Intelligent Lighting Control System
Spatium Lucis
User Manual Document
Version 1.0
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Contents

I.   Introduction

A. Purpose Document

The purpose of this User Manual is to detailed instructions on how a user can operate the Intelligent Lighting Control System. This user manual will go into detail over many aspects of the system. First, the system description will cover the 3 subsystems, the environment in which the ILCS needs to be in to work as well as the operations that can be performed on the Intelligent Lighting Control System. Next, the installation of the system will be discussed as well as how to configure, start, suspend, and stop from the Control Subsystem. After System Installation, the System Usage will instruct the user how to use the webpage and discusses the rules and error messages that may appear on the website

B. Scope

This document is for system administrators, registered users without administrative privilege and unregistered visitors. System administrators will find information in this document to fix common errors with the system and how to set up new additions to the system if needed. Registered users will be able to find information on how to access respective sections of the system, and unregistered users will learn how to view the system.

II.   System Description

A. Key Features

A. Key Features

1. Control Subsystem:

a. Functionality: Users communication with the intelligent lighting system is done through the control subsystem webpage which will be hosted on the mini-PC server. The webpage will contain menu options that users can use to add, edit, or delete room settings.

Key Features:

- Audio file and visual message is output through the webpage whenever there is a new notification.

- A blinking round colored button, audio file and visual message is output through the webpage whenever a led degrades

- Administrative users will be able to pair a Sensor Subsystem and Lighting Subsystem by adding a new room using the Control Subsystem website

- Administrative users will able to un-pair a Sensor Subsystem and Lighting Subsystem by deleting a room using the Control Subsystem website

- Administrative users will be able to view logs of the Intelligent Lighting Control System. The logs will contain timestamps of when new users or rooms is added, when any of the room's light or color degrades, when a room is deleted, when the sensor settings for a room is changed and when a new user is added

- Sensor intensity and color spectrum values are displayed on the Control Subsystem in the text and donut chart forms
- When a room degrades, an audio sound is played, a text notification is added to the notification drop down list and a blinking color led is displayed on the web page, are ways to ensure that the user notices the degradation

2. Sensor Subsystem:

a. Functionality: The Sensor Subsystem is the intermediate Subsystem between the Control Subsystem and the Lighting Subsystem. It manages the circadian table which is the main component of the Intelligent Lighting Control System and sends color spectrum values to the Lighting Subsystem. The circadian table holds red, green, and blue color values for every minute of the day. The purpose for this is that for a proper circadian rhythm, the amount of blue light should increase in the morning to make the user feel more alert, and the amount of red light should increase toward the evening (with blue light decreasing) to make the user feel more relaxed.

b. Key Features:

- It uses an ultrasonic range sensor to measure that the Lighting Subsystem is at least 8 feet away from the Sensor Subsystem.
- A PIR motion sensor is used to detect motion within the room that the Sensor Subsystem is placed in
- When the Sensor Subsystem detects that the brightness output from the Lighting Subsystem is too bright, it sends a dim command to the Lighting Subsystem using an RGB color sensor.

3. Lighting Subsystem:

a. Functionality: The Lighting Subsystem outputs the correct color spectrum values for every minute of the day. It will be able to go to sleep mode when motion has not been detected after 1 minute. It will also be to increase and decrease its brightness when the primary LEDs degrades or when the Sensor Subsystem detects that the lights are too bright.

b. Key Features:

- The Lighting Subsystem goes into sleep mode when motion is not detected within the room after 1 minute
- The Lighting Subsystem changes progressively in color rather than an instantaneous change

B. Inventory
- Mini Pc: This device acts as a webserver and it is where the webpage and database for the webpage is hosted
- Sensor Subsystem: This subsystem is made up of RGB color sensor for detecting color output from a lighting source, an ultrasonic range sensor, to ensure that the lighting subsystem is 8ft

away, a PIR motion sensor to detect for motion within a room and a raspberry pi to manage all sensors on the Sensor Subsystem and communication with the other Subsystems

- Lighting Subsystem: This Subsystem is made up of an LED array which is a panel that holds the LEDS, LED drivers which is used to drive individual red, green and blue LEDs, relays to turn on and turn off the power of the LED array, Power Supplies which is used to power the LEDs, one for the primary LEDs and another for the secondary LEDs and a raspberry pi to manage communication with other subsystems and the hardware on the Lighting Subsystem

C. Environment

- A room that has enough room to hang the Lighting Subsystem 8 feet above the Sensor Subsystem

- Browser capable device that will be used to control and view the status of the Intelligent Lighting Control System

- System administrator must have technical knowledge to configure and start up the Sensor and Lighting Subsystems

- Wireless network is active and running properly

D. System Operations

- Administrative users can add new rooms by pairing an unpaired Lighting Subsystem IP address and Sensor Subsystem by using the "add new room" option on the Control Subsystem website

- Administrative users can un-pair a Lighting Subsystem and Sensor Subsystem by deleting the room using the delete room option on the Control Subsystem website.

