POLITECNICO
MILANO 1863

Music And Acoustic Engineering

Computer Music - Languages and Systems
Homework #3
Group: Algorhythmics - A.Y. 2022/2023

YASC

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1 Introduction

The goal of the project is to to develop an interactive recorder performance tool, incorporating Joy-Con controllers(fig. 2) via a web interface for gesture-based inputs and SuperCollider for sound synthesis. The system is able to emulate the recorder experience with real-time, responsive feedback to enable an immersive musical performance.

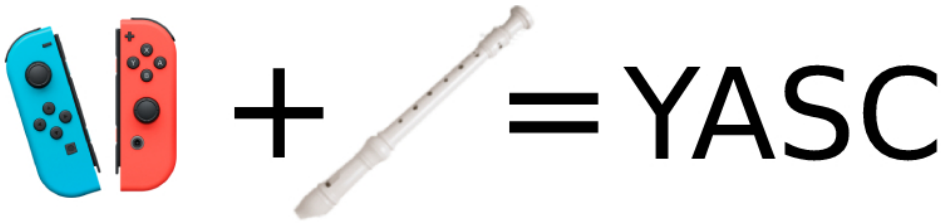


Figure 1: YASC

2 Features and GUI

For the whole system, it is divided into interaction and sound synthesis. The web part and Joy-Con controllers involves user interaction, visualization, and real-time communication. The sound Synthesis involves sound generation.

2.1 Joy-Con controllers

The Joy-Con controllers(fig. 2) consist of two individual units, each containing an analog stick and an array of buttons. In the project, the left controller are used to control the parameters in super collider and the right one is responsible to play notes.

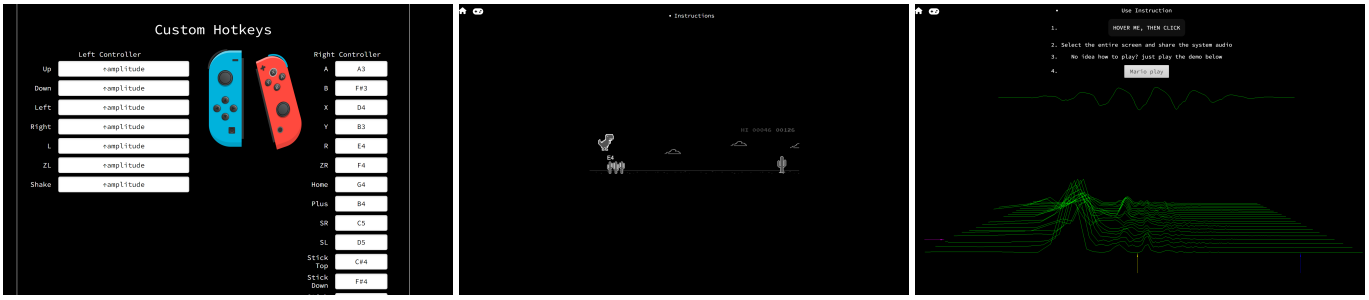
Figure 2: Joy-Con Controller

2.2 Web system

The web system is responsible to connect Joy-Con Controllers, customize hotkey map, and show immersive sound visualization effect. To be precise, the three pages included below. For further information, please refer to the link.

- *The hotkey page(fig. 3a)*: it serves as an interface for users to personalize their recorder experience. Through this page, users can customize their Joy-Con controller buttons to map to different recorder sounds. In particular, the left controller is responsible for adjusting parameters of recorder in SuperCollider. And the right controller is working for playing notes.
- *The dino game page(fig. 3b)*: it serves as an interactive training tool designed to help users familiarize themselves with their custom hotkeys. The key point in our implementation is that the jumping action is triggered only through the correct Joy-Con button that the user has previously mapped in the Hotkey Page. Please note that as the game progresses, the speed increases, making it more challenging.

- *The Spectrum Page (fig. 3c)*: it provides an immersive audio-visual experience by representing sounds as visual spectra. Additionally, we prepare a short mario audio for beginners to follow.



(a) The hotkey page (b) The dino page (c) The spectrum page

Figure 3: Web System

2.3 Sound synthesis

The recorder sound is handled by SuperCollider, offering a couple of params parameters for customization.

