SonicAire Fully Automated Industrial Fan

Western Carolina University
School of Engineering + Technology

Original Objectives

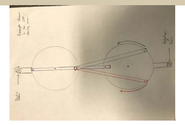
- To find a reliable, cost effective fan airflow limiting solution that can be applied to all SonicAire Fan Models across the fan voltage spectrum 208-575.
- To prove the efficiency of the solution in manufacturing environments that are high temperature and high humidity and require watertight high temperature (up to 180F) controls.
- To provide a solution (or solutions) in three different gearmotor schemes. (Proposed gearmotors are three different individual solutions involving 2 different motor windings, and two different internal wiring schemes (Wye and Delta).
- Currently the oscillation and rotation of the fan are linked through a single drive system. The potential solution may propose the creation of a separate drive that would disconnect the oscillation pattern from the rotational pattern.
- To create an easily maintainable and understandable airflow limiting solution which can be simply adjusted by facility maintenance staff.

Requirements

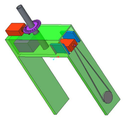
Req #	Requirement	Description	Verification	Requirment Type	Affected Requirement	Met?/Not Met?
1	Voltage 208VAC-575VAC	Product must be applicable for variable line Voltage	Test	Functional	3,4,6	YES
2	Temperature	Product must be able to withstand environment of up to 140 F	Analysis	Performance	3,5	YES
3	Stepper Motors	The Product must use stepper motors to implement oscillation and rotational motion	Analysis	Functional	4,6,7,8	YES
4	Test	The product must complete a trial to prove the products operation	Test	Qualification	1	NO
5	UL	The product must be UL certifiable outside of the microcontroller	Analysis	Qualification	1,3	YES
6	Independent Solution	The product must be independent of the main fan drive system	Analysis	Functional	1,7	YES
7	Adjustable	The solution should be easily adjusted to change the cleaning area	Test	Functional	3,6,8	YES
8	Separate motors	Control of oscillation and rotation must be separate	Analysis	Functional	1,2,3,5,6,7	YES

Concepts

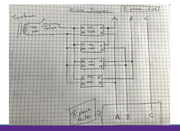
Concept 1: Four Link Crank
- Strictly Mechanical Design
- Meets every temp/Voltage requirement
- Cost effective



Concept 2: Motor Relocation/Stepper Motors
- Two independent motors, one for oscillation,
- one for rotation
- Microcontroller to control setpoints
- Full customizable, smart fan



Concept 3: SSR Concept
- The original concern was the the fan's contactors could not withstand high temp, this SSR design uses an SSR that is good up to 80C
- Simple, cost-effective design



Problem Statement

SonicAire Corporation has two different systems for their dust control fans to rotate and the switch rotation once it gets to a certain point. They refer to these systems as reverse control kits (RCK); one is used for high-temp applications and the other is used for all other scenarios. The high-temp application uses a limit switch that is mechanically actuated by armatures that are moved by the rotation of the gear that rotates with the fan. The regular application uses a proximity switch and magnets that are placed on the gear that rotates with the fan, reversing controls when the magnets reach the proximity switch. Both of their current RCK are run by single phase power, while their fan motors are operated by three phase power. SonicAire is upgrading their RCK using stepper motors to control the rotation and oscillation of the fan. The consumer of the dust control fan will appreciate a new and improved system because it will give them freedom to change the cleaning area of the fan by adjusting the code for the micro controller.

Final Design/Results *

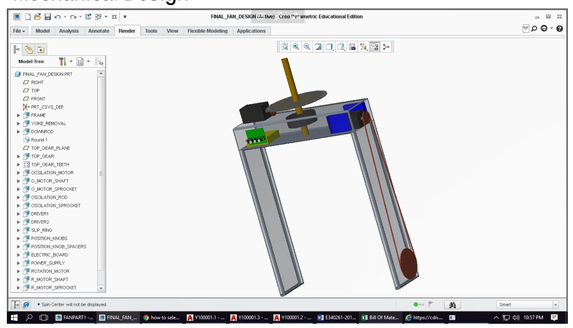
Stepper Motor Design

We chose this design collectively with SonicAire since this is the direction their company is wanting to move towards in the future. "Smart Ass Fans" as they called it, is where their company can beat out the competitor.

