

Sunrise Simulator



Team:
Gold Squadron

Members:
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Executive Summary:

At the start of each day, the moment you wake up is critical in setting your mood for each morning. Even though we don't realize it, the conditions in which we wake up can affect our overall lifestyles. Imagine a scenario where you are well at rest after a full night's sleep, and it's the early hours of the morning. The sun is just beginning to rise and break through into your household, but instead of the sun striking your face disturbing your deep sleep, you're met with a slow and gradual light change over a long period of time that would help you adjust to the drastic light change that happens the second that light breaks through your window. Our solution would be to design a window and curtain system that corresponds with the alarm that you set on your phone the night before. The system will check the time of sunrise the following day and prepare a schedule for the window to function and allow the customer to enjoy their valuable moments of rest without being disturbed by natural sunlight.

1. Statement of Problem:

The problem is the interference of natural sunlight on the sleeping human body. The change in lighting of a room where a person is sleeping disrupts the person's sleeping pattern.

2. Major Design Objectives (Goals that must be met):

- (1) Create a wireless smart device that can control the natural lighting in specific room.
- (2) Create a smartphone application that allows users to control the amount of natural lighting being let into a room.
- (3) Make sure the system is able to add and delete rooms or specific windows and have either multiple or a single window be controlled at a time.

2. Customer Requirements:

2.1) CREATE A SOLUTION THAT CONTROLS THE LIGHTING IN A SPECIFIC ROOM.
Develop device that will control amount of light coming through a window.

2.2) Have the device communicate to a main hub via nRF configuration.

2.3) Have a main hub that stores information of all window controllers and controls the windows.

2.4) Have the main hub communicate with smart device via bluetooth communication.

2.5) Have the smart device be able to select a window/room and control the tint on selected window(s).

2.6) Create Android OS smart device application to communicate with main hub and serve as a user interface.

2.7) The system must be able to add/delete a window or a room. Effectively making the system expandable.

3. Deliverables:

Our product will be a reasonably priced home improvement solution that will be incorporated along with standard windows and curtain systems in customer's bedrooms. The product will be wireless in a way where the user will not be burdened with fixing its settings or interface on a daily basis. Instead the user may interact with it easily from the android application interface. The interaction between the device and the application will operate via Bluetooth.

- 1) User Manual for the smart device.
- 2) Downloadable via wired computer install application for Android smartphones.
- 3) Wireless smart device for installation in home to control the window tinting manually.

4. Approach:

4.1) Identifying Specific Requirements:

One of the main objectives of the project would be making it modular. Users should be able to easily add extra panels and have it seamlessly integrate into the overall system. Their smartphone application should be able to handle an addition and/or removal of a new window or a room. One of the most important aspects in making it realistic is having the system be non-invasive with wires, and easy to maintain. Finally, making sure the whole system is intuitive in both the install process as well as day-to-day use.

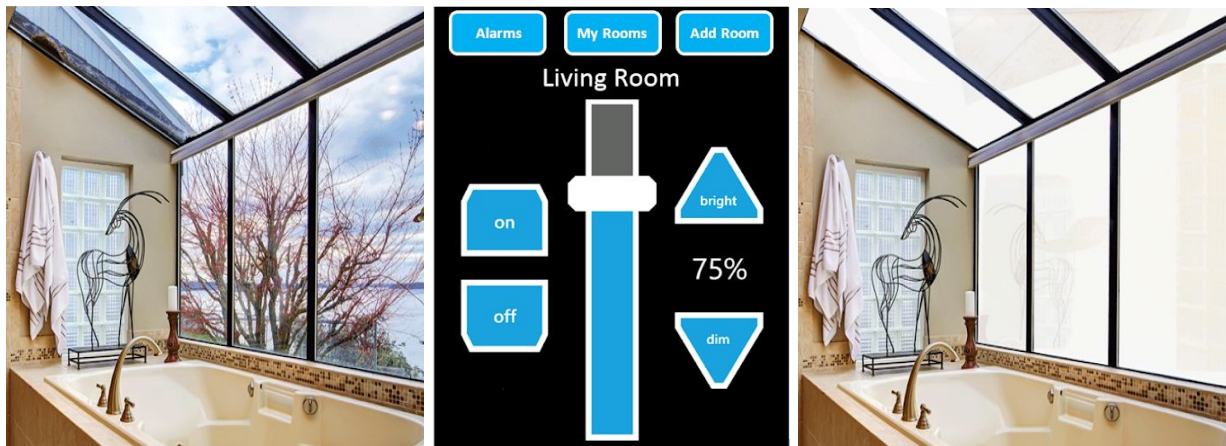
4.2) Research and Design Concept Generation

- (1) Using tinting film on glass makes adding additional panels or windows easier for users.

