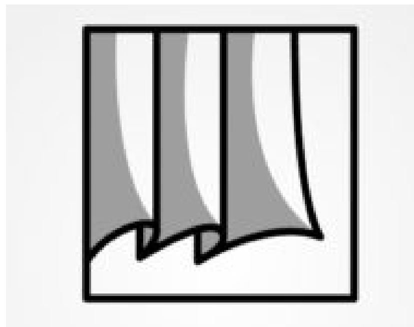
Smart Curtain System



Project Proposal

Team 3N3

Arthur Chen

David Erdner

Caleb Key

Pierre Vu

James Streets

Department of Computer Science

Texas A&M University

Date 02/17/2022

Table of Contents

1 Executive summary

In the home automation industry, the Smart Curtain system will provide a simple solution to . The sun brings a lot of energy into a room through windows directly exposed to sunlight. Without such a system, curtains must be controlled manually, requiring time and effort that would otherwise be avoided with an automated system. This project will implement such a system, offering users simple and intuitive control over their home that would be managed and scheduled internally. Completing this project will be achieved through automatic control over the curtains combined with an effective measurement system. The success of the product will be determined by the amount of energy saved through blocking sunlight from entering the covered window.

Two separate measurement systems will be implemented. A light intensity sensor will be used to measure the intensity of the light from the sun outside the window, while the thermometers will be used to measure the temperature of the room and outside. An Arduiono will be programmed to monitor each measurement system. The information collected will be used to tell the motor whether to open or close the curtains. Two separate bluetooth modules will be used. One will communicate between the microcontroller and the curtain control remote, while the other will be used to receive UI input from the user.

Once this system is implemented, it will be tested to ensure the effectiveness of the project. It would be impractical to estimate the energy needed to heat the ambient temperature of a room by one degree given that no two rooms are the same. Therefore, the results will be measured based on the amount of energy blocked by the curtains. The curtains used will be specially designed to block sunlight. So, assuming no sunlight is allowed through, the energy saved is equal to the energy from the sun measured over time.

The main benefits enjoyed by the user will be the control over their indoor climate. While air conditioning units are the main driving force of temperature control, heat energy from the windows will work directly against it. So a system like this would assist the air conditioner by reducing the energy required to reach a specific temperature. Our team has successfully completed the set up work for this project to be successful. Our combined knowledge and experience will prove essential to the overall success of the final system, each team member brings extensive and unique skills to the table. If we continue to carefully consider the needs, goals and objectives of our project, and carefully test our implementation, then the final product will be of high quality.

2 Introduction

The scope of the Smart Curtain project is in Automation, or specifically Home automation, otherwise known as domotics. This is a branch of robotics that includes the automatic monitoring and control of lighting, entertainment, temperature, security, as well as home appliances. In this case, the Smart Curtain project focuses on in-home climate control. The market for home automation was $64.58 billion USD in 2020.

2.1 Needs statement

Without blinds or curtains, the sun can heat a room through a window substantially after prolonged exposure. Covering the window with curtains will block the energy from the sun and prevent a majority of the energy from heating the room. While this can be managed by manually opening and closing blinds, the amount of time that it would take to do so could stack up for many people as they go throughout their daily routine. When leaving the room or the building, users are unable to manually control the curtains. A system that could manage the curtains without the need for manual control would allow users to freely go about their typical routine without needing to worry about managing the curtains.

2.2 Goal and objectives

The goal of our system would be to create an environment in which the energy from the sunlight would always be controlled to the desires of the user. If the user would like a cool room, the system would automatically block out sun from the room by closing the curtains, and vice versa. This way the user would never have to waste time or energy by manually setting curtains throughout the room, or multiple rooms. Our proposal is to solve this problem using an automatic system that will schedule the opening and closing of curtains in a room. If done properly, the room will be heated and or cooled by blocking or allowing ambient sunlight to enter the room. While this would not be able to heat or cool the room past the possible temperature allowed by the sunlight (would not be able to cool a room to 50 when it is 80 outside), it would push the room temperature in the correct direction or, if possible, to the exact desired temperature.

To achieve this our first objective will be to automatically control the curtains through some electronically controlled medium. Requirements to meet this objective include electronic control of the curtains, full range of motion for the mechanical controls, and satisfiable conditions for the *closed* and *open* settings. The *closed* setting should allow as little energy through the window as feasible for the given curtains. The *open* setting should allow as much energy through the window as possible. The second objective is to have an acceptable and readable measurement system. The two necessary measurements include indoor temperature, and light intensity in the window. Requirements to meet this objective include readable and accurate measurements using an indoor thermometer for the indoor temperature, as well as using a light intensity sensor for the window light intensity. Finally, we would be able to combine these to create a fully automatic smart curtain system that would control the curtains based on temperature and light intensity.

2.3 Design constraints and feasibility

The designed system will need to either be low profile or have an aesthetic design. In order to drive demand for our product, it must be made in a way that would not dissuade the average consumer from wanting to place in their home. The system must be safe, including a secure mounting, contained electronics, and substantial warnings to users. A number of safety hazards could occur from a lack of these precautions. The system could fall without proper mounting. Exposed electronics could potentially be harmful to users. Finally, consider the curtains catching on an object while opening or closing; users should be warned to keep the area clear.

