# ECE 445

# Angling Blinds: Project Proposal

Team 20

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# 1) Introduction

## 1.1) Problem

As working from home has become more popularized, people have become more accustomed to sitting in their rooms all day. However, many workers may not be getting consistent sunlight from their windows while being preoccupied with work and neglecting to angle their blinds accordingly. Several studies have proven that natural sunlight provides measurable health benefits, including boosting Vitamin D, improving sleep, etc. [1], and for people to get consistent levels of sunlight, it is crucial to frequently adjust their blinds throughout the day. However, this frequent action is often forgotten.

## 1.2) Solution

We propose building blinds that adjust its angles based on a user's desired level of brightness using a pulley that pulls on the blind's strings. This would be done using a photo sensor to detect how much sunlight exists outside and another sensor to detect how much sunlight is actually coming in. With the data from these sensors and the current time from the device's real-time clock, the device will adjust the blinds based on the current brightness level and also the time, where a desired brightness level may vary throughout the day. The device's behavior based on these two factors may be adjusted through an application, which can cater to a user's specific need. This would mean that the user does not have to constantly adjust the blinds to get their desired brightness and they will get consistent sunlight.

## 1.3) Visual Aid

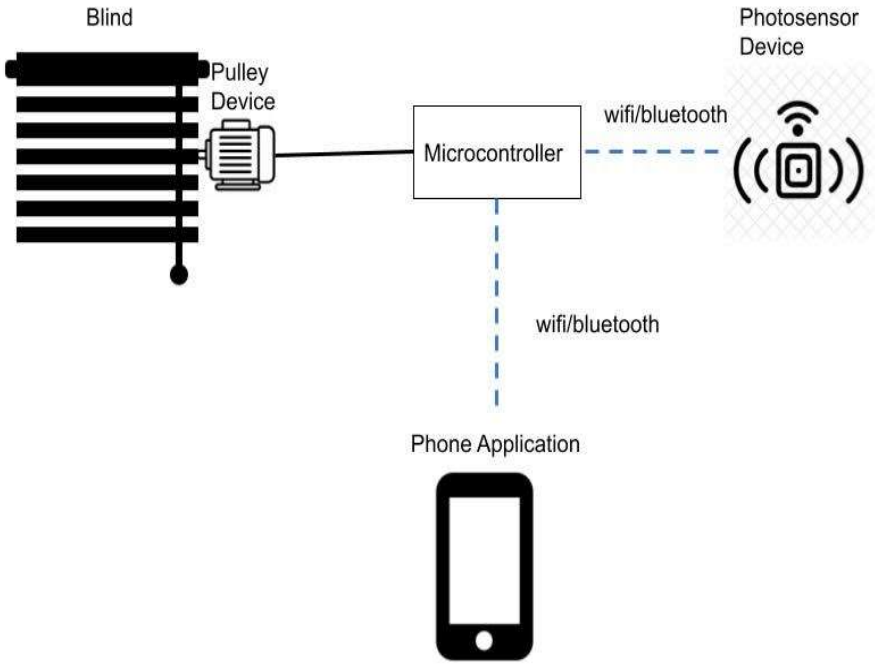


Figure 1. Visual aid

### 1.4) High-Level Requirement List

1. The blinds must start adjusting to the target brightness when the inside brightness is ± 200 lumens of the target.
2. The battery for the photo sensor devices must be able to last at least three months.
3. The blinds begin to adjust to the desired brightness within 5 seconds of the user inputting a value.

