February 21st, 2021
Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
British Columbia, V5A 1S6

Borealis Systems

RE: ENSC 405W/440 Requirements Specification for Aurorea Lights by Borealis Systems Inc.

Dear Dr. Rawicz,

This document outlines the requirement specifications for the Aurorea Lights bias lighting kit by Borealis Systems Inc. The goal is to make a personalized lightshow within your own living room. The Aurorea Lights device primarily targets desktop users, as there are few bias lighting options out there that is compatible with desktop monitors. Aurorea Lights is also designed to be compatible with televisions, thereby satisfying home theatre enthusiasts. This means that the varying sizes and different interface connectors must be considered when building this device. With Aurorea Lights, we plan to build the world's most versatile bias lighting kit, by using LED strips of adjustable length, with a robust algorithm software driving it.

The requirement specification outlines the intended outcomes of the project and are split into three development stages: 1) proof-of-concept, 2) engineering prototype 3) final product. Sustainability and safety specifications are outlined with ease of use and user comfort in mind. Specific engineering standards are also referenced. In the appendix an acceptance test plan is included.

Our team hopes that this document provides to you a clear overview of the product. If you have any additional questions, please feel free to send an email to justinek@sfu.ca, the Chief Communications Officer.

Sincerely,

Justine Kwan

Justine Kwan
Chief Communications Officer
Borealis Systems Inc.

Requirement Specifications:

AURORA LIGHTS

By

Borealis System Inc.

Team:
Ian Carlsen
Justine Kwan
Daiki Miyanabe
Ryan Kiew

Submitted to:
Dr. Andrew Rawicz
Dr. Craig Scratchley
Dr. Shervin Jennesar

School of Engineering Sciences
Simon Fraser University

Issue Date:
February 21st, 2021

1 ABSTRACT

This document outlines the requirements specifications of the Aurorea Lights, a bias lighting product. Bias lighting is when lights are placed behind a display screen, illuminating the area behind it. Some also matches the colors on screen to create a visual spectacle. Currently, there are no bias lighting products that targets desktop computers. Aurorea Lights aims to fill this market but also intends to have strong compatibility such that it can work with different monitor sizes and televisions.

This document covers the general system and functional requirements, as well as accessibility, electrical, software, and hardware requirements of the device. They are grouped by development stages: proof-of-concept, engineering prototype and final product. Sustainability and safety requirements are also included, and the relevant IEEE standards we complied to are referenced at the end. An acceptance test plan is included in the appendix.

2 CONTENTS

List of Figures:

List of Tables:

3 GLOSSARY

Term	Description
Bias Lighting	Lighting on the back of a display screen that illuminates the surface behind.
IR	Infrared used for remote sensing
TX	Transmitter
RX	Receiver

Table 1: Glossary

4 INTRODUCTION

The goal is to create a bias lighting kit that can fit a wide variety of display sizes and devices including computer monitors, laptops, and televisions. It will extrapolate video data such that light colors will match up the localized border color of the video.

4.1 BACKGROUND

Bias lighting is a lighting fixture behind a display screen that luminates, creating a glow. Benefits include reducing eye strain and fatigue by easing the brightness disparity from the screen. Some forms of bias lighting emit light that reflect the localized color at the bordering regions, which increases the visual spectacle when watching movies.

Currently there is no competition for bias lightings that adjusts for device sizes, nor is there a product that targets desktops. As desktop computers are becoming more popular than televisions as the primary entertainment device, there is a greater market demand for that.

4.2 SCOPE

This document outlines the requirements specification of the device, the sustainability goals, and compliancy with standards. The specifications are grouped according to the development stages. An acceptance test plan is included in the appendix.

4.3 INTENDED AUDIENCE

The main audience would be desktop users; however, it will also include compatibility with other devices (e.g., televisions, laptops).

5 SYSTEM OVERVIEW

Figure 1 shows the system schematic.

A source will provide the video data via the Source Video Input.

Display Video Input 1 can output the video data; however, the video data will also be processed using the microcontroller. The microcontroller will send the processed data to the LEDs.

The microcontroller can also take user inputs via a user interface that will be displayed to Video Input 2. User inputs are taken via a controller using remote sensing.

