Northern Illinois University

Open-Source Controlled Environment Agriculture Including Development of Water Quality System

Overview

- Executive Summary
- Current State
- Design Objectives
- Project Details
- Acknowledgements
- References

Executive Summary

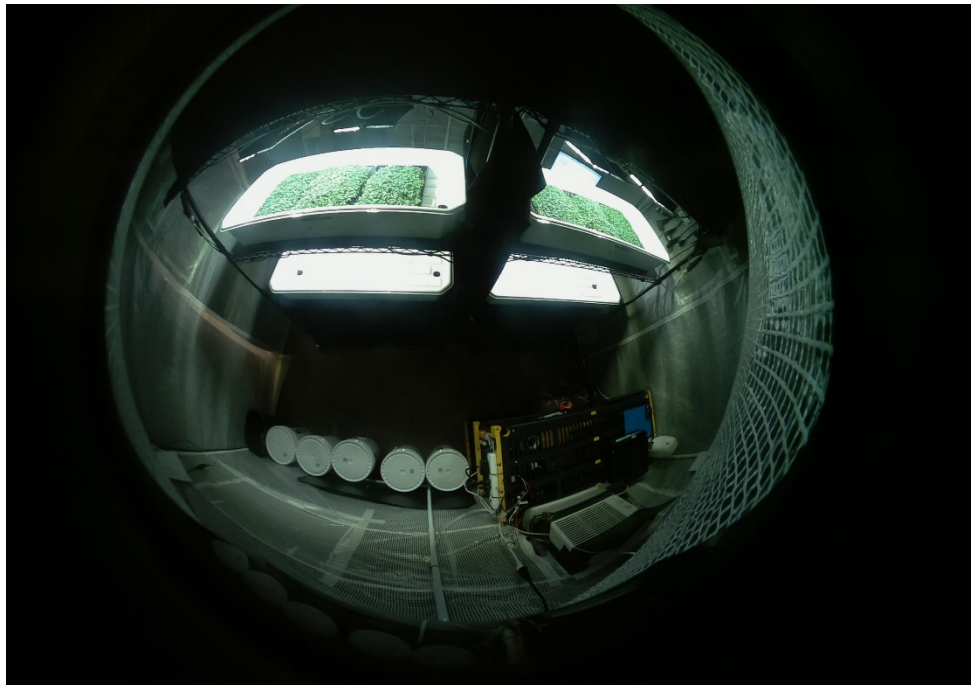
- We are developing/optimizing an automated microgreen vertical farm system.
- The design focuses on lighting controls, climate conditions, and water quality system.

