A Flying Robotic Centrifuge
Design for Microgravity and Spaceflight Applications

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Problem Background

There is currently no ability to simulate Earth gravity for mixed material separation and biological experiments in microgravity laboratories. How can the team create a centrifuge for microgravity use that doesn't revolve around the usage of a motor?

Fig. 1 – Bench Top Lab Centrifuge

Requirements

Requirement	Target
Centripetal Acc.	$9.81 m/s^2$
External moment	0 Nm
Time to 1g	<60s
# of Thrusters	>2
Onboard Air Storage	>=1 Tank
Weight	<35lbs

Fig. 7 – Client Requirements

Experimentation and Concepts

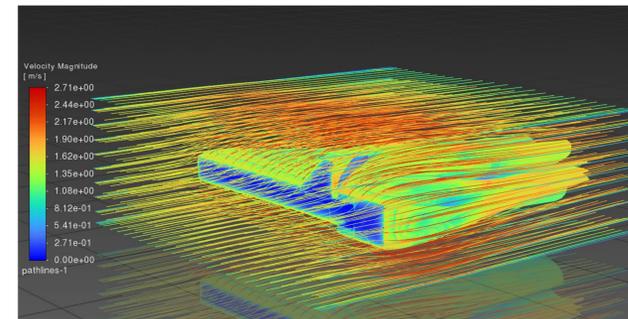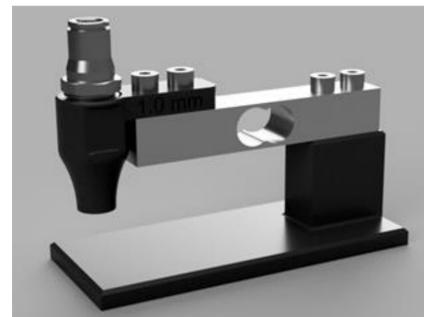Fig. 2 – Generative Design of "Rotor Ring"

Fig. 3 – CFD Simulation of "Spoke"

Figure 2 illustrates a sample "rotor ring" which can be mounted around the centrifuge, housing test samples.

Figure 3 and 4 shows how we determined what thrust we will require, and which nozzle diameter helps us achieve that.

Fig. 4 – Rig to Determine Nozzle Thrust

Final Design (Patent Pending)

Figure 8 shows the custom circuit board that controls the system. Figure 9 shows a 3D render of the prototype without pneumatic piping.
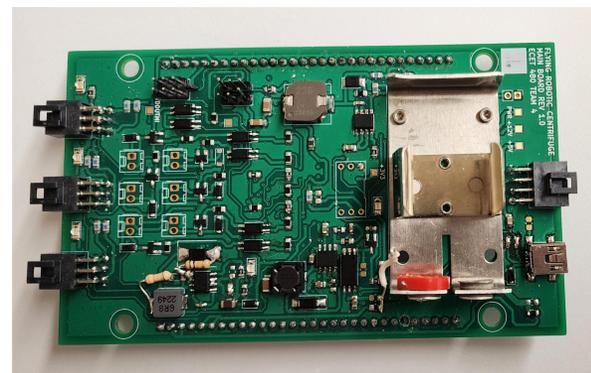
Fig. 8 – Custom Control Circuit Board
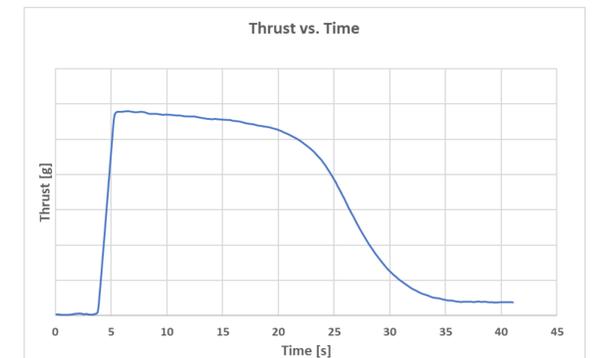
Fig. 9 – 3D Render of Final Prototype
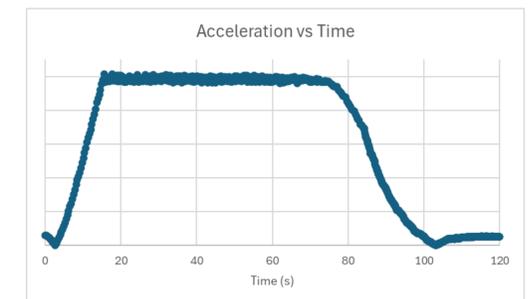
Testing

Fig. 5 – Thrust vs Time Testing Graph

Fig. 6 – Acceleration vs Time Testing Graph

Future Development

Mechanical:
- Sample holding ring
- Integrated air-brakes

Electrical:
- Additional sensors
- Rework electronics
- Power generation (i.e. solar cell)

Pneumatic:
- Higher-volume tanks
- Higher-pressure system
- Translational nozzles
- Integrated air-compressor
- Traditional cold gas thrusters