- Users can view the sensor readings on the Control Subsystem website by requesting the webpage using a browser capable device.

- The Lighting Subsystem outputs the right color spectrum for every minute of the day

III. Product Installation

A. First-Time Users

- Connect to the "spatiumLucis" wireless network

- To access the website, open your web browser and enter "192.168.1.6" and hit enter

B. Access Controls

- Only logged in users with administrative privilege can view, add, delete, and edit a room. They can also view the logs of the Intelligent Lighting Control Subsystem

- Logged in users without administrative privilege can view and edit a room only.

- Users not logged in can only view the sensors readings and degradation alerts in the rooms

C. Installation

- Lighting Subsystem: The Lighting Subsystem shall be mounted so that the LED mounting plate sits flush with the wall or ceiling that it the unit is mounted to. The installer may use either the ½"-13 that connects the LED array to the hardware mounting plate to

secure the Subsystem or may utilize the Lexan plate that the Lighting Subsystem hardware components are mounted to. There must be a minimum clearance of two (2) inches between the top of the hardware component mounting plate to ensure that there is no interference between the hardware components are whatever might be in that side of the wall or ceiling. There must also be a minimum distance of two (2) inches maintained between the bottom of the hardware component mounting plate and the bottom of the LED mounting plate. The footprint of the hardware component mounting plate is eight (8) inches square and the diameter of the LED mounting plate is 5.75 inches in diameter. The Lighting Subsystem must have access to 120/240 AC power, and both the power supply line and Raspberry Pi 3 power supply have a 2-prong U.S. outlet connection. To ensure the safety of the install technician and the hardware components, the Lighting Subsystem must be securely mounted in place before power is supplied to the system.

- The Sensor Subsystem must be mounted so that the surface of the RGB color sensor is a minimum of eight (8) feet from the surface of the LED mounting plate. The RGB color sensor must also be oriented such that its top surface is parallel with the surface of the LED mounting plate and centered on the center-line of the LED mounting plate. The Sensor Subsystem mounting plate is four (4) inches by five (5) inches and the top surface of the RGB color sensor lies approximately 1.25 inches above the top surface of the Sensor Subsystem mounting plate. The sensor subsystem must have access to 120/240V AC power, and the system is powered by a single 2-pronge U.S. power supply for the Raspberry Pi 3. Again, for the safety of the install technician and the hardware components, the Sensor Subsystem must be securely mounted in place before power is supplied to the system.

- Control Subsystem: The Control Subsystem may be installed in any location that is convenient if it has access to 120/240V AC power. The mini PC and router are both powered by a single 2-prong U.S. power supply each. The router must be placed in such a fashion so that it is within wireless communication distance between all Lighting and Sensor Subsystems, as well as the mini PC.

D. Configuration

- First time users will need to be connected to the local wireless connection to communicate with the Intelligent Lighting Control System

- To connect to the Control Subsystem, first time users will need the Control Subsystem IP address to view the website

- In the web browser address bar, enter the Control Subsystem IP Address, "192.168.1.6"

- To login to the Control Subsystem, the user will need to request a valid login ID and password from the system administrator

E. Starting the System

a. Start the Control Subsystem:

    i. Power on the Control Subsystem

      ii.   Login with admin credentials

      iii.   Proceed to Lighting Subsystem Steps

b. Start the Lighting Subsystem: (if multiple Lighting Subsystems exists, follow these steps for all of them BEFORE doing any Sensor Subsystem steps)

      i.   Power on the Lighting Subsystem(s)

      ii.   Open a terminal window

      iii.   Type "sudo python lighting_sub.py" and hit enter

      iv.   If there are more Lighting Subsystems, repeat steps 1-3. If not, proceed to Sensor Subsystem steps

c. Start the Sensor Subsystem:

      i.   Power on the Sensor Subsystem(s)

      ii.   Open a terminal window

      iii.   Type "sudo date -s '<Day of the Week> <Month> <Time in 24 format>'" and hit enter

      iv.   Type "sudo reboot"

      v.   After reboot open a new terminal window

      vi.   Type "sudo python sensor_sub.py" and hit enter

      vii.   If there are more Sensor Subsystems, repeat steps 1-3. If not, then the System is now fully restarted

F. Stopping the System

- Delete all rooms using the Control Subsystem delete button. This un-pairs all Lighting and Sensor Subsystems

- Use a laptop or any network enabled device that use an ssh client to ssh into the Control Subsystem and each of the sensor and Lighting Subsystems and issue the command "sudo shutdown"

- Wait for the connections to close themselves. This will indicate that the subsystems are powered off.