Radish

Broccoli

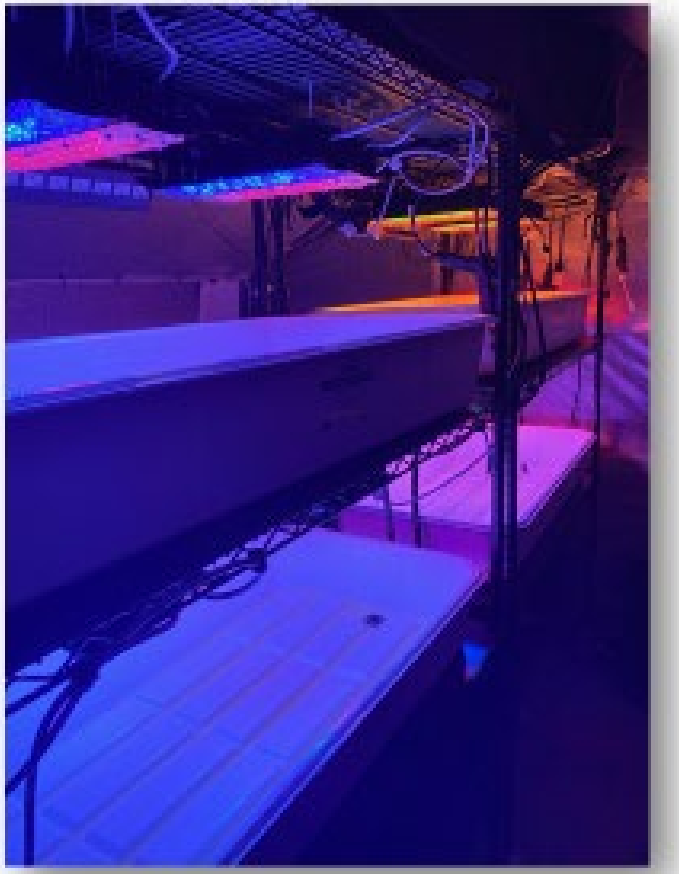
The Vertical Farm

Outside the tent

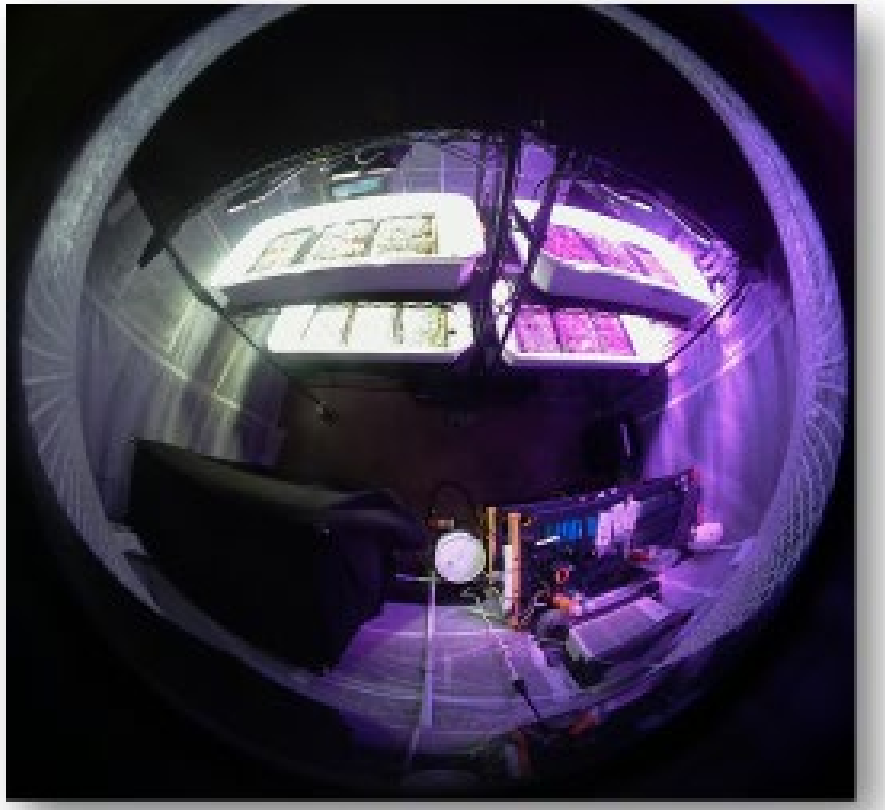


View of farms

The Vertical Farm



Internal View



During Growth Cycle

Design Objectives

- A user-friendly lighting and watering control system
- Improvement of the automated environmental control system for growing microgreens
- Improvement of a feedback-controlled water quality and quality correction system
- Design of Experiments to characterize the light inputs to plant growth outputs to optimize plant yields

Control System Overview

DMX Controller

Raspberry Pi 3 (B+)

GrowEmity IDB LED kit

UVA LED Bar Light

Controllable Relay Module

Pump

Humidifier

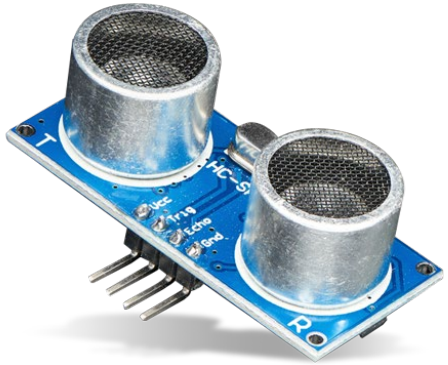
Camera

Controllable Relay Module

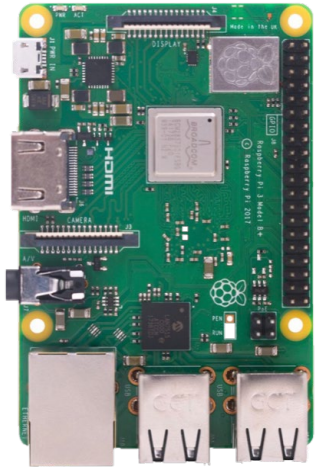
Dehumidifier

A/C

Control System Overview (Sensors)



Ultrasonic Sonar Distance Sensor



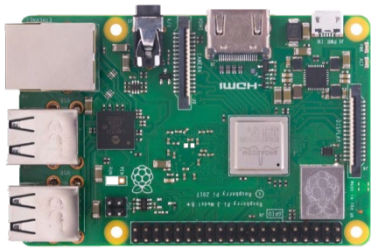
CM0124 CO_2 Sensor

CM0187 CO_2 Sensor

DHT22 Temp/Humidity Sensor

ENVIRONMENTAL SYSTEM

Climate Control Sub-System



Raspberry pi 3 (B+)

