Stepper Motors

The stepper motors are driven by an ATmega328P Arduino microcontroller and an A4988 stepper driver. Outputting a square wave from the Arduino to the stepper driver causes the stepper to rotate. If the frequency of the square wave is matched to that of individual notes, then the sound produced by the stepper matches that of the note. By combining various notes together at different time intervals musical pieces can be played. Three different methods have been looked at for the generation of the square wave at specific frequencies. **Timers/PWM (andrei’s bit)** , a 555 timer and a digital signal synthesizer IC.

555 Timer: The LM555 timer is an IC capable of generating specific frequencies at various duty ratios by connecting two resistors and two capacitors [1]. Multiple ICs would be used, one for each note and since the IC has an enable pin, the Arduino would be able to turn it on/off with ease. This is a good solution as a lot of the software is now simplified due to the hardware used. However, more hardware is needed making it more expensive to produce. A closer investigation on the components needed to produce some of the frequencies resulted in resistor values in the microohm magnitude. This poses two issues, first, it is hard to procure micro-ohm resistors and most importantly the datasheet recommends resistor values of 1KΩ to 1MΩ [1]. This method has therefore been ruled out.

Digital Signal Synthesizer: A DSS is an IC capable of generating a vast range of frequencies. The DSS considered for this application is the AD9837. The AD9837 is capable of producing frequencies between 0-5MHz, with a 0.02 Hz resolution making them incredibly accurate [2]. The IC requires no external components (apart from a decoupling capacitor) and the frequency is set by three internal registers. The IC communicates with the microcontroller via SPI [2]. This is advantageous as it can be easily reprogrammed to another frequency, allowing one IC to play multiple notes. As expected the IC is more expensive than the 555 timer. The team is currently designing a breakout PCB for it in order to test it. The AD9837 offers a promising solution, and will most probably be used.

[1] <http://www.ti.com/lit/ds/symlink/lm555.pdf>

[2] http://www.analog.com/media/en/technical-documentation/data-sheets/AD9837.PDF