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ENGN 1931I: Design of Robotic Systems
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Final Project Proposal: Helios

Project Description:

Helios, the next generation of smart shades, will make it possible to control window blinds with voice commands and schedule the behavior of the blinds in the future. Smart shades make controlling the light in the room more accessible and can be used to adjust lighting while in a zoom meeting, create privacy while changing, or insulate a window during colder days. The scheduling feature can be used to allow the natural sunset to light up a room while blocking light pollution during the night, or even move the sunrise by slowly letting light in at a later time.

Precedent Research:

- Smart shades exist, but require a remote or app to control them
- Voice controlled shades usually require an existing smart home system
- https://www.serenashades.com/ has a lot of the features we want to implement (privacy, scheduled wake up time, follow the sun)
    - This one has a vacancy sensor!!
    - Minimize fading of expensive furniture
    - Very expensive
    - Needs a smart home system
    - Installation is a big issue -- cant integrate into existing shades

Line		Product Name		Unit Price	Qty	Subtotal
1		**UNTITLED SHADE [2021-04-05 06:53 PM]** **Style:** Wood Blinds **Power Type:** Battery **# Batteries (Not Included):** 12AA Lithium* ***Batteries required may vary when shades are narrow and tall.** **Hold Down Bracket:** No **Color:** ■ Walnut **Order Handling:** 15 Business Days **Mount:** Outside Mount (Frame) **Layout:** Single Blind **Dimensions:** W: 24 in. × H: 48 in. **Control Type:** RF **Valance Style:** Morgan **Wood Finish:** Stained	Edit Delete	$499.00	Duplicate 1 Update	$499.00

User Research Questions:

- What is the biggest frustration related to your windows?
    - Hard to open
    - Being sticky
    - Lack of insulation -- (**product could insulate**)
    - Shade doesn't sit easily
    - Not tall enough to raise blind all the way
- What room do you change the blinds in most? Why?

    - Living room -- cold/warm, how sunny
    - Kitchen / living room -- roommates put blinds down
- When do you open/close your blinds?
    - **Changing in bedroom**
    - **Light in the way of zoom call**
- How much time do you typically spend with your blinds all the way up / light coming through?
    - All the time
    - Bedroom -- closed usually for privacy
- What time do you try to go to sleep?
    - 11
    - 1/2
- What makes it hard for you to fall asleep?
    - Stress and anxiety
    - Insomnia
- Does window light make it hard to fall asleep?
    - No -- general night light (streetlights) doesn't bother her
    - No --
- Does sunlight wake you up?
    - Direct sunlight / car headlights wake her up
    - Sudden changes in light
    - Yes -- general morning light wakes him up
- What time do you like to wake up? Is it dark or light?
    - **After the sun comes up** -- 9
    - After the sun comes up -- 8:30/9
- Do you prefer to wake up to natural light or a dark room/with an alarm clock?
    - Natural light
    - Natural light -- sucks during winter
- Do you ever go back to sleep after closing the blinds?
    - No
    - No -- never closes blinds
- General Notes:
    - Its in the black mirror --
    - Wants it to beep at him -- fully integrated alarm
    - Sounds like an alexa feature
    - Some windows are hard to access
    - Accessibility issues -- not able to close blinds