G. Suspending the System

- From any device that has ssh capability, ssh into the Sensor and Lighting Subsystem that needs to be suspended

- Type "sudo python suspend.py" on both the Sensor and Lighting Subsystems

IV. Step-by-Step Usage

A. Instructions

To perform any of the system functionality listed below, the user's browsing capable device must be connected to the Intelligent Lighting Control System local WIFI network. Also, the Intelligent Lighting Control System webpage must be open on the device.

- To pair a Sensor and Lighting Subsystem:

  o First get the IP address of Sensor Subsystem and Lighting Subsystem by entering the command "ifconfig" on the terminal for the Sensor and Lighting Subsystems. (A new terminal can be opened by pressing the CTRL, ALT, and the t-key at the same time)

  o Write down the wlan0 or wlp1s0 inet addr value

```
spatiumlucis@spatiumlucis ~ $ ifconfig
enp2s0    Link encap:Ethernet  HWaddr 00:01:2e:6f:4d:57
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:3976 errors:0 dropped:0 overruns:0 frame:0
          TX packets:3976 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:972099 (972.0 KB)  TX bytes:972099 (972.0 KB)

wlp1s0    Link encap:Ethernet  HWaddr b8:81:98:34:28:35
          inet addr:192.168.1.13  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::3eee:9be6:92e9:60bb/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:77 errors:0 dropped:0 overruns:0 frame:0
          TX packets:118 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
```

  o Next, open the web browser and enter "192.168.1.1" in the address bar

  o Login to the router with the proper credentials

  o Click "DCHP Reservation"

- o In the pop-up window, check the box next to the IP address that was written down earlier

- o Click "Add Clients"

- o Click "Save Settings"

- o Repeat for the remainder of the subsystems that to be added

- o On the Lighting Subsystem, open a new terminal and type "sudo python lighting_sub.py" then hit enter

- o On the Sensor Subsystem, type "sudo date -s <Today's date and time in 24hr format>" then hit enter

- o Then type "sudo reboot" and wait for the Raspberry Pi to reboot

- o After rebooting, open a new terminal and type "sudo python sensor_sub.py" and hit enter