The looks of our design could be a complicated problem. Without being able to manufacture our own parts, its aesthetic is subject to the parts we order. Therefore, given the situation that our final system is not at or able to be at the artistic level that we desire, our secondary goal will be to make it not stand out. System safety is a major point that we will be addressing, and the mounting and electronics will be properly addressed. Use by the consumer is less manageable. Let's consider a use case: a user puts an expensive, breakable vase on a table in front of the curtains. The system opens the curtains, catching on the table or vase knocking it over. Aside from property destruction, the shards from the broken vase could be dangerous. This could be mitigated during system design, but not reasonably prevented, leaving it necessary to provide ample warning to users.

3 Literature and technical survey

This project's goal is to build a curtain system that will save energy by determining the need for more or less radiation from the sun through the window that the curtain will be setup at. Based on this goal, we needed to begin our research with finding the radiation from a common exterior window. Once we found this information, we then needed to discover what material(s) would best block that radiation. We were able to find a material blocking out most of the radiation from the window which would help us reach a near binary state of the curtain system since ideally, we could block out all the sun, none of it, and everything in between. These two pieces of information were a catalyst for our design process and along with that, we deemed it necessary to be concerned with similar products currently available on the market. We found 3 various automatic curtain systems that had various levels of influence on our design process.

Mengting Zhu and others from the College of Civil Engineering and Architecture at Wenzhou University in Zhejiang, China performed a research on the influence of key parameters of exterior windows on energy saving. During this research they used seven different types of glass, conducting thermal analysis on each of these through a simulation software. The environment parameters for this study were daily average temperatures through 4 months, varying in their time of year. These months included January, April, July, and October with January and July simulations being the two extremes of the experiment. For our project, our only concern were the common exterior windows which the research concluded that “When the glass is ordinary glass, the incident rate of solar radiation is 100%...In this case, 15% of the total solar radiant heat is isolated and 85% is transmitted indoors.” [1]. This means that we will be concerned with 85% of the total heat radiation from the sun. Knowing this now, we must find a material that will achieve close to a 100% blockout rate.

A research conducted by Joanna Szkudlarek and others from Lodz University of Technology analyzed the light intensity that broke through 3 different materials, particularly their fabric structure. Fabric 1 was a smooth, uniform material, fabric 2 being a woven material with a higher linear density, and fabric 3 was a smooth material with the lowest area density. This research concluded that fabric 2 had a permeability rate of 0.095%, or a black-out rate of 99.905%, which was roughly 0.025% better than fabric 1 and 1.185% than fabric 3 [2]. We used this information to select a curtain with a similar material structure to that of fabric 2 of this study. This would allow us to achieve a similar blackout rate and thus preserve more energy when attempting to block out all of the heat radiation from the sun.

Our first product review was a shading system developed by Graywind that has much potential with their use of blackout curtains and has the convenience factor with the ability to be controlled through home speaker devices such as Alexa, and Google Home. This product does not advertise energy-saving capabilities or user-less control. The blackout curtains as stated above would be a great energy-saving feature and thus would have decided to take this route in our design.

Our second product review, SimpleSmart’s curtain track, has many capabilities as it can be controlled through a remote control, through an Iphone/Android application, or through home speaker devices such as the ones mentioned above. This is a very simple track system with only user-mode controls and no energy-saving features. Our main takeaway from this item is it’s diversity of control platforms through the use of Alexa, an application, and an external remote.

Our final product, developed by SmartBot, is an electric motor that glides across a curtain rod system. This product can be controlled by either a remote control for the device or through their iphone/android application. This design seems simplistic and easy to use which is why our design will use this product to move the curtain. This can be shown in the design section of this proposal.

This research review has shown us that our product is not only distinct but also very practical. Through the window parameter research by Zhu, we saw that common exterior windows have a very poor energy-saving performance which opens the door to desirability of our product. Then the research conducted by Szkudlarek gave us an insight into the blackout curtain material desired for the lowest permeability of light which is highly beneficial to reaching our goal, saving energy for the user through the use of a curtain system. The product reviews showed that there are developments in this area that have potential but lack the creativity and ingenuity it takes to have energy-saving features. Through all this, we concluded that our project is distinct and that there is a market for our product, waiting for a group to take over the landscape through the use of automated energy-saving features.

Existing product or projects:

- Proposal of Objective Assessment of the Phenomenon of Light Passage through Blackout Fabrics
- Study on the influence of key parameters of exterior window structure on building energy saving effect
- Graywind Motorized Shades
- SimpleSmart - Motorized Curtain Tracks
- SwitchBot Curtain Smart Electric Motor

4 Proposed work

4.1 Evaluation of alternative solutions (1 page, 10 points)

This is a critical aspect of your proposal. For any goal there are likely many alternative solutions. In most cases, the alternative solutions will emerge from your literature and technical survey. What you have to do here is analyze the pros and cons of each of these solutions (and hopefully additional solutions you come up with), and justify your decision to opt for a particular solution. As a guideline, this section should include *not less than five alternative solutions*:

