# Autonomous Multiple Cycle Farming in Space

**Dominic Allard, Philip Bernhard, Joshua Calhoun, Courtney Cline, Giampiero Corsbie, Timothy Frazier, Kali Jenson, Bryce Johnson, & Christopher Millsap**

**Faculty Advisor(s): Dr. Elisabeth Kames, Dept. of Mechanical Engineering, & Dr. Philip Chan, Dept. of Computer Science, Florida Institute of Technology**

## 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.

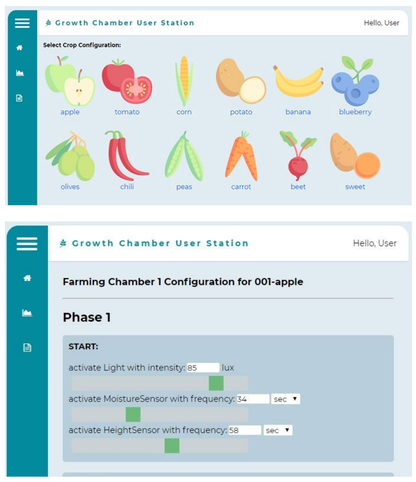
## CONFIGURABLE AUTONOMOUS SCHEDULING

- 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.



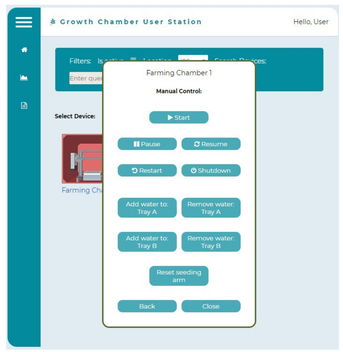

## GROWTH CHAMBER DESIGN

## 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

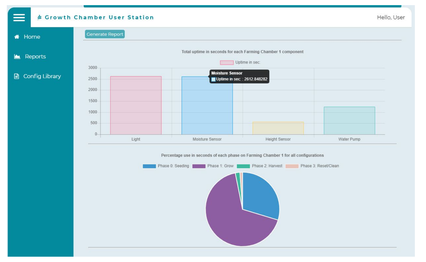
- Multiple iterations of the tray were tested through growth cycles, in order to achieve the requirement of 70% harvest.
- Circuitry and software was also successfully tested over several weeks, proving the autonomous capabilities of the system.

## 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.