Testu-Grow: Testing Biological Resilience at High Altitudes

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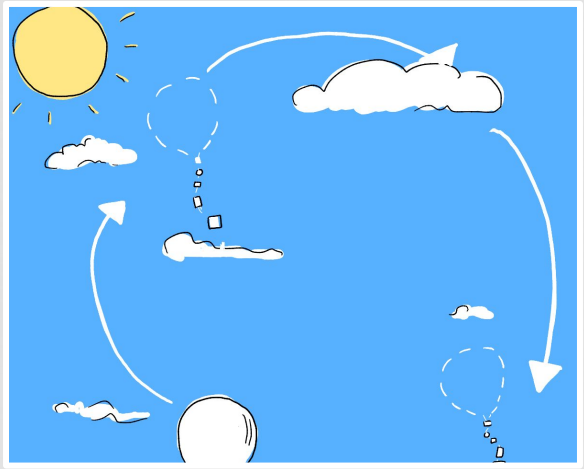
Background

- **Vertically Integrated Project (VIP): Engineering on the Edge of Space**
  - Our group is a part of VIP and we get to take on a specific objective for our payload that gets sent on a latex weather balloon up to an altitude of 100,000ft



- **What is our goal?**
  - As the Life-support team, we have the goal of sending organisms (yeast and seeds) into space so that we can collect meaningful data on the effects of space-like conditions

Payload Overview

Our Purpose

- Send a payload designed to contain organisms and keep them alive in order to collect data and research the effects of space-like conditions

Design Constraints

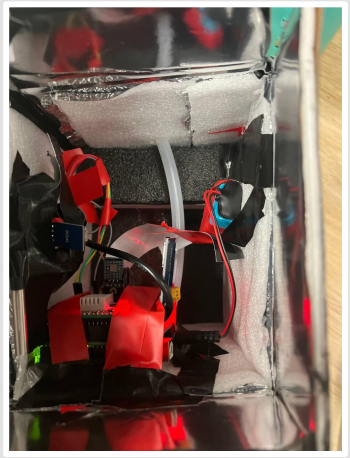
- Payload weighs < 1.5 lb
- New materials must cost less than $100
- Organism should be chosen appropriately (size, ethical concerns, safety, etc.)

Anticipated Data

- **Set up groups**
  - *Space group* = seeds that went on the flight
  - *Control group* = seeds from the same batch kept on Earth
- **Grow them side by side**
  - *Same* conditions (light, water, temp, medium, pressure)
- **Choose outcomes to measure**
  - Plants → germination % and/or height over course of 2 weeks
- **Run statistical tests**
  - Means (average height/growth rate): use a *two-sample t-test*
  - Proportions (like germination %): use a *z-test* for proportions
- **Interpret results**
  - Report *p-value* (did space change growth?)
  - Also show effect size (how big the difference is, not just if it's "*significant*")

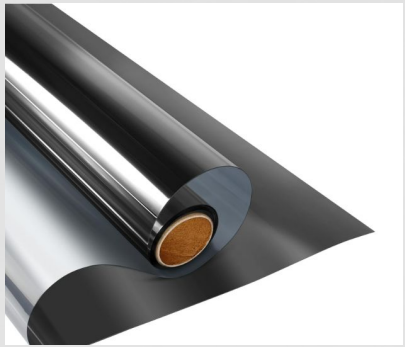
Payload Design Overview

Payload design:



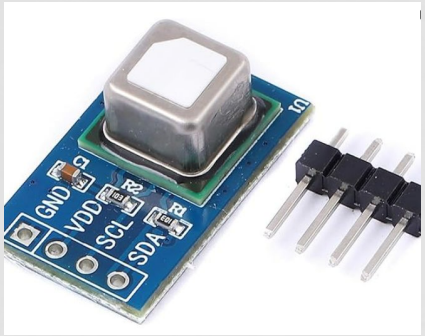
Key Components

- UV film
- CO2 sensor
- DHT22 Temperature and Humidity sensor
- UV sensor
- Organisms
- Lithium Ion Rechargeable Battery



