

MMI 604 FINAL PROJECT

Guitarizzz-

Pluck Synth Guitar

**Physical modelling of a Plucked String Synthesizer with
the Karplus-Strong Algorithm in JUCE**

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Introduction

Objectives

- Physical modelling of a guitar string
- Understanding the algorithm and midi architecture for a guitar synth in Juce.
- Participant study to find the effectiveness and the user experience





Problem Definition

Why do we need to design this synthesizer?

- A lot of current synthesizers struggle to capture the true essence of plucked string sounds, lacking authenticity.
- To meet the need of engineers and sound designers it is essential to create a specialized tool that would be expressive and would create lifelike plucked string sounds.

Solution

- Build a plucked String Synthesizer Using Karplus Strong algorithm in Juce Framework.
- It needs to support Polyphony to play chords and Velocity sensitive to control the dynamics of the notes.
- It needs to have functionalities to tweak the tone, modulate the amplitude, distortion, Delay and gain parameters to add more variation to the sound.

Major design blocks for this plugin



Karplus-Strong Algorithm: Our foundation was the renowned Karplus-Strong algorithm, known for its ability to replicate the vibrations and behavior of plucked strings with precision.



Decay Knob: controls the decay of the tone



Amplitude Modulation(Tremolo): Amplitude modulation is a powerful tool for sculpting evolving and dynamic sounds. It allows users to introduce amplitude change over time, giving our synthesizer an edge in creating expressive plucked string tones.



Distortion: Distortion adds character and grit to our synthesizer's output. Users can apply distortion to the plucked string sound, opening up possibilities for edgier and non-conventional timbres.

