The Aurora Aggies

Intelligent Lighting Control System

TOPIC # - TDC-25-F17

Team Members: Natalie Criscione, Kevin Lewis, Walter Pospick, Alyssa Valdez

Faculty Members: Dr. Bruce Gooch

Mentor: George Salazar

Team Information:

The Aurora Aggies team members (See Appendix A):

- **Natalie Criscione** - n.m.criscione@tamu.edu
- **Kevin Lewis** - klewiscse@tamu.edu
- **Walter Pospick** - wrpospick@tamu.edu
- **Alyssa Valdez** - alyssavaldez@tamu.edu

All team members are completing their undergraduate degrees in December 2017 through the Computer Science and Engineering Department at Texas A&M University located in College Station, Texas.

Collaborators:

- **Faculty Member: Dr. Bruce Gooch -** brucegooch@gmail.com
  - Associate Professor at Texas A&M University
- **NASA Mentor: George Salazar -** george.a.salazar@nasa.gov
  - Human Computing Interface Technical Discipline Lead at NASA
- **Hardware Mentor: Adam Mlynarczyk -** adammlyn17@gmail.com
  - Biomedical Engineering graduate of Texas A&M
- **Hardware Mentor: Bob Pospick -** bob@pospick.com
  - Engineer with 35+ years of industry experience working with small electronic devices

Abstract:

This is the final report written by Aurora Aggies for the Texas Space Grant Consortium (TSGC) Design Challenge - Intelligent Lighting Control System project and CSCE 482 - Senior Capstone Design course project. The team is writing this report to culminate the design process proposed in September, updated in October, and presented in November. This design solution is a lighting control system aimed to support the circadian rhythms of the astronauts living and working under it. The design solution creates two web-based applications: an administrator interface to initialize the lighting environment and an astronaut interface to display imperative information and control over the lighting. Low-level programming will be implemented for the basic functionalities of the system such as lighting animation, internet connection via ethernet, and light degradation detection. The project cost $393.21 to build as a proof of concept. The implementation of the design was presented on November 13, 2017 at the TSGC Design Challenge Showcase.

Research:

Current lighting systems are posing a health risk to communities. In 2017, Jeffrey C. Hall, Michael Rosbash, and Michael W. Young won the Nobel Prize in Medicine for their contributions in controlling circadian rhythms. Their work sheds light on the effects of external environments on organisms internal biological clock. S. H. A. Begemann studied the behavioural responses of people working indoors. He found that current lighting systems are insufficient for biological stimulation, which leads to many health problems, from “minor sleep and performance difficulties to major depression.” Richard Stevens discussed the idea that as communities become more Westernized, there is a higher risk of breast cancer. He suggested that living in sun-free environments during the day and using artificial light during night causes “circadian disruption [and] could lead to alterations in melatonin production” which increase the amount of tumor development in animals. Stephen Pauley went on to say that the lack of melatonin production may also cause colorectal cancers and recommended that current lighting fixtures should be “designed to minimize interference with normal circadian rhythms.” Not are these risks seen in cancer, but they are prevalent in mental health. A.J. Lewy studied the effects of bright artificial lighting on a manic-depressive man during the winter. He concluded that humans have seasonal rhythms and adjusting lighting may contribute to overall mental health.

Astronauts have suffered a variety of health problems from previous lighting systems on the ISS and other spacecraft (Evans, 1979). While in these structures, astronauts have had a history of having to use medication due to issues contributed to by these negative effects of lighting on melatonin production (Putcha, 1999). A lighting system needs to be developed using recent lighting technologies and a focus on how lighting impacts health.

The proposed alternative could also have applications for everyday use - in patients with Seasonal Affective Disorder, or in employees working night shifts. Research by Dumont et al. (2009) has demonstrated that exposing night shift workers to specific wavelengths of light during their shift improves alertness and regulates melatonin release, in turn promoting better sleep (Hunter, 2017). If the proposed system can provide similar results, there are numerous applications, such as in emergency rooms and hospitals with night workers that could see a dramatic increase in efficiency, resulting in an increase in treated patients and saved lives.

The proposed system could also have applications for sufferers of Seasonal Affective Disorder (SAD) which tends to be caused by decreased seasonal exposure to environmental light (Terman and Terman, 2005). Treatment generally involves direct exposure to an artificial light source that simulates natural light patterns, which then increases melatonin and serotonin levels, resulting in proper sleep patterns and an improved mood. Light therapy tends to be ineffective when the patient has little time or finds the process inconvenient (Vitiello, 2001). With the proposed system being automated, this would allow for convenience of treatment for the patient, and even be effective at preventing the condition from recurring (Nussbaumer, 2015).

The applications for this lighting system extend beyond night shift workers and sufferers of SAD. With a large percentage of the population working in office settings (Church et al., 2011) with fluorescent lighting, an alternative solution could provide better alertness in the workplace and better health and sleep patterns for employees. The LED technology in the system would also be more energy efficient and cost effective for the company.

