**Comfort Control**

**2. DESIGN REQUIREMENTS/CONSTRAINTS**

Comfort Control is made to further increase efficiency of Heating Ventilation and Cooling (HVAC) systems by creating an automated ventilation system. By using Comfort Control, users will not only be able to control the timing of when the HVAC system is running, but also allow for each room's climate to be controlled separately. Comfort Control must be fully integrable into existing HVAC systems. The Comfort Control system must consist of temperature sensors, WiFi capability, automated vents, and a temperature hub. Comfort Control must allow users to control the temperature within each room with the mobile application or the thermostat hub that will be installed. Comfort Control must be accurate in measuring temperature and controlling individual vents within each room. The constraints that were accounted for during the design process are as follows. The two subsections will be the Technical Design Constraints, then the Practical Design Constraints.

**2.1. Technical Design Constraints**

Table 2.1 contains five technical design constraints that the system must adhere to.

**Table 2.1: Technical Design Constraints**

|  |  |
| --- | --- |
| **Name** | **Description** |
| Range | The Comfort Control thermostat hub must be able to maintain connection with the Wi-Fi router and each room's thermometer probe, which can reach up to 70 feet apart in an average household. |
| Power-loss Ready | The Comfort Control vents must switch to open in the event of power loss. |
| Integration | The Comfort Control thermostat must be able to operate with existing thermostat connections. |
| Size | The Comfort Control system must be able to monitor and control the climate of at least five rooms. |
| Connectivity | The Comfort Control thermostat hub must maintain an internet connection to be controlled through the mobile application. |

**2.1.1. Range**

Comfort Control must be able to connect and control system devices from up to 70 feet apart in order to control each vent independently. Based on the average house size, 2,600 square feet, the average longest distance from the thermostat hub to the Wi-Fi router is approximately 70 feet. Wi-Fi has a range of 150 feet indoors. The thermostat hub must maintain connection with the Wi-Fi router in order to allow the user to monitor and control the system remotely via the internet and smartphone application.

**2.1.2. Power-loss Ready**

Comfort Control vents must be designed with a fail open protocol. In the event that the vent loses power, this protocol will allow the room to continue receiving air flow. This will essentially revert the Comfort Control vent to operating as a standard vent. It must be designed this way because if it were to fail close and shut the vents completely it would restrict all air flow to the room.

**2.1.3. Power**

The Comfort Control thermostat hub must be fully integrable with existing thermostat connections. The typical thermostat connection includes one 24 volt AC supply line and three control lines for heat, cool, and fan. Because the thermostat hub will be controlled by a Raspberry Pi Zero, the hub must convert the 24 volt supply from the HVAC unit to 5 volts DC. The thermostat hub must be able to output 24 volts to the control lines connected back to the HVAC unit.

**2.1.4. Size**

To accommodate the average household size, the Comfort Control system must be able to control the devices required to maintain a comfortable climate in each room. The average household has at least five rooms, and since the system requires one thermometer probe and at least one vent per room, the hub must be able to connect to and control at least ten devices.

**2.1.5. Connectivity**

The Comfort Control system will include a smartphone application for users to monitor and control the system remotely. The thermostat hub must maintain an internet connection in order for the application to send and receive system information and commands.

**2.2 Practical Design Constraints**

Table 2.1 contains five practical design constraints that the system must adhere to.

**Table 2.2 Practical Design Constraints**

|  |  |  |
| --- | --- | --- |
| **Type** | **Name** | **Description** |
| Economic | Cost | The Comfort Control system's cost must remain under the project's budget — $400. |
| Environmental | Efficiency | The Comfort Control system must be more energy-efficient than traditional systems. |
| Sustainability | Sustainability | The Comfort Control system must be capable of receiving and installing updates. |
| Manufacturability | Availability | The Comfort Control vents and thermometer probes must be easily obtained to allow for system expansion. |
| Health and Safety | Safety | The Comfort Control components must be properly shielded. |

**2.2.1 Economic**

The Comfort Control system design must remain under the project's budget — $400. Each senior design team is given a $200 budget each semester totaling $400 over the course of two semesters. Comfort Control will be using a 3D printer which will cut down on the component cost. Parts must be chosen to encourage a more cost-efficient product compared to competitors. Due to Comfort Control’s design, there will be little to no maintenance cost.

**2.2.2 Environmental**

To give Comfort Control an advantage over the traditional HVAC system, it must be more energy-efficient than the original system. This must be achieved by more efficient airflow of the system as a whole. This must be achieved with a combination of the smart vents and temperature probes in each room. With the combination of this and the main hub, the user will be able to program and control the system to create a more efficient system.

**2.2.3 Sustainability**

Comfort Control must be designed for long term use and receive updates when needed. Having the ability to update the software of the system will allow Comfort Control to become more efficient as technology advances are made. The hardware must be able to accept updates and be compatible with software updates. Before sending updates to Comfort Control systems, software must be tested and reported.

**2.2.4 Manufacturability**

The Comfort Control system must be easily expanded to more rooms with additional thermometer probes and vents. The options for vents sizes must include all average household vent sizes, e.g. 4''x8'', 4''x10'', 6''x10'', and 6''x12''. The vents will be 3D printed and the thermometer probes must be designed with minimal components to increase manufacturability.

**2.2.5 Health and Safety**

The Comfort Control system must be designed and installed so that the system is safe for the homeowners. This entails making sure that all wiring is housed properly so that there is no shock risk. This also includes making sure the vents do not have sharp edges that could cause cuts or exposed moving parts that could present a pinching hazard.