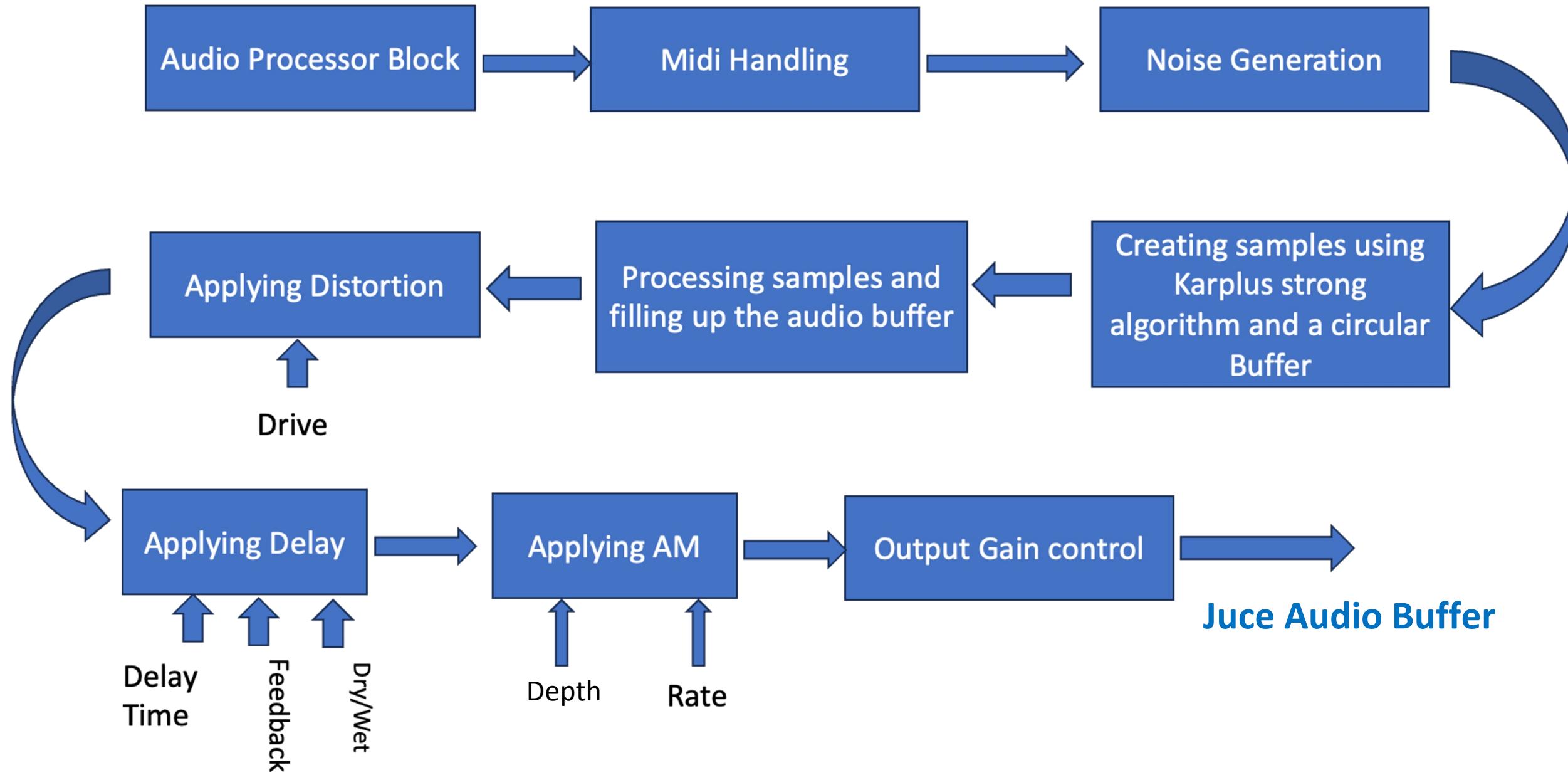


Delay: Delay Time, Feedback and Wetness control with linear interpolated indices.



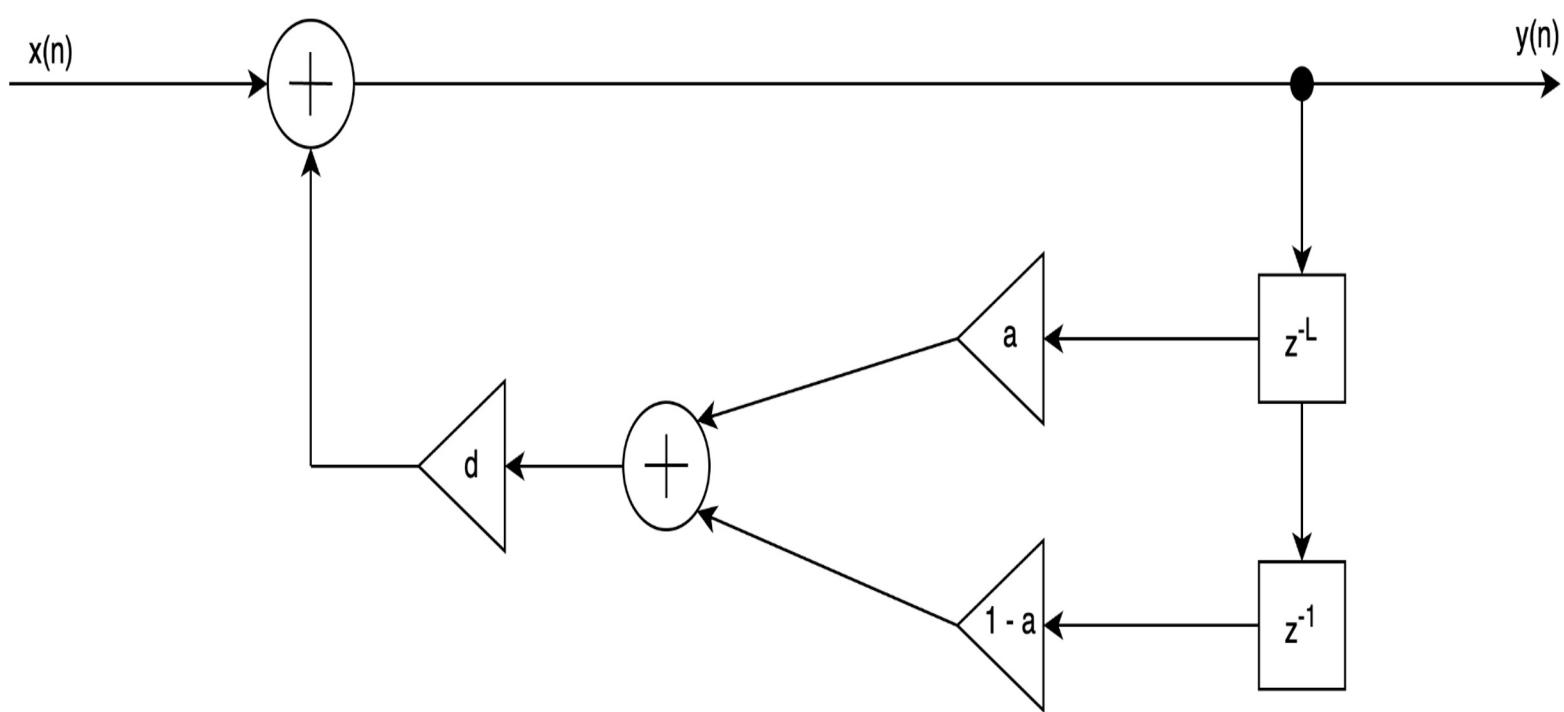
Gain Control: Gain control is crucial for achieving the right balance in audio output.

