting paddle, Parallel robot.

Below, Gantry Robot is our final design due to its stability and adequate speeds.



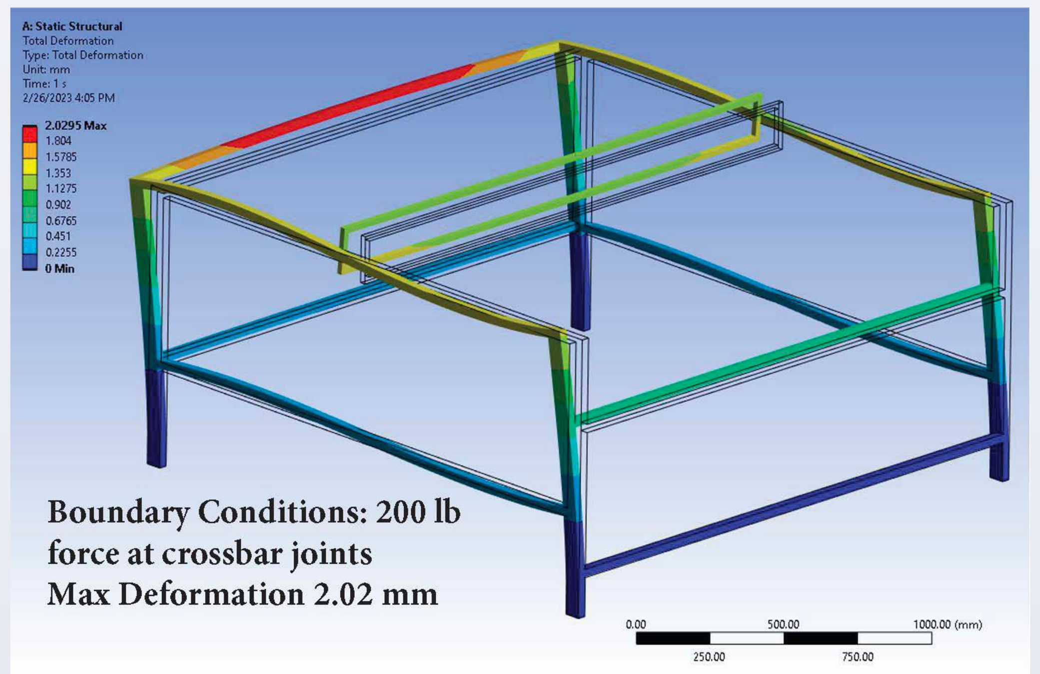
Prototypes

3D models were created to facilitate prototyping and allow for finite element analysis.



Finite Element Analysis

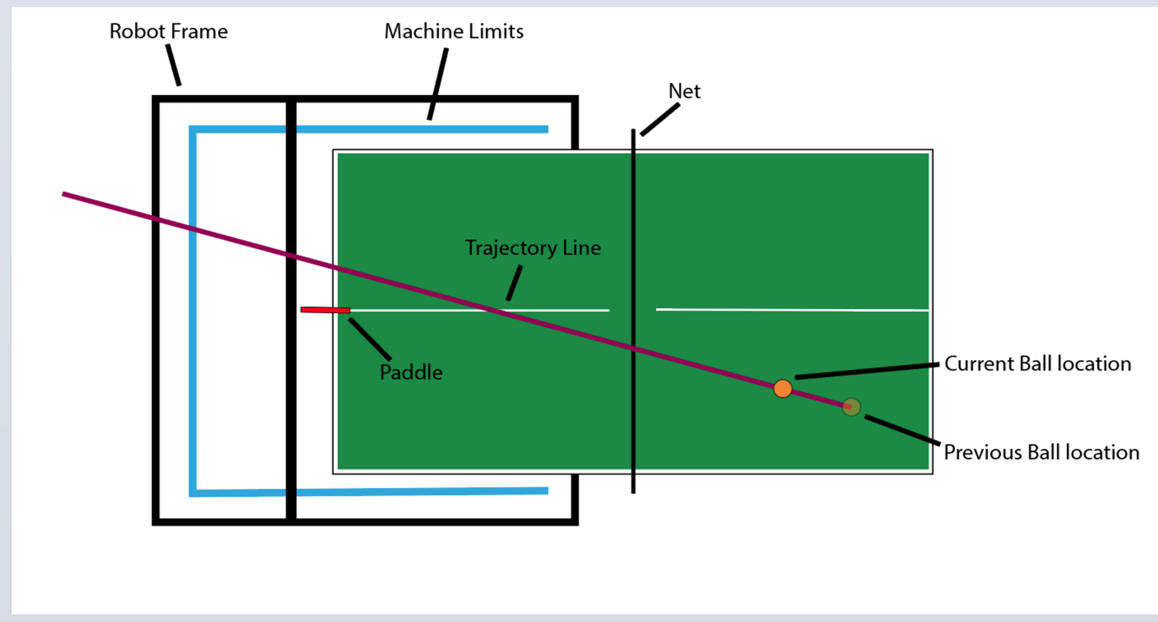
Deformation of frame caused by the movement of the crossbar (exaggerated for clarity).



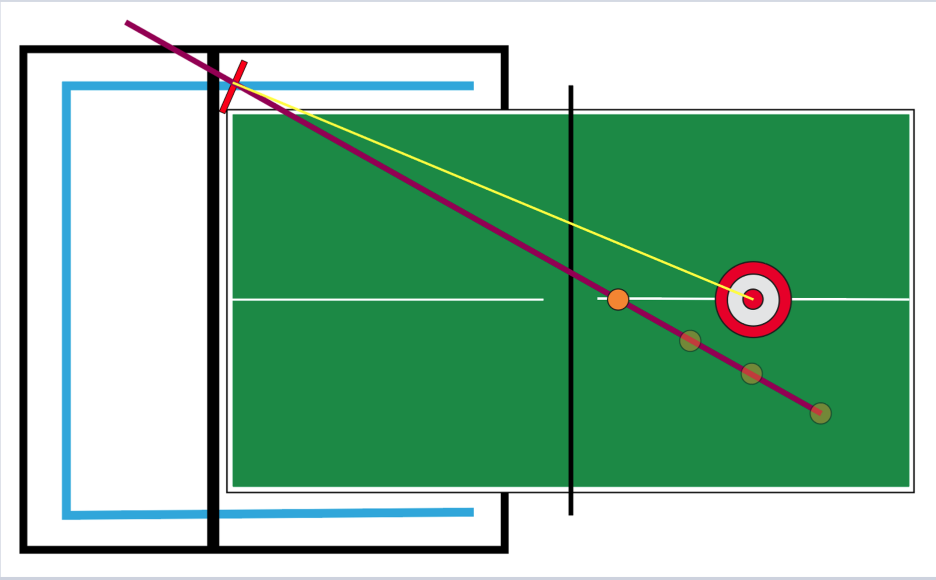
The addition of tiedowns, sandbags, and blind joints dispersed the force and reduced the deformation from 2 mm to .5 mm.

Software

The ball recognition information collected by the camera is sent to the computer and the robot moves to line the paddle up with the trajectory of the ball.



Once the ball is in range to hit, the robot aims the paddle to target location and moves forward to return the ball.



Conclusions

The robot was created to achieve certain metrics. The following data shows how well the robot performs on the original goals.

- Top Speeds – 1.5 m/s
- Top Acceleration – 10 m/s^2
- Top Rally Count - 10
- Paddle Range - 2 m x 2 m x .5 m
- Assembly Time - 45 minutes
- Setup Time – 5 minutes

Final Design

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