Senior Design BS Project
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X-Hab Miami: CERES Project

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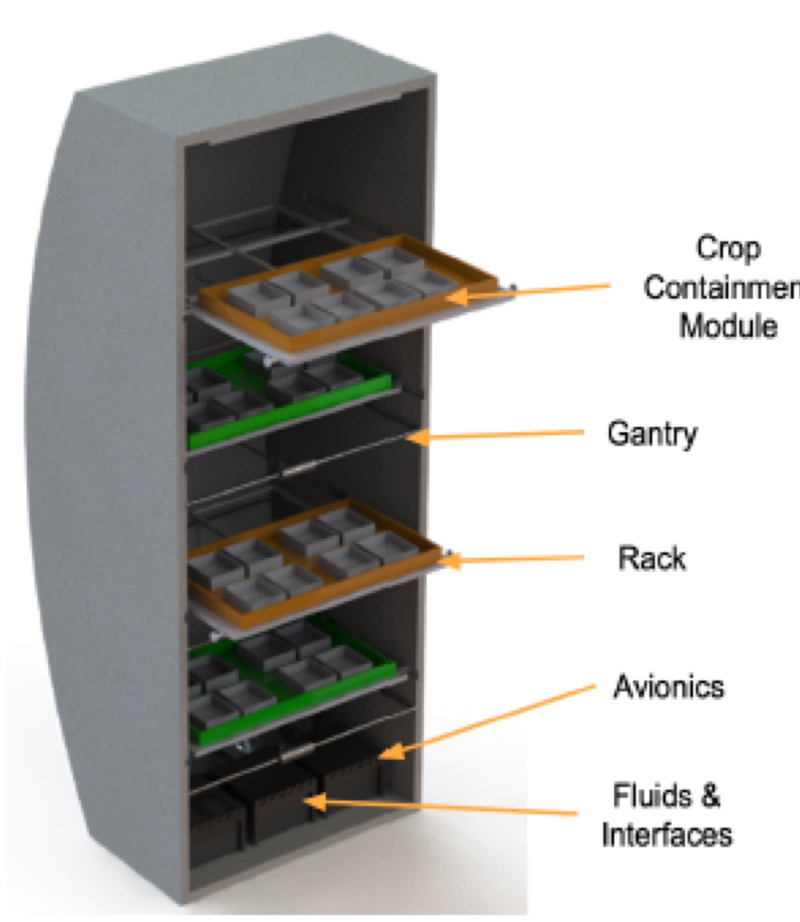
Abstract

For the 2020 NASA X-Hab Academic Innovation Challenge, a student team partnered with Made In Space to apply the best system engineering practices in approaching the problem of volume optimization for food production during deep space exploration. Proper management of the volume of critically grown food and their related resources will be paramount for future mission success in long-term human exploration. A volume optimized system was designed. It utilized robotic elements for resource management. Engineering tests were conducted to analyze the success of the design. The designed system improved upon the automation level and volume optimization of previous systems.

Introduction

Plants can provide nutrients, calories, carbon sequestration, oxygen production, and a psychological benefit for astronauts. Growing and harvesting the outputs of crops for In-Situ Resource Utilization (ISRU) has been seen by NASA as central for a sustained space presence.

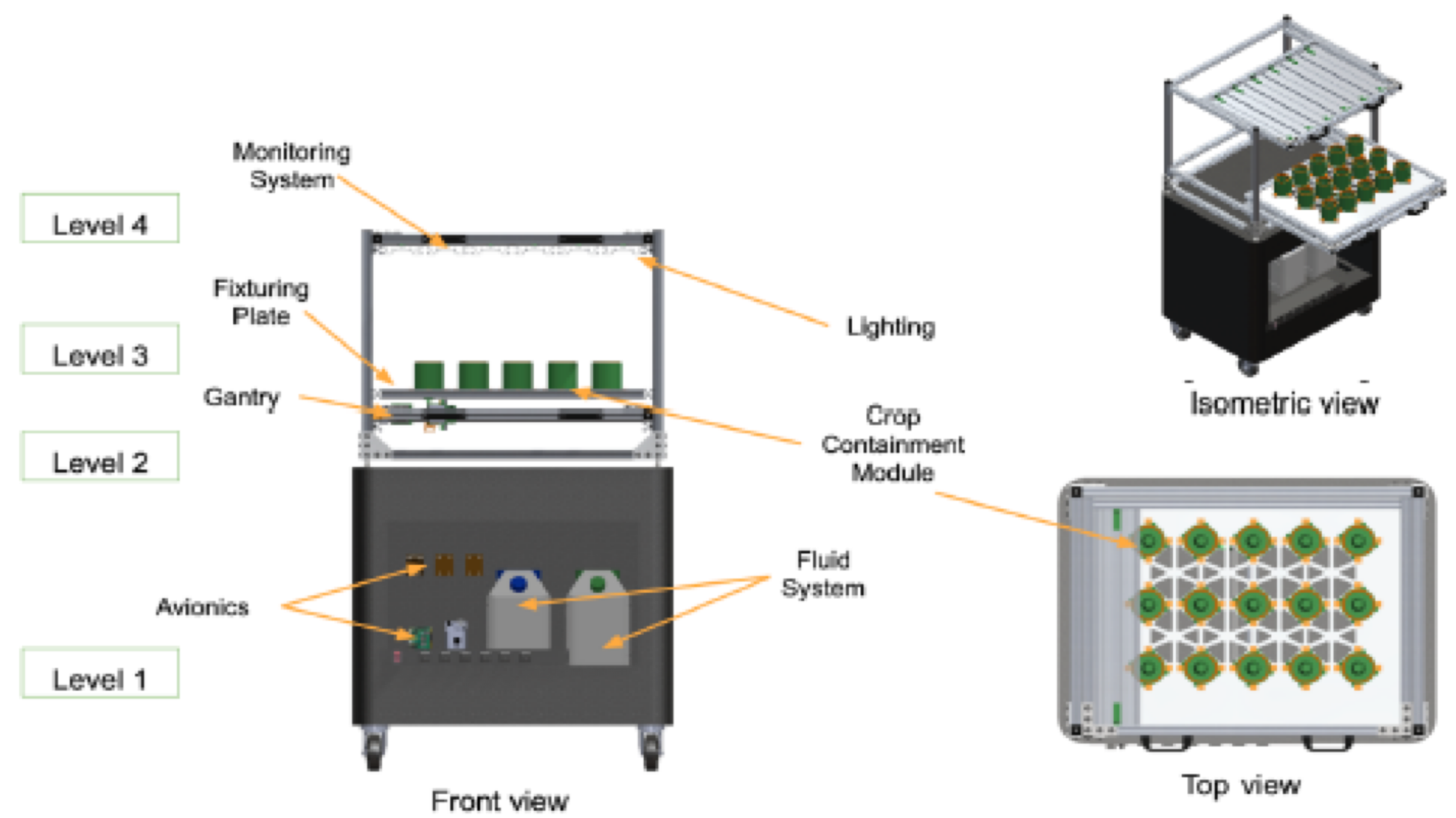
The social impact of growing these plants for long term space missions is that humans can be in space. This would mean that missions could be extended for longer times allowing for more exploration of space and the progression of the sciences. Additionally, the possibilities of mankind colonizing Mars have large societal impacts on the future of humanity. An increase in aerospace advancements will also create more jobs. Advancements in space sustainability will lead to more space missions. Each space mission employs thousands of people from engineers, manufactures, medics, payload engineers, astronauts, and many other types of personnel. Improvements in space flight will lead to growth of the aerospace industry.



