[Capstone Category]

Project Name	**Autonomous Multiple Cycle Farming in Space**
Team Lead:	Courtney Cline
Team Member(s):	Dominic Allard, Philip Bernhard, Joshua Calhoun, Courtney Cline, Giampiero Corsbie, Timothy Frazier, Kali Jenson, Bryce Johnson, & Christopher Millsap
Faculty Advisor(s):	Dr. Elisabeth Kames, Mechanical Engineering & Dr. Philip Chan, Computer Science, Florida Institute of Technology

****do not change font size or text color above this message/delete this before completion or put in a category. The category will be put in by Staff after submission ****

Project Description: 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, and can be configured or managed through a graphical user interface. To make an autonomous system that seeds, grows, and harvests plants four major systems are needed: water delivery, planting system, base and configuration. In conjunction with these four 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 requirements on International Space Station.

Design Problem Statement: Growing plants in microgravity is challenging due to the lack of directionality of water and substrate. Few solutions exist that accomplish growing sustainable food in space and even fewer of those solutions are always reliable and scalable.

Major Challenges: One of the major challenges in this project was designing a way to autonomously control and configure the Farming Chamber so that it would be able to grow various crop types in microgravity. Another major challenge was managing fluid flow in microgravity since our solution has no substrate.

Solution Method: The hardware on the chamber utilizes capillary action to manage water and the seed end effector pushes the seeds into individual compartments so they cannot float away. The chamber delivers water and nutrients to the seeds and then they grow. The software solution is more than just an application; it is a new configuration paradigm. We created detailed configuration file commands and parameters that the botanists can use to set each of the 4 states of the machine 1. Seeding 2. Growing 3. Harvesting 4. Cleaning for various crop types in a configuration file. We created a new scheduler that runs on the Growth Chamber that reads in sensor data to determine the optimal execution of tasks based on the configuration file on the same growth chamber. Finally, we created an application that runs on a separate computer for the astronaut to manage the Growth Chamber, called the Farming User Station (F.U.S.). The astronauts can manually control, edit configurations files, and view reports for all the Farming Chambers. Autonomous solutions were considered effective when we reached a %70 crop harvest yield. When a crop is ready for harvest the F.U.S. notifies the astronauts. When the crop is harvested the Farming Chamber can begin another cycle.

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.