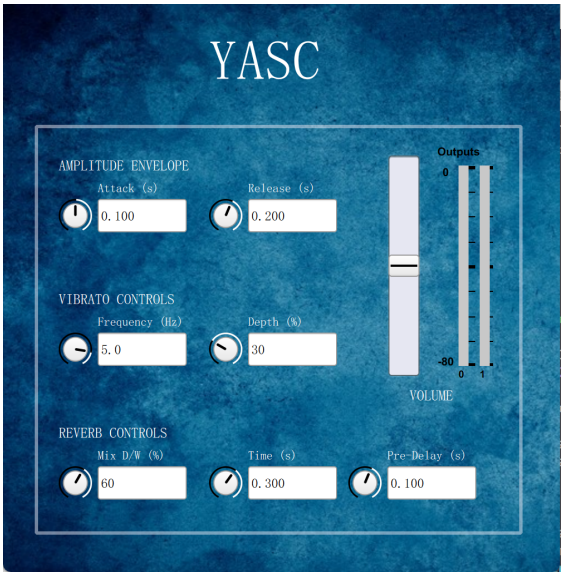


Figure 4: Sound synthesis

3 Key Implementations

3.1 Overall structure

In this structure(fig. 5), the system tracks interaction with Joy-Con controllers and use them as input. The web system acts as the center interface, providing users with an intuitive and interactive to set up and customize their performance experience. SuperCollider serves as the sound synthesis engine, generating the sounds according to the commands from web system via the Open Sound Control (OSC) protocol. Finally, the sound can be captured by web system to show the visual effect.

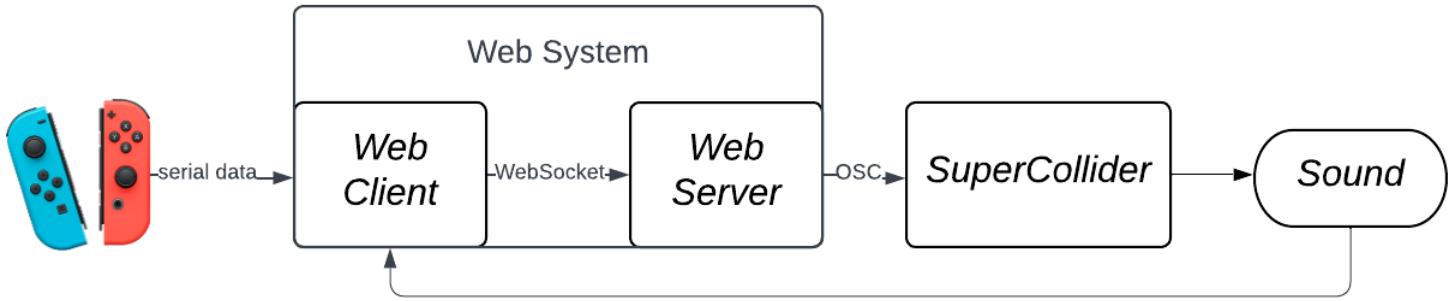


Figure 5: Overall structure

3.2 Communication in the web system

The web system consists a website and a server, mainly using WebSocket for real-time communication. it provide a persistent connection between the client and the server, allowing data to be transmitted as soon as it is available. This significantly reduces the delay between a user's action on the Joy-Con controller and the sound produced by SuperCollider.

3.3 Localstorage in the website

The hotkey configuration is saved in the browser using LocalStorage, which offers large capacity with 5-10MB data, client-side storage that can lead to quicker access times compared to Database and ease of use with simple methods.

3.4 SynthDef *flute*

The SynthDef "flute" emulates the sound of a recorder through digital waveguide synthesis. This model is based on Perry Cook's one with the addition of a simple vibrato.

