PeaPod - Design Proposal

Outlining a Proposal to the PeaPod Design Brief

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1 Introduction

1.1 Purpose

The purpose of this document is to outline a the fuction and features of a proposal to the PeaPod design brief.

It accomplishes this by answering the following questions on a recursively-scoping basis:

1. **What** is the design? What does it accomplish/what is its function?
2. **How** does it accomplish this? What are its features?
3. **Why** that functionality? Why that way?

2 Design

Functions of the design are derived from the input and output requirements.

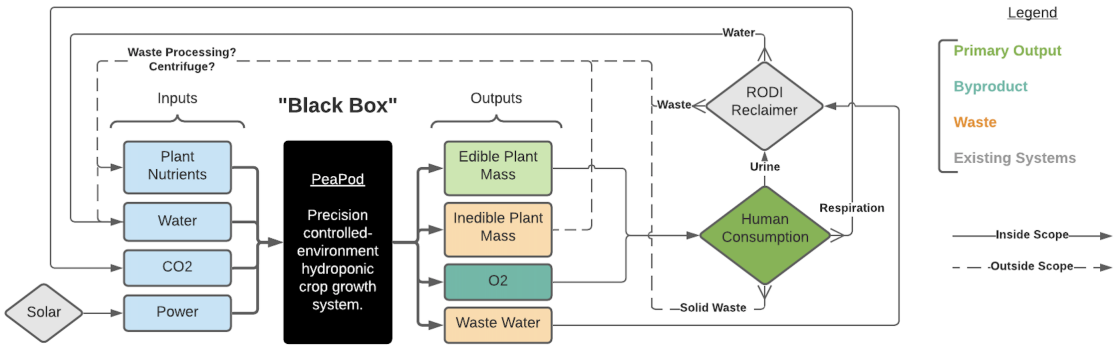

Figure 1: "Black box" input-output model of PeaPod.

Features of the design are developed to meet the function, and are derived from the opportunity statement:

PeaPod is "an automated and isolated aeroponic crop growth system, able to generate any environment from a combination of independent environment parameters, with both environment and crop growth data collection".

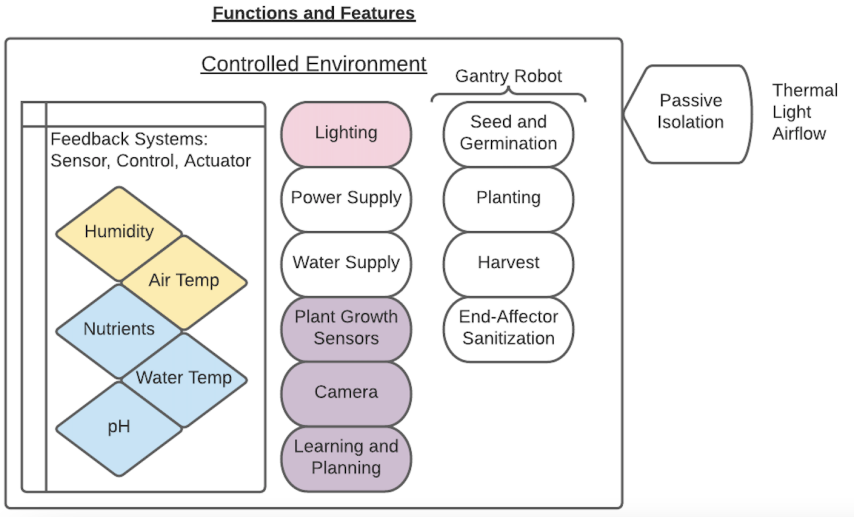

Figure 2: Features and feature types of PeaPod.

2.1 Automation

What: Performing tasks autonomously on a schedule or necessity basis

How: Fixed schedule; "Sense, Plan, Act" robotics/control model:

1. *Senses* current conditions
2. *Plans* a path to desired condition
3. *Acts* to change current condition to desired condition

Why: Increase accuracy/precision, minimize human hours spent

2.2 Isolation/Insulation and Housing

What: Isolates the growth environment from the exterior environment.

How: Cubic exoskeleton (aluminum extrusion) holds solid (acrylic/foam) interenally-reflective (mylar) panels in place and aids in mounting plant growth platforms, lights, etc.

Why: Increases thermal and light efficiency. Isolation increases protection against pathogenic substances. Simple and strong construction.

2.3 Aeroponics

What: Medium-free growing method that uses nutrients dissolved within atomized water

How: High-pressure (pump-tank-switch system) nozzles deliver atomized (≈50 micron droplet) nutrient solution to plant roots. Parallel distribution topology (T-quick-connects at every unit height, solenoid ball valves at tank out and in each tray)

Why: No water parameter feedback, 98% more water efficient, minimizes pathogens and waste water

2.4 Environment Control

The environment control feature can be broken up into **control systems** (2.4.1-2.4.3; sometimes in two parts) and **set systems** (2.4.4-2.4.7).

2.4.1 Air Temperature

What: Maintaining desired air temperature within the enclosure

How: Thermoelectric heating/cooling system (peltier tiles w/ polarity switch and 'dimming' current control) on a heat sink w/ fan

Why: Better space and energy efficiency, less complexity (no liquids, pressurized fluids, etc.), better control

2.4.2 Air Humidification

What: Adding water vapour to air

How: Ultrasonic nebulizer (piezo disc w/ custom driver circuit), RO water

Why: Piezo for droplet size, commonly used; RO for purity of water vapour

2.4.3 Air Dehumidification

What: Absorbs water vapour from the air

How: Silica gel beads, controlling airflow rate across

Why: Non-toxic, safe, cheap, effective. Color-changing indication at saturation, easily reset by baking and recapturing water

2.4.4 Solution Temperature

What: Maintaining desired water temperature within the water store

How: Same as 2.4.1; on a water block

Why: Same as 2.4.1

2.4.5 Solution Nutrients

What: Precisely dosing the correct amount of nutrients to the water system at setup/water addition

How: Syringe dosage via servo motor to set ppm based on fill volume

Why: Syringe dosage is precise, easy to refill

2.4.6 Solution pH

What: Precisely adds pH up/down solutions to set the solution pH at setup/water addition

How: Same as 2.4.5

Why: Same as 2.4.5

2.4.7 Lighting

What: Wide spectrum precision LED lighting targeting PAR

How: N LED series/colors, N controlled-current PWM drivers, M LEDs per series = NxM LEDs. Custom LED boards wired in series, one power board per tray, w/ diffusion

Why: LED > every other type in every way, PWM easy protocol, CC because they're LEDs