With LED technology advancing, it is quickly becoming more than an alternative to fluorescent and incandescent lighting. The potential for its application in medicine, agriculture, and health and science is limitless, given its low cost, efficiency, and potential for UV applications and effective simulation of natural light. Research shows that the proposed system would not simply be a development reserved for astronauts on space missions, but for the common office worker, a nurse in an emergency room, or a patient suffering from sleep disorders.

Background:

Several issues are present with the current and recent lighting systems onboard spacecraft and the International Space Station (ISS). The current system involves using fluorescent lighting, which can greatly affect astronaut's sleep patterns and circadian rhythms (Lunn et al., 2017). This is often dealt with by the use of sleeping medication (Putcha, 1999), however these have a distinct impact on the astronaut's alertness and aptitude in the space station.

Light-Emitting Diode (LED) systems have already proved themselves as a promising solution in ground tests. NASA installed a prototype LED fixture on the ISS during Expedition 18, but this was not implemented across the entire station (Brainard et al., 2013). These lights are far more versatile and energy efficient, emit less heat, and prove much more economical than their fluorescent counterparts. They also include the ability for Ultraviolet applications - recent research has already shown application in plant growth in space (Avercheva et al., 2016).

However, while LED lighting would seem to be a straightforward option, there are issues with moving the currently orbiting ISS over to this platform. At its construction in 1998, the ISS was entirely fitted with fluorescent lighting. At this time LED technology was still emerging, and RGBW and UV capabilities had not been developed. To implement a fully functional LED system, the entire existing lighting system would need to be replaced, and would involve removing old systems from the spacecraft and installing new ones. Once these old systems were removed, they would have to be stored or transported back to Earth for disposal. The LED system would have to be fully researched and developed before this stage. Replacement of the old system would also have to be compatible with the existing hardware and environment, which would render some of that development unusable in new spacecraft.

With the space shuttle program retired and NASA moving towards rockets and deep space exploration, these systems need to be researched and developed further for implementation on upcoming spacecraft. Future manned-explorations to deep space may require astronauts to live long-term on a base and such an LED system would be crucial.

Objective:

The Aurora Aggies team focused on researching, designing, and implementing an intelligent lighting control system as a proof of concept design for future spacecraft. The designed lighting system will dynamically emit appropriate lighting conditions based on astronauts' circadian rhythms. The system will be notified by RFID tracking when an astronaut enters a room and will adjust the lighting accordingly. The system will utilize a small amount of power and compensate for lights as they degrade over time. Additionally, there will be two web-based user interfaces: an astronaut user interface, that will provide the current status of the lighting system, displaying room occupants and alerts if applicable, and an administrative user interface that will allow for the manipulation of room parameters, lighting parameters, and room occupants from an administrative/ground control aspect.

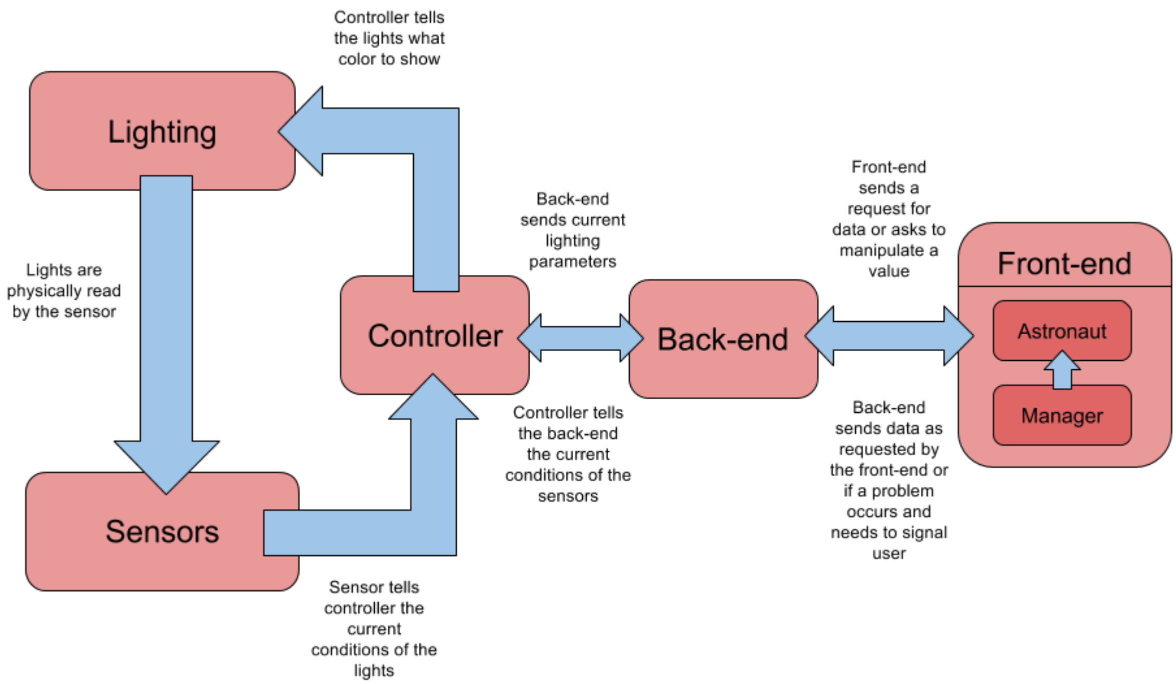
Design Plan:

