CLEAR

Colored LED Event Automated Reader

ELECOMP Capstone Design Project 2021-2022

Sponsoring Company:

Voltserver
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http://www.voltserver.com

Company Overview:

VoltServer 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 Directors:

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Project Motivation:

VoltServer's devices are built with integrated colored LEDs that can display status codes to the user by different sequences of LED blinks. There are generally three LEDs; one blue, one green, and one red. The status codes for each device are different but the same type of light blinking sequences combining the three lights are used across the entire Digital Electricity™ platform.

There are times during the life cycle of a VoltServer device where it is useful to decipher what the LEDs are doing. One use case is for End of Line testing in the manufacturing environment. This test device would be used to make sure that the LEDs work properly and are positioned in the correct place. Sitting at a device and watching the blinks is a mundane task that should be automated. To that end, VoltServer is proposing a colored LED blink reader that can tell the user what sequence of blinks is currently being displayed by the device.

Anticipated Best Outcome:

The Anticipated Best Outcome consists of the delivery of a protype colored LED blink reader that meets all the requirements. The LED blink reader should be able to easily apply to any of VoltServer's devices with accurate colored LED blink sequence reading. 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 two PCBs
- 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

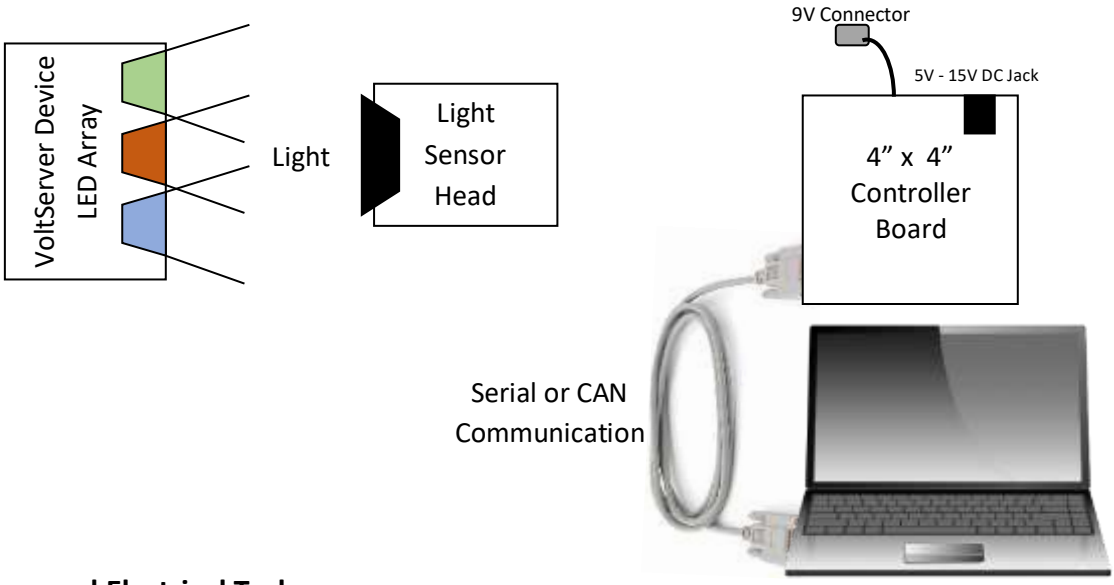
Project Details:

Colored LED Blink Reader

- Develop a sensor head that can easily be pointed at status code LEDs on VoltServer devices.
    - The sensor head must be mountable to standardized mounting solution
    - The sensor head must be able to accurately detect red, blue, and green LEDs.
- Develop Mounting Solution for the most common VoltServer product (TX550)
    - The sensor head can be easily attached to the TX card
    - The sensor head must point at the LED array on the TX card
    - The sensor head must stay at an operational distance from the TX card, at all times
- Develop a small (4” x 4” max) main circuit board for required internal circuitry.
    - The circuit board must run on a Microcontroller.
    - The circuit board must have a DC jack as well as 9V battery connector.
    - The circuit board will accept a voltage range between 5-15V.
    - The circuit board will have a nominal current consumption below 100mA.
    - The circuit board must have either CAN or Serial communication to send status code messages to a computer.
- Develop accompanying Firmware for Microcontroller to determine blink sequences on VoltServer devices.
    - Firmware must be able to differentiate between red, blue, and green LEDs.
    - Firmware must be able to differentiate between blinking LEDs, solid LEDs, and no active LEDs.
    - Firmware must be able to determine length of a blink to within 1ms
    - Firmware must be able to calibrate for ambient light.
    - Firmware must be able to tell when LED blinks have started and ended.
    - Firmware must be able to tell when LED blink sequences have started and ended.
    - Firmware must have a way to explain sequences of blinking LEDs to user.
    - Firmware must include accompanying features for CAN or Serial communications.
    - Firmware must be able to measure absolute and differential LED intensity.

OPTIONAL:

- Firmware can detect location in which LEDs are installed.
- Device has on-board display that can explain detected sequence to user.



Hardware and Electrical Tasks:

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

Firmware Development and Software Tasks:

- Establish communication between main controller PCB and user computer via CAN or Serial.
- Develop light processing firmware capable of distinguishing color and intensity of light, while accounting for ambient
- Accurately detect LED sequences from colored LED arrays
- Convey LED sequence messages to user computer via CAN or Serial
- Develop graphical user interface for monitoring and saving LED sequence message stream

Composition of Team:

2 Electrical Engineers & 2 Computer Engineers (Team of 4)

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 or Serial 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

Having a functioning prototype for testing will allow VoltServer to eventually include automated LED tests to End of Line tests during manufacturing. It will also give VoltServer the ability to convert LED sequence-based error messages and status codes into a readable format in an on-demand basis.

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

Automated LED tests will give VoltServer a slight increase in testing efficiency. The current tests depend on user input for validating LED functionality, which ultimately rely on the tester to be attentive during manufacturing for maximum efficiency. This will save time.

Being able to accurately decipher LED sequences on-demand will help technicians accurately troubleshoot our products, which will ultimately be reflected in the amount of VoltServer units that are misdiagnosed as "faulty" in the field.