Hydrogen Fuel Cell Stabilization

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Velocity Solutions (Student Led Project)

NM STATE

BE BOLD. Shape the Future.
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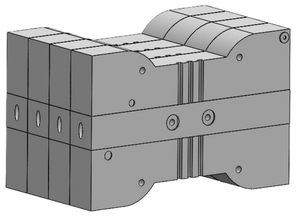
Mission/SOW

Our mission is to deliver innovative lightweight stabilization solutions that maximize efficiency, reduce emissions, and advance drone technology

Our goal for this project was to optimize Hydrogen fuel cell power output in Drones.

- 90x75x60 mm in size
- Control vibration testing at ~150Hz
  - 10 min interval testing x 4
- External force - mechanical gust simulations



Research

Hydrogen Fuel Cell Technology for Drones

•Background:

Hydrogen fuel cells are a promising alternative for drones. They offer extended flight times and reduced environmental impact.

•Production Methods:

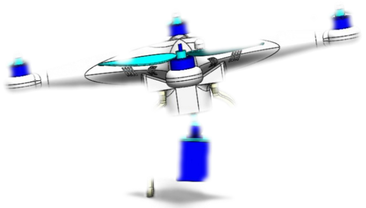
- ○Electrolysis
- ○Steam methane reforming
  - ▪Storage methods like compressed gas and liquid hydrogen have various challenges.

•Efficiency:

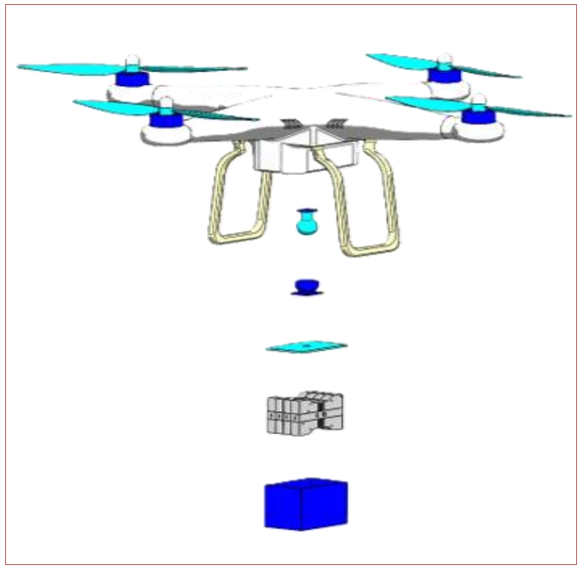
- ○Proton Exchange Membrane (PEM) fuel cells are preferred for drones achieving 40-60% efficiency.
- ○Optimizing stack design and power-to-weight ratio is key for drone integration.

•Integration & Safety:

- ○Brushless motors
- ○Power electronics
- ○Thermal management.

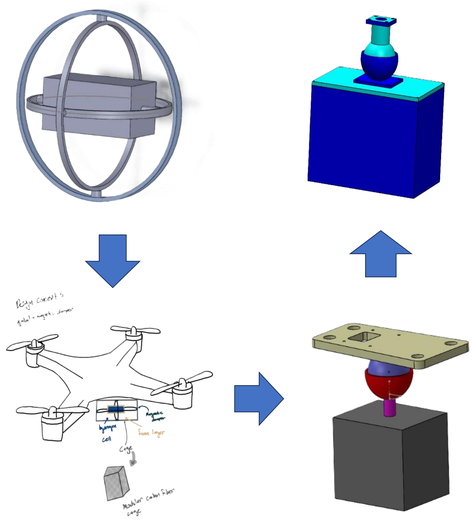


Final Design



Final Design Description

- Utilized pendulum physics to design a knee and socket joint.
- Ensured the fuel cell remained parallel to the ground (z-axis).
- Placed the fuel cell in a small box lined with vibration-absorbing EVA foam.
- Modifications stabilized the fuel cell, maintaining a constant and maximum power output.
- Increased drone velocity due to improved fuel cell performance.

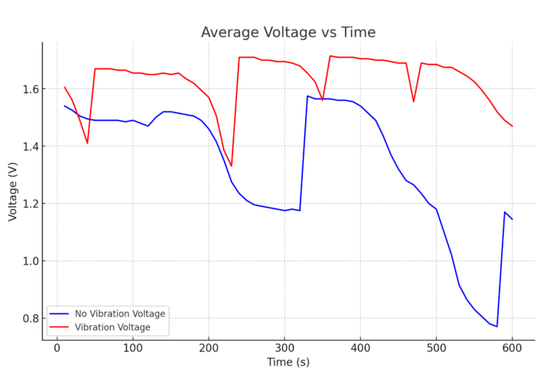


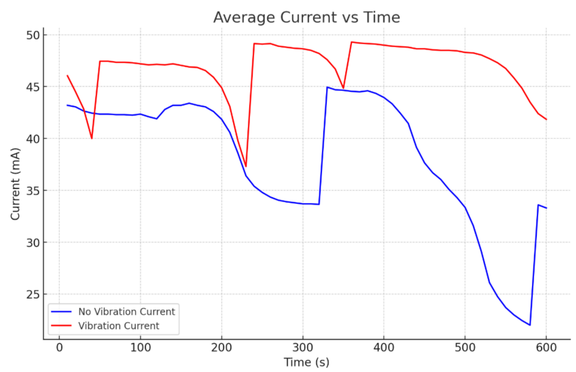
Concept Development

- **Initial Design**
  - Gimbal
  - Gyroscopic system
- **Explored**

  Magnetic repulsion system
- **Finalized**
  - Pendulum-based design

Data Analysis & Test Results





The voltage output from the fuel cell under vibration conditions consistently remains higher and more stable than the voltage under no vibration throughout the 600-second duration. The flow of water out of the battery affected the voltage greatly which is indicated by the sharp declines in voltage.

Key Findings and Future Direction

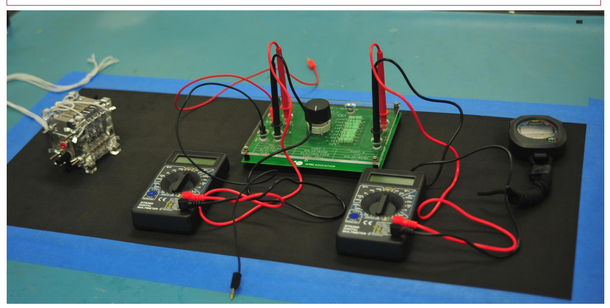
Initial Hypothesis:

We expected that rapid drone movements (e.g. wind gusts, sharp turns) would decrease hydrogen fuel cell performance.

- **What We Found:**

  Testing with a 100W hydrogen fuel cell showed **no significant performance drop** due to motion at small scales.
- **Why That Matters:**

  While motion didn't impact small-scale tests, we believe larger drones or longer missions may still experience issues—so the original idea could still apply at scale.
- **Rethinking the Design Scope**
  - Our suspension system **can still be useful**—just in a different way.
  - It could help transport **motion-sensitive instruments** like:
    - ▪atmospheric sensors
    - ▪precision cameras
    - ▪delicate scientific payloads
- **Next Steps**
  - Refine our gimbal/suspension design
  - Test with **different payload types**
  - Explore applications in **research drones, mapping, or sampling missions**



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