

## EXPANDED ELECTRIC GUITAR: A CONTROLLER FOR DIGITAL PROCESS AND VIDEO INTERACTION IN REAL TIME

Guitarra eléctrica expandida: un controlador para procesos digitales e interacción con video en tiempo real

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### Abstract

The expanded instruments have gone through different variants, but electronic-digital technology has given them sufficient expansion and sound production. An expanded electric guitar is a hybrid electric-digital instrument, equipped with a joystick and foot switches. These components allow the instrument to create alternative forms of controlling 3D shapes and audio effects in real time, making a representation that goes beyond the traditional use of the guitar as a musical instrument. This instrument was developed for interacting as a MIDI controller with diverse audio and video *software* to generate an audiovisual experience. This tool facilitates the modification of the parameters of the visuals such as color, position, and dimensions; and it modifies them according to the sound effects you choose.

**Keywords:** Expanded, MIDI, developed, joystick, foot switches, 3D shapes, electric guitar.

### Introduction

For many years, artists were looking for a way to link sounds and images. There are some studies about the similarities between sound frequencies and light frequencies and how artists have looked for an artistic idea to explore the relationship between color and timbre. Even some artists tried to add a color to the sound of each musical instrument. They wanted to evoke sound through sight and create the pictorial equivalent of a symphony that not only stimulates the eyes but also the ears.

This project involves a practice that generates discourses where images and sound effects, produced or processed digitally, are controlled through interactive processes implemented on an expanded electric guitar, which is an innovation for the conventional way in which an electric guitar is played.

### Description of the project

The development of this project was based on the use of an expanded electric guitar as a tool to control processes of synthesis of audio and digital images in real time.

An expanded electric guitar is an electric-digital hybrid instrument, which allows the formation of a reciprocal link to control image and audio synthesis. This tool facilitates the modification of the parameters of the work such as the color, the speed of visuals playback, and the handling of sound effects. The instrument is equipped with a joystick and foot switches with which it controls digital processes. This allows one to create alternative forms of representation that go beyond the traditional use of the guitar as a musical instrument since it allows the interaction with diverse audio and video *software* to generate an audiovisual experience.

The project presented custom computer software and hardware that produce, in real-time, feedback between visual language and sonorous. At present, technology allows us to control digital processes so we can create alternative forms of representation that go beyond the classic use of the guitar and facilitate the interaction with diverse software of audio and video. The electronic part will be developed using *Arduino*. “Arduino is an open-source prototype platform based on easy-to-use hardware and software. Arduino tables allow you to read inputs (light on a sensor, a finger on a button or a twitter message) and return outputs, Turn on an LED, post something online.”<sup>1</sup> With this software and hardware, you can create different tools that the user can use for your convenience. This has an intimate relationship with the product design.

The processing of the audio and visual signals were edited using *Max for Live*. “Max for Live puts the vast creative potential of the Max development environment directly inside of Live. It powers a range of instruments and effects. And for those who want to go further, it lets you customize devices, create your own from scratch, and explore another world of devices produced by the Max for Live community.”<sup>2</sup> Using this programming tool, you can develop audio and visual custom interfaces.

## The foot switches

The Expanded Electric Guitar has five-foot switches, the first one was used to control and overdrive, the second was used to control a Flanger, the third one controls a stereo delay, the fourth- and fifth-foot switches serve to start, record, and playback a loop recorder. All the foot switches are also connected to a visual Max for live device and created an interactive change response in the shape of a 3D sphere.

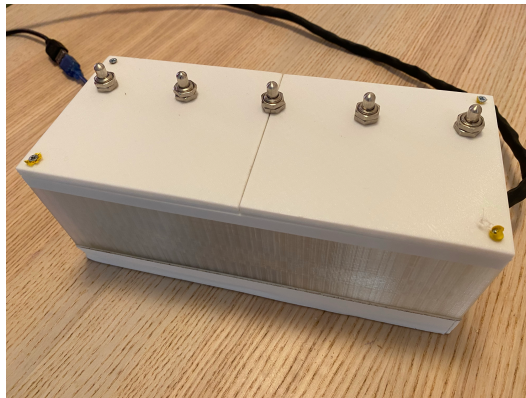


Figure 1. Foot switches and the case of the Electric Expanded Guitar.

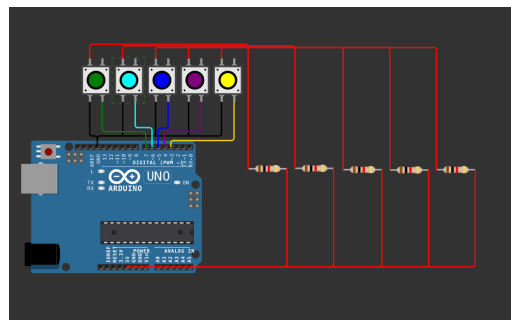


Figure 2. Foot switches schematic.

<sup>1</sup> Arduino, Accessed: November 9, 2022. <https://www.arduino.cc/en/Guide/Introduction>.

<sup>2</sup> Ableton, Accessed: June 17, 2023. <https://www.ableton.com/en/live/max-for-live/>

## The joystick

It is a two-axis joystick (X and Y axis). It was added to the body of the electric guitar. This hardware piece controls a modulation effect and adds glow to the 3D sphere.

