Sun Station Monitor

Prepared for

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Executive Summary

In this technical report, we're going to cover the Sun Station Monitor system in details from project introduction to prototype overview. The whole project is quite straightforward but it takes us a while to figure out a suitable solution.

In here I would like to appreciate our telecommunication program head Ed Casas for continuously supporting us with his outstanding programming skills and Linux knowledge, and also Curt Shelton who has provided this excellent opportunity for us to utilize what we have learned from school on building an actual electronic device.

In the introduction, we will briefly talk about the idea behind Sun Station and the reason for building a project for it. Secondly, we will move onto the project description which presents the appearance of our Sun Station Monitor prototype, along with its specification and challenges. Next, moving onto conclusion and recommendation, we will talk about our experience for building the whole project and developed a plan for it.

Introduction

This report introduces the Sun Station Monitor which is designed and manufactured for Counselling and Student Development Department (CSDD) of the British Columbia Institute of Technology (BCIT). In order to know the times of usage and its used time so that CSDD could make a better decision on distributing these lamps, Mr. Curt Shelton from CSDD has appointed us to build a monitor that could achieve these functions.

Sun Station therapy lamp is also called day-light therapy lamp and it's used to help people who experienced symptoms of mood and sleep-related disorder during fall and winter time (the sky turns dark earlier) (Figure 1). Therefore, CSDD has distributed multiple Sun Stations all over the campus (Figure 2).

Figure 1 - The Sun Station

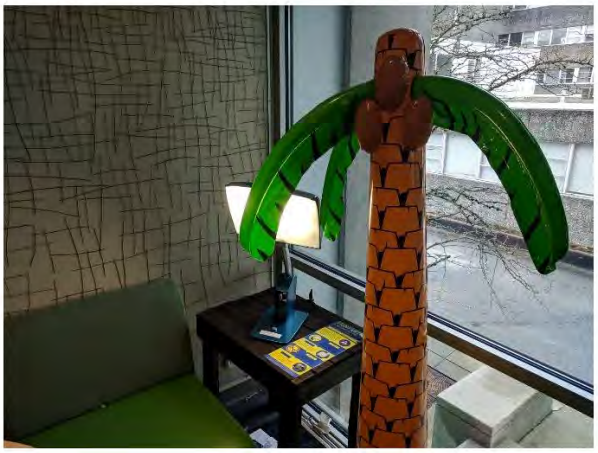


Figure 2 - The Sun Station Distribution Map

This report demonstrates the detailed information about Sun Station Monitor which is manufactured and tested by us, the schedule as well as the cost of building this project. Finally, the conclusion and future developing idea for this project.

Project Description

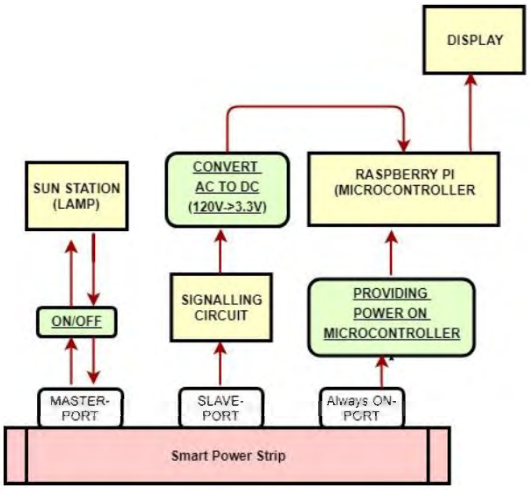
Overview

The idea of this project is to utilize a micro-controller to read the Sun Station's state and compute it's used duration, then send the result to a display screen (Figure 3).

Figure 3 - Initial Idea

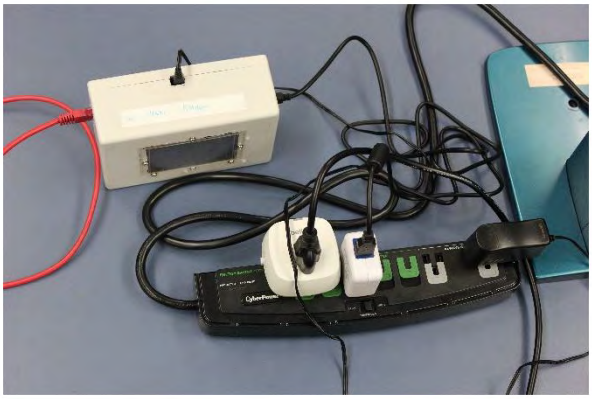
The solution we came up with is to use a mater-controlled power strip as the Sun Station state indicator, send the state signal to a Raspberry Pi micro-controller through an AC to 3.3 VDC converter circuit. The Raspberry Pi will do the record and compute with our python program then send the result to the display screen with a proper graphics user interface (Figure 4).