- (2) Having a smartphone application allows users to manipulate the amount of natural lighting from anywhere (amount being all or none).
 - (a) This application also will allow the user to set an alarm clock for the smart device to naturally wake the user up at the specified time.
(extra feature we would implement in the future).

4.3) Selection of Design Concept (Ideal Future Scenario):

For solving the problem discussed above, our team chose a solution that will adjust the lighting in the room at a specific time to wake up customers. For the remote control of our windows, we have decided to develop an Android software application. Since it is easier to publish the Android application on the market (which would be a future goal). Our customers can set the time they want the light to break through our windows for different rooms at different times, and adjusting the brightness for each room/window. The customer may download the application on their smartphone if that is more convenient than the display on the main hub.



(Figure 1: A ideal process of our solution as a final product)

4.4) Constraints:

The realistic constraints for the project would be budget and time, two resources that are very difficult to manage in a project process of this fashion. The next constraint would involve the implementation of the product in a real world situation. The product would likely have to be an addition to a house that is currently being built, or it would be a costly upgrade to an already standing household. Instead we will design a small scale setup that would simulate our system operating in an entire household.

4.4.1) Budget/Cost(Constraint):

Part Name	Part Number/Model	Units	Cost	Part Description	Supplier
Smart Film	Smart Tint B-12-12SK	x1	\$99.99	This will attach to the window hub and through commands provided will adjust the amount of light shown through.	Smart Tint
Elegoo Mega 2560 R3	EL-CB-003	x1	\$13.99	This will be used as the processor for the main hub.	Amazon
Elegoo Uno R3	EL-CB-001	x1	\$10.90	This will be used as the processor for the window hubs.	Amazon
Kuman TFT 2.8" Touch Display	K60	x1	\$14.80	This will be part of the main hub as a user interface.	Amazon
DSD Tech HC-06	sh-hc-06	x1	\$8.99	This will be part of the main hub and will allow for a user to control the main hub from the application on their smart device.	Amazon
Foxnovo NRF24L01	76145840B7OHS5042	x10	\$9.89	This will be part of the window hub and main hub. These items will allow communication to be established between the various window hubs and the main hub.	Amazon
OPTO 22 SSR	120D10	x1	\$24.40	This will connect between the window hub and the smart tint to allow the window hub to adjust the film depending on commands provided by the main hub.	Future Electronics
Uxcell 3.3K Resistors	a11102400ux0138	x1	\$3.88	This will be used for a voltage divider to protect the HC-06 on the main hub.	Amazon
E-Projects 1K Resistors	25EP5141K00	x1	\$5.78	This will be used for a voltage divider to protect the HC-06 on the main hub.	Amazon
MclglcM Schottkey Diode	1N5822	x1	\$7.99	This will be used for to ensure the HC-06 will not be shorted by the Arduino Mega 2560.	Amazon
eBoot Prototype Bread Board and Assorted Wire Kit	4330125372	x1	\$9.99	These wires and breadboard will be used to connect the various modules to either the main hub or the window hubs.	Amazon

Table 1: Items to purchase for project

4.4.2) Other Realistic Constraints:

A few other constraints could be that we do not have any prior experience with Android development, so it could take a while to get up to speed with that. Another will be making sure we can connect each of the individual parts together without any complications.

Another constraint will be implementation of the gradual light feature, due to hardware complications, our team is hesitant to test and build for this feature as we fear it will damage the hardware that would then need to be replaced, costing time and money.

4.6) Test Plans (Design Documentation):

Our final project will be tested by having a small sample of film that will serve as our "window". We will make sure all the electrical components of the film are wired correctly and enclosed in an electrical safe container. We will open our Android app on a smart device that has downloaded the application and connect the device to the smart film. When we have made a connection, we will select our desired window/room and test it by turning the film on or off, which should then cause the window to let in the corresponding amount of light. We will then test the ability to

modularize the application by setting up a wiring board with LEDs that will represent individual windows. We can then designate these windows to rooms, and test the organizational aspect of the app.

Extra feature Test: We will test the alarm feature by setting the film to its darkest setting, and then setting an alarm on the smart device. As the set alarm time approaches, we should see the film on the window gradually let more light in, simulating a sunrise.