Closed Loop Cooling and Humidity Contı

(3) 12A Controllable Relay Module

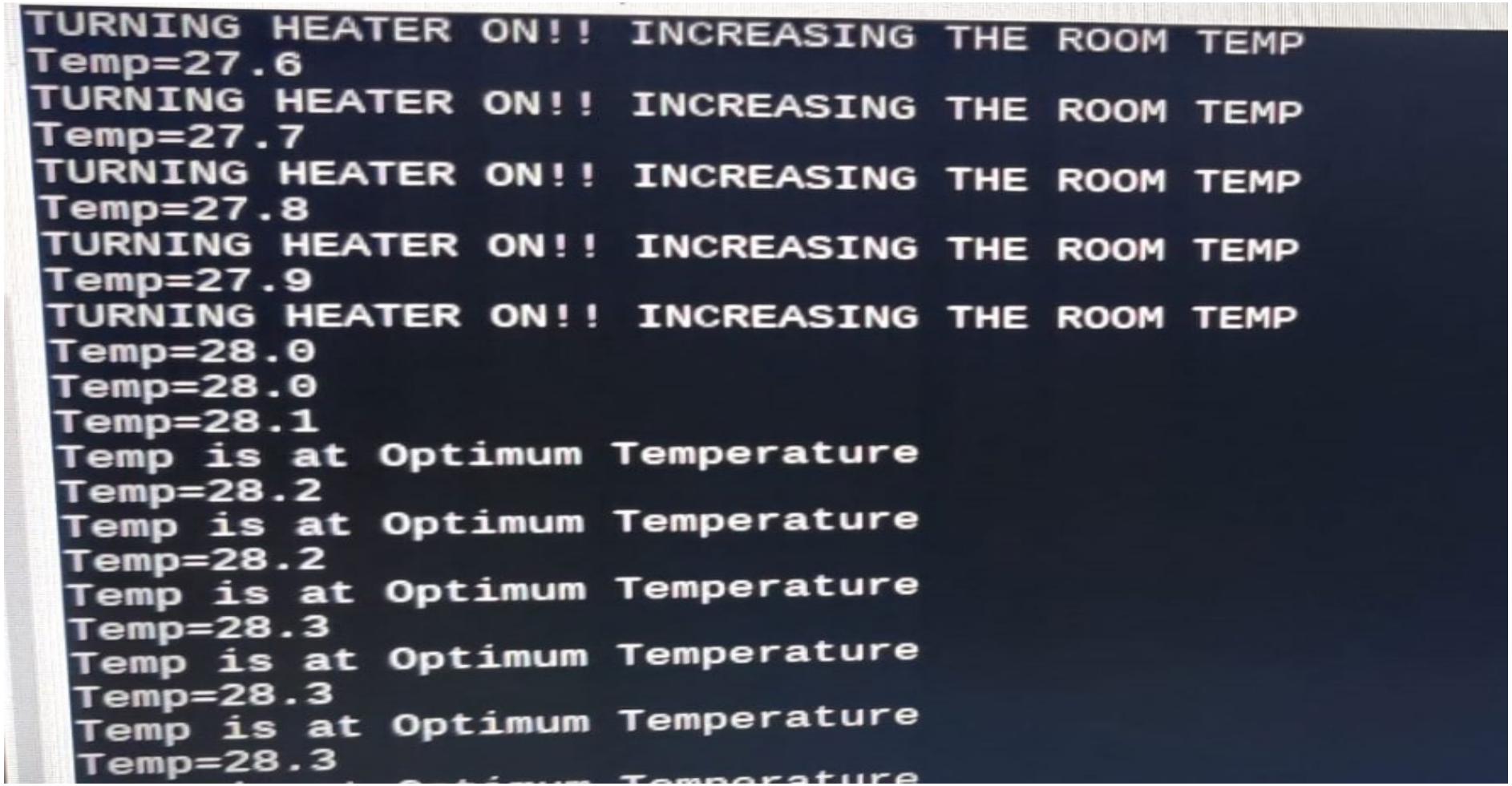
6 gal. Humidifier

Heater

(2) DHT22 Temp/Humidity Sensor

5,000 BTU/hr A/C

Maintaining the Optimum Temperature



LIGHTING

Light Control Sub-System

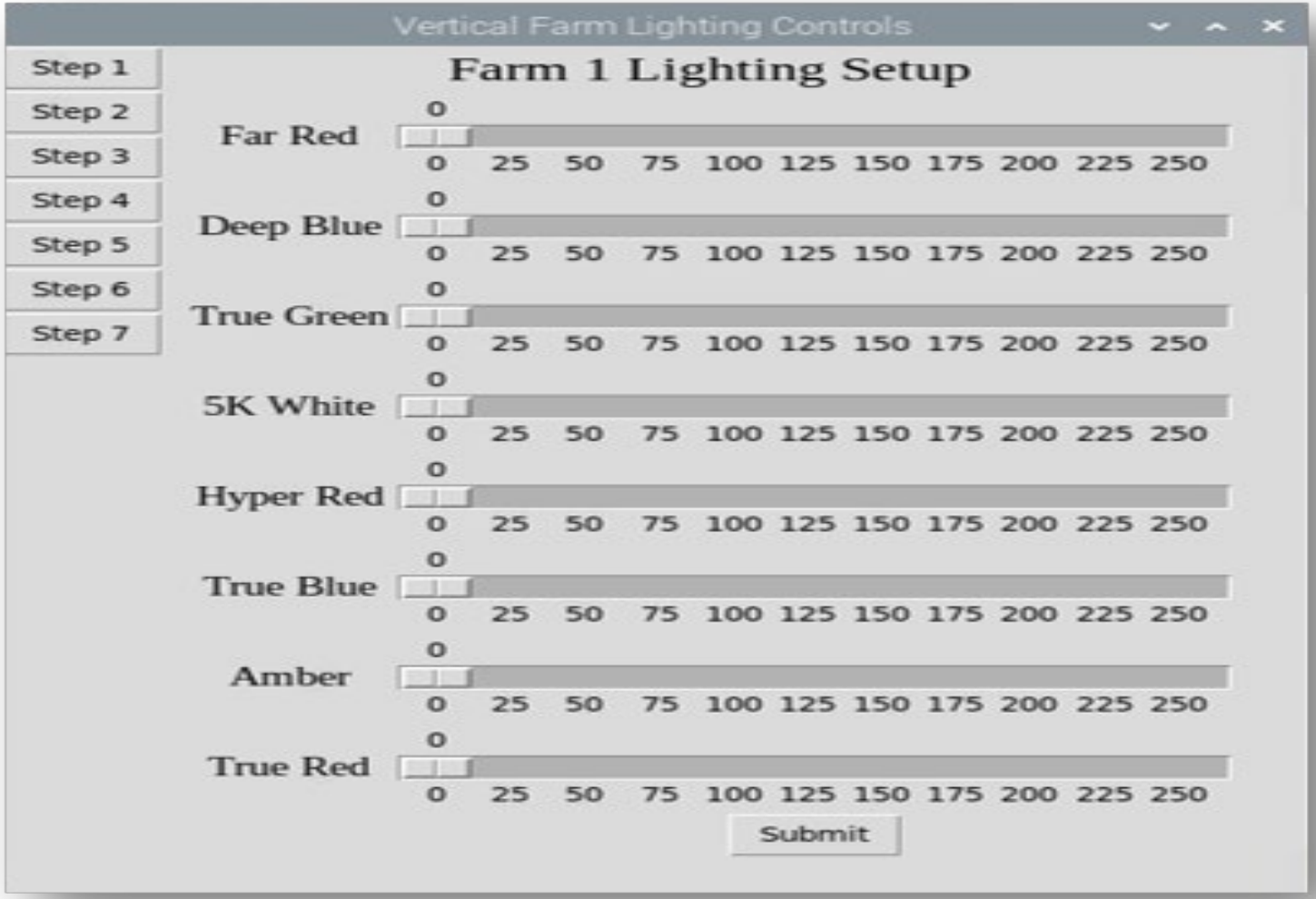
Raspberry Pi 3 (B+)