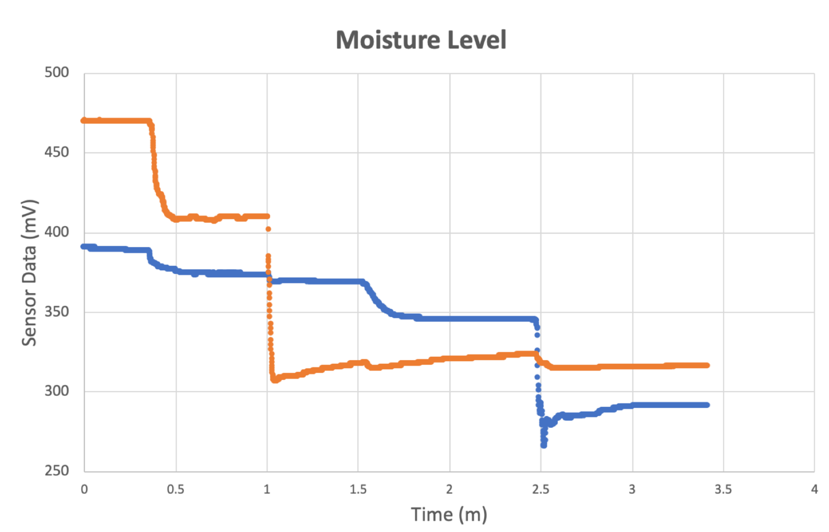
Methods | Design | Analysis

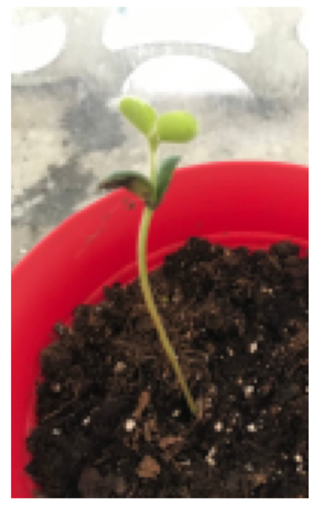
The Crop Environment for the Resupply & Extension of Space Missions (CERES) system includes the crop containment module, the gantry sub-system, the avionics sub-system, the lighting sub-system, and the fluid sub-system.

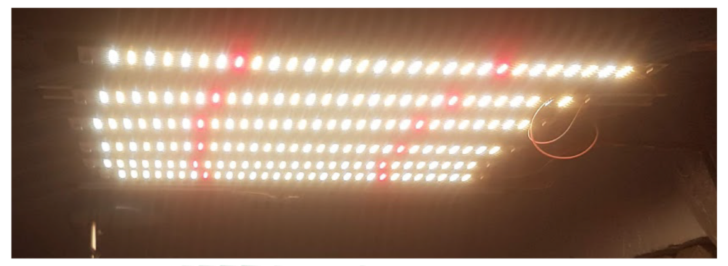
- Raspberry Pi (RPi) Model Four wireless control board. The RPi was successfully able to control each sub-system and make programmed decisions for efficient plant care.
- Each sub-system is responsible for ensuring the plant has enough water, nutrients, and light while achieving a design with little crew interaction and optimized volume.



Results







Conclusion

By following the NASA systems engineering approach a system was designed to facilitate crop growth in a microgravity space mission environment. The final design will use a hydroponic approach along with a gantry system, environmental monitoring system, and a specialized containment module. The health of the plants will be monitored, and robotic elements will be used to control light and fluid delivery. Much of the system has been built but due to COVID-19, the system could not be finalized. Several tests were conducted to analyze the functionality of the lighting system and computer modeling done to improve the stiffness-to-weight ratio of the fixturing plate. The system successfully achieved a higher level of volume utilization than previous science missions.

Acknowledgments

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References

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