AGMESH

Active Greenhouse Monitor for Efficient Sunlight Handling

ELECOMP Capstone Design Project 2022-2023

Sponsoring Company:

VoltServer Inc.
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http://www.voltserver.com

Company Overview:

VoltServer Inc. is developing and delivering to market, an innovative power distribution platform based on the company's patented Digital Electricity™ technology, which is reinventing how electrical energy is distributed by safely delivering electricity where, when, and how it is needed. VoltServer's Digital Electricity™ solutions began shipping in 2015 and are powering 4G/LTE/5G mobile services, converged desktops, LED lighting, and IoT applications in over 1000 large stadiums, airports, convention centers, office towers, hotels, condominiums, hospitals, and indoor gardens.

Technical Director:

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Project Motivation:

VoltServer Inc. has designed, developed, and deployed in the field, a lighting platform for high intensity LED agricultural lighting using our patented Digital Electricity™. Due to Digital Electricity's ability to be installed with Class 2 installation practices, this type of system has become highly sought after in the agriculture world for its simplicity, safety, and expandability. There currently are discussions of a joint project between VoltServer Inc. and the URI Department of Plant Sciences and Entomology which, if all goes as planned, will eventually lead to a Digital Electricity™ system being installed in one of the URI greenhouses.

The existing system in the proposed space (27' x 30') consists of 8 grow tables, each with its own lighting fixture, which are controlled by plugging them into wall power. One of the benefits of the Digital Electricity™ agricultural lighting system is that it supports dimming to accommodate varying levels of luminosity. Using the dimming controls of the system allows for regulated levels of luminosity despite of sunlight, when implemented with light intensity sensors. To that end, the intention of this project is to design, develop, and prototype an agricultural controller for light optimization utilizing dimming.

Anticipated Best Outcome:

The Anticipated Best Outcome consists of the delivery of a protype agricultural controller for light optimization utilizing dimming that meets all the requirements. The solution will withstand the environment for which it is built and be able to interface directly with Digital Electricity™ transmitters. Test results and a demonstration of all features will also be required.

Other deliverables to accompany the prototype hardware include:

- Schematics, layout, fabrication, and assembly files for PCBs, as needed
- A complete bill of materials for the system
- Well commented firmware and software source code and compiled binaries
- A system user manual describing the hardware and software

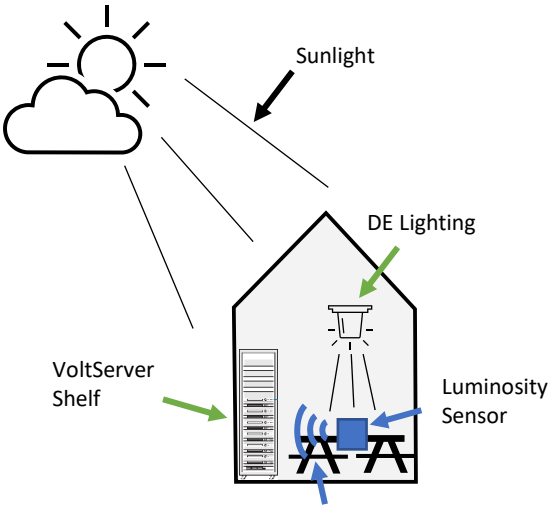
Project Details:

Agricultural Controller for Light Optimization Utilizing Dimming

- Develop a table surface-mounted sensor solution that can withstand the greenhouse environment.
    - The sensor is intended to monitor the luminosity level at the plant table height.
    - The sensor must be able to accurately report changes in light intensity.
    - The sensor must withstand damp greenhouse environment.
    - The sensor has a small (1.5” x 1.5” max) circuit board for required circuitry.
- Develop controller (preferred outcome) or identify off-the-shelf controller/computer (should be a fallback option) for sensor digitalization and communications with Digital Electricity™ transmitter.
    - Device can make sense of light sensor signals.
    - Device uses some communication protocol (CAN, Wi-Fi, SSH) to talk to the transmitter.
    - Device correctly detects light intensity.
    - Device sends correct commands to transmitter for dimming regulation.
    - Device will self-correct until desired luminosity is achieved, if possible.
    - Device can be powered both by battery and by DC barrel plug.
- Develop accompanying FW/SW for controller/computer:
    - FW/SW must be able to differentiate light intensity from sensor.
    - FW/SW must be able to determine whether more light is needed.
    - FW/SW will decrease or increase dimming level based on previously stated determination.
    - FW/SW must be able to establish communication with Digital Electricity™ transmitters.
    - FW/SW must be able to correctly communicate new dimming level, when needed.
    - FW/SW can correctly communicate with monitoring and configuration GUI.

OPTIONAL:

- Device has on-board display that presents luminosity status to user.
- Device can be powered by POE as an option.
- Device supports both Wi-Fi and ethernet protocol.
- Design the unit to be IP compliant, or at least tested to roughly IP standards for water and or dust resistance



System Diagram

Actual photo of URI greenhouse

Hardware and Electrical Tasks:

- Identify potential major system components: light intensity sensors, embedded processor or computer, DC/DC converters, etc.
- Develop schematics for light sensor/controller board, identifying how all system requirements are being met.
- Layout light sensor and main controller (if needed) PCBs.
- Build and test light sensor board and main controller board (if needed).
- Document all aspects of the hardware development and subsequent testing.

Firmware Development and Software Tasks:

- Establish communication between main controller/computer and Digital Electricity™ transmitter via CAN, SSH, or Wi-Fi.
- Develop light processing firmware capable of distinguishing and intensity of light.
- Accurately determine the required dimming level to achieve the desired luminosity.
- Convey required dimming level to transmitter via comm. Protocol.
- Develop graphical user interface for setting luminosity parameters and monitoring communications between main controller/computer and Digital Electricity™ transmitter.

Composition of Team:

2 Electrical Engineers & 2 Computer Engineers

Skills Required:

Electrical Engineering Skills Required:

- Low power embedded circuit design
- Voltage regulation circuit design
- Microprocessor circuit development
- Schematic capture
- PCB layout

Computer Engineering Skills Required:

- CAN, Wi-Fi, or SSH communication interface development
- Embedded firmware for microcontroller or similar meeting design requirements
- GUI development using Python or Visual Studios (C#)

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

Apart from being a cool solution to optimizing luminosity in a greenhouse, a device like this can be implemented into our consumer's solutions for automated light intensity control. With a device like this we can make sure that the optimal level of light is reaching the plants and avoid over-powering the LEDs in specific application, which will lead to lower power usage. Ultimately, optimizing light output at indoor farms & greenhouses has the potential of decreasing the consumer's utility bill.

Broader Implications of the Best Outcome on the Company's Industry:

The ability to deliver a light intensity solution such as this one will give VoltServer's agriculture platform one more added benefit that our consumers can enjoy. Currently dimming levels are controlled manually by the greenhouse or indoor farm operator. Unfortunately, due to variations in lighting fixtures it is possible that the dimming levels set by the operator are either overpowering the LED fixtures, or not delivering the sufficient light density for plants to grow well. This sensor will ensure that the correct amount of light, and no more, is being delivered at the plant table level in both greenhouses and indoor farms.