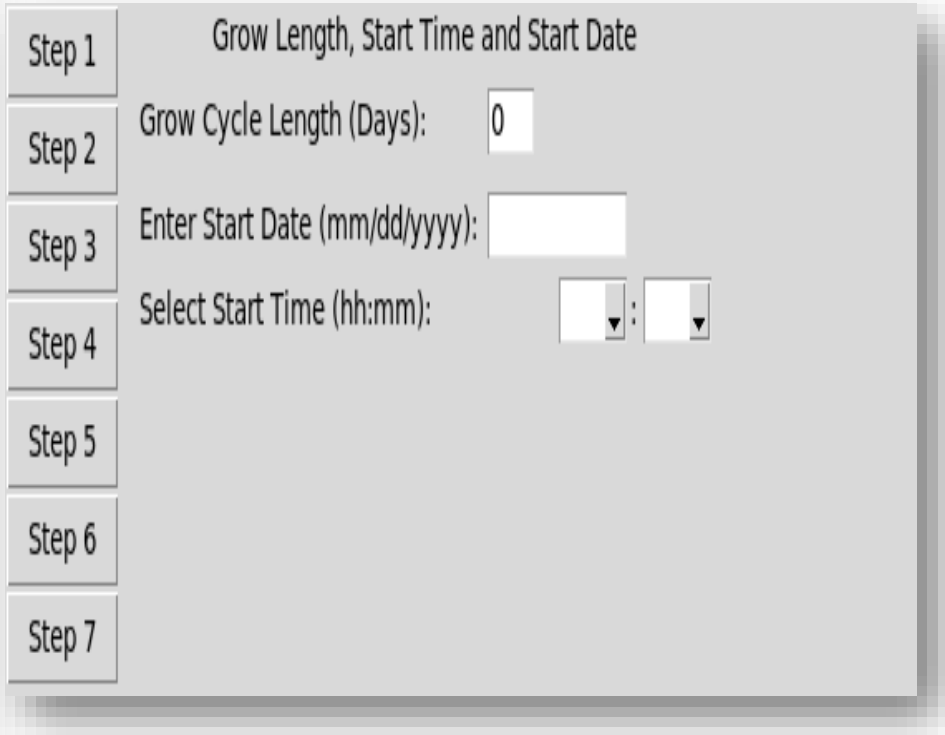
Vellman USB Controlled DMX Interface(1)

Max 465W GrowEmity IDB LED kit (8)

Max 27W UV LED Bar Light (4)

