Autonomous Multiple Cycle Farming in Space

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OBJECTIVE

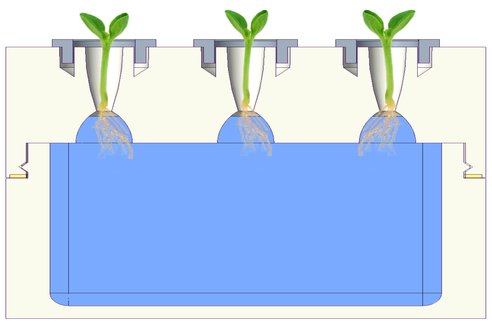
With NASA gearing up for the Artemis program and space exploration expanding rapidly to accommodate life beyond Earth, there exists a need to grow food autonomously that can support humans reliably, without compromising valuable time, or energy, from other missions in space. Therefore, students across multiple disciplines joined forces to build an Autonomous Multiple Cycle Farming System (AMCF) that grows plants autonomously through robotic functions with limited human interaction for multiple cycles.

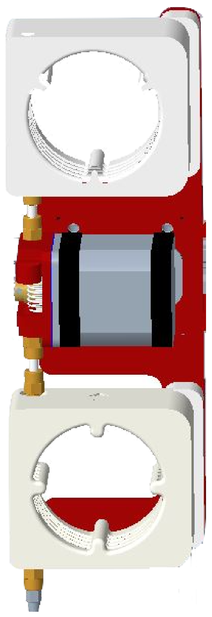
DESIGN CRITERIA

To make an autonomous system that seeds, grows, and harvests plants, three major systems are needed: water delivery, planting system, and base. In conjunction with these three systems, there will need to be a power supply, lighting, nutrients, and plumbing for support. Design is in accordance with SSP 52000-IDD-ERP NASA ISS requirements.

SEEDING SYSTEM

The End Effector is capable of planting seeds in microgravity by forcing seeds out with filament driven by a stepper motor. The seeds are precisely placed into their respective tray hole.

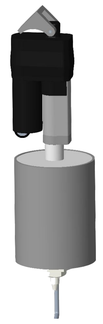




GROWTH CHAMBER DESIGN

WATER DELIVERY

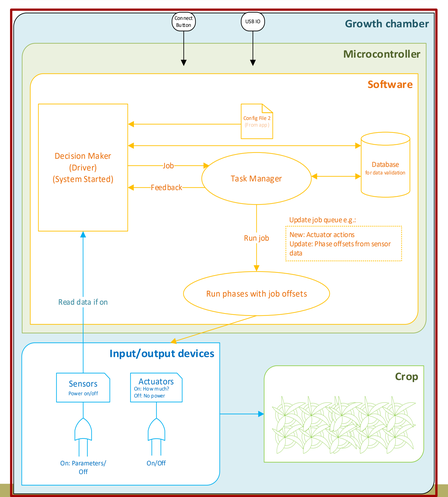
The water delivery system is comprised of an aluminum tank, that controls the intake and outflow of water nutrient solution with a linear actuated plunger while solenoid valves control the direction of the water through commands of the software.



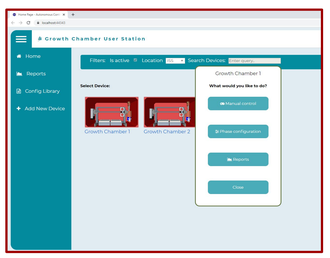
FARMING CHAMBER & USER STATION

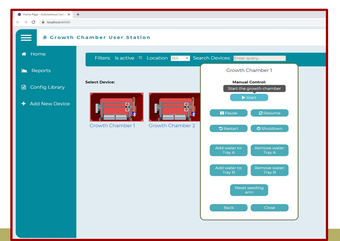
The Growth Chamber **runs autonomously** based on user configurations and the User Station allows users to **manually control**, **update configurations**, and **view reports**.

CHAMBER



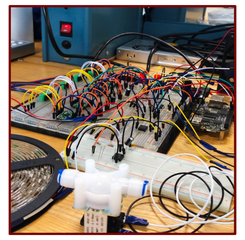
USER STATION





TESTING & VALIDATION

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



COST ANALYSIS

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

FUTURE PLANS

It is with great pleasure to announce that we have already submitted the Autonomous Multiple Cycle Farming System concept to two different NASA programs: “Technology Advancement Utilizing Suborbital Flight Opportunities ‘Tech Flights’,“ as well as “Student Payload Opportunity with Citizen Science (SPOCS)” at Johnson Space Center.

ACKNOWLEDGEMENTS

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