UV Film

UV Sensor



CO2 Sensor

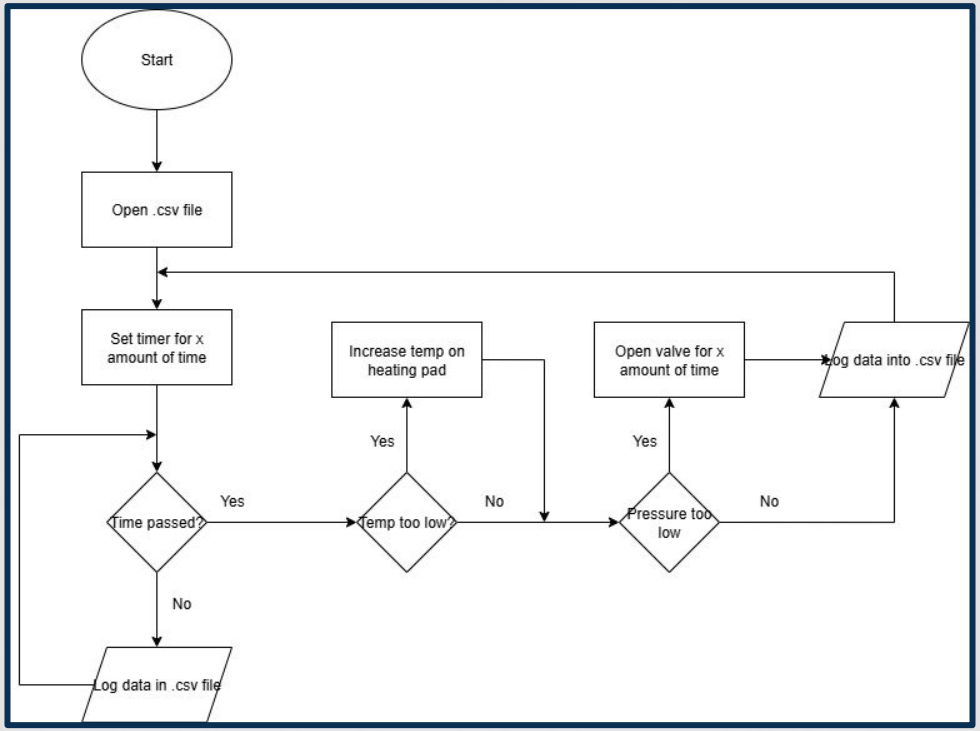
Temp and Humidity Sensor

Growth Procedure

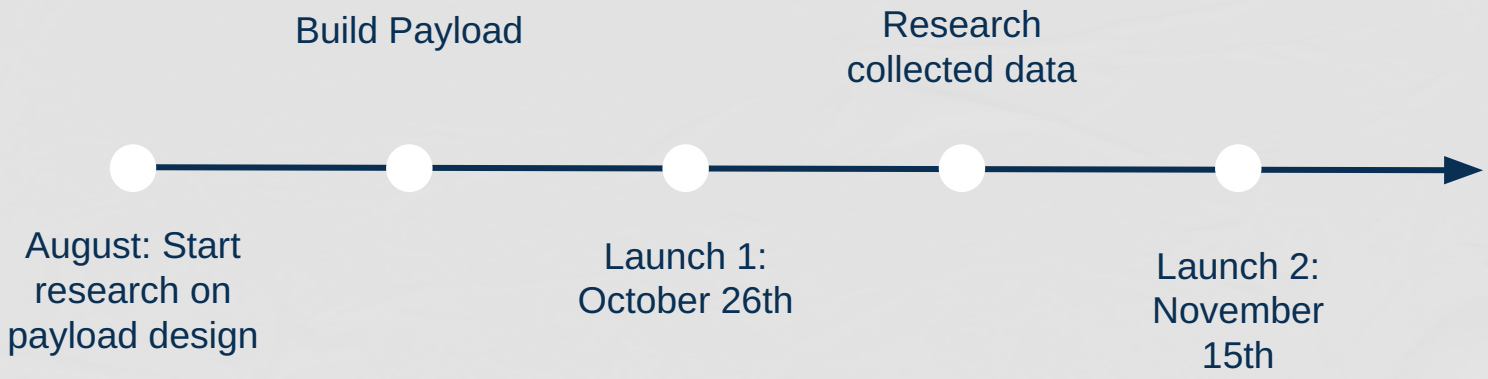
Left to Right: Radish, Lettuce, Basil, and Mustard seeds