Requirements

The intelligent lighting control system is intended to be a lighting system to minimize power, improve reliability (such as compensating for degrading lighting sources), and provide the quality of lighting necessary for a healthy living environment. The system must have multiple lighting sources and sensors in various rooms linked by a communication network and controlled by a end-user application, all of which should utilize commercial components. The lighting sources must run on AC power and generate nominal light intensity around 500 lux measured at 8 feet as well as the range of color spectrum and intensity changes required to maintain circadian rhythms. These parameters should adjust to at least two separate circadian rhythms, but also be able to be changed manually from the interface. The sensors are required to monitor the light intensity and color spectrum over time to send information to the controller to compensate and correct the lighting as it degrades. The user must be alerted to any lighting degradation through auditory and visual warnings in the interface. Meeting these requirements will produce an intelligent lighting control system that is efficient and reliable, and provides both utility and health benefits to users.

Approach

The team completed the proof of concept design by November 13, 2017 through detailed methods that aided in the accomplishment of several primary goals satisfying the requirements of the design. These goals are to establish an intelligent lighting control system that contains multiple lighting sources that are circadian rhythm maintained, sensors that compensate for light degradation, an administrative web-based application for spacecraft initialization, and a simple web-based application that provides a unified control over the system. A graphic representation of the overview design is shown below:



The Environment

The environment in which the lighting solution will be tested is a small closet where ambient light sources can be controlled (See Appendix B). Within the closet, a desk and chair will be placed along one of the walls to simulate a workstation. The hardware aspect of the lighting solution consists of three parts: the light source, the sensor, and a computer. The light source will be a singular unit with power input and a network connection to the computer. The system will have the ability to scale and provide multiple light sources in and across rooms. The sensor will be one smaller unit to measure the status of the light source. The sensor unit will have a power input and a network connection to the computer. The computer will be a laptop for hosting the back end software and bridging the communication between the light sources and the sensors. For demonstration and testing purposes, the computer unit will be located on the desk but could be located anywhere as long as it is connected to the same network as the other two physical components. In a scaled environment, one larger computer would be used for all the lights and sensors in the environment. Testing the lighting solution will consist of mounting the light source in a variety of locations within the environment and measuring the luminosity of different places within the environment to determine the optimal placement. Once a location for the light source is determined, the sensor will be placed in various locations until a suitable location can be determined. Testing the sensor's ability to detect degradation of the light source will be performed by scaling back the luminosity to 70% of maximum, simulating degradation.

The Software

The software portion of the design calls for two web-based applications that work together within the system design to produce algorithms that compensate for lighting degradation, allow for manual lighting control, and maintain a circadian-rhythm-based lighting schedule. Both applications will be written in JavaScript and while they will work together, they are able to be developed as two different entities. This is because the user-end application does not require complicated parameters and only needs to know important, vital, and relevant information, whereas the administrative application will handle the specifications of the entire craft, or information that the user does not need to know but is important to the algorithmic aspects of the system and can vary from craft to craft.

Front-end

Administrative Application

The administrative application will contain several input parameters for the administrator, or manager, to provide to the system. These parameters will detail several aspects about the lighting system within the craft for algorithmic purposes. Parameters such as the number of rooms, number of people, names, which people reside in the rooms over time, room type, number of light fixtures in the room, enabling power save mode, and so on. This application will be used to initialize the system with the spacecraft, enabling the user application to be synced with the correct data about the craft, and not be impaired or overwhelmed by unnecessary clutter. Once initialized, any changes that occur in the craft parameters can be easily changed through the administrator application on demand. This allows for proper delegation of information between the software portions of the system, and prevents overwhelming the user.

User Application

The user web-based application will boast a GUI design that is simple and astronaut-friendly. Furthermore, it will feature detailed information about the status of various crew members and rooms within the spacecraft, as well as provide manual controls for each room. Manual controls will include GUI sliders that directly affect the intensity of the lights and switches to turn on and off the lights as well. In the event that lighting conditions have degraded severely, the application will notify the user through auditory and visual warnings. Auditory warnings will be tested so that they are not too bothersome or abrupt, however they will still call attention to the user. Visual warnings will include a prominent graphic that will clearly indicate degradation has occurred and that compensation is being performed on the system. The application will also display who is in the room and a toggle for power save mode for the room.