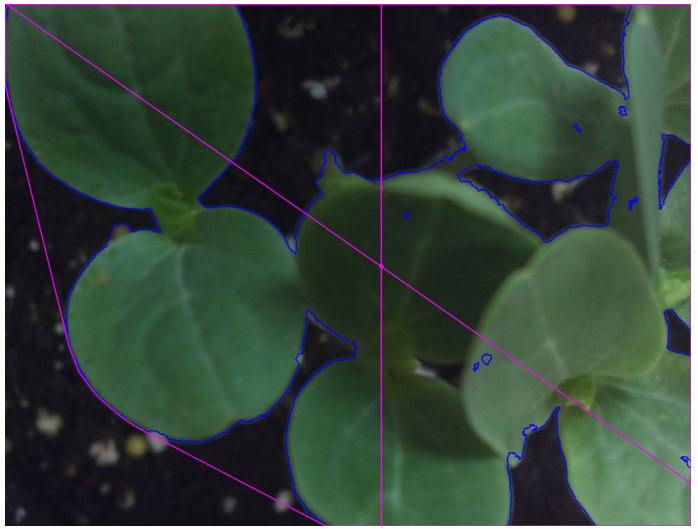
Lighting GUI





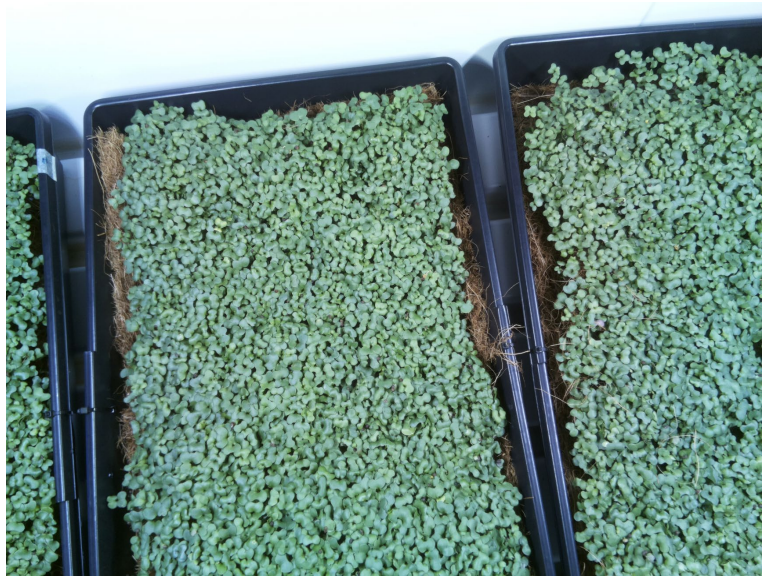
Computer Vision - PlantCV

- Touchless data gathering
- Leaf Area Index

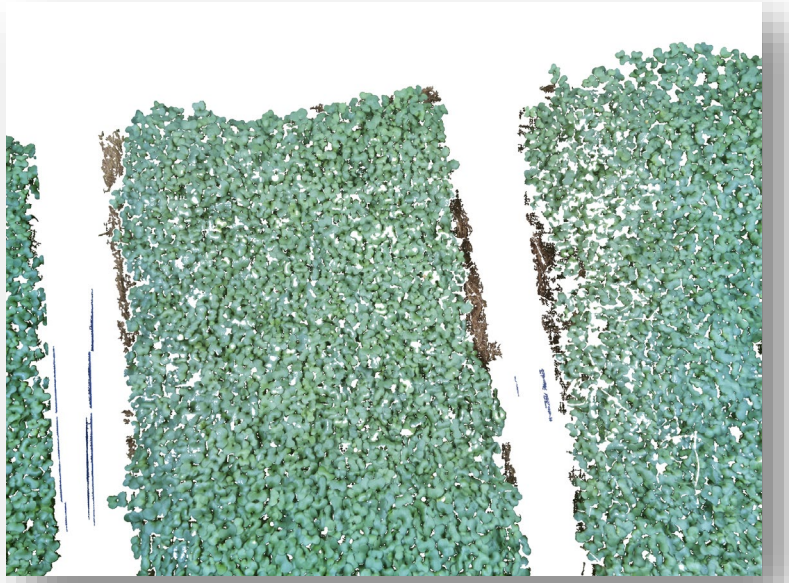


Computer Vision - PlantCV

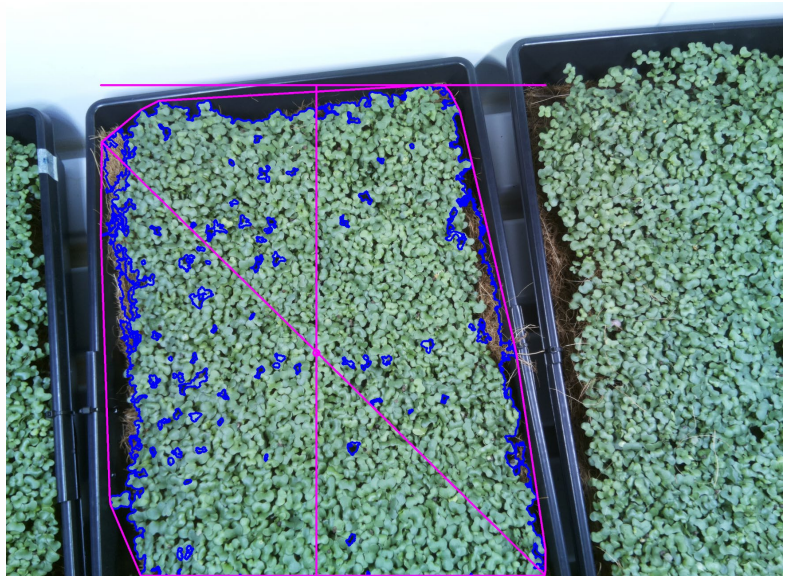
Computer Vision - PlantCV



Input Image



Background removed



Area of interest captured

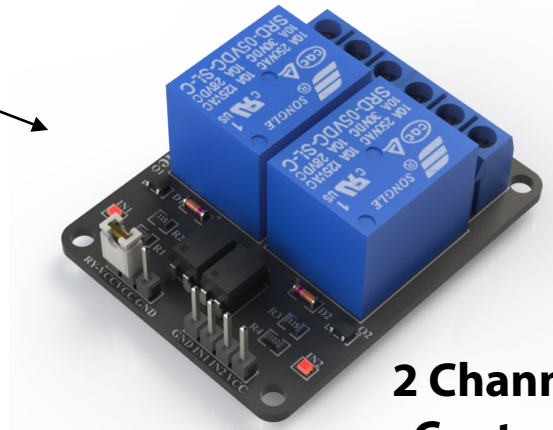
IRRIGATION SYSTEM

Germination/Irrigation Sub-System

Raspberry Pi 3
(B+)