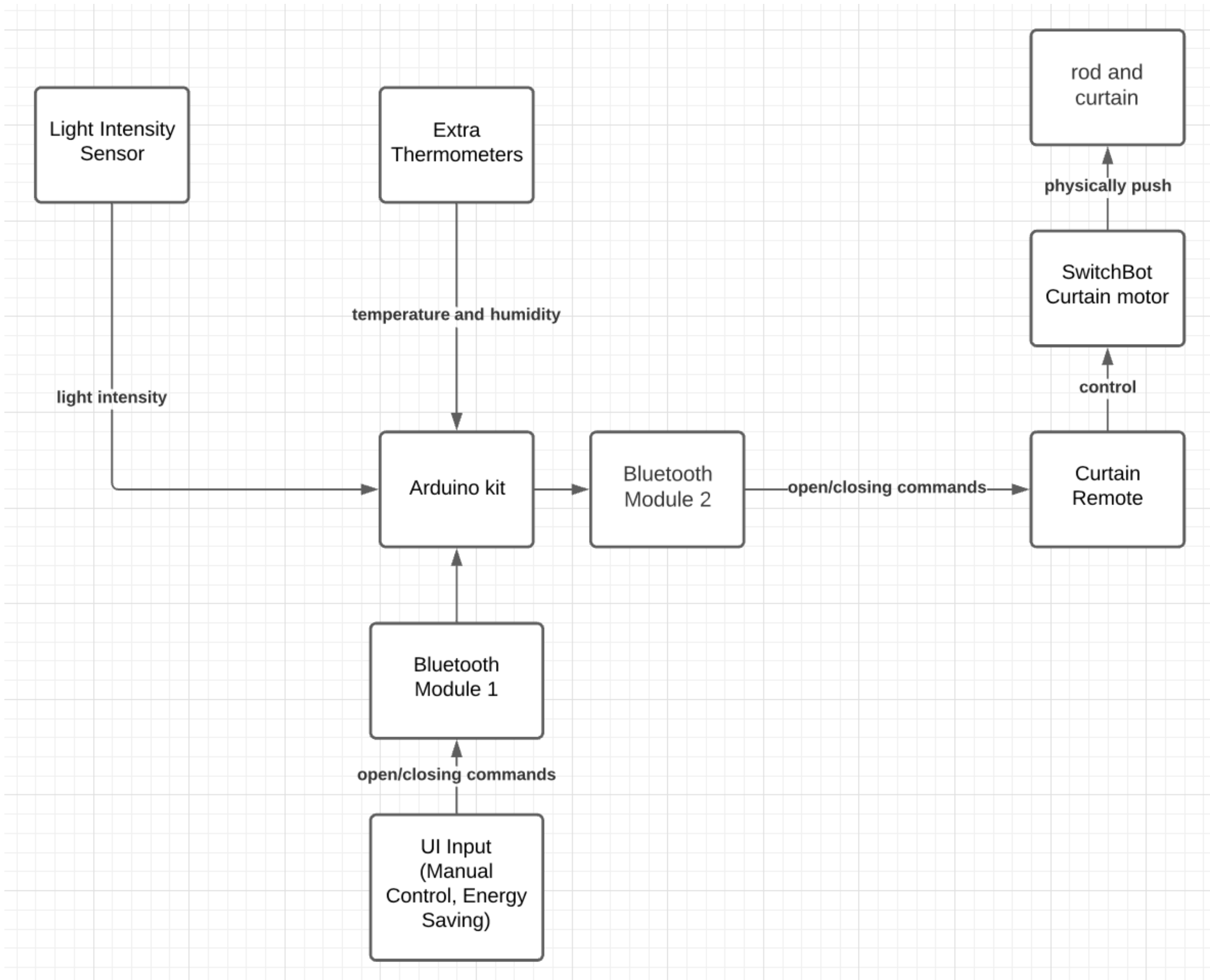
There are multiple alternative solutions existing in the related field of study. Based on the literature and the technical survey in the previous section, the alternative solutions will be evaluated by comparing their pros and cons. Lastly, after the evaluation of all the alternatives, we are proposing a particular solution which will be detailed in the following section.

There are the alternative solutions:

- Proposal of Objective Assessment of the Phenomenon of Light Passage through Blackout Fabrics
  This research paper is an existing approach to discover the relationships between the transparency of light through wild range of the materials. This paper helps us to decide which type of fabric we should use in our design.
- Study on the influence of key parameters of exterior window structure on building energy saving effect
  This research paper found the correlation between the temperature and the matrix equation between eh energy saving effect through grey theory and regression analysis, which helps us to understand the why energy could be saved through porper control of the curtain.
- Graywind Motorized Shades
  This particular shape of curtain is widely used commercially due to the fact that the spaces preserved within the holes in the shades reduce the heat exchange between indoor and outdoor.
- SimpleSmart - Motorized Curtain Tracks
  SimpleSmart is an existing product that uses an autonomous system to control the curtain remotely and automatically, which adjust curtain positions to save energy when residents are not around while keeping the desired temperature.
- SwitchBot Curtain Smart Electric Motor
  This electric motor is similar to the previous one mentioned above, where it is wildly used as well. The product uses an alternative approach to control the curtain, by using a motor to physically push the curtain.

4.2 Design specifications

High-level data flow chart:



Light Intensity Sensor

The light intensity sensor will be used to measure the intensity of the light from the Sun outside the window. This sensor will provide this information digitally, so that we can use it in our code to program the motor.

Thermometers

The thermometers will be used to measure the temperature of the room and of the outside. These thermometers will be digital, so that we can use the information provided in our code to program the motor.

