|  |  |  |  |
| --- | --- | --- | --- |
|  | secs MAX | WPM=140 | num words |
| **Intro** | 40 |  | 90 |
| **Audio** | 30 |  | 70 |
| **Modular parts + LIT** | 60 |  | 140 |
| Overall system | 40 |  | 90 |
| LUTs and lerp | 50 |  | 120 |
| Wavetable | 50 |  | 120 |
| Filters | 50 |  | 120 |
| Waveshaping | 60 |  | 140 |
| ADSR | 40 |  | 90 |
| Generator | 50 |  | 120 |
| GM | 40 |  | 90 |
| **Overall tests** | 40 |  | 90 |
| **Conclusion** | 40 |  | 90 |
|  | 9.833333 | mins | 1370 |

**Intro**

Hardware synthesisers play an important role in all of music today since the inception of analogue sound synthesisers in 1928. A hardware synthesiser refers to a physical system that generates audio signals.

The aim of this project is to design and implement wavetable-based audio generation software, targeted for microcontrollers. The system can play up to a fixed number of notes, each with an arbitrary frequency, by using on/off note triggers.

It produces high-quality stereo audio, while taking computational speed and memory consumption into account, and implements all the basic synthesis features: volume modulation; filtering and frequency cut-off modulation; ADSR envelope control signals; FM; waveshaping.

**Audio**

I will now play 5 different sections from Beethoven’s Moonlight Sonata, generated by the system from a MIDI file, each with different configuration parameters.

**Modular parts + LIT**

Modular synthesis is a form of synthesis that uses eurorack modules, which each perform a basic function, that produce control signals to modulate other modules’ parameters.

A basic monophonic modular setup can be seen the following diagram.

The voltage-controlled oscillator generates the audio signal at a specific frequency, and usually operates at a 1V/octave standard. A voltage-controlled filter has a similarly controlled cut-off frequency.

A voltage-controlled amplifier can be used to act as a signal multiplier to control the volume of the oscillator, which is often controlled by an ADSR envelope control signal. The ADSR envelope can also modulate the VCF’s frequency.

With the addition of waveshaping, which refers to running the audio through a function such as the hyperbolic tangent, all these modules were combined in this project to create a digital synthesiser software system ideal for microcontroller implementation.

The wavetable aspect refers to how oscillator sound is generated. This is done by storing a waveform in a look-up table (or LUT) and using a pointer into this table to linearly interpolate between samples.