Gesturally Controlled Guitar Pedal for Real-Time Effects

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Purpose

Our project is a real-time signal-processing electric guitar effects board with gesturally changed parameters, allowing a musician to have the unique and convenient experience of changing effects while playing.

System Architecture

The guitar signals path is highlighted in the diagram below.

Figure 1: High Level Block Diagram

The project employs five primary components: an audio shield, Teensy microcontroller, IMU, slide potentiometer, and push buttons.

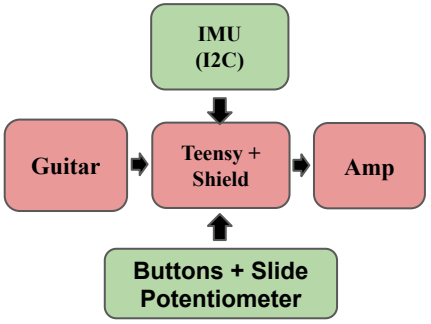

Figure 2: Hardware Interface Block Diagram

Four buttons are used to select the guitar effect, and various effect parameters can be modified.

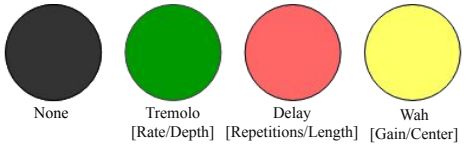

Figure 3: User Interface of Effect by Button [Guitar Tilt Parameter/Slider Parameters]

Digital Signal Processing

Tremolo Effect

Implemented by applying a sine wave on the output over time. The user has control of the rate of the sinusoid and depth of its amplitude.

Delay Effect

Implemented by adding multiple delay blocks. The user has control of the number of delay blocks, and the time step length of the delay block.

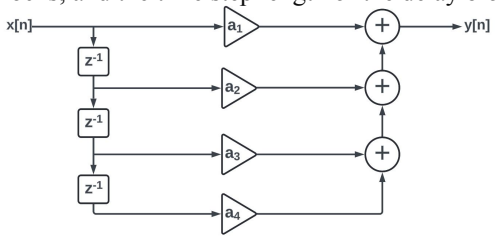

Figure 4: Diagram of Delay Effect

Wah Effect

Implemented by attaching either a peak or notch filter, allowing for a specific frequency to be highlighted. The user has control of the gain and the center frequency.

A digital biquad filter is used for the WAH effect. The normalized coefficients needed for the transfer function are computed in live-time.

$$H(z) = \frac{b_0 + b_1 z^{-1} + b_2 z^{-2}}{1 + a_1 z^{-1} + a_2 z^{-2}}$$

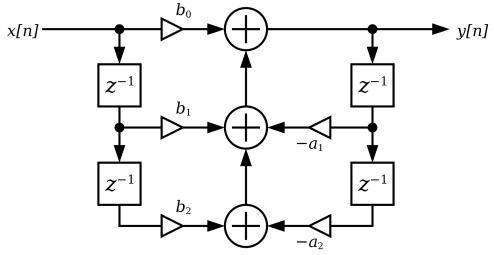

Figure 5: Transfer Function and Diagram of Wah Effect

Results, Testing Method, and Data

We have verified that the tremolo rate (1 Hz to 15 Hz) and depth (0 to 0.5), delay repetitions (2 to 10) and time step length (100 to 44100 samples), and wah gain (-30 to 30 dB) and center frequency (500 to 5000 Hz) works well by observing behavior under a spectrogram and spectrum analyzer.

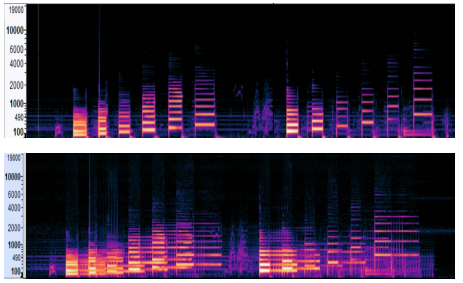

Figure 6: Spectrogram of Guitar Notes Being Played – Top Has No Effect, Bottom Has Delay

Collecting accurate potentiometer and accelerometer data at 10 Hz, our project continuously recalculates parameters and IIR coefficients for any of the three effects reliably.

Hardware Implementation

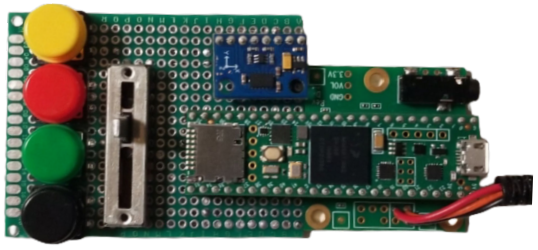

Figure 7: Image of Our System on a Protoboard with All Components

Acknowledgements

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