Microcontroller kit

We will be using a microcontroller to program our motor. Between a microcontroller and a microprocessor, the microcontroller is more commonly used for simple motor functions, so we thought that it would be easier to use for a smart curtain. The microcontroller will read in the information from the light sensor and the thermometers, and we will use that information in our program to tell the motor whether to open or close the curtains.

UI Input

This will be our way of communicating with the microcontroller the settings that can be changed. We will use a bluetooth module to send the preferred settings to the system and then to the curtain.

Bluetooth modules

These modules will be used for communication between the microcontroller and the remote for the curtain. This will also be used to send commands to the microcontroller.

Curtain Remote

This remote will be used to send signals to the motor of the curtain and tell it to open or close. It will receive those commands from the bluetooth module that is attached to the microcontroller.

SwitchBot Curtain Motor

This is a motor specifically designed for moving curtains, so we are using it in our project. This motor already has a connection with its remote, so we do not need any additional configuration besides using the remote, or bluetooth signal from the remote to control the curtains.

Rod and Curtain

This is a standard curtain rod that is used for holding curtains. It needs to be able to move freely, so that the motor can work. The curtain is going to be a blackout curtain because that will be the most effective in blocking out sunlight and maintaining temperature inside. Any amount of translucency will make it significantly worse in stopping the sun's energy.

4.3 Approach for design validation

The system was designed to save energy when no one is home by opening and closing the curtains to control the temperature instead of solely relying on a thermostat. To test this, we will monitor the curtain in various conditions with various parameters to ensure that it functions as intended based on different light intensities and temperatures. Evaluating the energy cost is the tricky part as we need to have access to the electricity bill and be able to control the thermostat ourselves over a long period of time, so we might not be able to fully evaluate the cost benefits of this product. Since this is virtually impossible to do in the given time frame, we will attempt to calculate the energy saved rather than measure it to analyze the success of the system. We will test the basic functions of the curtain by manually sending the open and close commands to the motor at first to make sure that the motor functions work before we start to work on the algorithms. Then we will test the thermometer and light sensors. We can do this with simple output statements once we figure out how to incorporate them into the software. We cannot start if we don’t know how to use the sensors. Then we will make sure the motor is working with our software to make sure we can control it. At the end, in order to test the product, we will measure the temperature and light intensity ourselves, and see if the curtain will close or open according to our algorithm. If it functions as intended, then our product works at a functionality level. The energy costs and savings will mainly be tested from a calculatory standpoint as it will be unlikely that we can conduct a full research into the costs without a long period of time, access to the thermostat, and measuring the temperature and curtain at every point in the day. We do not have the time to do all of those tasks, so we will settle for calculations rather than measurements. Based on the light intensity and the temperature outside compared to inside, we will calculate the amount of energy saved from blocking it, and then we will calculate how much that would convert to hertz of power used by the thermostat inside a building. This will give us the amount of energy saved by the building, and we could use the cost of electricity to calculate how much we are actually saving. The amount of savings we would have is expected to be low due to our understanding of correlation between light and heat from the sun, so we expect there to be minut differences.

5 Engineering standards

5.1 Project management

The team that has been formed for this project has a plethora of different qualifications. Everyone on the team has taken the same core classes that are required for Computer Science and Engineering, but we all have our own areas of expertise. Along with this, each member of the team brings in their own specialized knowledge pertaining to the areas of focus developed during classes, internships, projects, hobbies, and research. Between all 5 members of the team, we have had several internships in industry, undergraduate research experience, high quality projects, and team leadership opportunities. Below is a list of qualifications for each team member, as well as what area of the project they will be a main contributor for.

Arthur Chen - Team Leader. Arthur comes into the team with a lot of leadership experience, as well as very impressive technical skills. Along with doing undergraduate research for the Auto Drive Challenge Team at Texas A&M University, Arthur has had two different software development engineering internships. He is a well suited leader for this project.

David Erdner - Systems Design. David brings experience from multiple internship experiences, working in software development, hardware engineering, and data engineering. He has had experience in system design from his internships, and has also participated in multiple projects at Texas A&M University which require a high degree of system design.

James Streets - Hardware Design. James has had fantastic experiences in both hardware and software, and has been instrumental in determining the hardware that will be used for the project. He has experience with FPGAs, RaspberryPis, ARMv8, and microcontrollers . Along with working for MR3 Health as a software engineer for almost a year, James has been involved in multiple hardware projects, and has great experience with the microcontroller system and hardware components that will be used for the project.

Pierre Vu - Software Design. Pierre is a very experienced software engineer. He has built very impressive projects using Python, JavaScript, SQL, HTML, CSS, and others. In the summer of 2021, he worked at Enbridge helping users solve security problems, as well as helped provision virtual machines during the company's cloud migration.

