Kinetic Artwork Spinner

Spring 2020 - ENME 444 Mechanical Engineering Systems Design

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Project Scope

Background:

Our client, Dr. Eric Dyer, is a professor in the Visual Arts department of University of Maryland, Baltimore County. His work focuses animation and interactive media.

Objective:

The objective of this project was to design and produce a product that was capable of spinning 7 kinetic artwork disks at speeds between 60 to 120 RPM to produce an animated effect on the art.

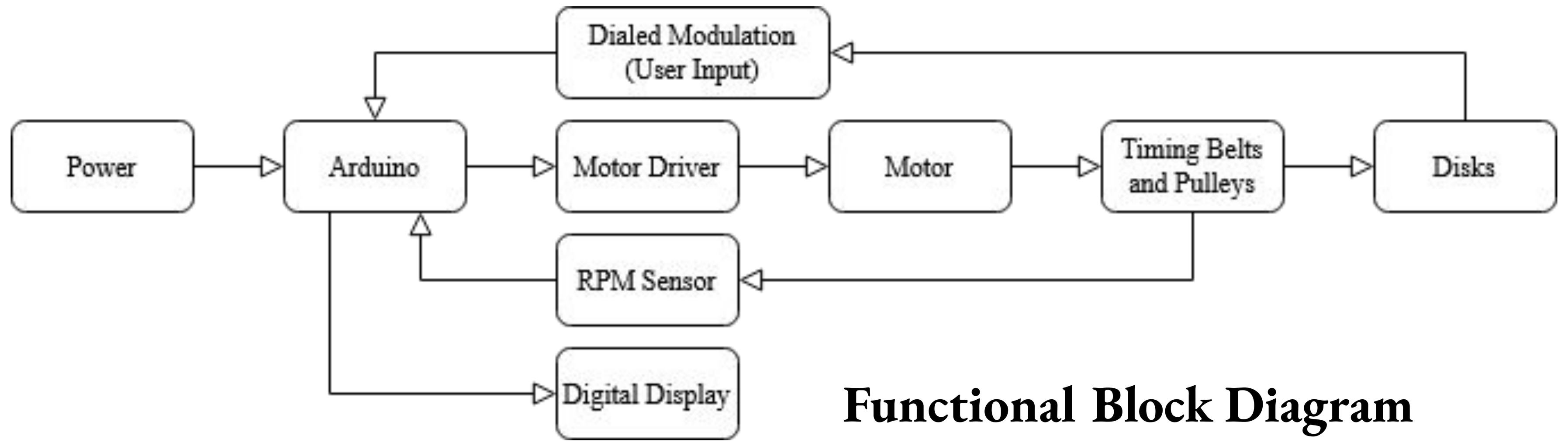
System Requirements

The client specified the following requirements:

- Maintain rotational speeds of 60 to 120 RPM
- Quiet and wobble-free (<60 decibels, <3° rotation)
- Easily sourced parts from reliable manufacturer
- Easy to assemble with little to no training
- Driven by timing belt system
- ≤3" gap between wall and disk

After the first prototype, the client asked that the system include a rotary encoder to output a signal to the clients strobe controller.

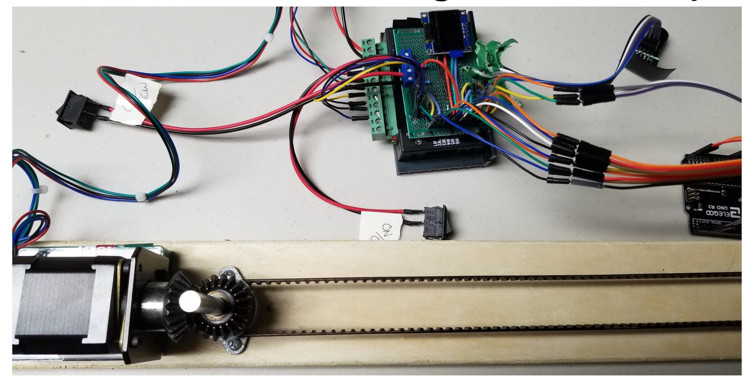
Below is the functional block diagram of the system based on the system requirements listed above.