- o Wait until the terminal says that it is ready to be added

o Login on the webpage with a user with administrative rights
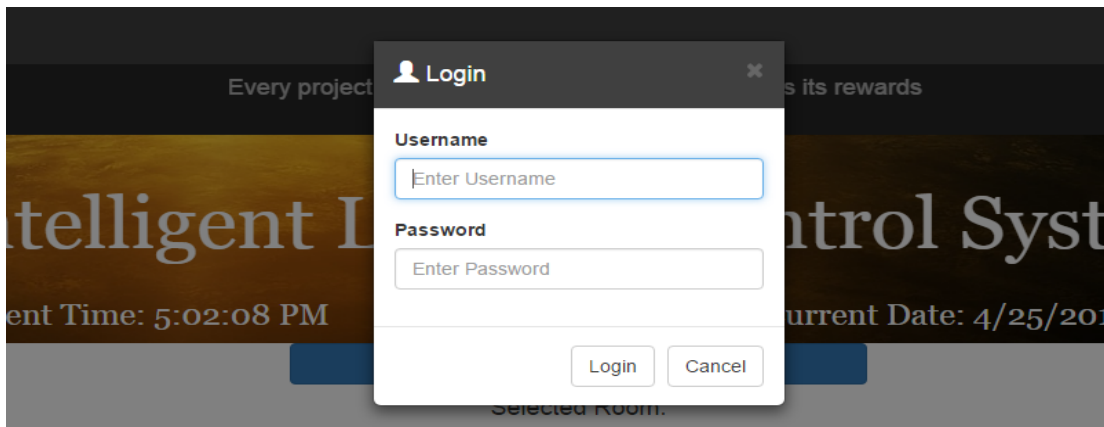
o When logged in with a user with administrative right, click on the Add New Room menu option in the admin menu
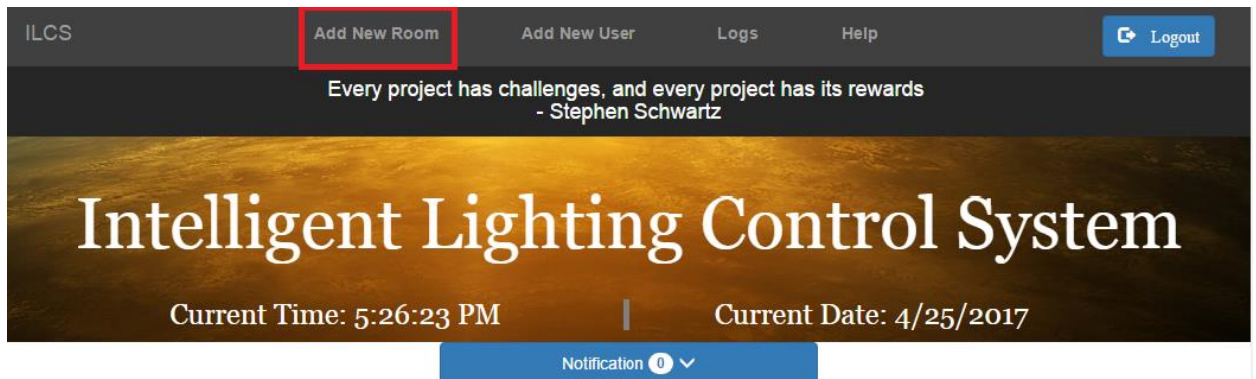
o In the opened box, enter the room name, only alphanumeric characters are allowed, wake up time, and threshold intensity for the room. All fields are required to have a value
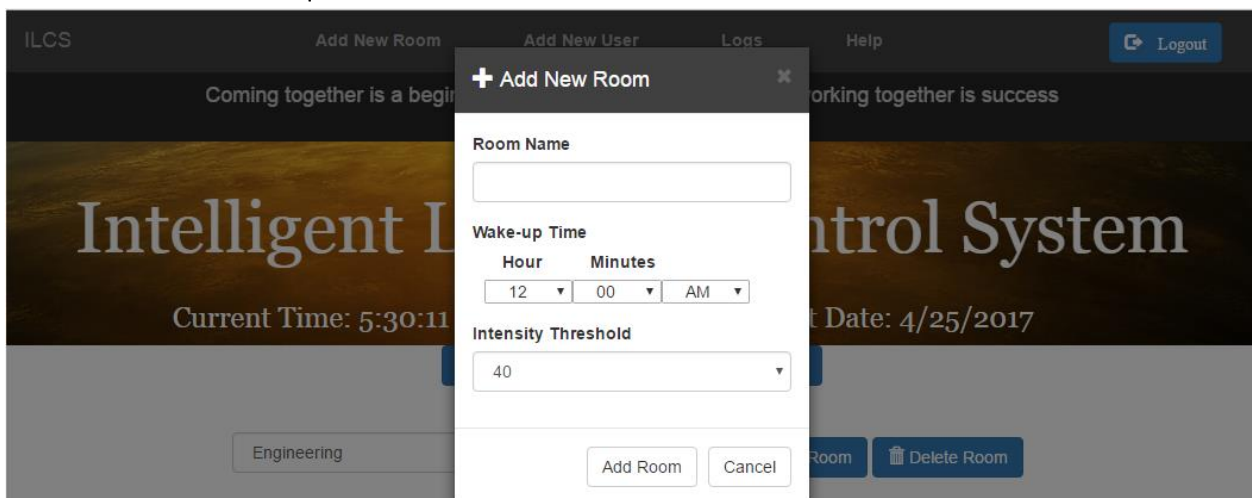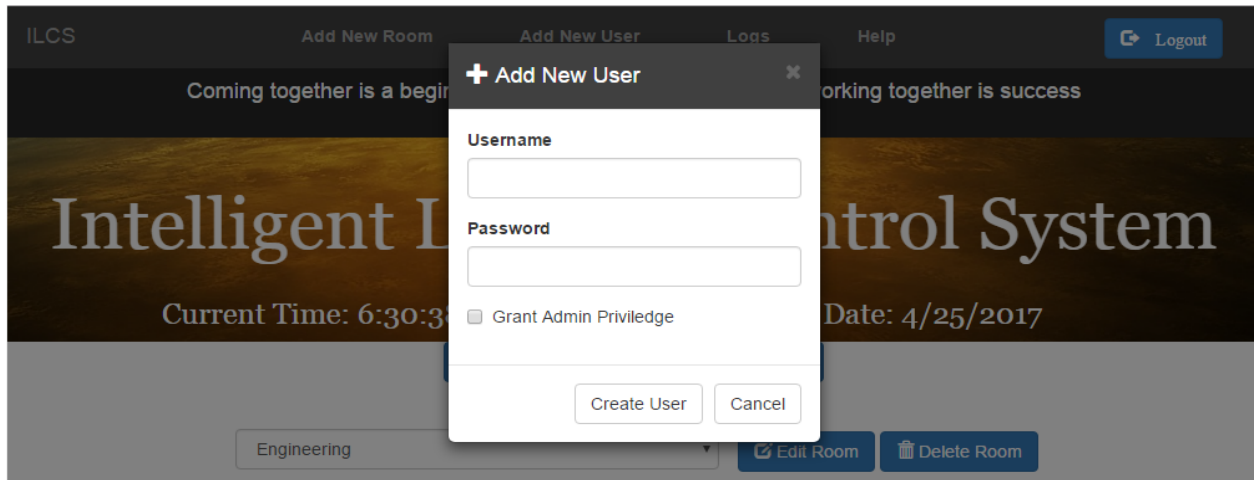
o   Click the Add room button to add the room