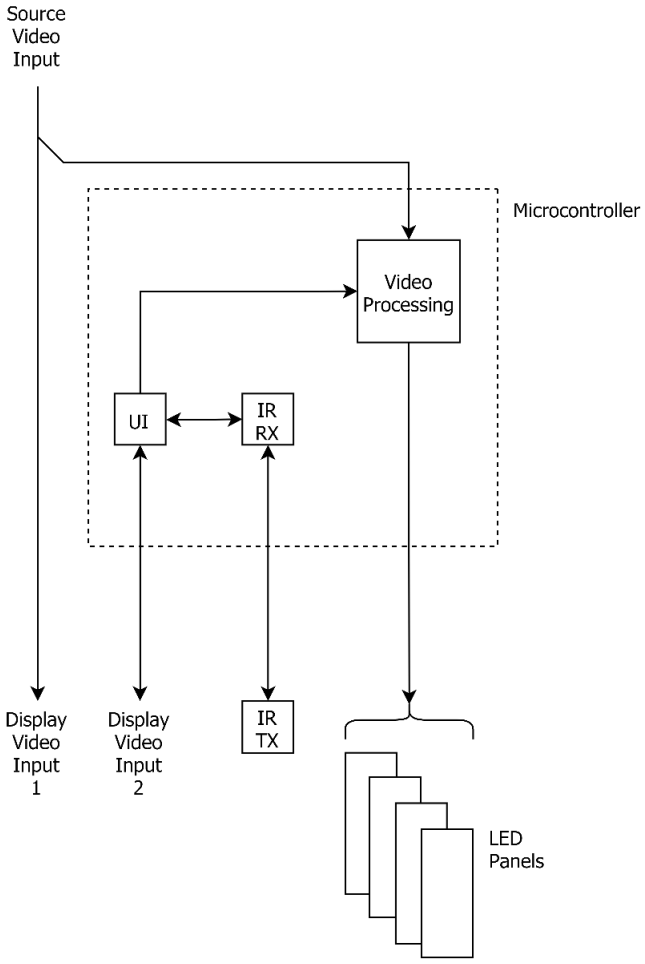

Figure 1: System schematic

6 REQUIREMENTS

The specifications in this paper will be organized in the following manner:

Req {Section}.{Subsection}.{Requirement Number} {Development Stage}

Phase	Development Stage
C	Proof-of-concept prototype
E	Engineering prototype
F	Final Product

Table 2: Requirement Specification Notation

6.1 GENERAL REQUIREMENTS

This section outlines the general requirements of the device, including system requirements and functional requirements.

6.1.1 System Requirements

Requirement ID	Requirement Description
Req 6.1.1.1 C	The system will consist of a microcontroller device, a video input and output, LEDs with variable spacing
Req 6.1.1.2 E	The device must have an on/off switch
Req 6.1.1.3 E	The device should be small enough to fit behind a monitor

Table 3: General System Requirements Specifications

6.1.2 Functional Requirements

Requirement ID	Requirement Description
Req 6.1.2.1 C	The device must be able to read video input from a source
Req 6.1.2.2 C	The device must determine what colors the LEDs should be depending on the display
Req 6.1.2.3 E	The LEDs of the device must have variable spacing between one another

Table 4: General Functional Specifications

6.2 ACCESSIBILITY REQUIREMENTS

This section outlines the accessibility requirements of the device. Specifically, device input flexibility such that it can be used by multiple different devices.

Requirement ID	Requirement Description
Req 6.2.1 C	The LED strips must have adjustable clips to attach to different devices
Req 6.2.2 E	The device must include connectivity to different devices
Req 6.2.3 F	The system must include a conversion manual
Req 6.2.4 F	The LEDs of the device must be easy to put together

Table 5: Accessibility Requirements Specifications

6.3 Electrical Requirements

This section outlines the electrical requirements of the device. Specifically, the control of the LEDs and wiring.

Requirement ID	Requirement Description
Req 6.3.1 C	The LED strips must have individually accessible RGB/RGBW LED's

Table 6: Electrical Requirements Specifications

6.4 Front-End Software Requirements

This section outlines the front-end software requirements of the device. This includes specification about the user interface and user interaction.