(2)12A
Controllable
Relay Module

(4)250gph
Agromax
Submersible Pump



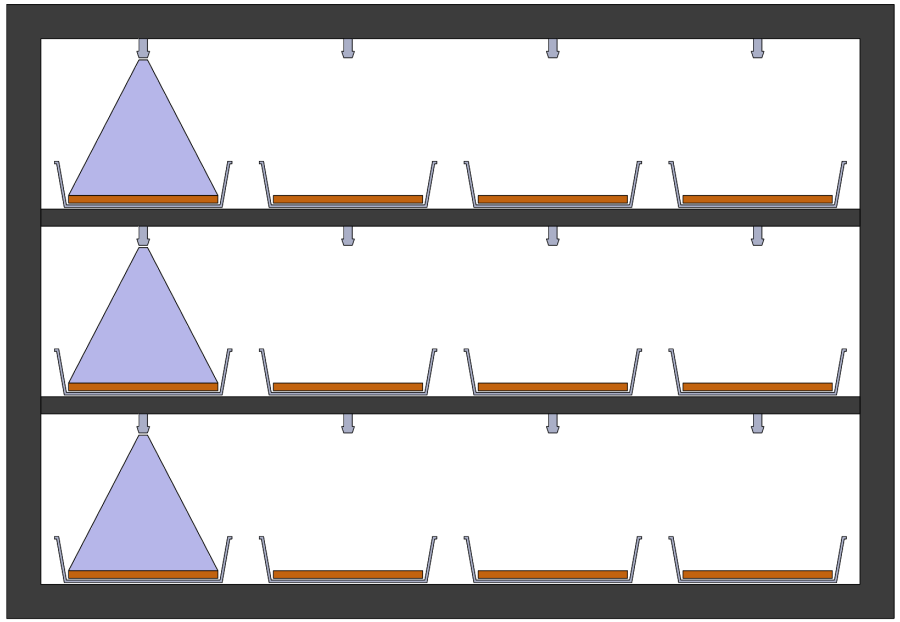
2 Channel Relay
Control Board

250gph Agromax
Submersible Pump

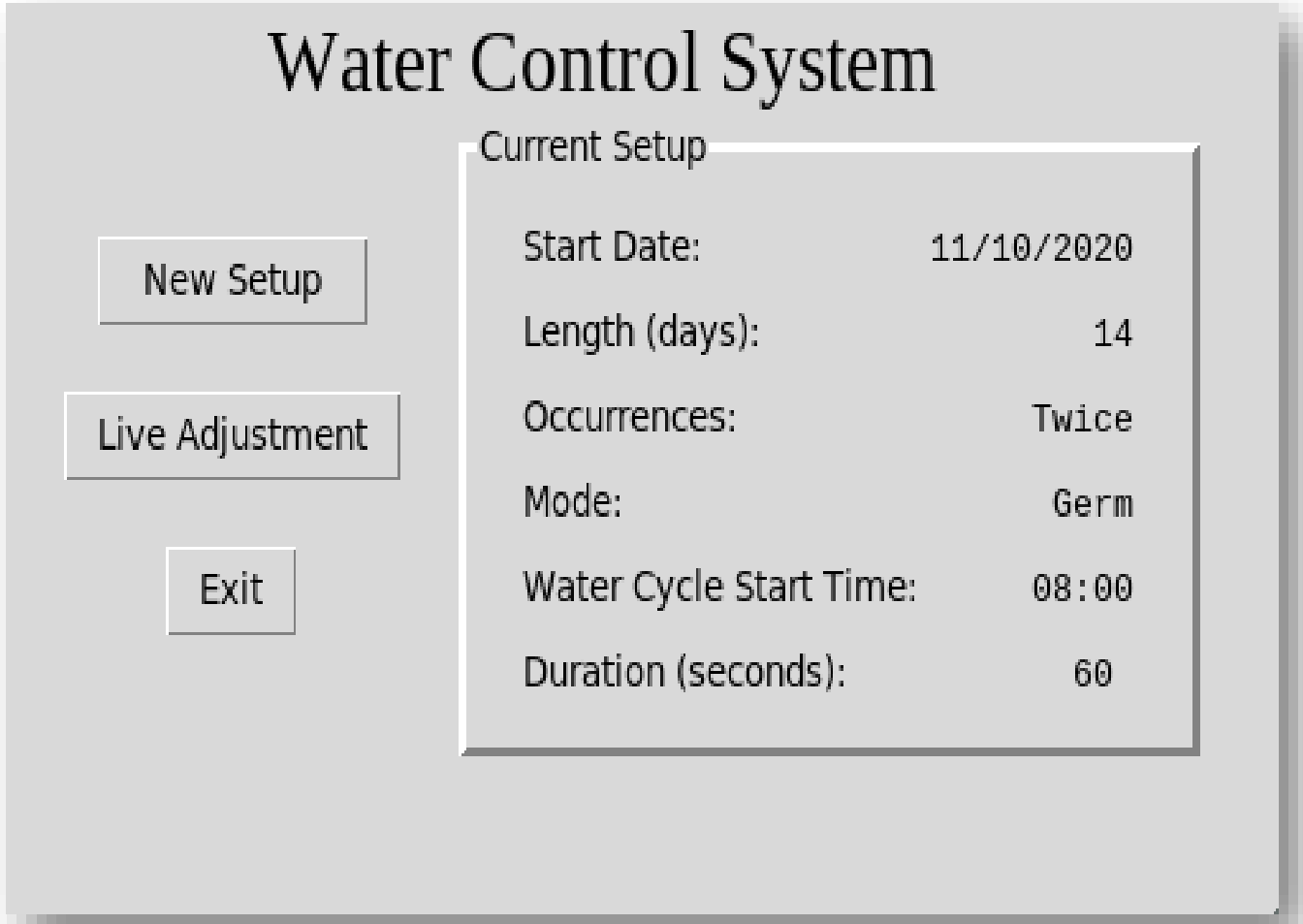
Automatic Germination Sprayer System

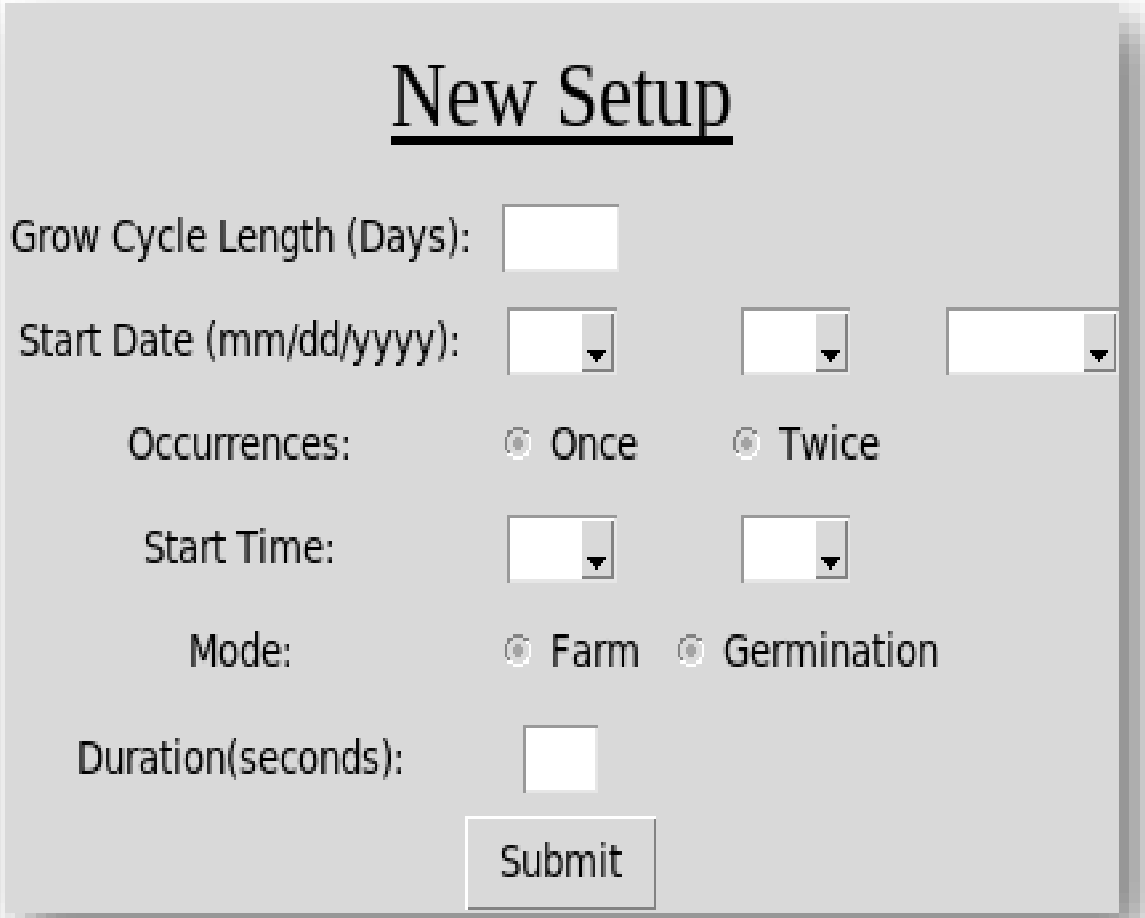
Design implementation

- Tray mounts
- Misting sprayers
- Control relay
- Misting automation program



Hydroponic System – GUI