- To unpair a paired Sensor and Lighting Subsystem:

    o   Login on the webpage with a user with administrative rights

  o Click on the Delete room button in the room menu options
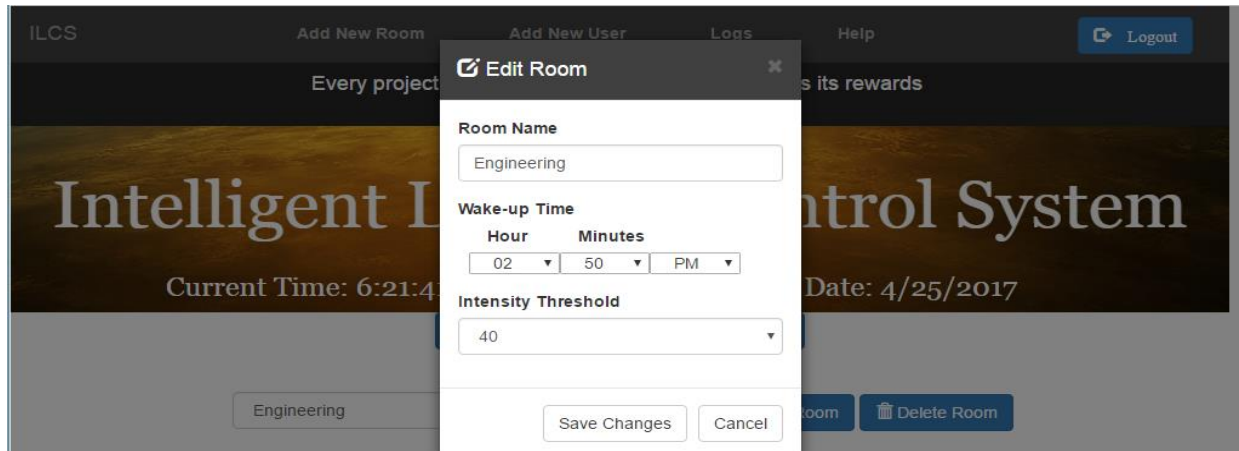
 • To modify a room settings:

   o Login on the webpage with a user with or without administrative rights
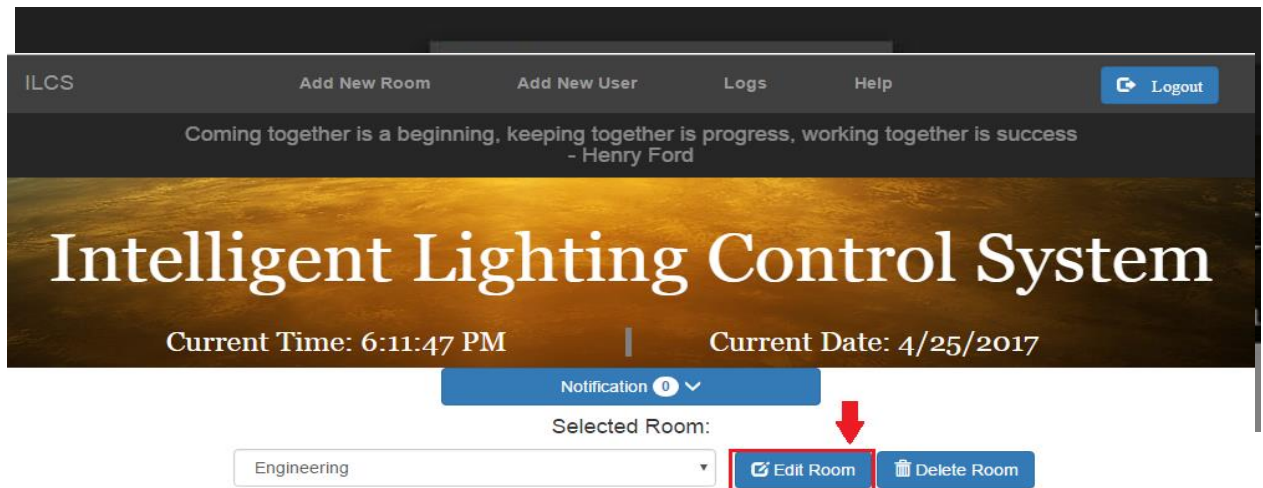
  o Click on the Edit room button in the room menu options