6.4.1 General Requirements

Requirement ID	Requirement Description
Req 6.4.1.1 C	The application must have a user interface
Req 6.4.1.2 C	The application must include an option to adjust brightness of the LEDs
Req 6.4.1.3 E	The application must include option to adjust color saturation of the LEDs
Req 6.4.1.4 C	The application must display whether it is connected to the device
Req 6.4.1.5 C	The application must be able to display any error messages transmitted from the device
Req 6.4.1.6 E	The application must provide the user an interface to enter aspect ratio information of the monitor, and send that information to the device

Table 7: General Front-End Software Requirements Specifications

6.4.2 Performance Requirements

Requirement ID	Requirement Description
Req 6.4.2.1 E	The application must have a start-up time of less than 10 seconds
Req 6.4.2.2 E	The application must not take longer than 30 seconds to connect to the controller
Req 6.4.2.3 E	The application must not take longer than 5 seconds to send commands to the device

Table 8: Front-End Software Performance Requirements Specifications

6.5 Back-End Software Requirements

This section outlines the back-end software requirements of the device. This includes video data input analysis and ensuring connectivity within the system.

6.5.1 General Requirements

Requirement ID	Requirement Description
Req 6.5.1.1 C	The software should run with ESP32 MCU unit and/or FPGA
Req 6.5.1.2 C	The software must be able to determine the colors of the LEDs depending on the display
Req 6.5.1.3 E	The software must be able to receive and transmit data from and to the application
Req 6.5.1.4 E	The software must ensure that the system never results in an undefined state
Req 6.5.1.5 E	The software must ensure connectivity between devices
Req 6.5.1.6 E	The software must be able to adjust the brightness of the LEDs according to the settings on the front-end software
Req 6.5.1.7 E	The software should not turn on the LEDs if no input is detected
Req 6.5.1.8 E	The software must be able to receive information regarding the aspect ratio of the monitor from the application, and change the colors of the LEDs accordingly
Req 6.5.1.9 E	The software should adjust the brightness of the LEDs depending on the display
Req 6.5.1.10 E	The software should send appropriate error and warning messages

Table 9: General Back-End Software Requirements Specifications

6.5.2 Video Processing Requirements

Requirement ID	Requirement Description
Req 6.5.2.1 C	The software must be able to detect video input
Req 6.5.2.2 C	The software must be able to interpret and process video data from the input source
Req 6.5.2.3 C	The software must use color extrapolation algorithms to determine the colors of the LEDs
Req 6.5.2.4 F	The software should utilize motion compensation algorithms to determine the colors of the LEDs
Req 6.5.2.5 F	The software should consider the frames per second of the source and adjust the LEDs accordingly

Table 10: Software Video Processing Requirements Specifications

6.5.3 Performance Requirements

Requirement ID	Requirement Description
Req 6.5.3.1 E	The software must have a start-up time of less than 5 seconds
Req 6.5.3.2 E	The software must change the colours of the LEDs synchronously with the display
Req 6.5.3.3 E	The software should automatically turn off after 5 minutes if no video data is being transmitted
Req 6.5.3.4 E	The colors of the LEDs must be visually indistinguishable from the colors of the display

Table 11: Software Performance Requirements Specifications

6.6 HARDWARE REQUIREMENTS

This section outlines the hardware requirements of the device.

Requirement ID	Requirement Description
Req 6.6.1 C	Must use an embedded controller and/or FPGA for processing
Req 6.6.2 E	Must be able to connect to different devices via different interface connectors
Req 6.6.3 E	Must have a module to enable control from the front-end software

Table 12: Hardware Requirements Specifications

7 SUSTAINABILITY AND SAFETY

To ensure sustainability and safety by the device, the following requirement are specified.

7.1 SUSTAINABILITY

One way to meet sustainability needs is to have flexible compatibility. This reduces the need to for specialized adaptability parts which could be wasteful or unused. The device should also be durable enough that the user can easily move the device to a different screen if they choose to.

The variable spacing modules should be able to reach the sizing length of average lengths television, however, the variable spacing modules should not, within reason, generate excessive waste.