- **Groups**: 4 species (Radish, Lettuce, Basil, Mustard)
  - Space group: seeds flown in payload
  - Control group: identical seeds kept on Earth
- **20** seeds per group per species
- **Setup (Day 0):**
  - Plant seeds, mist with distilled water
  - Place all trays together under identical light (16 h light)
- **Daily Conditions (Days 1–14):**
  - Rotate trays daily to prevent light bias
  - Keep constant room temp
- **Measurements**:
  - Count germinated seeds each day
  - Measure height of 5–10 randomly selected seedlings per group
  - Germination (%) analyzed with a **two-proportion z-test**
  - Plant height analyzed with a **two-sample t-test**

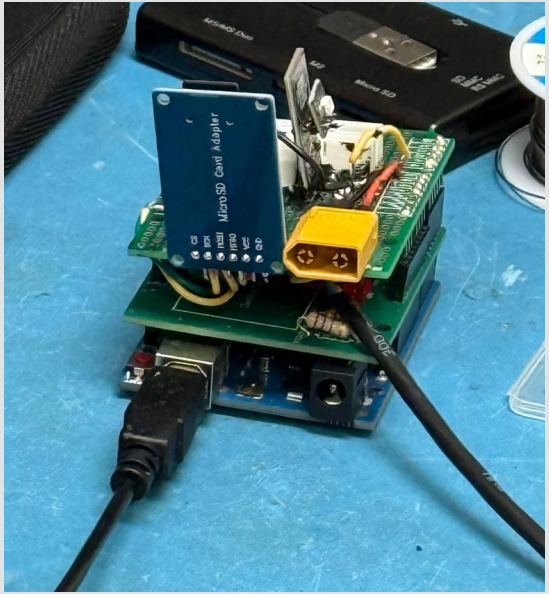
Program Flowchart

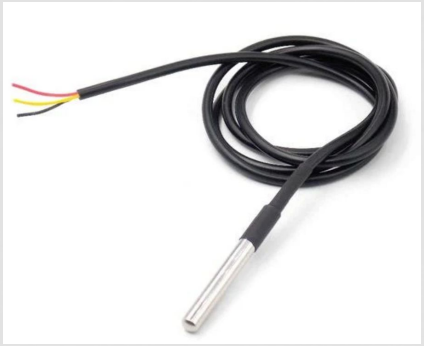


Concept of Operations



Electronics





Launch #1

Launch #1 Results

Left to Right: Radish, Lettuce, Basil, and Mustard seeds

Launch #1 Analysis

- **Germination** (Day 7)
  - *Radish*: 90% (Control) vs 90% (Space) – no difference
  - *Basil*: 100% vs 90% – no difference
  - *Lettuce*: 80% vs 80% – no difference
  - *Mustard*: 70% vs 80% – no difference
- All germination p-values **>** 0.05

- **Growth-Height** (Day 14)
  - *Radish*: 4.95 cm vs 4.85 cm (p = 0.16) – no difference
  - *Basil*: 12.25 cm vs 12.09 cm (p = 0.053) – not significant
  - *Lettuce*: 8.17 cm vs 8.10 cm (p = 0.17) – no difference
  - *Mustard*: 6.97 cm vs 6.88 cm (p = 0.07) – no difference
- All height p-values **>** 0.05

- **Conclusion:**
  - Space-exposed seeds grew just as well as controls
  - No significant reduction in germination or height
  - Our model **successfully** protected the seeds during flight

Launch #2

- **Future Implications:**
  - Increase flight duration to test our model under longer near-space exposure
  - Expand to microbes, starting with the yeast sample we launched this Saturday (Launch #2)
  - Adapt the model to safely support simple live organisms

Thank You!

Any Questions?