Back-end

This area of the software structure is where the front-end and controller meet. It handles the input and output of data between interfaces, stores information about the rooms and users (database), responds to requests made by the administrator, and performs appropriate calculations. The back-end formats data for sending using JSON (JavaScript Object Notation) schema. Additionally, it sends and receives messages via HTTP requests.

Low-Level Applications

Some low-level applications will be implemented in the design to provide the basic functionalities of some of the hardware components needed for the system. Such applications include lighting functionalities, Ethernet connection, and light degradation detection. The applications will provide for vital yet basic practicalities of the system such as changing the color of the lights, changing the intensity of the lights, establishing a network connection, RGB detection, and more.

LED Animation/Functionality

The low-level lighting applications will include functionalities such as changing the RGB values, changing the brightness values, setting these values to each light pixel, maintaining the current circadian rhythm light cycle in the board's memory, performing various lighting animations, and even converting RGB and brightness values to color temperature values. Certain libraries, such as the "TempColor" library, have been implemented with the arduino program to perform some of these tasks which can be referenced in appendix H. Json Parsing will also be tied in with this portion of the program, as we will be sending Json strings to the light controller to inform the controller of which tasks it needs to perform and the necessary data it needs to compute (This can also be found in Appendix H). A data structure will also be created for each "room" within the space station, and will contain information about the circadian rhythm of that room in the station. With this data structure, the lights for each room will be able to continue cycling through the circadian rhythm daily cycle, or schedule, without needing to continuously poll the backend for more information about the system and can essentially stand alone on its own after the values have been given to it. A board has been selected that provides for 8KB of SRAM (or Sketch RAM, Memory during run-time) to allow for appropriate storage and computation of the data structure.

RFID Technology

RFID, or Radio Frequency Identification, will be utilized and developed for our system as a check-in protocol for our circadian rhythm algorithm. This has powerful implications towards our design. First, it provides us the capability of automatically computing the circadian rhythm of each room based upon who is in the room. We know who is in the room through wireless communications between the astronauts' RFID tags and the room's RFID reader (a short range communication of about a max of a few feet). We will utilize this alongside a priority scheduling system to properly and dynamically compute the circadian rhythm of the room. Secondly, this allows us to implement power saving modes with ease. Once everyone leaves a room, if power save mode is on for the room it will then shut off the lights. The room's lights will come back on after an astronaut enters the room, as the room is no longer empty. Finally, RFID also brings convenience to the list of its advantages. Since maneuvering throughout space stations has proven to be difficult in space conditions, it will be a relief to the astronaut that they can be identified in a room wirelessly, and not have to use their hands to swipe a card, type in a code, or operate a device. One could seamlessly hover their RFID tag (ideally sewed inside the clothing) over the reader and be properly identified in the room.

Our design utilizes all of these advantages. Each astronaut will be given an RFID tag that properly identifies who the individual is, and a RFID reader will be placed at the entrance for each room where the astronaut will need to check-in and check-out to properly use the sophistication features of the algorithm.

Ethernet Connection

The low-level Ethernet application will work alongside the LED functionality application as well as the LED light degradation detection application. This entities will remain separate, as they are located on two different boards (one for the LED sensor, and one for the LED strip), yet the ethernet application that works with both of these entities will practically function the same. The application will establish a connection with the backend and in regards to the LED functionality, will be able to send and receive messages from and to the backend. In terms of the LED sensor, it will only need to send messages and not receive them, as we don't really need to tell the sensor to do anything in particular.

LED Light Degradation Detection

Perhaps the simplest, yet one of the most practical, of the low-level implementations is the light degradation detection application. This program will simply read the RGB values given in by the LED's through the LED sensor and send that information to the backend. The backend will then look up what the RGB values should be at that time within the cycle, and determine if it needs to send a message to the lights to compensate the difference in RGB values.

Evaluation

Various methods will be performed to verify the software and hardware components meet the specified requirements. All software functions will be verified with individual unit tests and combined integration tests. Once the software functions have passed the unit and integration tests, a final functionality test will be performed. The functionality test will evaluate the software with real-time data from the hardware. Verification of the hardware is less complicated. The use of commercial hardware limits the need for traditional hardware verification. Careful selection of hardware components that have been verified by the manufacturer will reduce hardware verification to a visual inspection of the physical system. The combination of the software and hardware verification will sufficiently evaluate the solution against the specified requirements.

Accomplishments:

Level 1

The team has done extensive research in regards to identifying the problem, finding possible solutions to the problem, and all the aspects of the final solution that they are proposing. The required hardware parts have been gathered and ordered to thus setting up the environment. The team has met with NASA mentor George Salazar in regards to the project design and consulted with faculty member Dr. Bruce Gooch on project specifications. Aurora Aggies have also sought consulting outside of the project space for hardware mentoring through two individuals: Adam Mlynarczyk and Bob Pospick. All required documents and graphics have been produced including a patch design (as seen in Appendix C). Mock up design diagrams and design breakdown documents have been produced as well (See Appendix D).