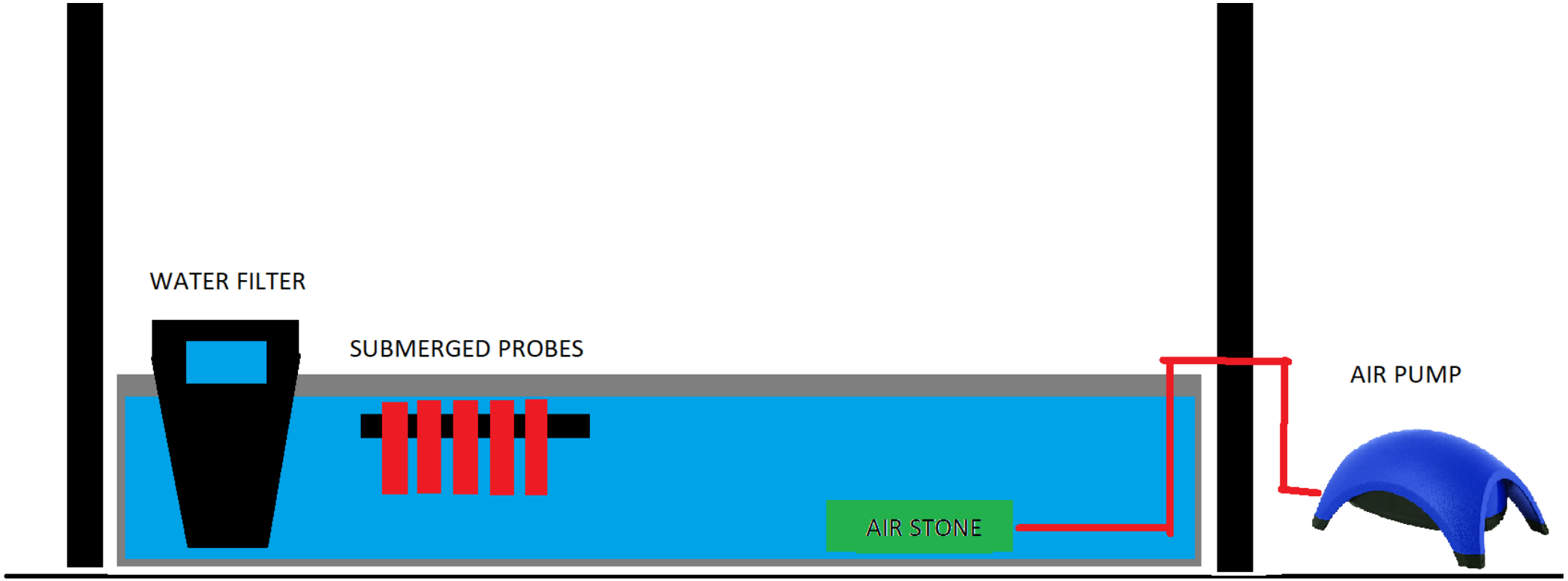




Hydroponic System

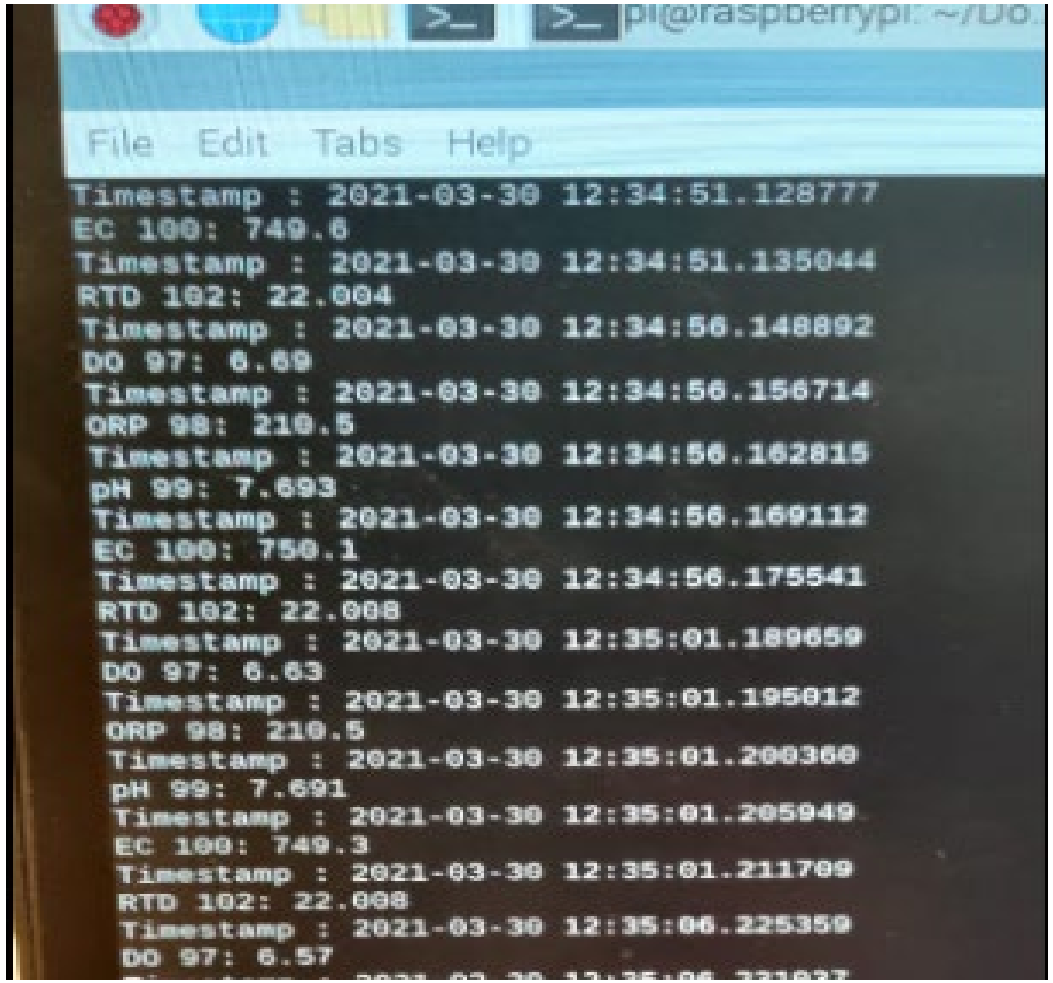
- Water quality system implement to reduce:
  - Electrical conductivity (300-400mV)
  - Dissolved oxygen (4-5 mg/L)
  - pH levels (5.5-6.5)
  - Temperature (70-80°F)

Hydroponic System - Additions



Water Quality Sensor Readings :

- DATA IS RECORDED INTO A CSV FILE



Acknowledgements

- Dr. Kevin Martin *Northern Illinois University, DeKalb, IL USA*
- Dr. Pratool Bharthi *Northern Illinois University, DeKalb, IL USA*
- Bhama Krishna Pillutla *Northern Illinois University, DeKalb, IL USA*
- Ethan Tse *Georgia Institute of Technology Atlanta GA, USA*

- **Funding**
  - Department of Engineering Technology
  - NIU College of Engineering and Engineering Technology

References

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