<u>Personas:</u>

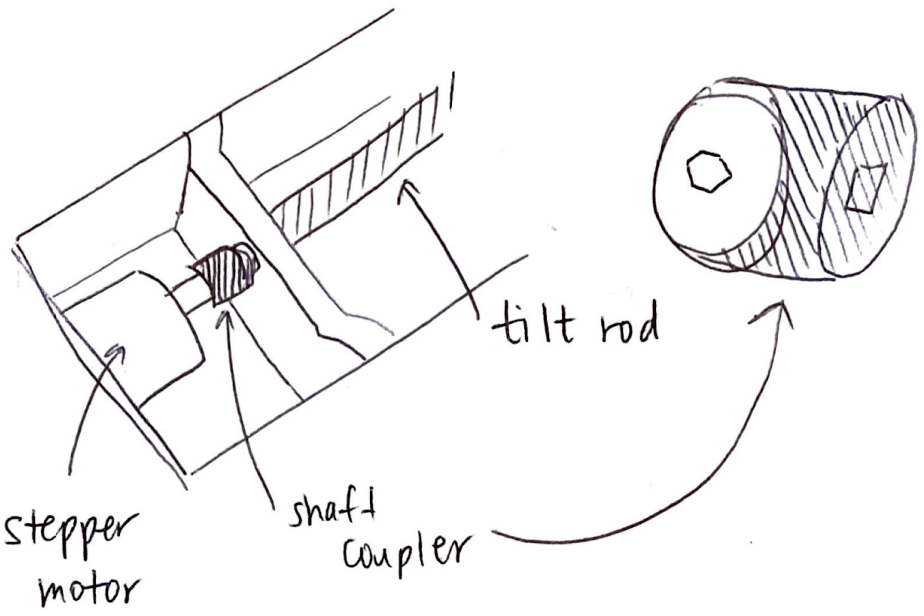
- **College Student with Insomnia** (moving sunrise as an alarm)
    - Always sleep deprived
    - Very difficult to fall asleep and stay asleep
    - Hard for them to wake up because they are always tired

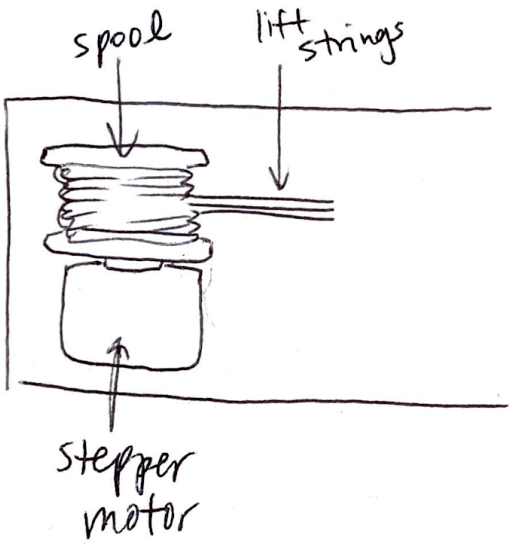
    - Need the light in the morning to get them up, but want to sleep in to catch up on sleep
    - Wants to wake up to the sunrise, at 10am
- **NYC resident** (blocking light pollution but allowing for natural sunrise)
    - Lots of light pollution -- street lights shining directly into room
    - Wants to wake up with the natural sunrise but closes blinds at night to deal with light pollution
    - Very cold in the winter and wants insulation, except when direct sunlight would be shining through the window
    - Now works from home and wants to have good lighting during zoom calls
- **Wheelchair user** (controlling blinds with voice commands)
    - Difficult for user to reach and use the blinds
    - Hard to maneuver wheelchair to windows with obstacles (furniture)
    - Wants the freedom to control their own blinds without asking for help
    - Has multiple voice controlled devices in their home already and is comfortable with the technology, but doesnt want to activate other devices when controlling the shades

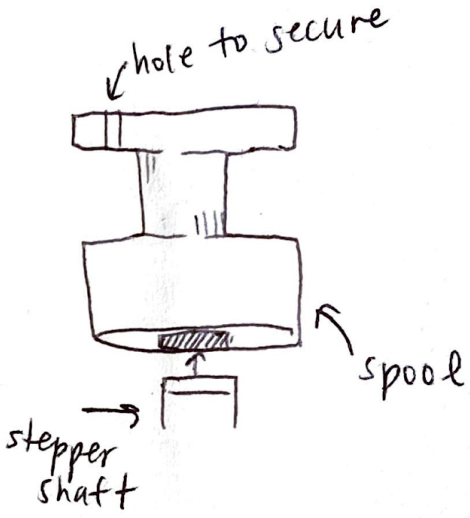
Addressing Issues From In-Class Proposal