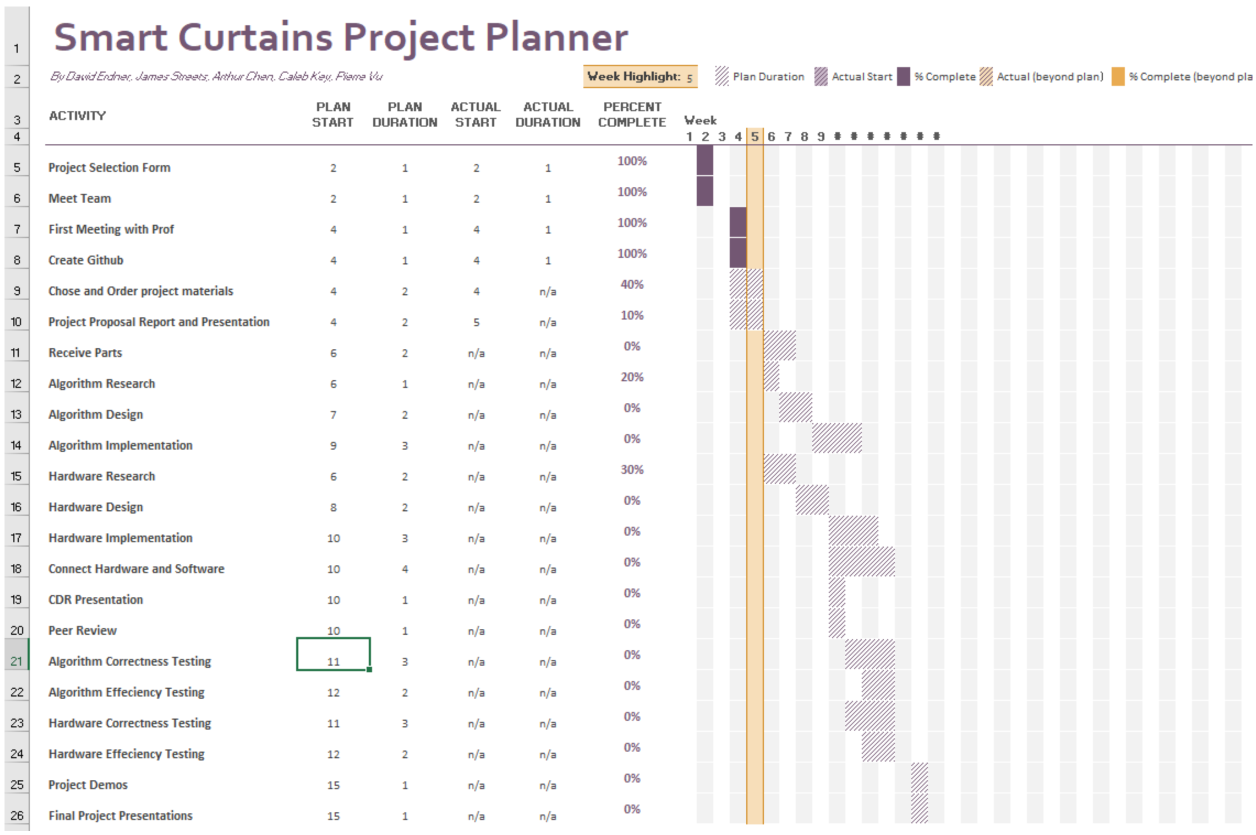
Caleb Key - Testing, Technical Reporting. Caleb brings the team a very diverse skill set, including computational thinking, design and implementation of algorithms, data types, implementation of computer languages, experience in PYTHON and C++. Caleb has also worked on system support for application programs, and inter-process communication, which is excellent experience to have when it comes to testing the product giving the technical reports.

We will be using discord as our main channel for communication throughout the project, because we can easily share tasks, files, assignments, and hold meetings all in one place. We have all been very vocal about our opinions on the different aspects of our project in our weekly meetings and brainstorming sessions, and we decided to use a Gantt chart as our primary tool for keeping track of our progress.

5.2 Schedule of tasks, Pert and Gantt charts

Below is the Gantt chart and flow chart containing tasks, dependencies, and schedule over the 16 week semester. Please note that the flow chart is broken into multiple screenshots and displayed in this report for ease of viewing. A link is also included to the flow chart.

Gantt Chart:

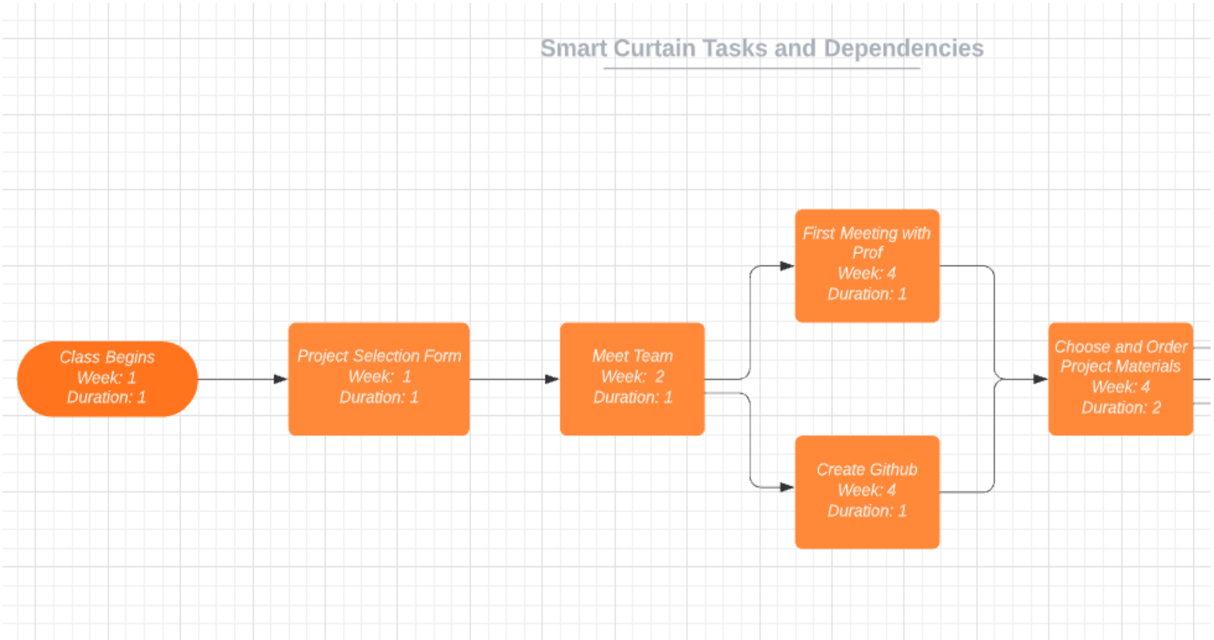


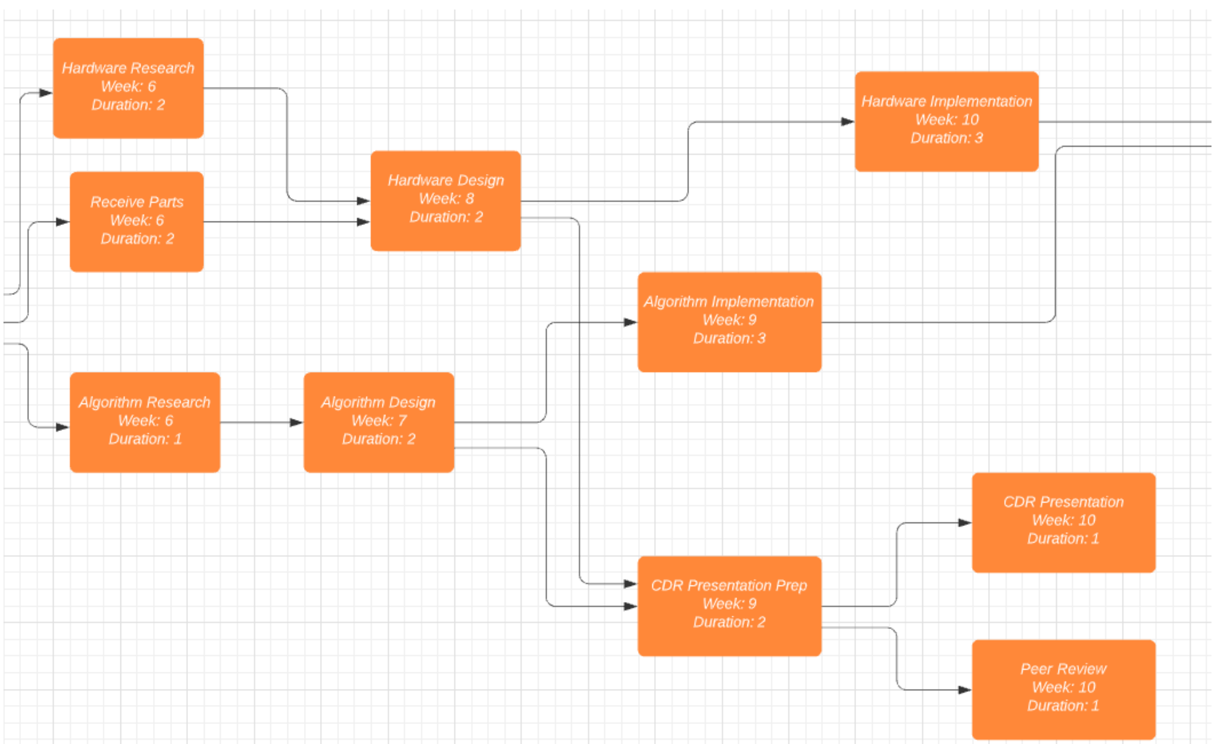
ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Project Selection Form	2	1	2	1	100%
Meet Team	2	1	2	1	100%
First Meeting with Prof	4	1	4	1	100%
Create Github	4	1	4	1	100%
Chose and Order project materials	4	2	4	n/a	40%
Project Proposal Report and Presentation	4	2	5	n/a	10%
Receive Parts	6	2	n/a	n/a	0%
Algorithm Research	6	1	n/a	n/a	20%
Algorithm Design	7	2	n/a	n/a	0%
Algorithm Implementation	9	3	n/a	n/a	0%
Hardware Research	6	2	n/a	n/a	30%
Hardware Design	8	2	n/a	n/a	0%
Hardware Implementation	10	3	n/a	n/a	0%
Connect Hardware and Software	10	4	n/a	n/a	0%
CDR Presentation	10	1	n/a	n/a	0%
Peer Review	10	1	n/a	n/a	0%
Algorithm Correctness Testing	11	3	n/a	n/a	0%
Algorithm Effeciency Testing	12	2	n/a	n/a	0%
Hardware Correctness Testing	11	3	n/a	n/a	0%
Hardware Effeciency Testing	12	2	n/a	n/a	0%
Project Demos	15	1	n/a	n/a	0%
Final Project Presentations	15	1	n/a	n/a	0%