Level 2

The team has done vigourous work on the low-level functionalities of the project. The controller can communicate to the lighting system to indicate what colors to display. The controller can send and request data from the web server using ethernet connection and parse the data coming from the web server to change the lights at certain intervals of time. Additionally, the team has started development on the back-end and administrator user interface.

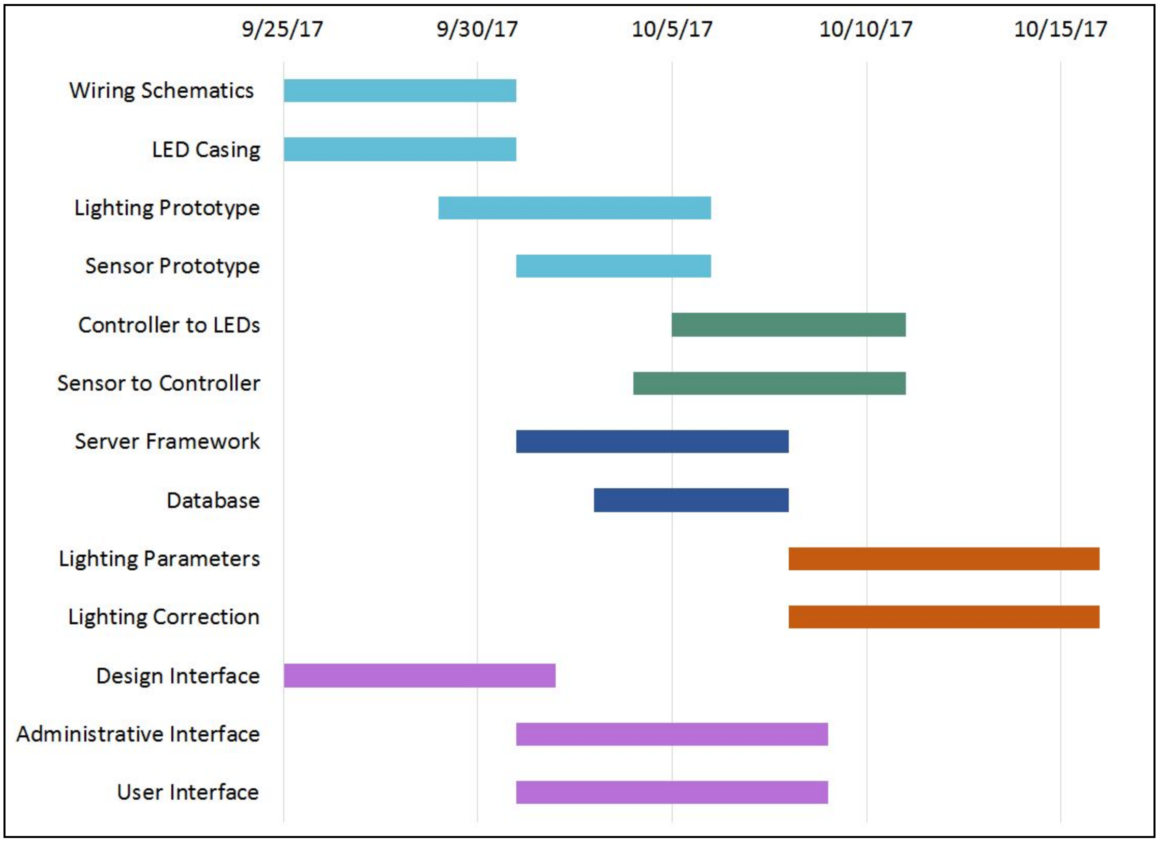
Walter, Aurora Aggies' hardware designer, has been working on setting up the hardware environment. A prototype of the lighting fixture and the sensor was built on protoboard with a 3D printed enclosure. The purpose of the protoboard is to provide a physically secure connection between the arduino and the lights and sensor. The enclosure is a simple 3D printed box made of PLA and ABS with a place for the lexan diffuser.