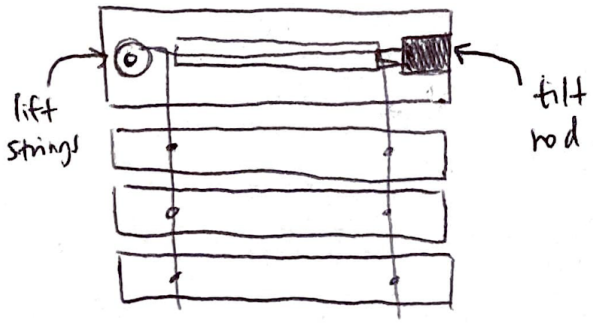
The idea for Helios as pitched to the class was to have a window shade that opened when a certain light threshold was reached, typically in the morning, and closed when the light level fell below that threshold, typically in the evening. One piece of feedback we received was that users may not want the shades to fully open up at the beginning of the day, which could potentially let an extremely bright and uncomfortable sunlight pass through the window before one needs to wake. To address this issue, this design needs to 1) allow varying levels of light to pass through the window and 2) not open up immediately when that certain ambient light level has been reached. To resolve the first problem, the shades will either have slats oriented horizontally or vertically that could rotate. Since the slats do not need to rotate more than 180 degrees, this can be accomplished using a small servo motor connected to a string which pulls on the slats. A possible resolution to the second problem involves adding a programmable timer into the shade such that the shade opens at a certain time in the morning which the user sets beforehand. This could also be integrated with an alarm or buzzer that chimes a short jingle when the shades are opening up in the morning.

