Collaborative Research: Robust and Intelligent Optimization of Control Agriculture System for Food Productivity and Nutritional Security

PIs: Zhaohui Tong & Guanghui Lan, Georgia Institute of Technology
Co-PIs: Yongsheng Chen, Xiaoming Huo, Georgia Institute of Technology;
Co-PIs: Aditya Singh: University of Florida

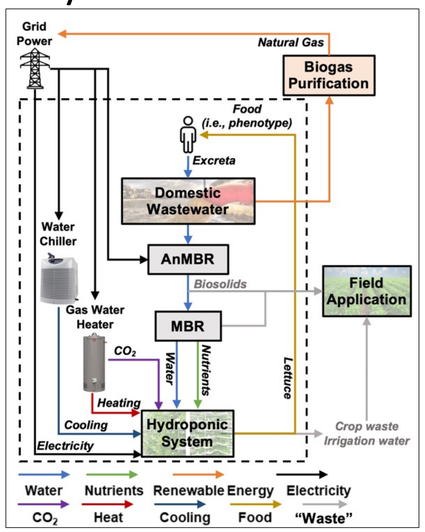
Overall objective: To study novel **optimized technology-driven controlled-environment agriculture (CEA) systems** that can achieve high areal vegetable productivity to increase food and nutritional security in a decentralized configuration with low operating cost and reduced energy consumption.

Physical-Cyber System:

- A pilot testbed of wastewater (WW) treatment & hydroponic farm for vegetable growth

Key Problems:

- Dynamic and robust optimization for process & complex systems to achieve high yield but satisfy various performance specifications



Scientific Impact:

- Novel and efficient control algorithms (reinforcement learning, RL)
- Machine learning (ML) models to establish multiple relationships in CEA.
- Methodology for integrated systems

Technical Approaches:

- Develop first principles for water models
- Develop ML or RL for biochemical processes with parameter estimation and unmodeled dynamics.
- Devise control algorithms for desired closed-loop performance despite disturbance and uncertain dynamics.
- Implement in simulation and experimentally validation to a feasible deployment scale.

Key Innovations & New Contributions:

- New optimization method for water/biochemical composition estimation
- New RL algorithm for biochemical process with increased resilience against uncertainty.
- New imaging/sensor technologies combining the ML method for non-destructive composition/nutrient tracing in WW and production estimation.

Broader impact (Society)

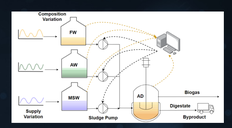
- Addressing the grand challenges
- Producing low-cost vegetables and fruits for environmental control and food security
- Training next generations, and increasing employment, healthy diet.

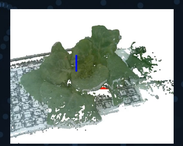
Broad Impact (Education & outreach)

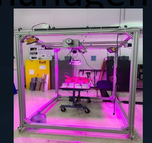
- Training undergraduate and graduate students
- Promoting women and minority
- Extension service in land-grant university: UAS-based sensors for precision irrigation water management

Broad Impact (quantify potential impact)

- Training 2-3 women PhD or UG students and 30 farmers
- The RL AD control achieved 99% demand satisfaction.
- Robotics/AI and SPOT facilities for biomass estimation and nutrient management.







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