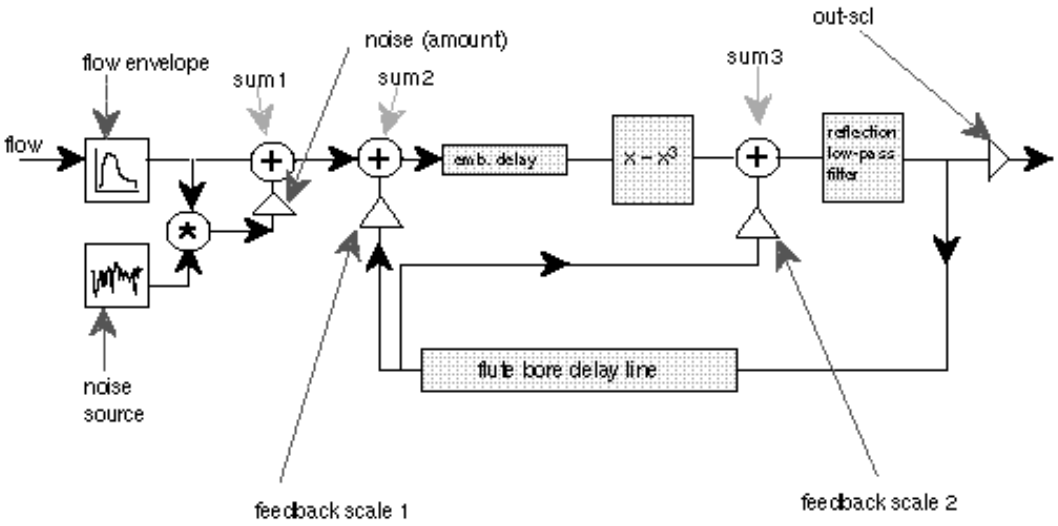


Figure 6: Perry Cook's digital waveguide flute model

The procedure is summarized by the following steps:

- The initial sound (*sum1*) is generated through a clipped noise modulated by an envelope and summed with a low frequency sinusoidal oscillator to simulate vibrato.
- The second sound (*sum2*) is obtained as the sum of the first one and the actual output processed by a cubic interpolated delay line (used for bore effect emulation, one period's worth of samples

long), modulated by a coefficient smaller than one (to prevent instability in the feedback loop).

- The second sound (*sum2*) is processed by another cubic interpolated delay line (used for embouchure effect emulation, half period's worth of samples long) and the cubic polynomial $x - x^3$ is computed for each sample: this result is then summed to the actual output (processed as described in the previous point) modulated by a new small coefficient (always smaller than one for the same reason stated before) to give the third sound (*sum3*).
- Finally, a low-pass filter is applied to simulate the natural decay of high frequencies in a flute sound.

4 Conclusions and further improvements

In conclusion, given the constraints of time and workforce, our accomplishments to this point are commendable. In particular, for the playability, the dino game and visualization effect are enjoyable, the system is easy to control and intuitively understandable to the player. For the sound quality, the picture shows a great similarity between the obtained and the real one in shape, the main difference exists in low frequency because the noise of breath is simulated.

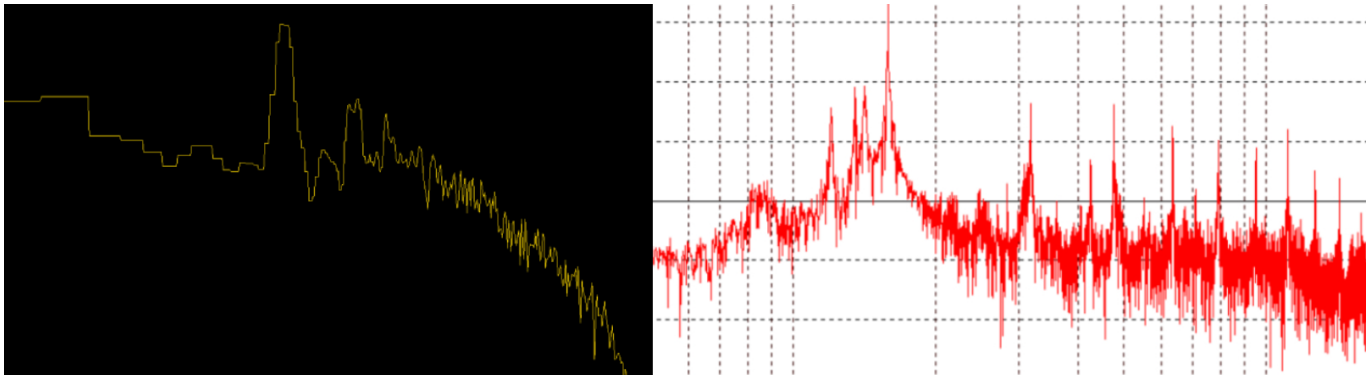


Figure 7: Compared with real recorder

However, the pursuit of excellence is a continuous journey, the following ideas could be implemented

for the future work.

For the web system:

- In order to further reduce the delay, use JUCE with WebSocket to replace SuperCollider.
- Explore the possibility of integrating with other motion-sensing devices or MIDI controllers, expanding the performance options.
- Implement a feature that allows users to record, save, and replay their performances.
- The Madgwick filter will be used for improving motion tracking with controller devices.

For the sound synthesis:

- At high frequencies, the sound of recorder model is not perfect and could be unacceptable especially at extremely high frequencies. In the short future, multi-modal or multi-dimensional models is going to be adopted for that problem.
- Offer more sophisticated sound parameters for users to manipulate, allowing for greater customization of the sounds generated by SuperCollider.
- The current recorder model uses a cubic non-linearity to simulate the effect of the mouthpiece. More accurate results might be achieved by incorporating higher-order non-linearities.