Level 3

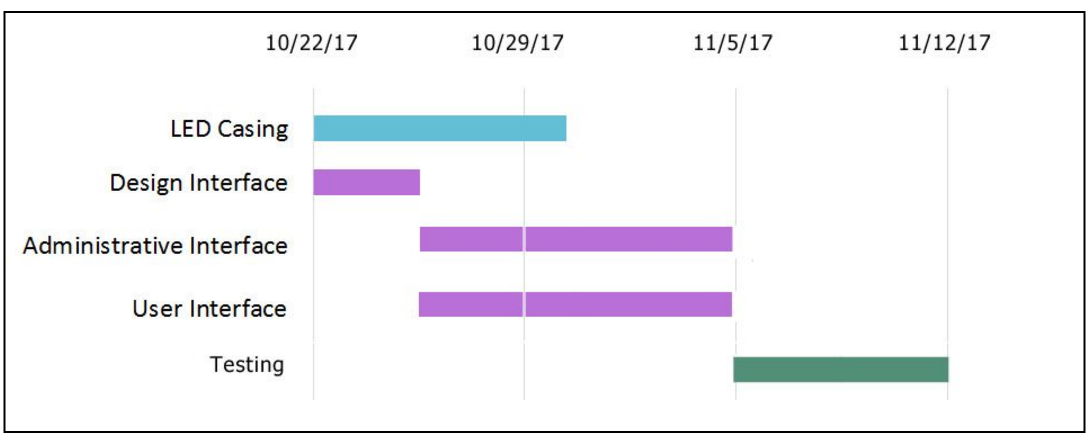
The Aurora Aggies completed their proof of concept and presented their design at the TSGC Showcase to an audience that included fellow student teams, Faculty Advisors and Mentors, the NASA/JSC community and industry partners, and TSGC representatives. The team won fourth in the poster presentations, first in the oral presentation, and fourth best team overall!

Timetable:

The design process was divided into 13 initial components that were developed and tested separately before linking them together, testing by pairs, and testing the system as a whole.



We were able to accomplish all but the LED casing and the interface components of the timetable by the time of the midterm report. We decided to focus on the hardware aspect of the project since we needed more time on that part.



The next steps of the project will focused on continuing with the server framework, database, and interfaces. A new enclosure was designed and 3D printed on campus in time for the showcase demonstration. The first prototype was behind schedule due to unexpected shipping delays, but a loose breadboard design was been suitable for software development to begin. Since all the components being utilized are off-the-shelf components designed and built by Adafruit or SparkFun, the wiring of the components follows the guides they published. The lights are connected to an arduino with an ethernet shield that connects to the computer. Similarly, the light sensor is connected to an arduino with an ethernet shield that is connected to the same computer.

All of the tasks were completed by showcase and allowed time for thorough testing and the pursual of one of our personal stretch goals of implementing the RFID tagging.

Budget:

The project stayed within the budget outlined below. The design required the purchase of several hardware components, some of which needed replaced or changed during the evaluation phase of the project. The budget below outlines the cost of only the components that were used in the completed proof of concept, which cost $393.21.

Earnings	**Expected**	**Actual**
Level 1 (Proposal)	$100	$100
Level 2 (Midterm)	$200	$200
Level 3 (Final)	$700	$700
Total	**$1000**	**$1000**

Expenditures	Expected	Actual
LED Strip Lighting	$40.00	$10.88
Arduinos	$60.00	$123.39
Ethernet Shields	$65.00	$65.00
Color Sensors	$20.00	$7.95
Cables, Wires, Capacitors, Resistors, and Protoboard	$80.00	$53.82
Materials for Fixture Construction	$40.00	$47.33
Materials for RFID Tagging	$100.00	$84.84
Showcase Travel Expenses and Hotel Rooms	$240.00	$317.64
Total	**$645.00**	**$710.85**

Conclusion:

The Aurora Aggies' plan for a new lighting system design for future spacecrafts stands out from other lighting systems because of its lighting artificial intelligence that adheres to the circadian rhythms of astronauts and its monitoring of and compensation for light degradation. The design features a user-friendly GUI application that provides the user with simplicity and usability, as well as a backend administrative application that will initialize and update the detailed parameters of the system within the craft. The delegation of software tasks provides the user with only significant information pertaining to them, and provides the administrator a means to detail and monitor aspects of the lighting system outside of the user application. The framework of an RFID tagging system promises ease of use to the astronauts living and working under the lighting system. The design also features low-level software that performs basic functionalities of the system. In terms of hardware, the design is optimized through use of LED lights, LED encasings, power optimization, light sensors, a computer, a networking system, and an optimal placement of each these hardware elements. The tasks for each team member will be properly delegated and will work in unison with our project timetable. The Aurora Aggies were highly motivated and dedicated to completing this project in half the amount of time that was originally allotted for the team, and were ready to present the project at the TSGC Showcase on November 13th of this year. Future iterations for this design would involve specifically targeting the lighting environment in an area with a window. The system's intelligence could be expanded to detect astronauts' locations as they move throughout the spacecraft and adjust the lighting of adjacent rooms accordingly as an alternative to RFID. The intelligence could be further developed by producing optimal scheduling of which astronauts should be in which rooms for optimal power conservation. If two astronauts are at the same period in their circadian cycle at a certain time of day, the system could indicate that they can work in the same area to save power. Given another semester, the team would focus on improving their design and expanding it to provide more functional control to the users and administrators and more control through the RFID tagging capabilities. Research has shown that an intelligent lighting system has applications in medicine and agriculture because of its benefit to humans and plants. Similarly it also has significance in providing optimal astronaut conditions for space exploration and future planet colonization. Therefore the team's design is one that can be built, utilized, and improved upon for many generations to come.

