SMART VENTS
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Abstract
The design problem was to develop a budget-friendly and energy efficient smart vent system for a residential home, and to test the 20% energy efficiency claim set by manufacturers. The smart vent was designed using SolidWorks and was 3D printed using PLA and PTEG filaments. The smart vent control components include temperature and pressure sensors, and a microcontroller for regulating the functionality of the vent. Six smart vents were manufactured for testing in a residential home. Data was acquired for 2 weeks (1 for inactive testing and 1 for active testing) in order to compare energy consumption data. In the tested rooms, the amount of energy savings reached an average of 14%.

Introduction
Design Problem:
- To design, develop, and manufacture a smart vent system that is budget friendly for a residential home.
- To test the 20% energy efficiency claim set by existing manufacturers.

Methods
- Several design concepts for the open/close mechanism and flap design were modelled in Solidworks.
- The most feasible option was chosen by analyzing the required vent space for the control system components and implementing a Solidworks airflow simulation and ANSYS stress analysis.
- The control system was further developed by programming the microcontroller to adjust the vent actuations based on user input and to collect pressure sensor and temperature sensor data for the post testing stage, using Arduino code.
- The user is able to control the vent using Bluetooth connectivity or by the physical push button built into the smart vent design.
- Calculations included:
  - Motor actuation = 0.0507 mAh/actuation
  - Battery life = 415 days (5 actuations/day)

Results & Discussion
1. User defined temperature decrease
   - Battery life = 415 days (5 actuations/day)
   - Battery Life (days) = Battery Capacity / (Actuation Consumption * Actuations/day + Controls Consumption)

2. User defined temperature increase

Conclusions
- The smart vents yielded an energy savings of 14% for the rooms in which they were deployed. This was validated by our OpenStudio model.
- Rooms equipped with smart vents can expect to see temperature changes of +/- 1 °C within 30 minutes of vent actuation.
- The smart vents fit inside a residential home and were able to be used for continuous testing for 7 days.
- The control system fit inside the vent and functioned accordingly.