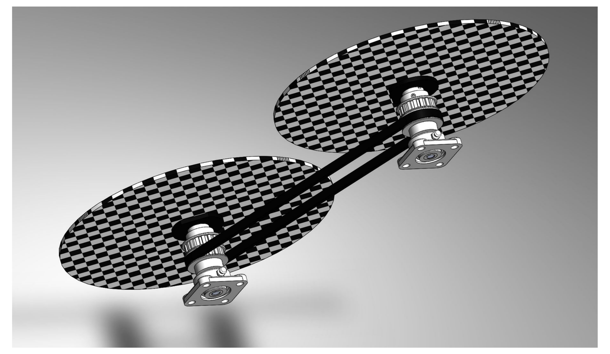
Functional Block Diagram

Initial Design

The initial design utilized a set of miter gears, a XL series timing belt, and a NEMA 17 stepper motor. A flange bearing acted as the base of each spinner with a 8 mm shaft secured to it through set screws. On each spinner shaft, there were two timing belt pulleys to receive and transmit power. Finally, a shaft collar at the end of the shaft secured the artwork to the rest of the spinner using a set screw. This prototype exhibited significant amounts of noise and some wobbling instability that must be resolved.



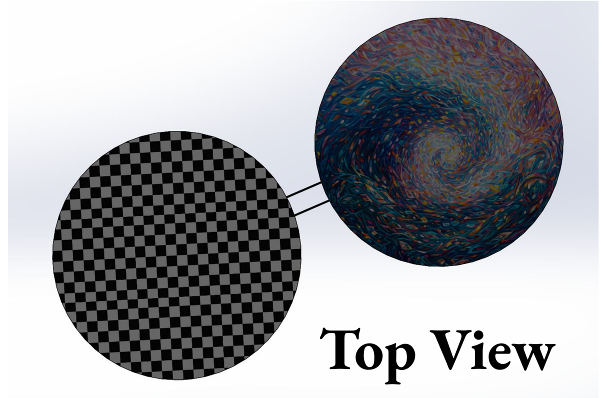
Physical Prototype



Prototype CAD Model

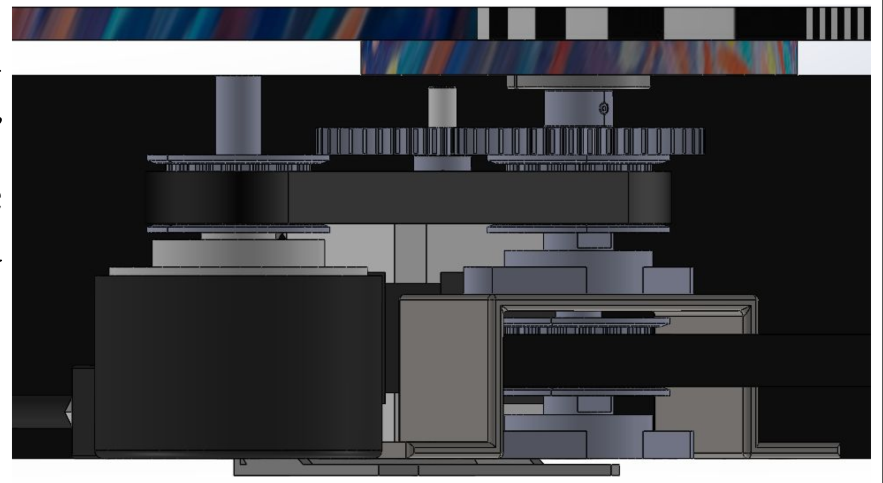
Final Design

The final design utilizes the same XL series timing belt and NEMA 17 stepper motor, but swaps the miter gears for straight gears to remove issues with noise and difficulty meshing the gears properly. Additionally, an extra flange bearing and a bracket were added to each spinner. At the base of each spinner is the first flange bearing with the first timing belt pulley. Then, there is a bracket and additional flange bearing for stability. The second timing belt pulley is next with the shaft collar attaching the artwork on top. The revisions to the design were focused on reducing the noise and clearance of the initial design while increasing the stability. This final revision has a clearance of 3 inches, supports a rotary encoder, adds a second point of contact, and dampens motor vibrations while using commercially available parts from online retailers.