References/Bibliography:

Church TS, Thomas DM, Tudor-Locke C, Katzmarzyk PT, Earnest CP, et al. (2011) Trends over 5 Decades in U.S. Occupation-Related Physical Activity and Their Associations with Obesity. *PLOS ONE,* (6:5), e19657.

"The 2017 Nobel Prize in Physiology or Medicine - Press Release". Nobelprize.org.Nobel Media AB 2014. Web. 18 Oct 2017. <http://www.nobelprize.org/nobel_prizes/medicine/laureates/2017/press.html>

Begemann, S.H.A., Van Den Beld, G.J., Tenner, A.D. “Daylight, artificial light and people in an office environment, overview of visual and biological responses.” International Journal of Industrial Ergonomics, Elsevier, 11 May 1998, www.sciencedirect.com/science/article/pii/S0169814196000534#! Accessed 17 Sept. 2017.

Stevens, Richard G. “Artificial Lighting in the Industrialized World: Circadian Disruption and Breast Cancer.” SpringerLink, Kluwer Academic Publishers, link.springer.com/article/10.1007/s10552-005-9001-x. Accessed 17 Sept. 2017.

Pauley, Stephen M. Lighting for the human circadian clock: recent research indicates that lighting has become a public health issue. (2004, May 06). Retrieved September 17, 2017, from http://www.sciencedirect.com/science/article/pii/S0306987704002336 Accessed 17 Sept. 2017.

Lewy, A. J., Kern, H. A., Rosenthal, N. E., & Wehr, T. A. (1982). Bright artificial light treatment of a manic-depressive patient with a seasonal mood cycle. The American Journal of Psychiatry, 139(11), 1496-1498. http://dx.doi.org/10.1176/ajp.139.11.1496 Accessed 17 Sept. 2017.

George S. Evans, Ralph E. Newton, Leslie J. Powell & John F. Richter (1979). Lighting Systems for Space Shuttle Orbiter and Spacelab. *Journal of the Illuminating Engineering Society*, 8:4, 188-194

L. Putcha, B.A. Berens, T.H. Marshburn, H.J. Ortega, R.D. Billica (1999). Pharmaceutical use by astronauts on space shuttle missions. *Aviat. Space Environ. Med.* (70), 705–708.C

Dumont, M., Blais, H., Roy, J., & Paquet, J. (2009). Controlled patterns of daytime light exposure improve circadian adjustment in simulated night work. *Journal Of Biological Rhythms*, (24:5), 427-437.

Hunter, C. M., & Figueiro, M. G. (2017). Measuring Light at Night and Melatonin Levels in Shift Workers: A Review of the Literature. *Biological Research For Nursing*, (19:4), 365-374.

Terman M, Terman JS (2005). Light therapy for seasonal and nonseasonal depression: efficacy, protocol, safety, and side effects. *CNS Spectrums*, (10), 647–663.

Vitiello, M. (2001). Dawn simulation and bright light in the treatment of SAD: A controlled study. *Biological psychiatry*, (50:3), 205-216.

Nussbaumer, B. (2015). Light therapy for preventing seasonal affective disorder. *Cochrane Database Of Systematic Reviews*, (11).

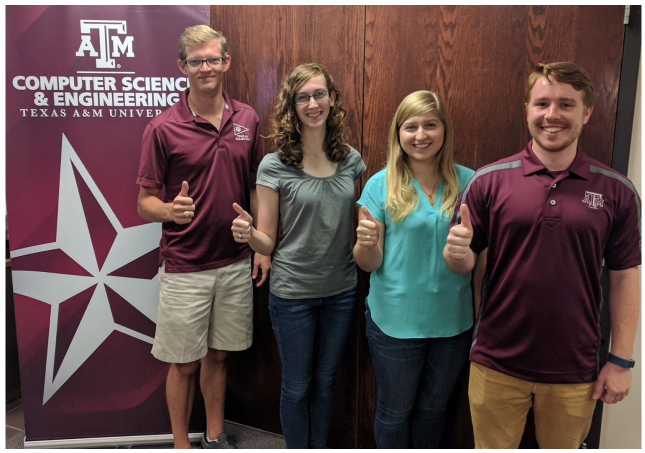
Lunn et al. (2017). Health consequences of electric lighting practices in the modern world: A report on the National Toxicology Program's workshop on shift work at night, artificial light at night, and circadian disruption. *Science of the Total Environment* (607), 1073-1084.

Brainard et al. (2013). Solid-state lighting for the International Space Station: Tests of visual performance and melatonin regulation. *Acta Astronautica* (92:1), 21-28.

Avercheva et al. (2016). Optimizing LED lighting for space plant growth unit: Joint effects of photon flux density, red to white ratios and intermittent light pulses. *Life Sciences in Space Research* (11), 29-42.