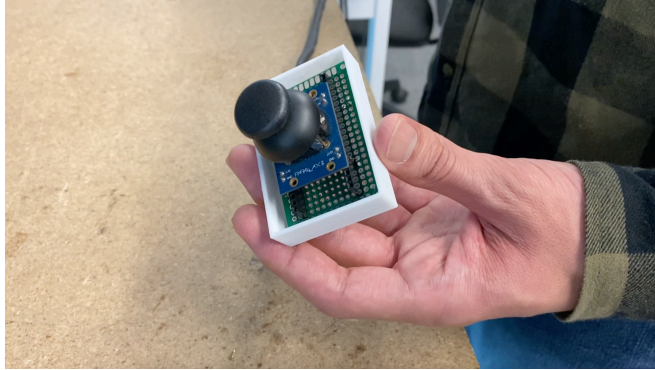


Figure 3. The joystick.

## The vocoder

This device uses the frequency of the electric guitar to modulate the signal coming from a vocal channel. The vocoder device should be placed in the track where the voice mic is connected.

## The 3D visualizer

This device created a visual link with all the effects developed. It is a custom interface that generates 3D graphics that react depending on how the user decides to use the audio effects. The 3D sphere was distorted depending on the modulation, amplitude, pitch, and layers of sound the user decided to use.

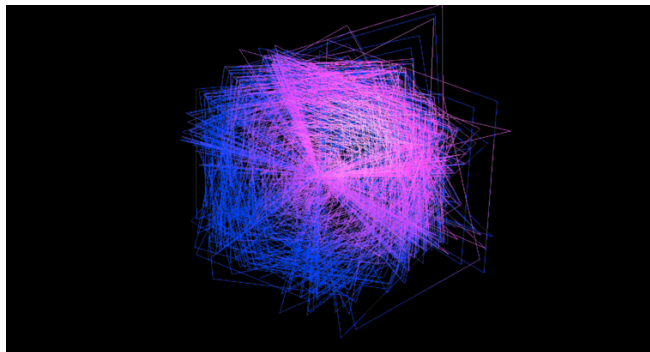


Figure 4. The 3D visualizer.

## Challenges expected and unexpected

Programming the Arduino sketch for the expanded electric guitar controls functionality was one of the hardest challenges. Learning, coding, and understanding how MIDI messages and data were structured was necessary to overcome the challenge. The most difficult part was to code the control change for the joystick. The developer learned through testing and trying several times with the Arduino MIDI library. The coding problem was solved when the developer mapped the values coming from the Arduino into a range from 0 to 127. The Applied Media Design classes were important for helping the developer fix the problems. 3D printing times were very demanding. It took more than 20 hours to have the 3D printed case for the foot switches. The developer was ready for that following the timeline for having the case before the deadline. Something unexpected was the problem caused by the temperature of the 3D printer bed.

After several hours waiting for the printer, the bottom right corner of the foot switches case was bent. This problem was caused by a bed adhesion issue. The developer did not have any idea about the impact of the long printing process. The way to fix this problem was to use a glue gun to fill the damaged part. Also, the developer used white tape for making a design and masking the problem caused by the bottom lift edge of the case.

## Future ramifications

There are some next steps for the artist. One of them is to prepare a multimedia performance with video mapping projection. With the expanded electric guitar already done, it would be good to start performing with it. Using this tool live would be a good challenge to discover how it works in real time performance. The more the artist uses it, the more the developer can discover new improvements or implementations. The next step is to start selling and distributing Max for live devices. These devices are meant to be virtual sound technology or audio plugins in the future. The first idea to make this possible is to create a platform for distribution. The idea of the developer is to have his own website. Creating a marketing strategy to promote this device and utilizing social media platforms, Ableton forums or online communities are important steps to have in mind. There are still details to enhance the product, that is why the reviews and user feedback would be valuable to improve the developer devices' functionality. Selling and distributing Max for Live devices would require a continuous effort in promoting and maintaining the quality of this product, but that is a future goal.

The last future ramification is to make a do-it-yourself tutorial or a workshop teaching how to develop hardware and software. A do-it-yourself expanded electric guitar workshop has innovative potential to promote an approach to music production. This workshop could be adapted for educational purposes, introducing students to electronics, coding, and music technology. By developing practical skills related to hardware and software development, participants may be inspired to pursue careers related to these fields. Sharing the knowledge learnt during the year at Berklee is one of the desires of the developer.

## Conclusion

The experimental sounds that were part of this project aimed to be related to visual effects to expand this concept of creating synesthetic sensations in the viewer. This produced unpredictable but related and automated results. Some of the visual effects were associated with the tone and intensity with which the strings of the electric guitar were played, generating answers like the color change in graphics. The processing of the audio signal was filtered to a tone detector. This allowed one to discriminate against signals associated with color on certain musical scales.

This guitar is a peripheral tool that controls certain actions of the computer and seeks to be an auxiliary device through which the musician communicates with the processing unit of a machine, which allows to enter external data when functioning as a complementary device.

Its interaction design can be edited according to the user, which could create new forms of alternative representation and with certain possibilities of improvement. The expanded electric guitar functions as a meeting point with a binding and multidisciplinary vision and serves to establish dialogue dynamics that will interlace the conditions in which the audio and video signals were edited, forming a new strategy of control of performance in real time.



The interaction with the expanded electric guitar served as a support that allows one to automate parameters and information of the artwork. The user was able to find comfort with the components of this musical instrument and was able to form multiple representations to make the way to handle each medium easier, conditioning their content in data synchronized with a computer.

The additions of the expanded electric guitar responded with fairly readable movements and corresponded with each with the manifestations that contribute to the work. This way of design emerged as an alternative proposal to the traditional forms, not intended to be a single model but rather a beginning of what could become a line of research that can be complemented with other forms of interaction.

## References

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