Figure 4 - Complete Solution



In the end, the device needs to have a proper enclosure to avoid unexpected damage to the circuits, therefore we handcrafted a plastic enclosure box and put all the circuits into it. The finished device is easy and safe to use (Figure 5).

Figure 5 - The Sun Station Monitor Prototype



Specifications

The following table shows the initial requirements for the Sun Station Monitor and the functions that our prototype is able to deliver (**Error! Not a valid bookmark self-reference.**).

Table 1 - Requirements & Completion

Basic Requirements	
Detects when the lamp is ON	✓
Clearly readable text or graphical display	✓
Display the number of times power was turned on and the total time power was on since the previous reset	✓
Reset by the user	✓
Includes a user manual describing installation and use	✓
Advanced Requirements	
Flash filesystem is unmounted and the system is shut down when power is removed	×
Connects to the BCIT WiFi network and uses NTP to set date & time	✓
Writes state+date+time to a remote MQTT server when lamp on/off state changes	✓
Appends one line, in CSV format, for each lamp on and off date+time to a file named after the current year and month	✓
Implements a web or FTP server that allows the on/off CSV files to be downloaded	✓
A web server with a page that shows the current lamp status	×
Looks neat (self-contained except power supplies, no exposed wires, have a neat label)	✓
Displays total time and number of cycles	×
Display backlight goes off 30s after user last touched screen	×

Challenges and Solutions

To make a qualified Sun Station Monitor, we have faced several issues. Although we managed to solve most of them, due to shipment delay and technical knowledge. There are certain problems remaining and needed to be developed in the future. Refer to the table below (**Error! Not a valid bookmark self-reference.**).

Table 2 - Problems & Solutions

Problem	Solved? (Yes/No)	Solution
Doesn’t have certification to work on AC circuit	Yes	Use pre-approved components only
Python program didn’t work properly	Yes	Test and debug the program step by step. Ask Ed for help
Didn't have proper tools to modify the enclosure box	Yes	Borrow tools from instructors and classmates
Display screen broke down during assembly	Yes	Replace with a new display screen
The hand-crafted enclosure isn't fitting perfectly	No	Design an enclosure box using a CAD program
The GUI isn't properly centred	No	Modify and fix the python program

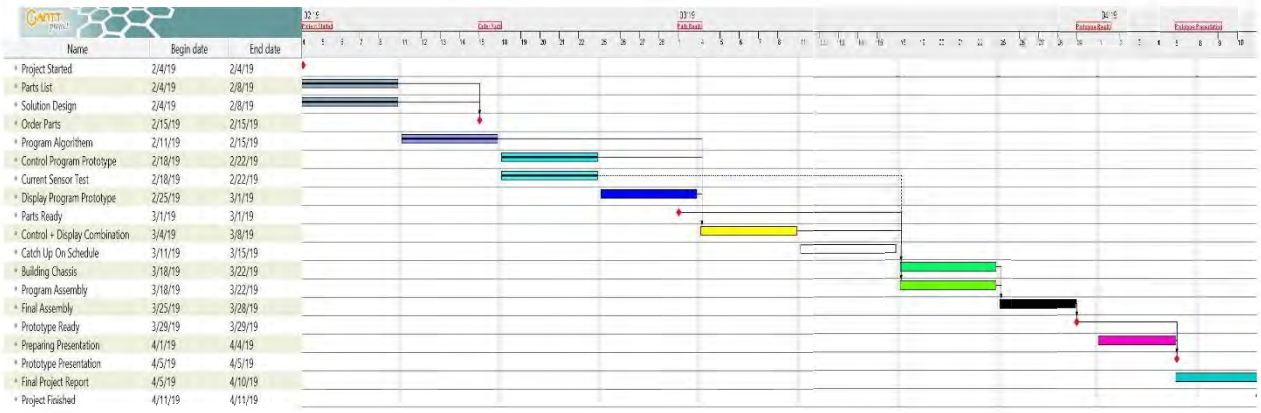
Schedule (with Gantt Chart)

After the discussion with our mentor and sponsor, we break down the project into several tasks (milestone). First, we come up with all the main components that we need. For example, a day-light sky therapy lamp, a smart power strip, microcontroller and enclosure box. Secondly, we also need to work out the algorithm for the project code and this requires lots of researching and testing (approximately spend 2-3 weeks on it). Finally, we build the enclosure and put everything up together. Therefore, a tentative schedule (**Error! Not a valid bookmark self-reference.**) and Gantt chart (Figure 6) are presented as followed:

Table 3 - Schedule Table

	Start Date	End Date	Instructor Sign-off
Gather Essential Components	Feb. 4th, 2019	Feb. 8th, 2019	
Raspberry PI Programming	Feb. 11th, 2019	Feb. 22nd, 2019	
Display Programming	Feb. 25th, 2019	Mar. 8th, 2019	
March Break	Mar. 11th, 2019	Mar.15th, 2019	
Building Chassis	Mar. 18th, 2019	Mar. 22nd, 2019	
Final Assembly	Mar. 25th, 2019	Mar. 29th, 2019	
Preparing Presentation	Apr. 1st, 2019	Apr. 5th, 2019	N/A
Presenting Prototype	Apr. 5th, 2019	Apr. 5th, 2019	N/A
Final Project Report	Apr. 5th, 2019	Apr. 10th, 2019	N/A

Figure 6 - Gannt Chart Schedule



Costs

The total cost of this project is almost 200$ which is a bit over budget and do not meet sponsor requirements. However, since we order most of the components (wires and case) from retailers so it would be pricey. But BCIT could get a better deal if it orders directly from manufacturers or uses stock components from the Electrical department.

The table below lists the components that we've used to build Sun Station Monitor prototype. The unit price and total price are included without tax (Table 4).

Table 4 - Table of Costs

Component Name	Unit Price ($)	Quantity	Total Price ($)	From
CyberPower P705G Power Strip	21.99	1	21.99	Amazon
Kuman 3.5" TFT LCD Touch Screen Display	24.99	1	24.99	
Walfront 200 pcs M2.5 Hex Nylon Spacer Stand-offs	13.99	1	13.99	
Raspberry Pi 3 B+	69.99	1	69.99	Ed Casas
16G Mirco-SD Memory Card	9.83	1	9.83	
AC to 3.3 VDC Circuit	2.00	1	2.00	Ed Casas
USB Mini-B Female Breakout Board	4.50	1	4.50	RP Electronics
Solderable PCB	4.40	1	4.40	
Plastic Enclosure Box	10.80	1	10.80	
3mm Hardware Assortment	12.70	1	12.70	
Extra-long 16-pin Header	5.40	1	5.40	
Other Accessories	10.00	1	10.00	BCIT
Total	190.59	1	190.59	

Conclusion

The Sun Station Monitor prototype that we've accomplished could present the functionalities that Curt is looking for. Although our sponsor-Curt is satisfied with the current solution, we could pursue a better result if time is permitted. For example, adding a web server feature on our device, so users could view the data on any computers from the campus. Creating a better graphical interface for users.

As the suggestion from our sponsor, we probably need to manufacture more Sun Station Monitors for the CSDD because there are multiple lamps around the campus. Therefore, we would definitely continuously work on the improvement of this device, so that it could eventually accept by employees and students.

The following are the issues we've noticed as we worked through the project.

1. Time management is very important in order to complete this project.
   We failed to follow our schedule properly and had to work double time during the March break to catch up.
2. Make every second count while working.
   We spent a lot of hours "on the project", but the result only worth about half of the time.
3. Understand the requirements clearly before actual work.
   The requirements of our project were unclear at the beginning and we didn't bother to ask for details. It cost us a lot of time later to modify our prototype to deliver proper results.

Overall, the project has sharpened our ability to participate as a team, improve our hands-on skills and complete certain tasks within a schedule. Additionally, learning how to analyze and develop a suitable solution is also an important lesson we've learned from our project course.

Recommendations

1. Extend the deadline so that the device can deliver all the desired functions with a field test to make sure it works under all circumstances.

2. Increase the budget for better quality components. This would provide a longer service life.

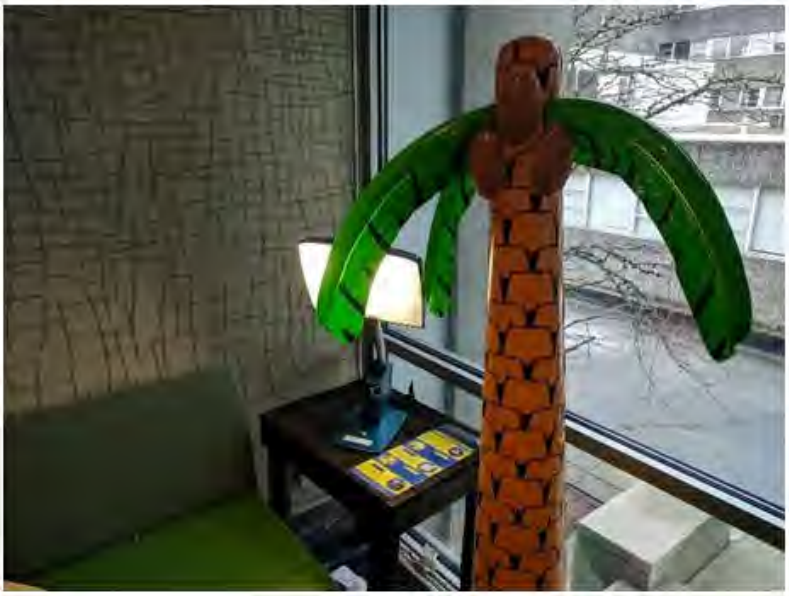
3. Standardize components for large quantity manufacturing, since Curt Shelton would like to have 11 working units across all BCIT campuses.