Requirement ID	Requirement Description
Req 7.1.1 F	The device should not need excessive parts
Req 7.1.2 F	The device must be durable enough to handle movement to multiple devices
Req 7.1.3 F	The variable spacers for the LEDs should not generate excessive waste

Table 13: Sustainability Requirements Specifications

7.2 SAFETY

It is understood that some people are sensitive to flashing lights. This system is not recommended for such individuals. Regardless, the device should still comply with the recommendations outlined by IEEE Std 1789-2015. To prevent direct exposure to bright lighting, there must be a diffuser covering and it should comply with the recommendations outlined by ST 196:2003 and RP 51:1995.

Requirement ID	Requirement Description
Req 7.2.1 F	The LEDs must come with a light diffuser cover to prevent blinding
Req 7.2.2 F	The LEDs must comply with the recommendation outlined by IEEE Std 1789-2015
Req 7.2.3 F	The LEDs must comply with the recommendations outlined by ST 196:2003 and RP 51:1995
Req 7.2.4 F	The system fully assembled should be completely enclosed and not pose an electrical hazard
Req 7.2.5 F	The packaging of variable spacers and LEDs should display warnings for choking hazard
Req 7.2.6 F	The device should not have sharp edges

Table 14: Safety Requirements Specifications

8 ENGINEERING STANDARDS

Relevant standards are listed below. The standards are in regard to sensitivity flickering lights and recommendations for indoor projection in films.

Standard	Description
IEEE Std 1789-2015	IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers [1]
ST 196:2003	SMPTE Standard - For Motion-Picture Film — Indoor Theater and Review Room Projection — Screen Luminance and Viewing Conditions [2]
RP 51:1995	SMPTE Recommended Practice - Screen Luminance and Viewing Conditions for 8-mm Review Rooms [3]

Table 15: IEEE Engineering Standards

9 CONCLUSION

Unlike typical bias lighting kits offered out there, Aurorea Lights will have adaptive LEDs that change colors and brightness according to the display. The LED strips are easily adjustable to any width, allowing it to be compatible with most common household monitors. The robust software that forms the back end of Aurorea Lights will be responsible for the video processing and LED adjustment. It will also come with an application that connects to the system - used to control the brightness of the LEDs, should the users choose to do so.

Aurorea Lights emphasize sustainability through reduction of specialized parts. With its high level of compatibility, users would not need to purchase extra adaptability parts that may result in extra waste. Aurorea Lights will also be compliant to IEEE standards to ensure the safety of our customers.

We at Borealis Systems believe that everybody should be able to experience bias lighting on any platform of their choice. Aurorea Lights is our answer to this sentiment. Our driven group of engineers will strive to build a polished final product that meets all requirements listed in this document.

10 REFERENCES

[1] "IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers," *IEEE Std 1789-2015,* Vols. 1-80, 5 June 2015.

[2] "ST 196:2003 - SMPTE Standard - For Motion-Picture Film — Indoor Theater and Review Room Projection — Screen Luminance and Viewing Conditions," *ST 196:2003,* pp. 1-4, 20 Oct 2003.

[3] "RP 51:1995 - SMPTE Recommended Practice - Screen Luminance and Viewing Conditions for 8-mm Review Rooms," *RP 51:1995,* pp. 1-2, 1 Jan 1995.

11 APPENDIX

11.1 ACCEPTANCE TEST PLAN

Company 15

Test Sheet	
	Date:

Software		
1- Application:		Comments:
Display whether the application is connected to the device	☐ Yes ☐ No	
Adjust brightness of the LEDs	☐ Yes ☐ No	
Displays error message from the device	☐ Yes ☐ No	
2- Device:		Comments:
Video input detected	☐ Yes ☐ No	
Video output displays video source	☐ Yes ☐ No	
LEDs change colors according to video source	☐ Yes ☐ No	
LEDs adjust brightness according to video source	☐ Yes ☐ No	
Changing to a different aspect ratio adjusts the LEDs appropriately	☐ Yes ☐ No	
Changing between 30 and 60 FPS adjusts the LEDs appropriately	☐ Yes ☐ No	
Connects to UI	☐ Yes ☐ No	
Changing the brightness setting on the app adjusts the LEDs appropriately	☐ Yes ☐ No	

Electrical		
1-Electrical:		Comments:
Lights are individually addressable	☐ Yes ☐ No	