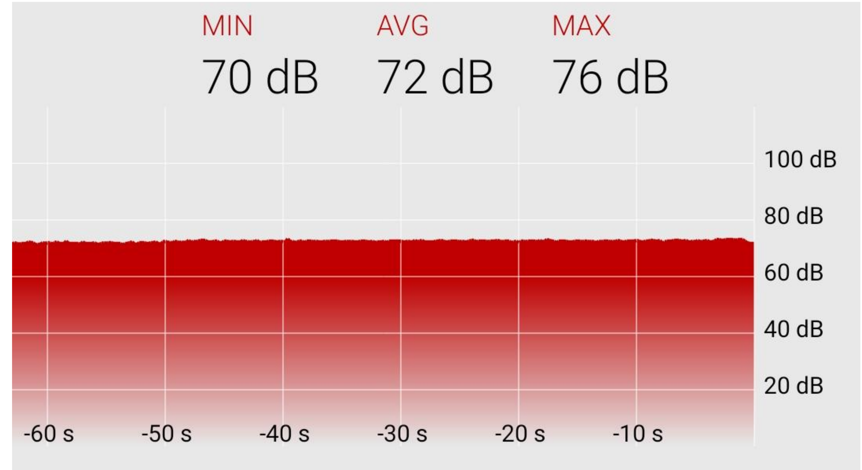
Top View

Main Spinner Side View

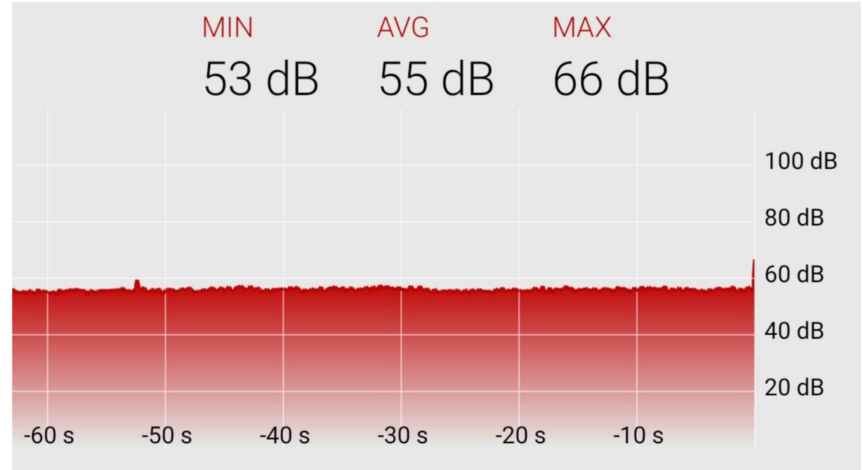


Testing and Results

Testing was focused on the physical and electrical performance of the system. The final design's hardware was installed on both drywall and plywood to test for stability and wobble. During testing there was no visible wobble or deflection that could be observed or measured. The RPM of the motor was determined through the use of a Hall-Effect sensor and a magnet attached to the rotating shaft. The readings from this sensor were consistent with the speed set by the controller with one rotation occurring in exactly half of a second. Lastly, the noise of the motor mounted to a piece of plywood was measured in decibels at a distance of one foot for the original configuration and the system with the dampener and microstepping. The second configuration was quieter than our goal level as seen below.



Original Configuration



Final Configuration

Deliverables

This project will be delivering several documents detailing the product and the initial prototype. These documents include a parts list, a detailed guide on fabrication and assembly, code for controlling the system, and a complete CAD model of the system. Using these documents, it will be possible for the reader to order the parts from retailers, fabricate certain parts, and assemble the system.

Acknowledgements

We would like to thank Dr. Jamie Gurganus, Dr. Eric Dyer, and Noelle Ray for their contributions and advice that culminated to produce this project.