4. Improve the Python program to deliver a better user experience.

Appendices

Appendix A: BCIT Sun Station

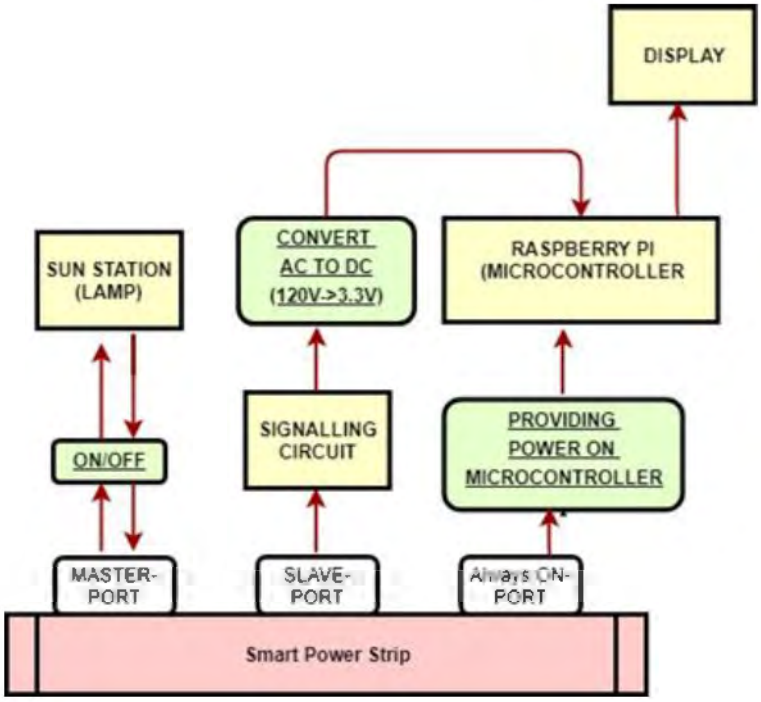
This appendix shows one of the Sun Stations at BCIT and the map for its location.



Burnaby Campus Locations:

Appendix B: Schematics & Block Diagrams

This appendix shows the initial design schematic and its developed block diagram.



Appendix C: Tables

This appendix shows the specification of the Sun Station monitor, developed problems of Sun Station Monitor and the cost of the whole project

Basic Requirements	
Detects when the lamp is ON	✓
Clearly readable text or graphical display	✓
Display the number of times power was turned on and the total time power was on since the previous reset	✓
Reset by the user	✓
Includes a user manual describing installation and use	✓
Advanced Requirements	
Flash filesystem is unmounted and the system is shut down when power is removed	×
Connects to the BCIT WiFi network and uses NTP to set date & time	✓
Writes state+date+time to a remote MQTT server when lamp on/off state changes	✓
Appends one line, in CSV format, for each lamp on and off date+time to a file named after the current year and month	✓
Implements a web or FTP server that allows the on/off CSV files to be downloaded	✓
A web server with a page that shows the current lamp status	×
Looks neat (self-contained except power supplies, no exposed wires, has a neat label)	✓
Displays total time and number of cycles	×
Display backlight goes off 30s after user last touched screen	×

Problem	Solved? (Yes/No)	Solution
Doesn’t have certification to work on AC circuit	Yes	Use pre-approved components only
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Extra-long 16-pin Header	5.40	1	5.40	
Other Accessories	10.00	1	10.00	BCIT
Total	190.59	1	190.59	

Appendix D: Datasheets

This appendix includes the datasheets of the major components

The Sun Station: https://images-na.ssl-images-amazon.com/images/I/A1HhjTKdocS.pdf

The Power Strip: https://dl4jz3rbrsfum.cloudfront.net/documents/CyberPower_DS_P705G.pdf

Raspberry Pi 3 B+: https://static.raspberrypi.org/files/product-briefs/Raspberry-Pi-Model-Bplus-Product-Brief.pdf

3.5 inch Touch Screen: https://cdn-learn.adafruit.com/downloads/pdf/adafruit-3-5-color-320x480-tft-touchscreen-breakout.pdf

Mini-USB Female Breakout Board: https://cdn-shop.adafruit.com/datasheets/14850.pdf