Sketches

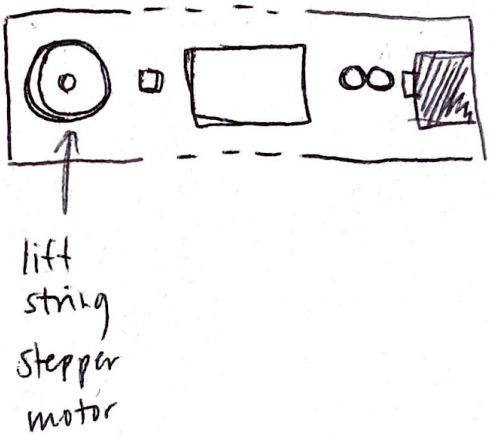

tilt rod
stepper motor
shaft coupler


spool
lift strings
stepper motor

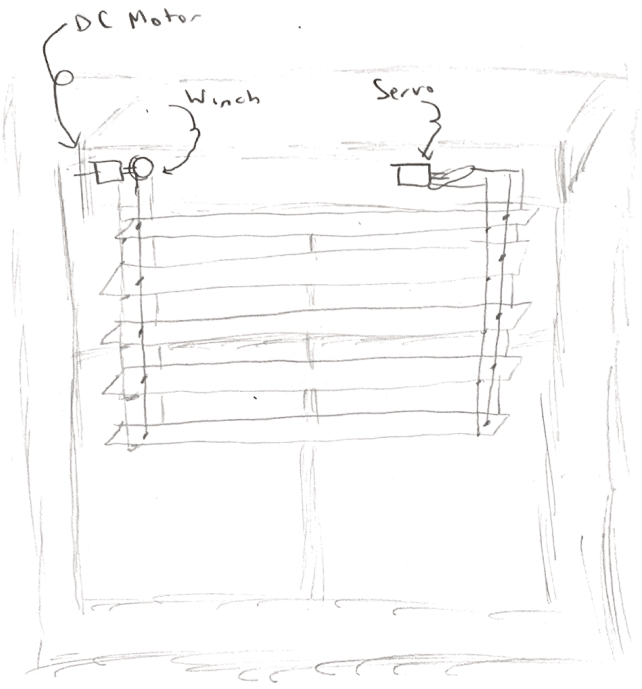

hole to secure
spool
stepper shaft

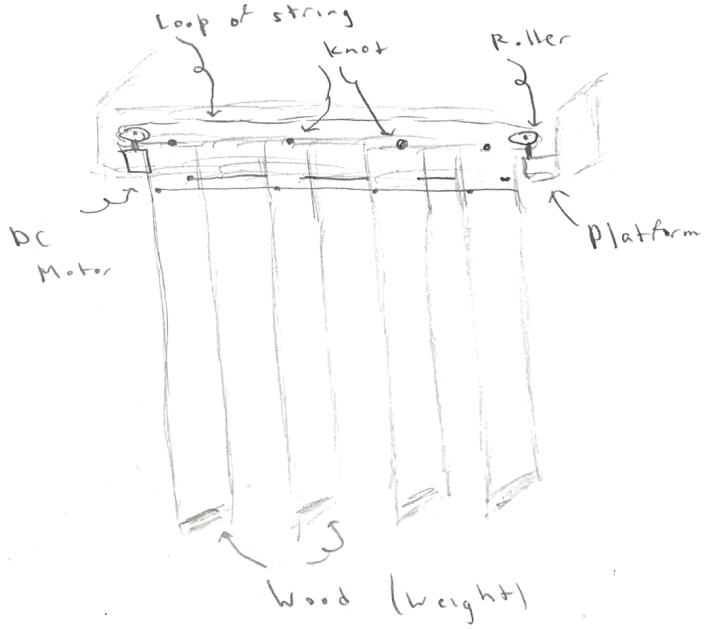

lift strings
tilt rod

elements:


lift string stepper motor

Smart Shader





Design Considerations

While we are unsure of the exact torques required to lift the slats up and down or left to right and rotate them, we will likely use two different types of motors to control them. Stepper motors allow for high torque and fine control over the number of rotations of the output shaft. Connecting the output shaft of a stepper motor to the winch or spool of string, which is connected to the center of an array of shade slats, will control whether the shades are deployed or not and how much. Two stepper motors on the left and right side of the shades will allow for symmetrical, synchronous and fine control. If we use a tilt rod to control raising and lowering of slats, only stepper one motor will be required. A servo motor, which only rotates 180 degrees, will be used to rotate the slats in either the horizontal or vertical configuration to let varying levels of light pass. This servo motor, which has a low torque output, nor the string connecting it to the slats themselves, will be supporting the weight of the slats.

Parts list

- Arduino Uno
- Windows laptop for running BitVoicer Server for voice recognition
- BitVoicer Server software - http://www.bitsophia.com/en-US/BitVoicerServer/Overview.aspx
- Adafruit MAX 4466 Electret Microphone Amplifier (used for recording voice commands from Arduino) - https://www.adafruit.com/product/1063 (included in kit)
- Stepper motors or DC motors for Moving blinds up and down
- Servo motors for rotating slat blinds(tentative) (included in kit)
- Set of blinds (tentative, we might build our own from scratch)
- Light sensor (photo cell) - https://www.adafruit.com/product/161 (included in kit)
- Piezo speaker - for outputting tones (included in kit)
- LCD display for displaying the time (tentative) (included in kit)

Components of robot

The stepper/DC motors and the servo motors will be used to actuate the blinds. While we are currently undecided on the type of blinds to use, if we choose to build the slats-style of blinds, the stepper/DC motors will be used to raise or lower the blinds, while the servo motors will rotate the angle of the slats. We could also attach a stepper motor directly to the tilt rod, instead of using two stepper motors. If we choose to build the single fabric-style of blinds, we will only utilize stepper/DC motors to raise or lower the blinds.

The BitVoicer Server software is the primary component that enables voice control of Helios. BitVoicer Server is a speech recognition and synthesis server for speech automation. The Arduino Uno does not have enough memory and processing power to perform advanced speech recognition and synthesis. BitVoicer Server eliminates the effects of these limitations by connecting to and using Windows' speech recognition and synthesis tools.

BitVoicer Server is able to either parse speech input from the PC's system microphone, or connect to the Arduino via a provided Arduino library. The Arduino library connects to an external microphone (in our case the Adafruit Electret Microphone) that is connected to an Arduino pin. BitVoicer Server then uses the Arduino's serial port to send the received audio from the Arduino to the program itself. Once speech recognition is complete, BitVoicer Server will send back to the Arduino binary data in bytes. The Arduino library receives the data and stores it in a buffer which is readily usable by other portions of the code. The binary data can contain many things, for instance it can be used to transmit PWM values to a motor.

A light sensor, like a photo cell, can be used to detect ambient light levels. We plan to use this to implement the ability to automatically raise the blinds once there is sunlight in the morning, and automatically lower the blinds in the evening.

A piezo speaker will allow us to play sounds on the Arduino. This way, Helios will contain alarm clock functionality. Timer interrupts can be used to play the sounds. We can tentatively use an LCD display to display the current time as well.

Division of Work

Stephen: Voice control, programming, control flow
Tyler: Mechanical Design
Aliya: User Experience / Visual Design
Everyone: Written report, presentation, integration of 1 additional sensor