Block Diagram



Implementing the Karplus-Strong Algorithm

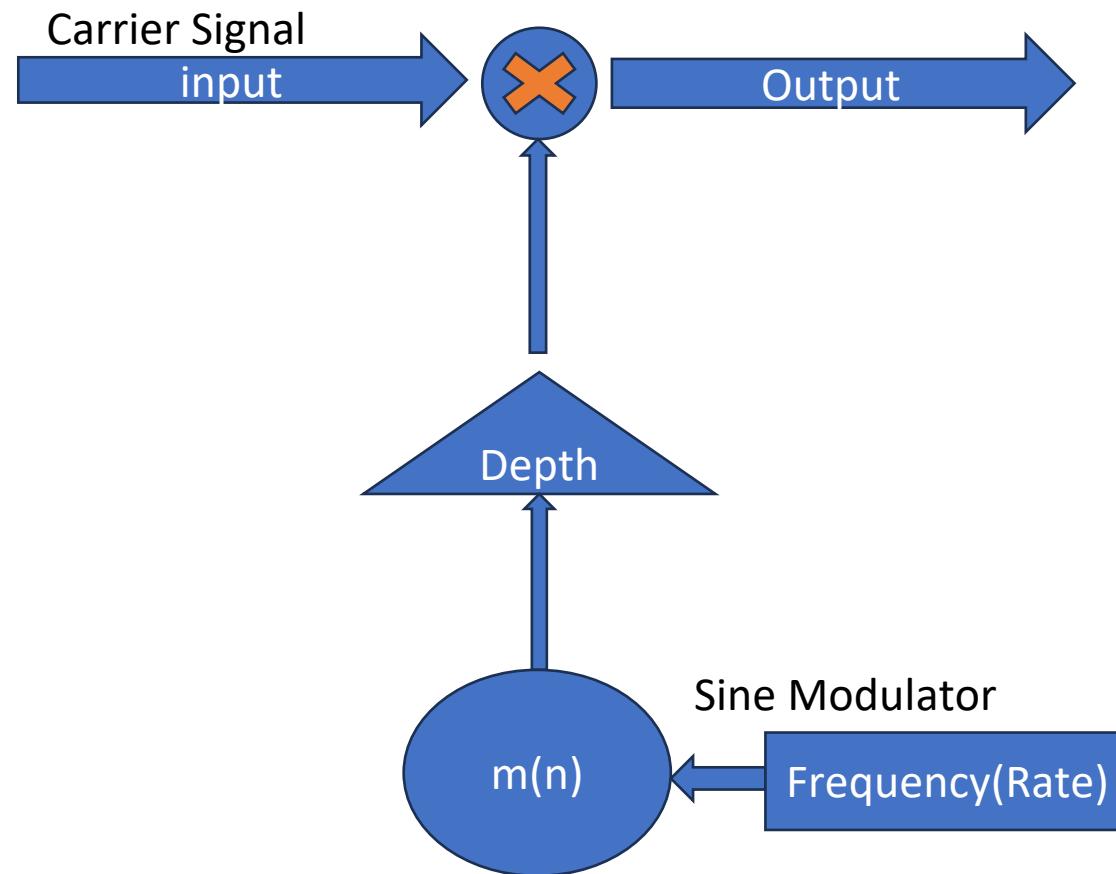
Noise burst of length $L = \text{Sampling Rate}/f_0$