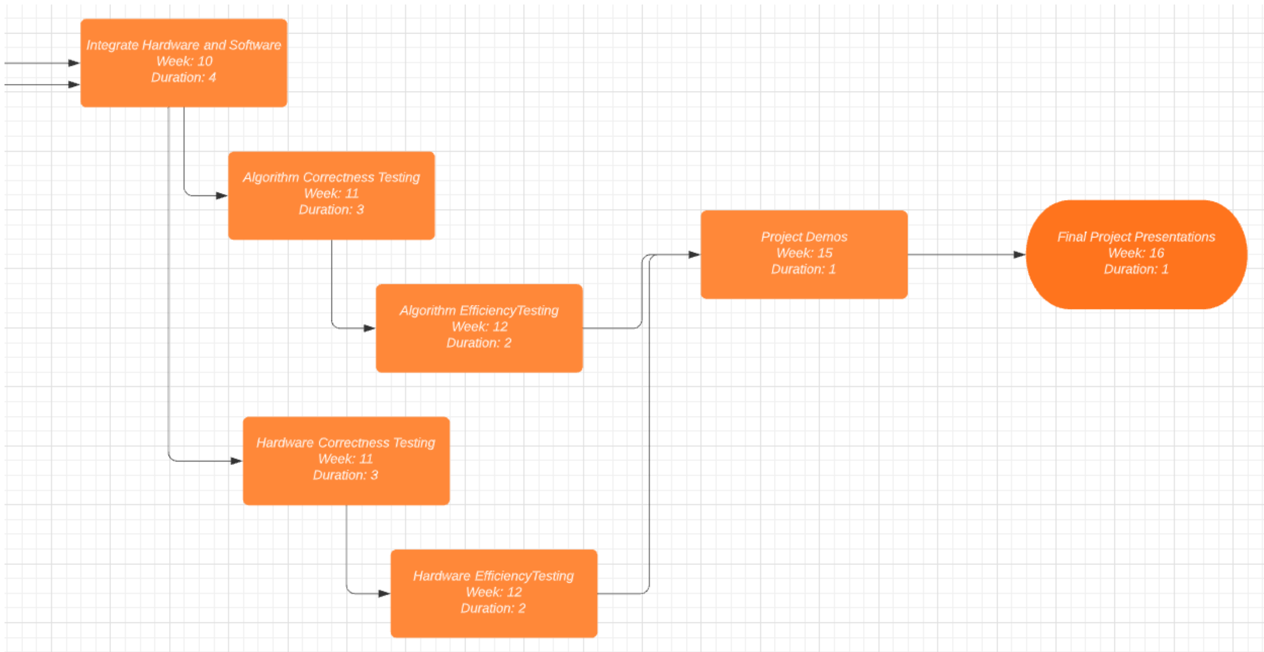
Tasks and Dependencies Flow Chart

(Critical Path follows top arrows and is 16 weeks in length)

Link (Must have Lucid account to view): https://lucid.app/lucidchart/90d94c2f-fc2a-4fff-a340-663b13384dc0/edit?invitationId=inv_db9dd6bf-7e75-4846-9719-195d84b5b5a4







5.3 Economic analysis

In order for a product to be successful in the market, it must be economically viable. A great idea might not necessarily correlate to a great product. Even if an engineering solution could significantly improve the lives of consumers, if it is not affordable, economically feasible, sustainable, and manufacturable, it will not be a successful product. In this section, we analyze all of these factors, and argue how feasible our system would be as a commercial product.

- Economical viability. While there are automatic curtain opener/closer systems in existence that are easily available for retail purpose, none of them come equipped with multiple thermometer or light intensity sensors as inputs to the smart curtain system. Thus, while a user could use the system to automatically open or close the curtains when desired as an attempt to save energy, the system does not automatically open or close to save energy without user instruction. Our system utilizes another market product (SwitchBot) as the curtain opener as the output for our product, but also includes other attributes such as thermometers and light intensity sensors as inputs in order to save energy automatically. Because of this uniqueness, the marketability of the system will be very high. The prototyping costs for this project are estimated to be around $230, and if this project was put into production, it would most likely fall below $200 for the production cost of each system.

- Sustainability. The parts required for this project are available in different variations from different vendors, but for the prototype we will be using very specific vendors because of our budget constraints. Apart from this, the system will require very little maintenance support. Battery replacements for the motor will be required every few months, but other than that, the system should be self-sustaining.
- Manufacturability. Because our system builds off of other market products, the manufacturing work for this project is generally going to be connecting the parts together onto the microprocessor, and packaging the system for ease of mobility. The microprocessor that is going to be used is a microcontroller kit which we will use as the center point of the project, which will connect all of the other components together into a working system.

5.4 Societal, safety and environmental analysis

The impact that this project could have on society if used on a large scale is quite significant. In terms of quality of life, the system provides a clear benefit to the user when it comes to saving energy. Since the primary goal of the system is to reduce the amount of work done by the air conditioning system, the result of a successful system is a significant amount of money saved on electricity over time. Along with this, the system provides the user with increased convenience. With smart homes becoming more popular, customers are having their homes equipped with voice controlled lights, music, air conditioning, and more. Users not having to worry about manually opening or closing curtains is just another simple thing that will make life just a little easier.

On the other hand, there is the possibility that a curtain system that automatically opens could open at a time that the user is not expecting, which could lead to a loss of privacy. Especially in areas where curtains are essential to privacy, a user may not want to use a smart curtain system that could be detrimental to their privacy. However, since our system will also have a setting that puts the user in complete control, they will have the option to keep the curtains closed in situations where they want to prioritize privacy.