o In the opened box, make the necessary changes. All fields are required to have a value
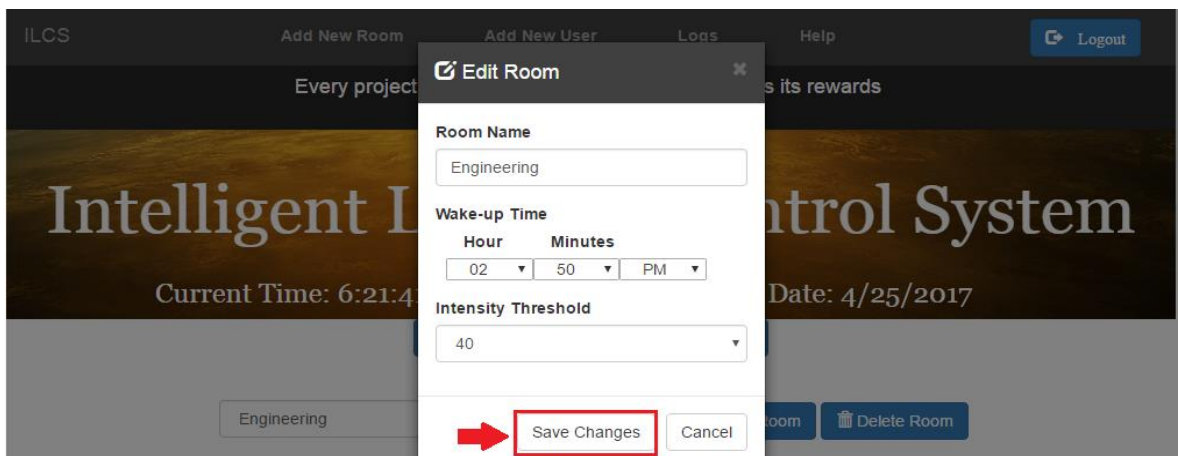
o Click save to finalize room settings modification

- To add new users:

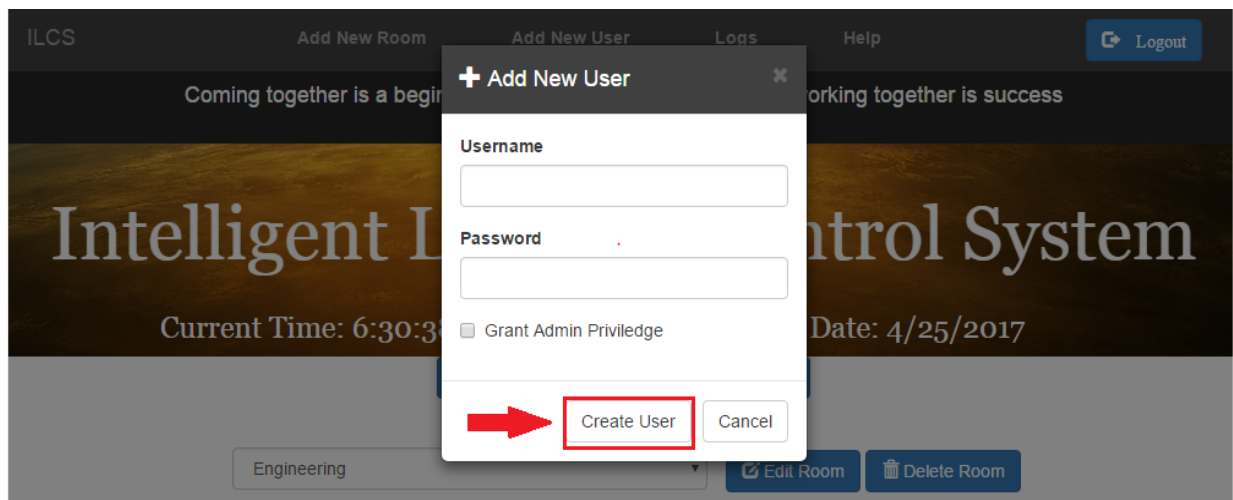o Login on the webpage with a user with administrative rights
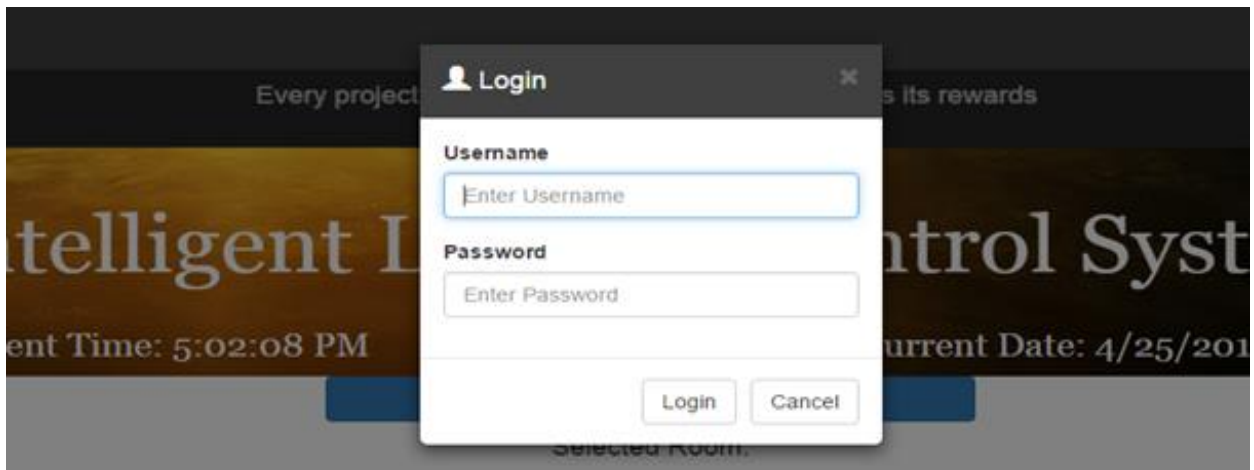
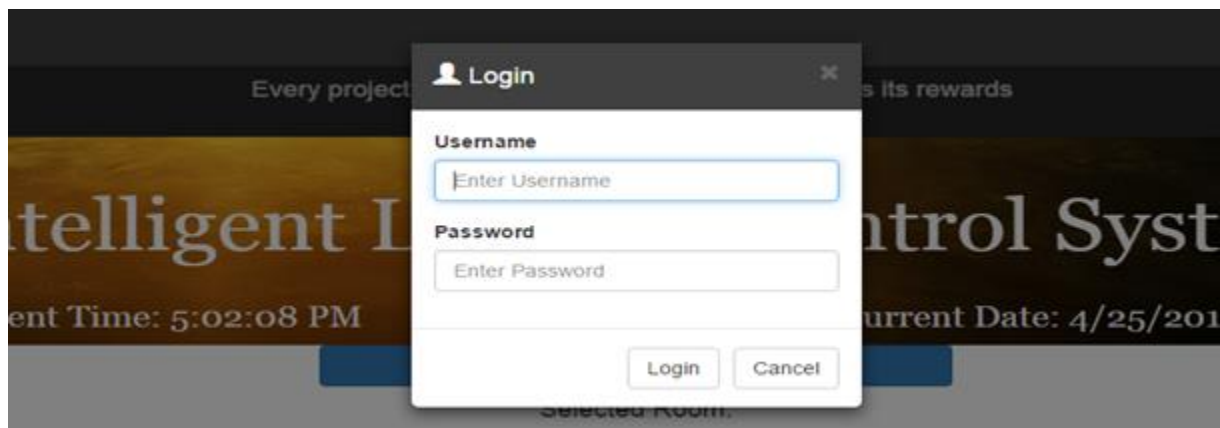o Click on the Add New User menu option in the admin menu