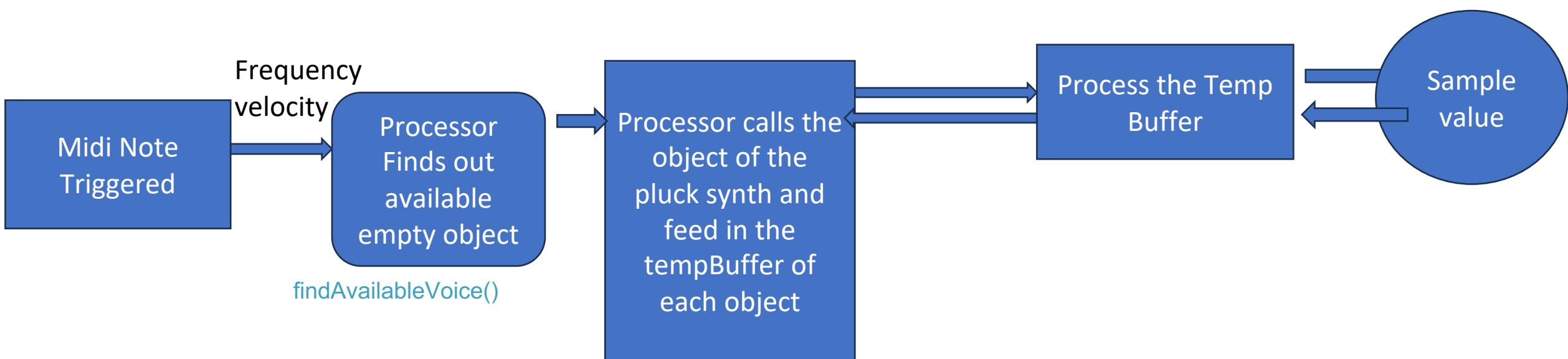
Implementing Soft clipping distortion Using tanh()