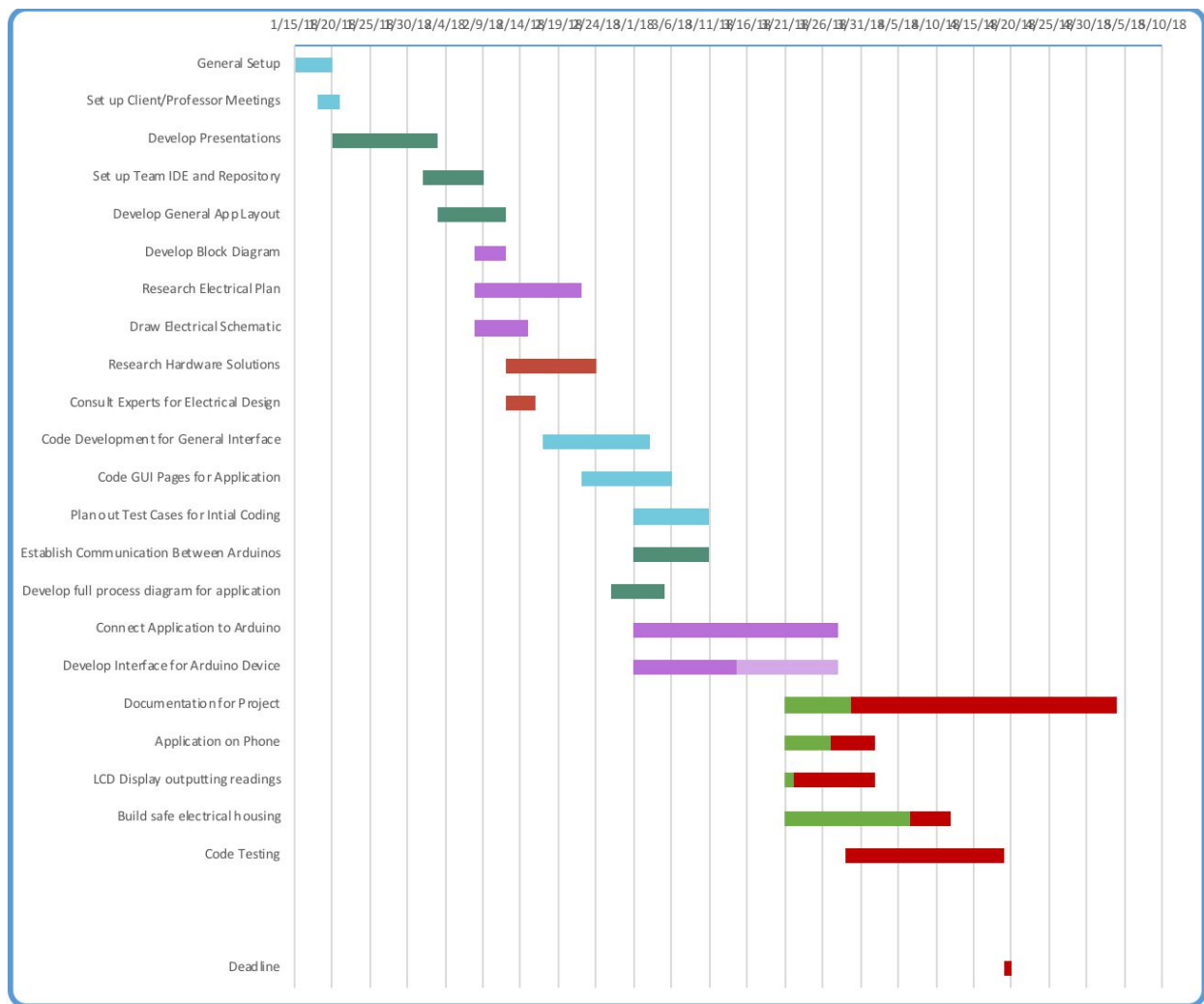
4.7) Knowledge and skill required:

There will be both hardware, software, and firmware components to develop in this project. The hardware portion will be wiring the smart film to a power supply and an electronic box that can connect to the internet to receive the transmissions from the app. Most of our group has taken Embedded Systems, Principles of Electronic Instrumentation, Digital Design, and Circuits, so these courses will help us wire the smart film without damaging anything else. The software portion of our project includes a smartphone application and a way to communicate from the application to the smart film. Each member of our group is on the computer track of ECE, which gives us a variety of programming experience in classes including Engineering Problem Solving II, Computers in Engineering, Computer Science I & II, Intro to Software Design, Fundamentals of Software Engineering, and Software Engineering Languages and Tools. No member of our group has any prior experience with creating an Android app, but we are all willing to learn and are confident that our prior experience will help with this.

