Airponics Chamber

Table of Contents

Stakeholder Needs

The Airponics Chamber is guided by a series of stakeholder needs, listed below.

1: Monitoring & Control of Environmental Conditions & Nutrients

In an aeroponics system, the environmental conditions & nutrients need to be monitored and controlled for successful plant growth.[1]

1.1: Environment Temperature

In an aeroponics system, the ideal environment temperature for plant growth is 25 to 30 degrees celsius[2]

1.1.1: Environment Temperature for Tubers

In an aeroponics system for tubers, the nominal environment temperature range is 4 to 30 degrees celsius, with an ideal temperature range of 16 to 19 degrees celsius for starting tuber formation.[3]

1.1.2: Nutrient Solution Temperature for Tubers

In an aeroponics system for tubers, the nutrient solution temperature should not exceed 20 degrees celsius.[3]

1.2: Humidity

In an aeroponics system, the required relative humidity is above 60% at 25 to 30 degrees celsius.[2]

1.3: Lights

Aeroponically grown plants require varying light spectra, light/dark period, and light intensity.[4]

1.3.1: Light/Dark Period

The amount of light exposure should be limited as per the plants light/dark period (a.k.a., critical day length or photoperiod); 14 to 18 hours of light for long-day (short-night) plants, 8 to 12 hours of light (with a continuous dark period of 14 to 16 hours) for short-day (long-night) plants.[5][6][7]

1.3.2: Usable Light Spectrum

Infra-red light should be filtered out, as to utilize only the portion of the light spectrum needed for plant growth and to reduce heat build up inside of the plant cells; blue light (mid-400 nm) is beneficial for seedling and vegetative growth; red light (600 to 640 nm) is beneficial for germination and generative (flowering/blooming) growth.[4][8]

1.3.3: Light Intensity

The required light intensity, or photosynthetic photon flux density (PPFD), varies per plant and growth phase; e.g., the PPFD for tomato/cucumber is 75 to 300 umol/m2/s for seedling phase, 250 to 400 umol/m2/s for vegetative phase, & 600+ umol/m2/s for generative phase.[5][6][7]

1.4: CO2 Concentration

Elevated carbon dioxide (CO2) concentration yields increased photosynthesis; e.g., in one study, white clover grown under elevated CO2 of 600 ppm, for 8 years, retained a 37% increase in photosynthesis.[9]

1.5: Water Level

In an aeroponics system, the liquid level of the nutrient solution reservoir should be monitored as to mitigate potential leaks or container nearing empty.[1]

1.6: Nutrient Solution EC and pH level

In an aeroponics system, the electrical conductivity (EC) and pH level of the nutrient solution are essential for the plants absorbtion of nutrients.[10]

User Stories

The Airponics Chamber's stakeholder needs are then used to identify a series of user stories which then lead to design decisions captured in data structure and activity definitions.

Data Structures

This section covers each data structure type in the **Airponics Chamber**.

[1] Imran Ali Lakhiar, Gao Jianmin, Tabinda Naz Syed, Farman Ali Chandio, Noman Ali Buttar, Waqar Ahmed Qureshi, "Monitoring and Control Systems in Agriculture Using Intelligent Sensor Techniques: A Review of the Aeroponic System", Journal of Sensors, vol. 2018, Article ID 8672769, 18 pages, 2018. https://doi.org/10.1155/2018/8672769

[2] Charisma Aulia Jamhari, Wahyu Kunto Wibowo, Aulia Rahma Annisa, Teuku Muhammad Roffi, "Design and Implementation of IoT System for Aeroponic Chamber Temperature Monitoring", Vocational Education and Electrical Engineering (ICVEE) 2020 Third International Conference on, pp. 1-4, 2020. https://doi.org/10.1109/ICVEE50212.2020.9243213

[3] V. Otazú, Manual on Quality Seed Potato Production Using Aeroponics, vol. 44, International Potato Center (CIP), Lima, Peru, 2010. https://doi.org/10.4160/9789290603924

[4] Indoor Plant Lights for Aeroponics https://aeroponicsdiy.com/indoor-plant-lights-for-aeroponics/

[5] What is the right light intensity and illumination length? https://hortione.com/2020/12/the-right-light-intensity-which-distance/

[6] Kang, J.H., KrishnaKumar, S., Atulba, S.L.S. et al. Light intensity and photoperiod influence the growth and development of hydroponically grown leaf lettuce in a closed-type plant factory system. Hortic. Environ. Biotechnol. 54, 501–509 (2013). https://doi.org/10.1007/s13580-013-0109-8

[7] Islam, Jahirul et al. "Comparative Growth, Photosynthetic Pigments, and Osmolytes Analysis of Hemp (Cannabis Sativa L.) Seedlings under an Aeroponics System with Different LED Light Sources." Horticulturae 7.8 239. Web. https://doi.org/10.3390/horticulturae7080239

[8] Understanding Light Energy for Plant Growth: Aeroponic growing systems For greenhouses and indoors the natural solution for CLEAN Aeroponic food indoors. https://www.aeroponics.com/aero65.htm

[9] Thompson, Michael et al. "Effects of Elevated Carbon Dioxide on Photosynthesis and Carbon Partitioning: A Perspective on Root Sugar Sensing and Hormonal Crosstalk." Frontiers in physiology vol. 8 578. 8 Aug. 2017. https://dx.doi.org/10.3389%2Ffphys.2017.00578

[10] T. Asao, "Hydroponics - A Standard Methodology for Plant Biological Researches", Intech, Rijeka, Croatia, 1st edition, 2012. https://doi.org/10.5772/2215