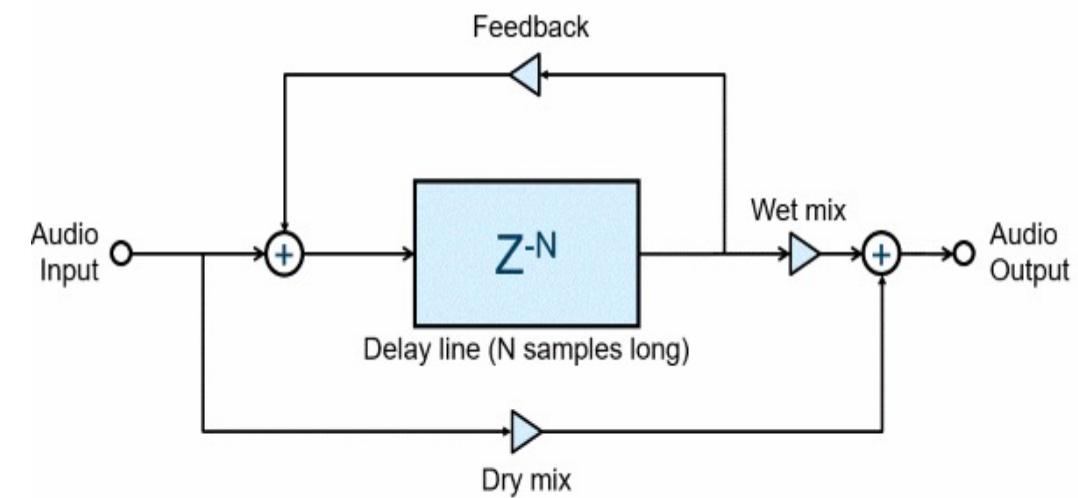
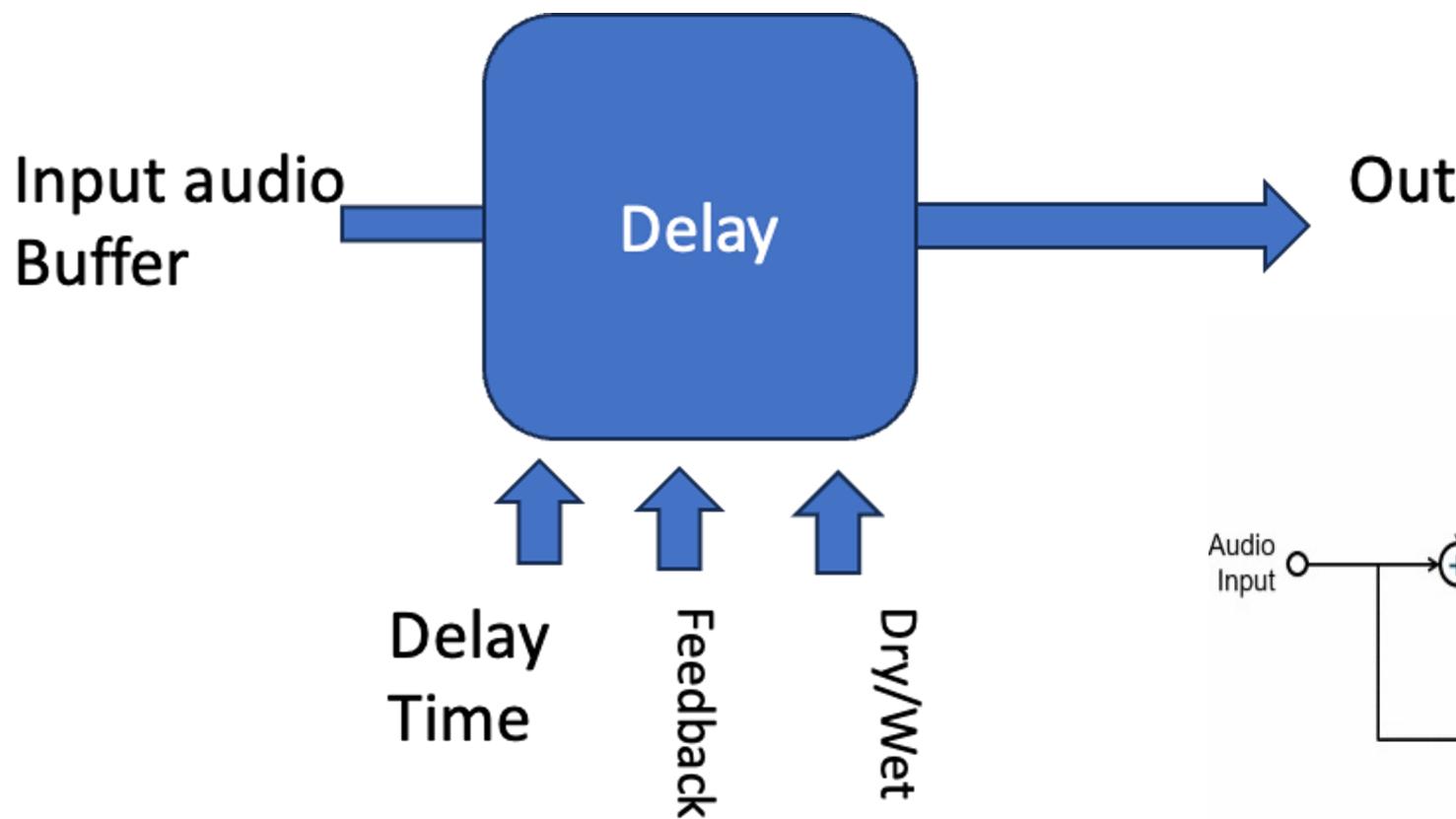
Amplitude Modulation



Polyphonic Midi Architecture



Delay



UI Design



Rise

Output Gain

Distortion

Decay

Roar(Delay)

Delay Time

Feedback

Wetness%

Revolt(Tremolo)

Depth

Rate

DEMO

Participant Study:

1. **Objective:** Determining the effectiveness and the user experience of our audio plugin in a real world context, by asking the participants to create a melody using our plugin.
2. **Participants:** Choosing 3 participants who have some level of interaction with audio plugins, ensuring they represent a diverse range of experience and preferences in the audio world in general.
3. **Ethical considerations:** Taking consent of all 3 participants to record their video and take their opinions and using them for the presentation and for the final project, by explaining them the purpose of the study, and how their data will be used.
 - Maintaining anonymity: While conducting the participant study, anonymity of the participants will be ensured.