# 2) Design

## 2.1) Block Diagram

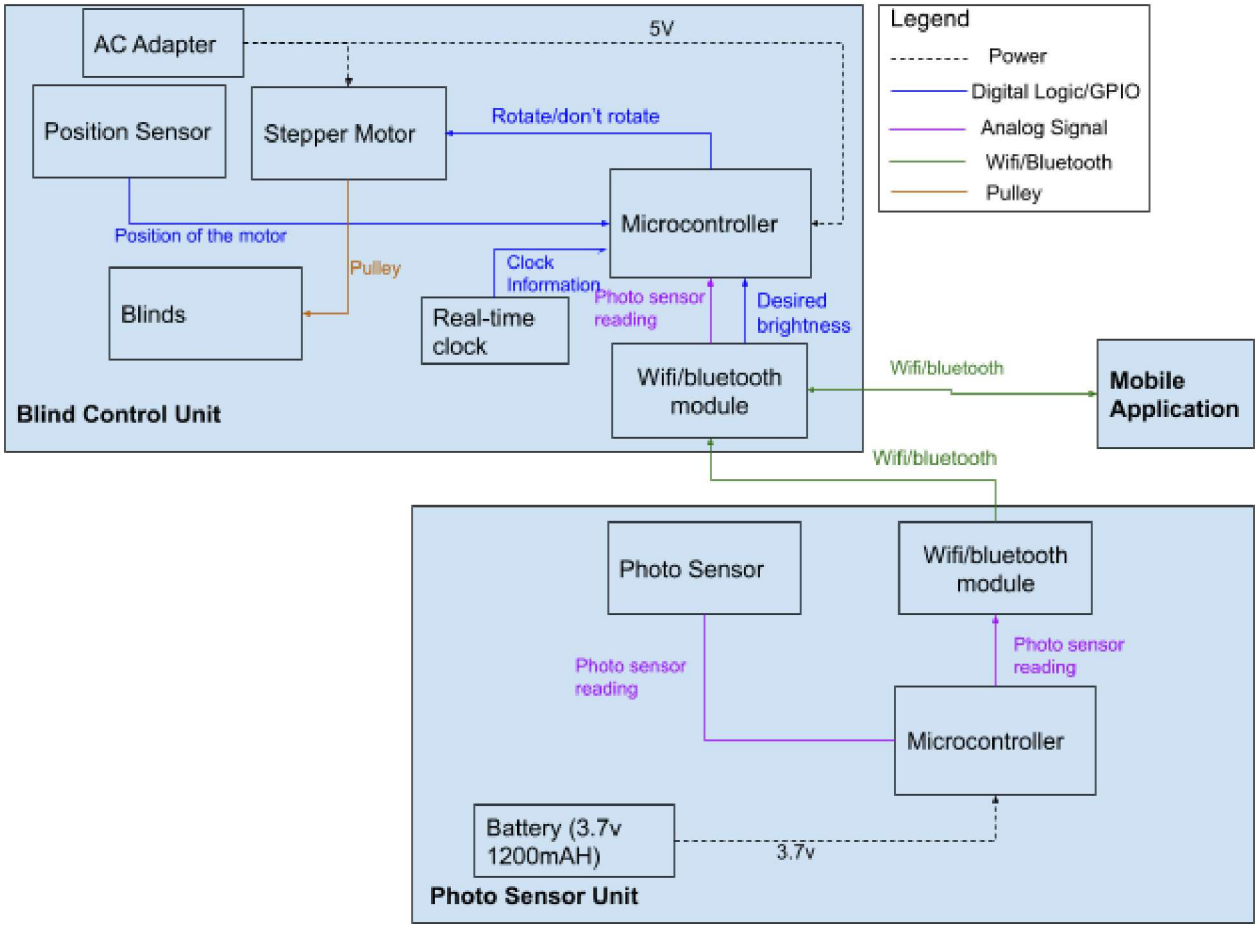


Figure 2: Block Diagram

## 2.2) Subsystem Overview

### 2.2.1) Blind Control Unit:

The blind control unit will determine whether to adjust the blinds and then adjust them. The subsystem includes a position sensor, stepper motor, real-time clock, microcontroller and the wifi/bluetooth transceiver module. The stepper motor will rotate the blind's strings as told by the microcontroller, adjusting the angles. This subsystem will receive light sensor data via wifi/bluetooth transceiver module and will control the motor based on the light sensor (Subsystem #2) and time data received. Ideally, the device will adjust the blind's angles so the room can have a user's desired brightness level throughout the day given through the application subsystem, where this level may vary as the day progresses. The microcontroller would take all of this data and determine whether the motor should rotate or not rotate. The stepper motor and the microcontroller would be powered by an AC adapter.

### 2.2.2) Photo Sensor Unit:

We will have two photosensors, a bluetooth/wifi transceiver module, a microcontroller and a battery spread out across the room. These devices are connected to the blind control unit (Subsystem #1) via wifi/bluetooth transceiver module. The first photosensor will read the output from the outside window to record the maximum brightness so that the user knows the maximum sunlight that can be brought inside the room. The second photosensor will be well within the room to abstain the general brightness of the room itself to make sure that the desired amount of sunlight is entering the room. Both of these readings would be sent via wifi/bluetooth through the microcontroller - the first photosensor's reading to the app and the second photosensor's reading to the blind control unit's microcontroller. The microcontroller would be powered by a 3.7v battery.

### 2.2.3) Mobile Application:

We will have a mobile application that sets a brightness level manually and this allows the blind system to operate accordingly. Through wifi/bluetooth, the app will receive the photo sensor readings of how much light is outside. It would let the user know and have a scale of how much light they would like inside. When the user adjusts how much light they would like inside, the app would send this information through the wifi/bluetooth to the microcontroller in the blind control unit. From there, the blind control unit can calculate how much the motor needs to rotate and also continuously rotate throughout to ensure that the amount of light the user wants is let into the room (unless it can't).

