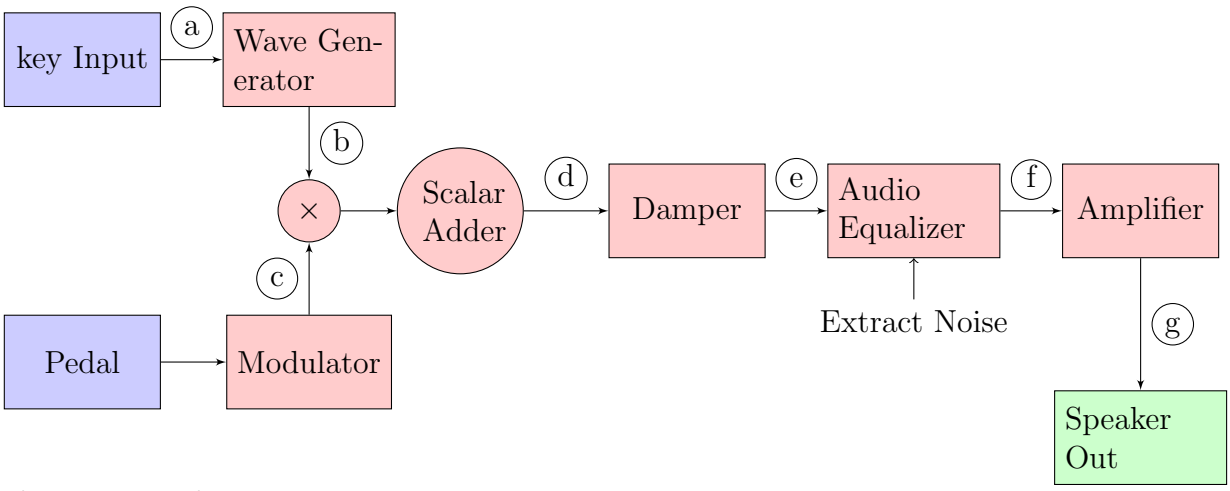
The Piano

Literature Review

The Analog signal generator design is a common project around the senior years of EN2090 module from the ENTC department. It engaged the circuit design of the Wien bridge oscillator, as a low-frequency sine wave generator. It can be utilized to produce sine waves in the audio frequency range. Analog electronic musical instrument designs available in the market engaged the concept of modulation with a sine wave to get a sudden change in frequency output. This strategy can be mimicked to implement a pedal design that can deliver an experience of sudden change in sound pitch.

Old speakers used an audio equalizer using RLC circuit to lower or boost certain frequency ranges specifically. This can be utilized in our piano to change the softness of the generated sound. In earlier days, most of the sound devices available in the market starting from simple analog radio up to studio speakers engaged voltage amplifiers to amplify the audio signal to a sustainable level. The circuit design of amplifiers also had the capability of removing dc offset which is a danger to the speaker.

Block Diagram



Analog Analysis

(a) : The effect resistor values in frequeny of the wave generation.

(b) : Pureness of sine waves generated with fundamental and over tone frequencies.

(c) : Modulation with a sine wave to get a higher octave.

(d) : Addition of the harmonic components according to the amplitude ratio.

(e) : Analyzation of exponential decay of audio signal.

(f) : Analyzing softness of sound by scaling different frequecy ranges.

(e) : Anlysing the output audio signal with different amplifiaction factor.

Methodology

Analyzation of Piano Notes
Analyzing the frequency spectrum of sounds from each note of the piano, as to mimic the exact spectrum through the addition of sine waves.

Wave Generation
We have decided to implement the Wein Bridge oscillator circuit to generate sine waves spans in the audio frequency range. The circuit allows modification of frequencies by interchanging values of resistance used. This character can be utilized to map the keys with corresponding wave generation.

Damping of Audio Signals
As a step of mimicing the sound from Piano we need to decay the audio signal in an exponential manner. As of now, it is decided to implement the strategy used in envelope detector as to get an exponential decay in sound.

Amplification
As a step of getting audible sound from the piano, we decided to implement a non inverter amplifier circuit using operational amplifier.

Modulation
Inorder to observe sudden change in octave on the pedal press, it is decided to implement a modulator. Modulator design consist of a simple wave generator of required frequency and wave Multiplication.

Audio Equalizer
Audio Equalizer softens the sound wave to give a pleasurable experience from the piano. The design of the equalizer consists of frequency filters. It separates the sound signal under frequency categories and boosts or lowers its amplitude as per preference.

References

1. Synthesizing Frequency of Notes → https://web.eecs.utk.edu/ hqi/ece505/project/proj1.pdf
2. Wave Generation → $https://en.wikipedia.org/wiki/Wien\_bridge\_oscillator/$
https://www.homemade-circuits.com/simple-sine-wave-generator-circuits/
3. Mathematics of Sound → https://www.ams.jhu.edu/dan-mathofmusic/sound-waves/
4. Similar Project with High Scope → http://www.jiisuki.net/reports/howto-build-analog-synth.pdf
5. Audio Equalizer → https://circuitdigest.com/electronic-circuits/audio-equalizer-tone-control-circuit-with-bass-treble-and-mid-frequency-control