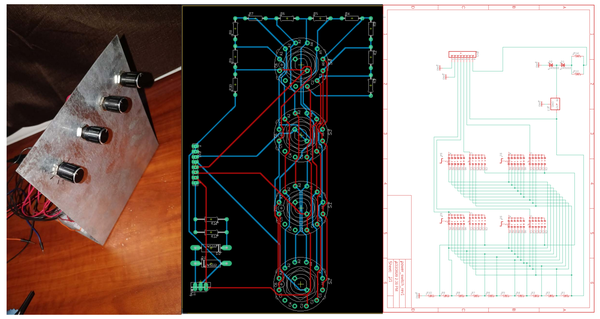
This design uses two stepper motors to control the oscillation, and rotation of the fan. These stepper motors will be controlled by motor drivers which use PWM (Pulse Width Modulation) to control the speed of the motors. The drivers will be controlled by a reprogrammable micro controller (PIC24HJ64GP502) which will work hand and hand with four, ten position, selector switches. These selector switches will control the upper and lower limits of the rotation, and oscillation with a total of 40 preset points. This design will be the most beneficial and cost efficient for the SonicAire fan.

- 2 Stepper motors
- 2 Stepper motor drivers
- 1 PIC24HJ64GP502 Micro controller
- 4, 10 position selector switches

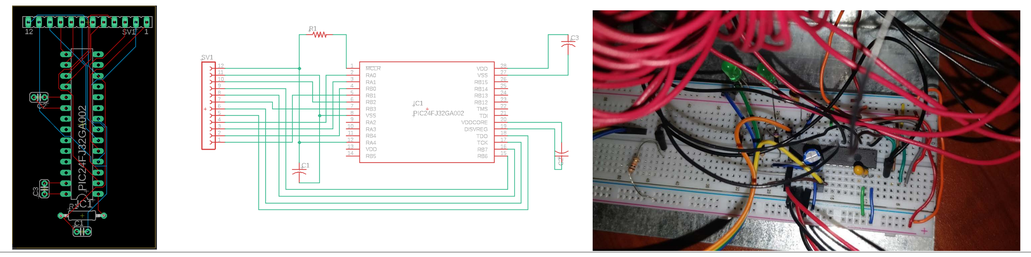
Mechanical Design



4, 10 position selector switches



Microcontroller Board



* On March 16, 2020 classes and labs were closed to students due to the COVID-19 Pandemic. Without access to fabrication and testing equipment, Objectives and Deliverables were modified accordingly.

Modified Objectives*

Expected outcome if COVID-19 did not happen:
- A finished, operable fan, with a working RCK
- All parts were ordered, and ready to be implemented
- Stage 4 was going to be the implementation, and testing stage
- Once the stepper motors were implemented a testing procedure would have to take place to ensure proper degree adjustments for the rotation, and oscillation

Outcome due to COVID-19:
- A more detailed mechanical, and electrical design
- All electrical schematics were transferred to EagleCad, and laid out on a PCB for easy understanding, and ease of manufacturing
- Informed SonicAire of MpLabx which is the software used to program the PIC24 microcontroller, this allowed for them to have time to get familiar with the program while questions can still be asked
- A more detailed/intricate 3D model with the expected designation of parts

Summary

- Designed a fully programmable RCK system utilizing two separate stepper motors for oscillation, and rotation
- Proposed several future solutions/ideas to SonicAire
- Allowed for future development with the system by providing simple schematics as well as a printable circuit board

Team & Acknowledgements

Team Members:
- James Jackson, B.S EE
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Mentor:
- Dr. Robert Adams

Sponsor:
- Taylor Andrews, SonicAire