On top of that, the application will support a schedule utility that determines the working hours of the blind system. We would also like a recommendation algorithm incorporated into the application and suggest brightness levels for users depending on the time of the day if time permits.

## 2.3) Subsystem Requirement

### 2.3.1) Blind Control Unit:

The blind control unit contributes to the overall design because it is the unit that controls the movement of the blinds through the stepper motor. This unit will interact with the photosensor unit by receiving photo sensor data to decide whether to adjust the blinds. This unit will also interact with the application by sending photo sensor data and receiving information from the application to adjust specific settings.

1. It must be able to adjust the angle of the blinds between the fully open and fully closed.
2. It must prevent the motor from spinning beyond the intended maximum to prevent damage to the blinds.
3. It must communicate with the photosensor unit wirelessly using Bluetooth or WiFi.

### 2.3.2) Photo Sensor Unit:

The photosensor unit contributes to the overall design because of how the blinds adjust based on the photo sensor readings from this unit. These units are crucial in monitoring the room and outside's brightness so that the blinds can adjust when necessary. This unit will interact with the motor device through WiFi/Bluetooth, sending photo sensor information in quick intervals to ensure consistent updated communication.

1. It must be able to accurately read the brightness of the area with a bound of $\pm 200$ lumens to turn the blinds in the right orientation.
2. This unit must communicate with the blind control unit in quick intervals through Bluetooth or WiFi to ensure that the blinds are well-adjusted to the current environment.

### 2.3.3) Mobile Application:

The application contributes to the overall design because the user mainly interacts with this subsystem. It is where the user inputs how much light they want in the room. The photo sensor detecting the amount of light outside will send the application the maximum brightness via WiFi/Bluetooth. It interacts with the blind control unit via WiFi/Bluetooth where the microcontroller in the blind control unit takes the desired brightness and controls how much to rotate.

1. If a user sets a certain brightness through the application, it must be able to quickly change the blind control unit's behavior to ensure that the user's preferences are met in a timely manner.
2. It is able to let the user know the correct maximum brightness outside.
3. If there is not enough light outside to match the desired brightness level, the application should let the user know.

## 2.4) Tolerance Analysis

The position sensor may not correctly sense the position of the motor. An imprecise read of the position of the motor can cause the motor to go beyond its threshold and keep pulling at the blinds' maximal angle and therefore damage the blinds. A full range motion of the blinds is approximately 28cm. For a conventional stepper motor with 200 steps per revolution, 1.8 degree step angle and attached to a 4cm diameter wheel. Thus,

$$(28/4) * 200 = 800 \; steps \; or \; 4 \; revolutions$$

are needed to achieve a full range of motion. In order to prevent the blind control unit from damaging the blinds while guaranteeing the optimal performance, we believe it's necessary to control the range of motion to around 794-798 steps. Moreover, a real time clock can also be implemented to prevent such false behaviors, while we can use time as an additional constraint to the blind control unit. For example, for a 150 rpm stepper motor, to achieve full range of motion, approximately

$$4/(150/60) = 1.6 \; seconds$$

are needed. In this case, it's possible for us to only allow the motor to operate for 1.59s in a full range of motion in order to prevent unwanted damages to the blinds.

## 3) Ethics and Safety

This project has potential ethics and safety issues that may conflict with the IEEE Code of Ethics, namely the safety and privacy of the user [2]. For instance, the user could get their finger, hair, etc. stuck in the pulley or motor area, which is a safety issue to watch out for. Also, the user must be okay with an automated system opening and closing their blinds as this can be a privacy issue. As the designers for this project, it is important to prioritize protecting the privacy of others. Therefore, it is important that the user understands the possibility of their space being seen through the opened blinds as the automated system tries to adjust the brightness level.

We will accept and apply honest criticisms of the product we produce as well as credit the proper contributions of others. As stated by the IEEE Code of Ethics, we will respect every person and not discriminate regardless of their race, religion, gender, disability, age, national origin, sexual orientation, gender identity or gender expression [2]. We will also not engage in harassment and avoid causing injuries to others, others' property, reputation or employment through any form of abuse or malicious actions [2].

## References

[1] Garone, Sarah. “11 Things to Know about Natural Light and Your Health.” Healthline, Healthline Media, 11 Aug. 2020, www.healthline.com/health/natural-light-benefits.

[2] “IEEE Code of Ethics.” IEEE, www.ieee.org/about/corporate/governance/p7-8.html.