Advanced Spacecraft Lighting Control System

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Problem Description

- Current lighting system lacks the ability to maintain the circadian rhythm for the crew members on a spacecraft and grow plants without sunlight.
- The objectives are:
  - To provide a innovative lighting system
  - To improve reliability and minimize power
  - To provide a lighting system that can maintain the circadian rhythm for the crew members and grow plants without sunlight.

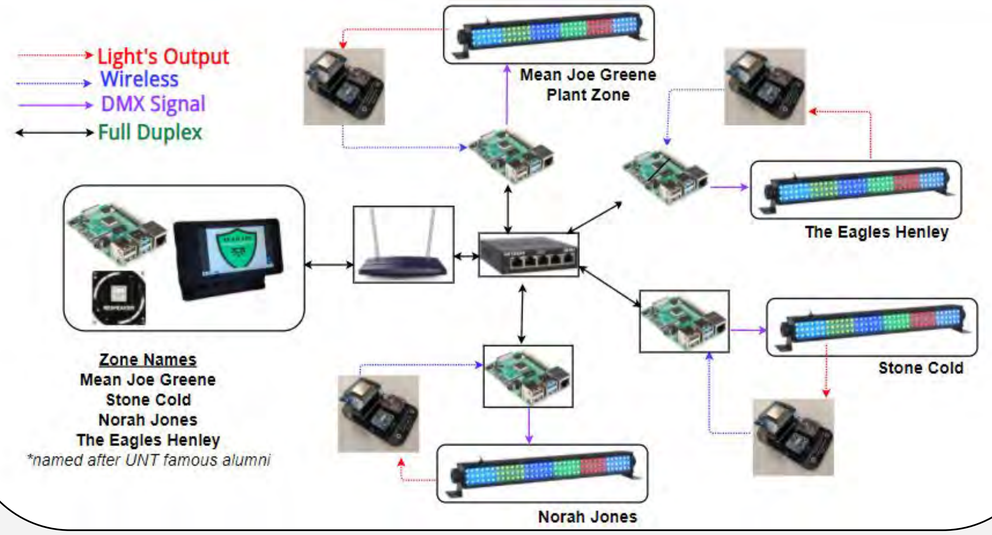
Background

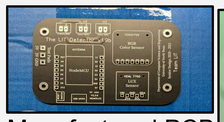
- Circadian rhythm is the 24-hour internal biological clock for the human body which regulates the sleep/wake cycle.
- Plants require a 18-hr light cycle for growing and a 12-hr light cycle for blooming.

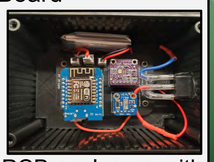
Proposed Solutions

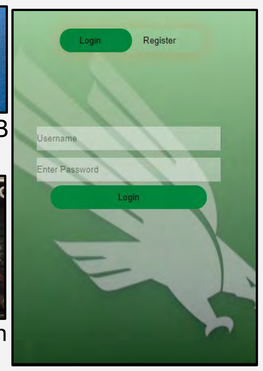
- DMX protocol to control the lights
- Raspberry Pi 4 controller connected to a network for each light.
- Database for the expected RGB values
- RGB and LUX sensors to detect the actual values of the color and the light intensity to readjust light for intensity/color degradation.
- Circadian rhythm routine for crew members
- Two-stage plant cycle routine for growth/bloom stages of a plants life.
- GUI web application
- Login system to restrict users
- Touchscreen control panel
- Voice command system
- Error detection and notification system
- GUI can be accessed with a mobile device

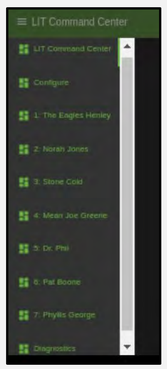
Overall System Design




Manufactured PCB Board


PCB enclosure with mounted sensors





Results

Requirement	Testing Method	What is Verified	Test Outcomes
Light Intensity and Color correction	RGB color sensor and LUX sensor data comparison	Attempt to match light intensity/color sensor values to the expected values	Successful
Voice Control	Providing voice commands only	The system performed the intended actions.	Successful
Login	Login validation	Ability to login and create accounts	Successful
Circadian Rhythm	Testing changes in color throughout the day	Maintains the circadian rhythm	Successful

Summary

- GUI created with a hashed login system, admin and diagnostic panel; referred to as LIT Command Center.
- Custom PCB for sensor system designed, prototyped, and manufactured; referred to as LIT Detector.
- A plant environment was used to grow tomatoes and mustard plants using artificial lighting.
- Voice Command System created; referred to as LIT Commander
- All the lights in the local network used OLA to change USB to DMX signals.

Future Developments

As part of the future development, we would like to see developed:

- Voice-Recognition System.
- Motion sensor detection of a human presence in each zone.
- Email confirmation for log in.

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