Appendices

Appendix A: The Aurora Aggies Team



Team Member Descriptions

Kevin Lewis

Senior - Computer Science (Major)

Team Roles: Team Lead, Software Design, Lighting Programming

Alyssa Valdez

Senior - Computer Science (Major), Art (Minor)

Team Roles: Team Communications, Software Design, and User Interface (UI) Design

Natalie Criscione

Senior - Computer Science (Major), Business (Minor)

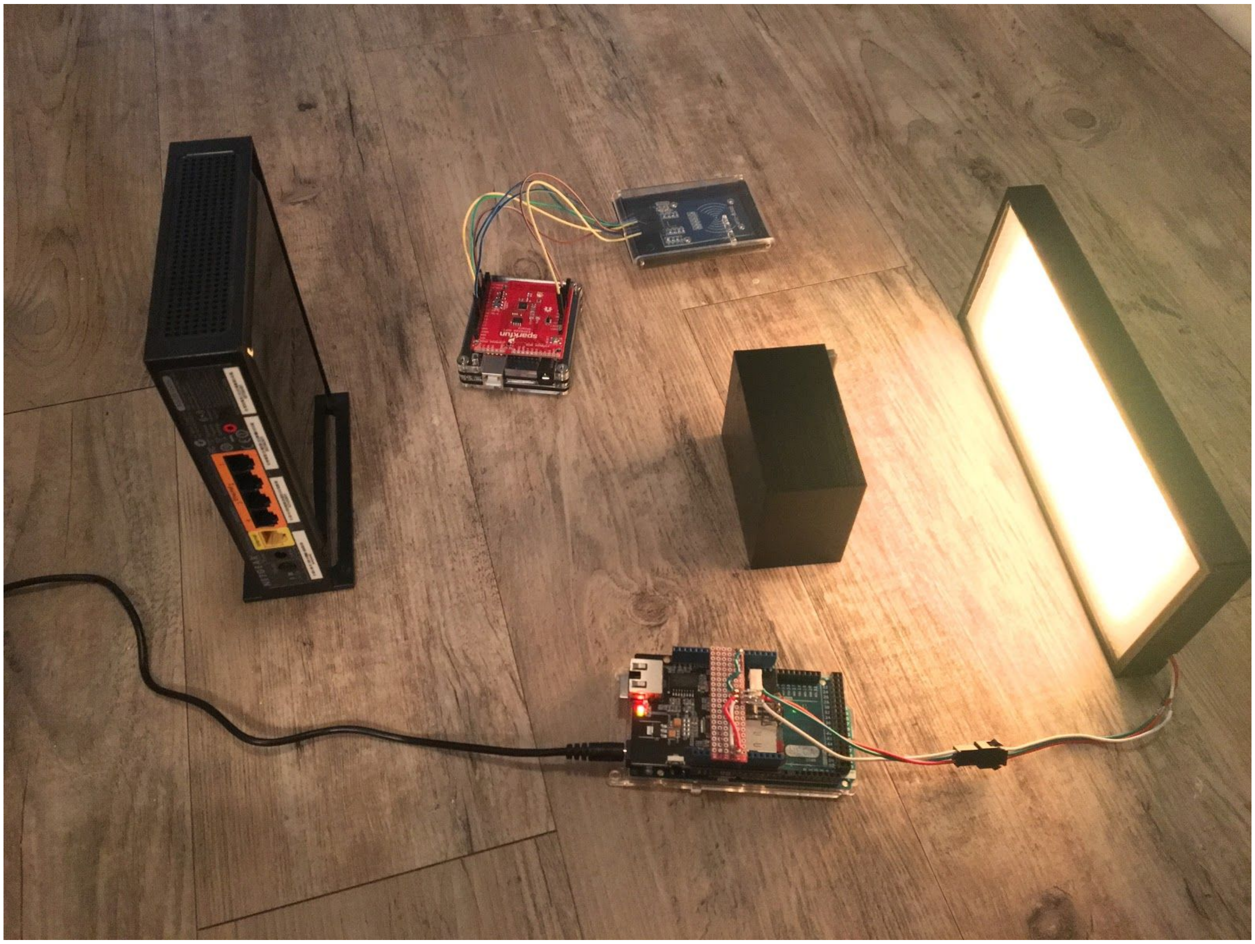
Team Roles: Software Design, Lighting Programming

Walter Pospick

Senior - Computer Science (Major), Business (Minor), Cybersecurity (Minor)

Team Roles: Hardware Design, Software Design

Appendix B: Completed Proof of Concept



Shown above from left to right are the router, RFID sensor, light controller arduino, encased sensor and controller, and encased lighting.

Project Video with Demo: https://youtu.be/c7I1IC-wSsw

Public Code Repository: https://github.com/Aurora-Aggies/AAILS

Appendix C: Pictures from the Showcase

The Team with NASA Mentor George Salazar

The Demo Setup for the Poster Presentation

The Team during the Oral Presentation

Audience Members Trying the Demo