o In the opened box, enter a user and password for the user. Also, check the checkbox if you want to grant the added user admin right. All fields are required and the username must be unique.
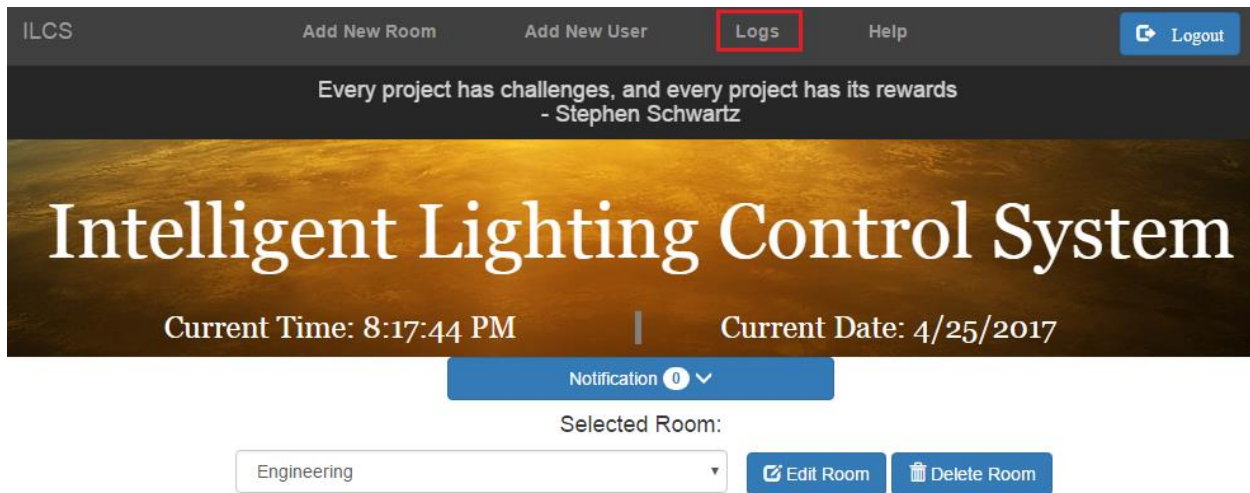
o Click on the Create User button to finalize the addition of the new user

