Stump Vinyl: An Organic Record Player

Albert Li, Daniel Sotsaikich, Kriya Wong, Matt Morrison, Miranda Maravilla-Louie, Sepehr Rostamzadeh

Objective

To present an elegant, modern record player equipped with motor control and audio digitization, using complex mechanical design concepts and multitasking, real-time software

Introduction

In our modern age of increasingly digital, cloud-based storage, CDs, vinyls and older music files are nearly obsolete as they are replaced by digital files. Our goal for this modern twist on a traditional belt-driven record player is to revisit the classic sound quality and aesthetic of an older era of music while utilizing more contemporary modes of motor control, noise isolation and needle tracking, and furthermore to allow the user to convert the vinyl being played to a digital MP3 file during use.

Methodology: Software

Signal Processing

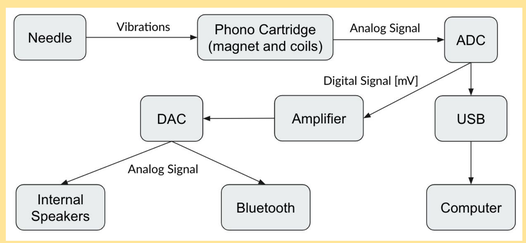

Figure 1: Signal Processing Diagram

Electronics Design

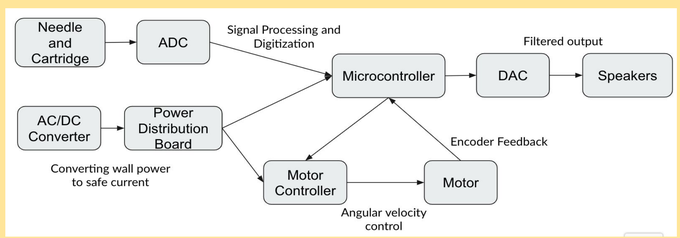

Figure 2: Electronics Design Diagram

Methodology: Hardware

Tonearm Assembly

Using the Lofgren B tracking method, the tonearm was located at a point which would allow for maximum tangency to the vinyl. This particular method minimizes tracking area over the most play surface, the parameters of which are shown in Figure 3 below.

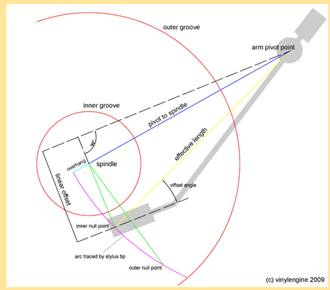

Figure 3: Tonearm tracking schematic and geometry (source: vinylengine.com)

Enclosure

A redwood cross-section was faced and pocketed using the Shopbot CNC together with our custom CAM toolpaths, in order to house the drivetrain assembly and electronics above an acrylic panel for viewing.

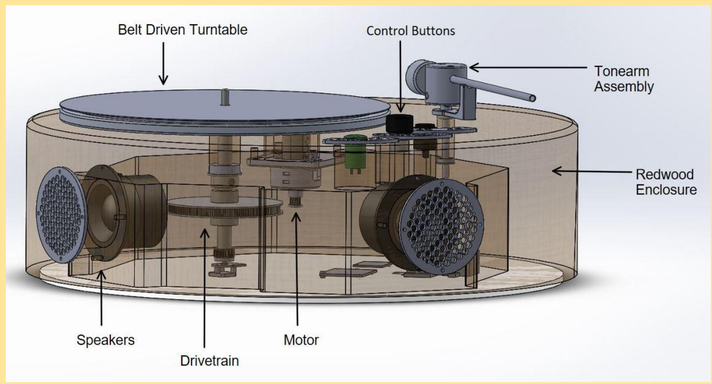

Figure 4: Enclosure CAD model

Drivetrain

A belt-driven system was chosen to help isolate the platter from motor noise and significantly stabilize generated signals from the tonearm for the majority of playing time. Since our motor was inexpensive and noisy, it was more beneficial to choose a system that would provide a robust environment to isolate the noise error generated from the gearbox. The turntable itself was custom manufactured out of aluminum and polished on the CNC machine.

Results and Discussion

Hardware

The assemblies were successfully integrated into the redwood stump after overcoming unexpected tolerancing difficulties in the aluminum turntable and wire routing complications through the tone arm. Both remain low-friction systems and can be manipulated with ease. However, the true challenges arose when manufacturing the redwood stump. Due to unforeseen limitations in the Shopbot dimensions and tools, the CAM toolpaths had to be cleverly designed and iterated on until a sufficient pocket was achieved.

Software

For optimized audio quality, enforcing both 16 bit precision and a 44.1 kHz sampling rate was necessary. An audio shield mounted onto the Teensy, our microcontroller of choice, allowed for this to be achieved with relatively small packaging. A PID control loop allowed us to get accurate motor actuation, though due to budget constraints, our motor was louder than desired. Interfacing mechanical and electrical components proved to be a challenge, especially with the auto-stop function, where a physical event needed to trigger an action in the firmware.

Future Improvements

Improvements to our design can be made in a few areas. Using a quieter (and more expensive) motor would help sound quality, as well as installing a subwoofer and using higher quality speakers. A better headshell and cartridge would also improve sound quality. Designing custom PCB's would clean up and simplify our wiring scheme and assembly.