Participant Study:

4. Data Collection Methods:

- Observational:
 - Recording a video of the participants while they interact with the plugin.
 - Noting down the plugin elements they interact with.
 - Noting down how much the user explores and tries to be creative with the plugin.
 - Noting down how easily the user achieves what their desired melody is.
 - Encouraging the user to think aloud during their interaction to capture their thoughts in real time.
- Quantitative:
 - Overall time taken to interact with the plugin.
 - Time taken to achieve the desired outcome.
 - Count how many plugin elements were used.
 - Count number of times a similar plugin element was used.
 - Range of plugin element used.

Participant Study:

- Qualitative: Through a google form, ask the user questions like:
 - Overall satisfaction with the experience of using the plugin.
 - Their opinion on the quality of effects.
 - Their opinion of effectiveness of the different components in the plugin.
 - Their opinion on how easy was it to create a melody that they wanted to create.
 - Features of the plugin they liked and disliked.
 - Suggestions on how to change the effects of the plugin to suit their preferences.
 - Ask if they faced any major issues.

5. **Integration and analysis of data:** Take all the collected data into consideration and take relevant inferences from the collected data.

6. **Reflection and Limitations:** Reflect on the study's limitations such as small sample size and potential biases. Get ideas for further development of the plugin.

Participant Study: Google form

Guitarizzz Synth User Experience

Pluck string synthesizer useful for creating melodies, specially as a live tool for performance.

vvd16@miami.edu [Switch account](#)



* Indicates required question

Email *

Record vvd16@miami.edu as the email to be included with my response

Are you willing to grant permission for the utilization of your participation data, which encompasses interactions with the synthesizer plugin, as well as a video recording without personal identification, for the purpose of evaluation aimed at enhancing this plugin? *

Yes

No

How much is your experience with music production and sound designing? *

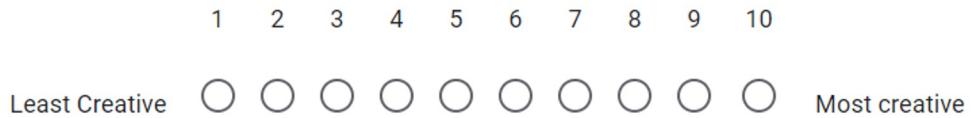
1 2 3 4 5

Lowest

Highest

Participant Study: Google form

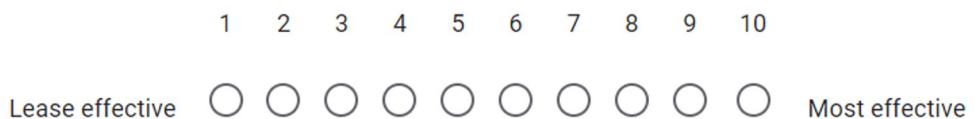
Using a scale from 1 to 10, express the degree of creativity you experience when utilizing the Pluck-Synth. *



How easy was it to learn to use the synth and its different capabilities? *



How effective did you think the different plugin elements were in doing what they *
were supposed to do?



How would you rate the UI of the synth? *



Participant Study: Google form

List the things that you liked about the plugin, its potential use cases if so, why could this be useful for you. *

Your answer

List the things that you disliked about the plugin, any potential areas for improvement. *

Your answer

Any final remarks for the developers?

