Autonomous Multiple Cycle Farming in Space

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MOTIVATION

- Space exploration expanding rapidly and the need to accommodate life beyond Earth.
- To grow food autonomously in space that can support humans reliably, without compromising valuable time, or energy, from other missions.

PROJECT GOAL

- To build an Autonomous Multiple Cycle Farming Chamber that seeds, grows, and notifies crew that crop is ready for harvest while in microgravity.
- Streamline the Growth Chamber configuration for multiple farming cycles by creating a web application user station.

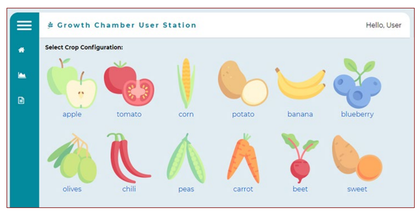
CONFIGURABLE AUTONOMOUS SCHEDULING

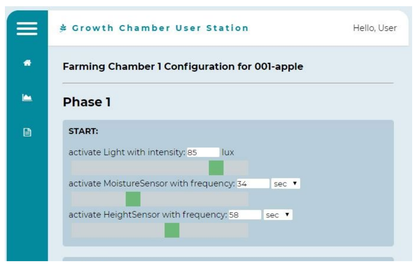
- Growth Chamber **runs autonomously** based on botanist and astronaut configuration files.
- Sensors and actuators can be uniquely scheduled to monitor or activate in a defined manner for any number of phases.

```
START:
  - - activate
    - Light
    - intensity: 5.3 lux

  - - activate
    - MoistureSensor
    - frequency: 5.2 sec

  - - activate
    - HeightSensor
    - frequency: 10 sec

MONITOR:
  HeightSensor:
    [0 cm, 1 cm]:
      - - set
        - HeightSensor
        - frequency: 10 sec

    [2 cm, inf cm]:
      - - transition
        - asap
```

USER STATION CONFIGURATION LIBRARY

- User Station allows many different crop configurations to be accessed and modified.
- Each may be saved and can be run on the growth chamber.

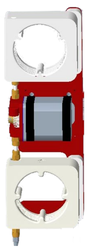




GROWTH CHAMBER DESIGN

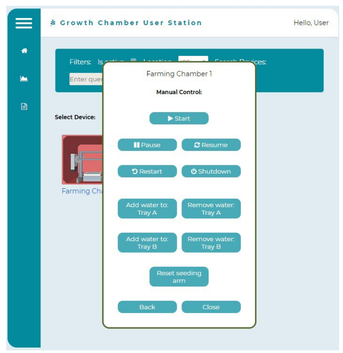
GROWTH CHAMBER FEATURES

- An aluminum tank, that controls the intake and outflow of water nutrient solution with a plunger. Solenoid valves control the direction of the water utilizing capillary action.
- The End Effector is capable of planting seeds in microgravity by forcing seeds out with filament driven by a stepper motor.



USER STATION CONTROL

- User Station allows any number of farming chambers to be selected for direct manual control or configuration.
- Users may also be alerted to important status updates, such as a signal to harvest.
- System administrators can load any number of farming chambers to the Farming User Station and control user access via Lightweight Directory Access Protocol.



TESTING & VALIDATION

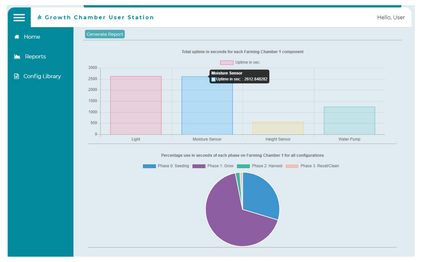
- Multiple iterations of the tray were tested through growth cycles, in order to achieve the requirement of 70% harvest.
- Circuitry and software was also successfully tested over several weeks, proving the autonomous capabilities of the system.

COST ANALYSIS

Planting System & End Effector	$560.21
Water Delivery & Tray	$329.16
Lighting & Electrical	$83.95
Miscellaneous & Case	$341.74
Total	$1315.06

USER STATION REPORTS

- The User Station provides reports for each device with metrics such as component uptime and phase runtime.



CONFIGURATION VERSION CONTROL

- The history of each configuration is recorded with the appropriate metadata.
- The user may reload any previous version for modification.