Automatic Window and Blind Regulator

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1. Introduction

1.1 Problem

Different people prefer to fall asleep and wake up to different ambient conditions. While some people may prefer to go to bed in a colder room and to wake up to natural sunlight, others may prefer a cozier room at night and not quite as much sunlight right after waking up. Some may like to fall asleep to the sound of the rain outside or to breathe fresh air in their room in the morning. Despite this, it's not always safe or practical to leave a window open for an indefinite period of time.

1.2 Solution

Our solution is to create a fully automated window/blind regulation system that operates according to multiple different indoor and outdoor environment conditions. Depending on the temperature, humidity, air quality, and level of available sunlight, the user would be able to set the window and blind to open or close according to their preferences. The indoor environment would be monitored by various sensors and compared to outdoor weather conditions as made available by an online weather forecast. Depending on the preferences set by the user, the window and blinds would be adjusted accordingly by motors connected to the system. All of these components would allow the user to fine tune the ambient conditions within their home to their own personal preferences without having to worry about safety.

1.3 Visual Aid

Physical window to be managed by the system
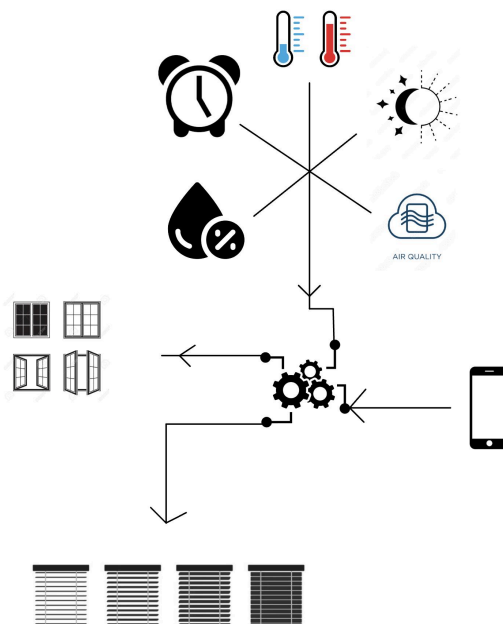
Conceptual diagram of system

1.4 High-level requirements

1.4.1 - The windows and blinds need to be able to close/open upon request. These need to have the minimum strength of 10 pounds of force as this is the weight of an average window. This should be done automatically instead of manually via motors and signals from the microcontroller.

1.4.2 - The windows and blinds need to have sensors that detect if the temperature is between 60 degrees to 80 degrees fahrenheit. If not, the windows would change accordingly depending on how the indoor temperature differs from the outdoor temperature.

1.4.3 - The windows and blinds should be able to correctly adjust at full extension of both closed and open. This full extension should be at minimum 2 feet for the windows to be fully closed or opened, as the blinds should be at least 4 feet.

2. Design

2.1 Block Diagram
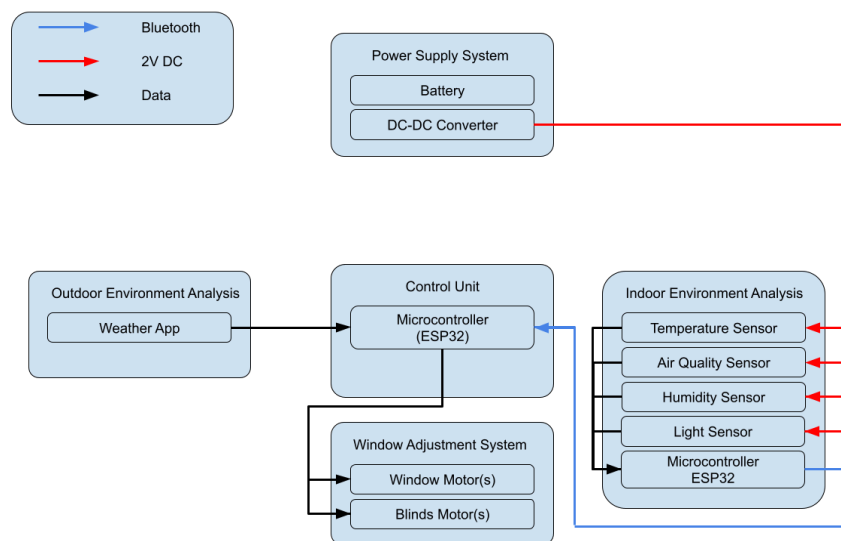
2.2 Subsystem Overview and Requirements

2.2.1 Power Supply System - This will be the system responsible for powering the entire system by distributing varying DC signals to each component. The whole system will be powered by a battery which will then be stepped down (or up) as needed by the other subsystems.

2.2.2 Indoor Environment Analysis - Using various sensors, this subsystem will record data about the environment inside the home and send it to the main microcontroller in the control unit through a different microcontroller via bluetooth.

2.2.3 Outdoor Environment Analysis - This subsystem will retrieve data from the internet containing information about outdoor conditions (temperature, humidity, etc.). It will then send this information to the control unit.

2.2.4 Control Unit - This subsystem will contain the main microcontroller which will be responsible for receiving signals from the indoor and outdoor analysis units to determine how to adjust the window and blinds separately. It will then send signals to the window adjustment subsystem accordingly.

2.2.5 Window Adjustment - This is the subsystem responsible for manually adjusting the window and blinds. There will be motors attached to the parts of the window and blinds that are responsible for their individual movements. The motors will do this using the signals received from the control unit.

2.3 Tolerance Analysis

An aspect of the Automatic Window/Blind Regulator that would pose a risk would be if the device has enough force to close the window correctly and successfully. Utilizing the equation Force = Mass * Acceleration, and Acceleration being equal to either negative or positive gravity

(depending on opening or closing the blinds/windows), we need to calculate both the force needed for the blinds and the window:

$$F = m \text{ (weight of the window/blinds)} * a \text{ (negative/positive gravity)}$$

Given this relation, we found that the average window mass is about 5 pounds and the average blind weight is 340 grams. We are now able to calculate the estimated force needed to open/close the windows and blinds:

$$5 \text{ pounds} = 2267.96 \text{ grams} = 2.26796 \text{ kilograms}$$
$$a = g = 9.8 \text{ m/s}^2$$

$$F \text{ (window)} = (2.25696 \text{ kilograms}) * (+/- 9.8 \text{ m/s}^2)$$
$$F \text{ (window)} = +/- 22.118208 \text{ Newtons}$$

$$F \text{ (blinds)} = (0.340 \text{ kilograms}) * (+/- 9.8 \text{ m/s}^2)$$
$$F \text{ (blinds)} = +/- 3.332 \text{ Newtons}$$

From these calculations the negative/positive forces indicate whether the current state of the mechanism needs to be pulled down or up. Thus, we can conclude that the design needs to have at least the force of +22.118208 Newtons of force since this is the greater of the two values. This force problem may pose a risk for the blind regulator as well since some blinds have a pull-down mechanism in order to regulate the blinds.

3. Ethics and Safety

3.1.1 - This project will need to retain the same level of security as that of a normal window. This requires a safety feature that can shut the window in order to prevent burglaries or other forms of danger.

3.1.2 - The window also poses a risk to the user under dangerous weather conditions (air quality, extreme temperatures and weather) and must be shut in accordance with these conditions to prevent danger to the user or home.