Your answer

Submit

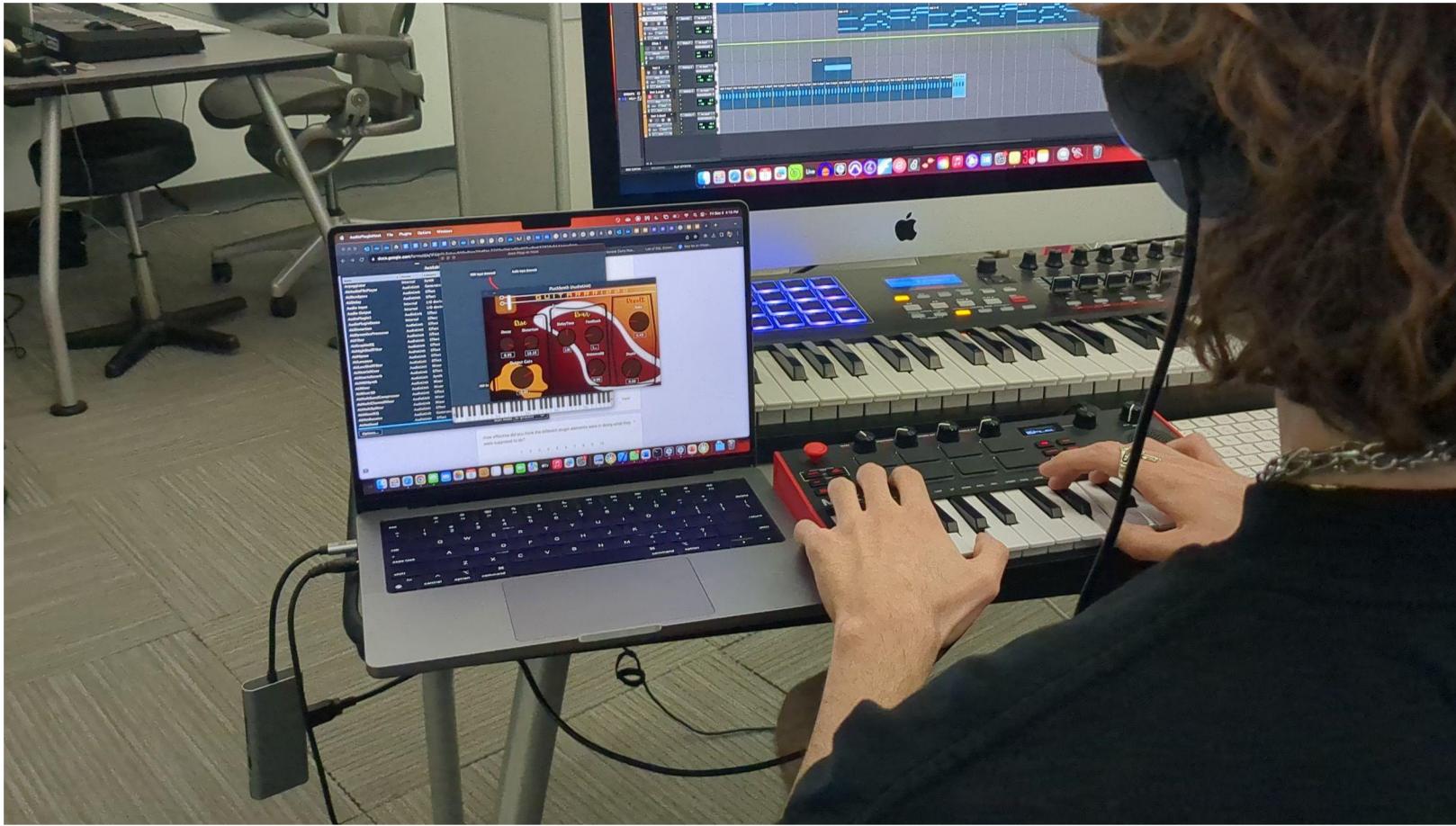
Clear form

Some Highlights of participants testing the plugin:



- Basic setup for testing the plugin.

Some Highlights of participants testing the plugin:



- One of the participants testing out the plugin

Findings from the study: Quantitative

- All users found the plugin element to be very effective, and the elements did what they were supposed to do (87%).
- Users felt they could be really creative with the plugin (80%).
- The UI was really liked by the users (83%)
- The learnability of the plugin was poor (30%).
- The users struggled to achieve a desired sound from the plugin (23%).

Findings from the study: Observational and Qualitative

- Effect name was a bit confusing, for one user, preferred something simpler.
- Users suggested more effects to be added to the plugin.
- On an average the users took around 45-50 seconds to create a sound of their liking from the plugin.
- All users really liked the overall sound of the plugin.
- All users really wanted to experiment with the plugin.

Where we can use this plugin?

- Music production : Electronic music and rock music
- Sound Design and use to emulate a particular guitar tone that you want
- Live performance

Why should you Use this plugin?

This plugin gives you the freedom of designing the kind of guitar sounds according to your application.

A close-up photograph of a harmonica lying horizontally across a page of handwritten musical notation. The harmonica has a dark wooden or bamboo body with a light-colored metal cover featuring a grid of holes. The musical notation consists of several staves of notes written in brown ink. In the center of the image, the words "Thank You" are overlaid in a large, white, sans-serif font.

Thank You