An Energy-Saving Smart Window System

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Abstract

The energy-saving smart window is a system of window actuators that work together electronically through a wireless system to control the climate within a residential home or office. The components include an actuator that mounts onto a traditional sliding window to open and close in response to weather conditions. The actuation is controlled by a wireless system that is coded to appropriately react to weather conditions. The determining factors will be the temperature gradient, humidity, and wind speed. The aesthetics, safety, and ergonomics have been considered in the design.

Introduction

Temperature plays a large role in comfort and health. Controlling the indoor temperature and humidity to ease discomfort is balanced against the cost of the utilities that it takes to effectively heat and cool a home. An efficient solution is the use of windows. Windows allow for air exchange between the exterior environment and the interior of the home. This exchange can benefit the level of comfort a homeowner experiences and alleviate the burden of high utility costs. An automated system to do this would save the homeowner time and allow for an increased level of effectiveness in the process of maintaining interior air quality. Generally, cooling and heating are done by a heater or air conditioning unit. To have these units work efficiently, windows must be closed. The addition of windows to the living space opens the way to natural lighting, room ventilation, warmth, and improves the overall look of a home. Deciding on the type of window for a home determines the positive and negative effects such as airtightness and ventilation. The project being introduced incorporates natural elements into the home to improve efficiency, comfort, and improve healthy air and lighting in the home. The window prototype will open and close depending on certain conditions, and the user interface will be ergonomic for the user.

Methods and Materials

The system consists of four primary components, including two sensors that measure both temperature and humidity, an actuator that opens and closes the window to best reach the desired temperature, and a controller that interprets the data and produces a command for the mechanism. The interior components reside within a small from-scratch enclosure that houses the window for temperature regulation. Outside the enclosure, a sensor measuring ambient temperature and humidity is connected to a computer which transmits the data. Found inside is the actuator with a connected controller that receives and interprets data from the exterior sensor. When a margin of error is achieved by comparing data of the two sensors, a pulse is fired through a relay which causes linear adjustment in the actuator. Which relay control is used depends on whether the detected error is positive or negative and will open or close the window appropriate to the conditions.

Results

Testing results include the actuator opening and closing the window. Everything working together and will need further testing and calibration. Total distance to open is 12 inches. Every inch allows a certain potential for air to travel inward. Wind speed will play a factor in the calculations.

Discussion

Testing process included actuator motion in response to environmental variables. Distance moved was in response to temperature and humidity taken from local weather variables supplied from sensors.

Conclusions

The introduction of technology is an integral part of the home-resource management process. Control over climate variables can be achieved using windows that allow for the perceived temperature to be optimized to preserve resources while heating or cooling the home. Though this could be done manually, the inclusion of a certain degree of automation will allow the user to reach desired outcome while saving a considerable amount of time. Due to the residential nature of the implementation of the design, safety must be considered in every aspect of the design to reduce the risk of harm. Through the limitation of the force it can apply, the ability to disengage and set aside the system in an emergency, auditory and visual warnings, and the minimization of the actuator's movement speed, the design should deliver the safest possible user experience while producing its desired behavioral outcomes.

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