5. Project Management and Milestones:

Task Name	Start Date	End Date	Duration (Days)	Days Complete	Days Remaining	Percent Complete
General Setup	1/15/18	1/20/18	5	5.00	0.00	100%
Set up Client/Professor Meetings	1/18/18	1/21/18	3	3.00	0.00	100%
Develop Presentations	1/20/18	2/3/18	14	14.00	0.00	100%
Set up Team IDE and Repository	2/1/18	2/9/18	8	8.00	0.00	100%
Develop General App Layout	2/3/18	2/12/18	9	9.00	0.00	100%
Develop Block Diagram	2/8/18	2/12/18	4	4.00	0.00	100%
Research Electrical Plan	2/8/18	2/22/18	14	14.00	0.00	100%
Draw Electrical Schematic	2/8/18	2/15/18	7	7.00	0.00	100%
Research Hardware Solutions	2/12/18	2/24/18	12	12.00	0.00	100%
Consult Experts for Electrical Design	2/12/18	2/16/18	4	4.00	0.00	100%
Code Development for General Interface	2/17/18	3/3/18	14	14.00	0.00	100%
Code GUI Pages for Application	2/22/18	3/6/18	12	12.00	0.00	100%
Plan out Test Cases for Initial Coding	3/1/18	3/11/18	10	10.00	0.00	100%
Establish Communication Between Arduinos	3/1/18	3/11/18	10	10.00	0.00	100%
Develop full process diagram for application	2/26/18	3/5/18	7	7.00	0.00	100%
Connect Application to Arduino	3/1/18	3/28/18	27	27.00	0.00	100%
Develop Interface for Arduino Device	3/1/18	3/28/18	27	13.50	13.50	50%
Documentation for Project	3/21/18	5/4/18	44	8.80	35.20	20%
Application on Phone	3/21/18	4/2/18	12	6.00	6.00	50%
LCD Display outputting readings	3/21/18	4/2/18	12	1.20	10.80	10%
Build safe electrical housing	3/21/18	4/12/18	22	16.50	5.50	75%
Code Testing	3/29/18	4/19/18	21	0.00	21.00	0%
Deadline	4/19/18	4/20/18	1	0.00	1.00	

(Figure 2: Gantt chart data table for our product design process)



(Figure 3: Gantt chart that represents the data table listed in Figure 2)

5.2) Communication and work among team members:

Our team has had a flexible schedule for each lab this semester. We found a few times a week that each member is available to meet. During these meetings, we discuss things that each member has finished and also work on problems as a group that any member has encountered. After that, we each decide on things that each member plans to accomplish before our next meeting. We also plan on meeting with our customer at least once a week in person to talk about progress, design changes, and any ideas to improve the end resulting project.

5.3) Communication and Coordination with Sponsor if applicable:

Our sponsor for our senior design project is Matthew Boddicker from Rockwell Collins. Matthew is a hardware expert at Rockwell. He is also an alumni of the University of Iowa and is familiar with the curriculum of many courses that our group has taken and the operations of a senior design project. Matthew has been involved with many projects both in school and in industry, his experience and guidance will be invaluable throughout our senior design process.

We plan to communicate with Matthew on a weekly basis via a coordinated meeting with an appropriate setting. We also have Matthew's email and cellular phone contact information that he has allowed us to use if we need to reach him during any reasonable time.

5.4) Team member qualifications and primary assignment:

- Leader: RJ Hemmingsen
 - Project Management, Documentation, Arduino Implementation
- Hardware: Reed Stock
 - Wiring the smart film to arduino, creating a box for Arduino to fit into
- Software: Junhan Wang
 - Developing the Android app
- Firmware: Aaron Ambrose
 - Connecting the Arduino to the app

6. References:

- 1) Installation Instructions for the Smart Film:
<http://www.invisishade.com/pdf/selfAdhesiveFilmForRetrofitOfExistingWindows.pdf>
- 2) Smart Film we plan on using: <http://www.invisishade.com/>
- 3) TFT Display:
https://www.amazon.com/Elegoo-Inches-Screen-Technical-Arduino/dp/B01EUVJYME/ref=sr_1_4?s=electronics&ie=UTF8&qid=1510361073&sr=1-4&keywords=arduino+lcd+display
- 4) Arduino R3:
https://www.amazon.com/gp/product/B008GRTSV6/ref=ox_sc_act_title_1?smid=A2GTSJRNFEVVSP&psc=1
- 5) Arduino Wifi:
https://www.amazon.com/gp/product/B00VWVD0FO/ref=ox_sc_act_title_2?smid=A3UVGO6W43MISJ&psc=1