As far as safety concerns go, there are a few safety hazards that could occur from a lack of thorough precautions. Without proper mounting, the system could fall from the support system and potentially harm something underneath it. Aside from this, exposed electronics could potentially be harmful to users if they are not properly covered. Finally, consider the curtains catching on an object while opening or closing; users should be warned to keep the area clear. These are all things that we are taking into consideration, and will be incorporated into the design.

Finally, environmental impact. As our product is designed to save energy that would otherwise be expended from an AC unit, the expected environmental impact if implemented on a large scale would be positive. Ideally, this system would save energy everywhere that it is implemented, which should decrease the average power consumption per home where the system is used.

5.5 Itemized budget

Below is a table of the itemized budget for this project. This list is subject to change pending the arrival and testing of parts.

Component	Price	Link
Microcontroller kit	$38.99	microcontroller
SwitchBot Curtain motor	$99.00	SwitchBot motor
Curtain Remote	$16.15	Curtain remote
Extra Thermometers	$10.29	thermometers
Light Intensity Sensor	$10.99	Light intensity sensor
Bluetooth Module for Microcontroller(2)	$18.00	Bluetooth module for microcontroller
Rod for holding curtains	$19.00	Rod for curtains
Black Out curtains	$16.00	Black out curtains
Total	$228.42	

6 References

[1] M. Zhu, R. Diao, J. Fu, X. Jiang, en Y. Zhang, “Study on the influence of key parameters of exterior window structure on building energy saving effect”, IOP Conference Series: Earth and Environmental Science, vol 675, no 1, bl 012051, Feb 2021.

[2] Szkudlarek J, Snycerski M, Owczarek G. “Proposal of Objective Assesment of the Phenomenon of Light Passage through Blackout Fabrics”, FIBRES & TEXTILES in Eastern Europe 2017; 25, 4(124): 50-58. DOI: 10.5604/01.3001.0010.2663

7 Appendices

7.1 Product datasheets

Digital Thermometer Datasheet: DHT11-Temperature-Sensor.pdf (components101.com)

Light Intensity Sensor Vishay TEMT6000

Bluetooth Module HC-05

Microcontroller ELEGOO UNO

7.2 Bios and CVs

Include a brief bio-sketch and CV for each team member. The bio-sketch is a brief summary of your professional / educational accomplishments, whereas the CV is a more comprehensive and detailed (itemized) description of you qualifications. Browse through some of the IEEE Transactions (http://ieeexplore.ieee.org/) for examples of typical bio-sketches.

Arthur Chen, as a computer engineering student, explored multiple subfields of Electrical Engineering and Computer Science during his undergraduate study. Additionally, with his knowledge learned from the business and math minor, Arthur found internships that manage databases in finance industry and assist research in crypto wallet service company. With the foundations and the exploration among Business, Electrical Engineering, and Computer Science, Arthur found himself interested in the application of robotics in autonomous vehicle. Thus, Arthur participated in the research team for a national competition on level 4 autonomous vehicle. During this time, he further explored the application of CS in robotics, and decided to pursue a master degree in autonomous systems starting Sep, 2022 in UCLA.

CV

James Streets is a diligent computer engineering student with 3 years experience developing, debugging, and designing code of varying complexity for projects including full-stack web development, point-of-sales systems, and microprocessor programming. As a freshman at Texas A&M he joined the Galveston Freshman Leadership Organization where he developed key leadership skills needed to propel his past, current, and future teams through adversity. He has experience with FPGAs, RaspberryPis, ARMv8, and microcontrollers which led him to becoming the Electronics Officer for IEEE at Texas

A&M. Here he led workshops on Hamming Codes, microcontroller components, and digital logic design. Along with working for MR3 Health as a software engineer for almost a year, James has been involved in multiple hardware projects, and has great experience with microcontroller systems and hardware components.

James Streets CV

Pierre Vu is a very experienced computer science student with experience in web development, machine learning, and cybersecurity. He has built very impressive projects using Python, JavaScript, SQL, HTML, CSS, and others. He has used neural networks and tone analysis APIs to build a recommender system for movies based on their posters and plot tone. He has also built various social platforms for clubs and students alike with features such as event schedulers and shop recommenders. In the summer of 2021, he worked at Enbridge helping users solve security problems, as well as helped provision virtual machines during the company's cloud migration.

Pierre Vu CV

David Erdner is a Computer Engineering Student at Texas A&M University with exceptional communication skills and problem-solving abilities. He has a full year of tech industry experience and worked with multiple teams. In 2018, he worked at Intel Corporation as a Software Engineering intern, and wrote multiple automated tests for Intel Cluster Checker software. In 2019 and 2020, David returned to Intel, but this time as working on the System On a Chip team in the hardware group. During this time, David designed a regression testing system for the chip design process, and ran TR experiments on 7nm technology to see the results of excluding certain cells from the SOC process. He also developed a script which collected and displayed relevant data from hundreds of reports that were automatically generated in the physical design process.

David Erdner CV

Caleb Key is a Computer Engineering student at Texas A&M. He has undergraduate research experience focused on the development of genetic algorithms in the scope of computer hardware. Caleb brings the team a very diverse skill set, including computational thinking, design and implementation of algorithms, data types, implementation of computer languages, experience in PYTHON and C++. Caleb has also worked on system support for application programs, and inter-process communication, which is excellent experience to have when it comes to testing the product giving the technical reports.

[Caleb Key CV]