

CAMDF For Pitch Detection

$$R(\tau) = \sum_{n=0}^{N-1} |x(\text{mod}(n + \tau, N)) - x(n)|$$

Our design utilizes the Circular Average Magnitude Difference Function (CAMDF) for calculating the pitch of the theremin and vocal audio signals. The CAMDF is a modified version of the autocorrelation function (ACF). The ACF is a useful algorithm for calculating pitch (among other properties) due to the fact that it has the same period as the signal it is being computed on. The CAMDF is useful in this context for a variety of reasons:

- It is symmetric, meaning only the first half of samples has to be computed
- It uses only subtraction and addition, rather than the ACF which uses multiplication
- It is robust against the “Double Pitch” error, where integer multiples of the actual pitch are computed, which can occur when in the presence of noise

FPGA

The FPGA samples incoming audio and theremin signals at 12 kHz and stores in separate buffers. The samples are then processed with the CAMDF pitch detection algorithm to find their fundamental frequency. The resulting pitches are sent to the DSP chip via SPI, and the theremin pitch is sent through MIDI to control an external MIDI synthesizer.

Audio

The Theremania has several audio I/O, including a speaker, headphone and line-out ports, and MIDI. A codec and power amplifier are used to process the audio signals.