- To view the System logs:
    - o Login on the webpage with a user with administrative rights

o Click on the Logs menu option in the admin menu

o A new tab will be opened with a table containing the logs of the system

- To view the status of any of the paired Sensor and Lighting Subsystem

  o Click on the Select dropdown menu to view the list of named paired room Sensor and Lighting Subsystem.
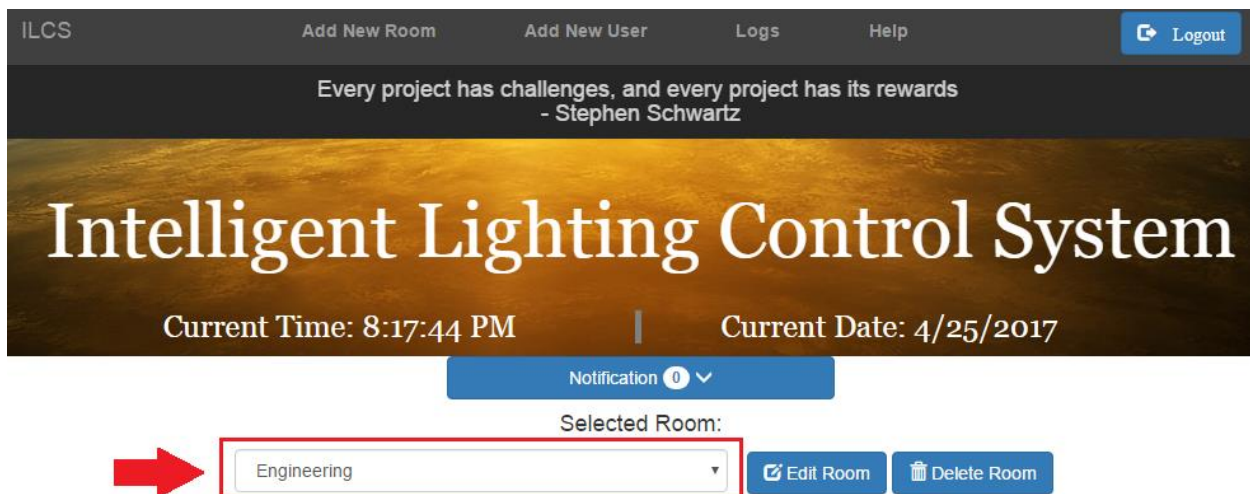
o Click on any of the room names to view the status of that paired Subsystem

- To view Notifications:
    - Click on the notification dropdown button to view notifications of all the paired Sensor and Lighting Subsystem

B. Conventions
Not applicable

C. Errors, Malfunctions, & Emergencies
- Sensor and Lighting Subsystem: (admins only)
    - Address already in use: This a python error message that occur when a port has not been cleared up by the system after the sensor_sub.py or lighting_sub.py script has ended. Simply wait about 5 minutes and try to run the script again. If the problem persists, then reboot the pi

D. Messages
- Invalid username/password: This error message is displayed when the entered login details (login and/or password) is invalid
- Room name must contain at least 5 characters: As the error message implies, this error message is displayed when a user enters less than five characters for a room name. The user will need to enter a room name that contains five or more characters
- Room name already exist: As the error message implies, this error message is displayed when a user enters a room name that already exist in the database. The user will need to enter a room name that is not already in the database
- No available IP in database: This error message is displayed when the webpage cannot find the IP address of a sensor subsystem for communication

V.   Quick Reference

ZOTAC ZBOX

Raspberry Pi 3

Motion Sensor

Color Sensor

Distance Sensor

VI. Appendixes

A. Reference Documents

- Intelligent Lighting Control System – Requirements Document
- Intelligent Lighting Control System – Specifications Document
- Intelligent Lighting Control System – Preliminary Design Document
- Intelligent Lighting Control System – Detailed Designed Document
- Intelligent Lighting Control System – Initial/Final Parts Order
- Data Sheets:
  - RGB LEDs
  - PIR Sensor
  - USR Sensor
  - RGB Color Sensor
  - Raspberry Pi
  - ZOTAC Mini-PC
- Intelligent Lighting Control System – Implementation Plan Document
- Intelligent Lighting Control System – Test Plan Document
- Intelligent Lighting Control System – Maintenance Manual Document
- Spatium Lucis – Status Reports

B. Glossary

Word	Abbreviation
Intelligent Lighting Control System	ILCS
Ultra Sonic Range	USR
Passive Infrared	PIR
Red Green Blue	RGB
Database	DB
Light Emitting Diode	LED

C. Index