

TheraGlitch: Gestural Control of Glitch Music

Danilo Pesevic
IDMIL - CIRMMT
McGill University
Montreal (QC), Canada
danilo.pesevic@mail.mcgill.ca

ABSTRACT

For as long as music has been mechanically reproducible, musicians have sought to employ the limitations of sound-generating tools and media in musical contexts – exploring error and noise as yet another compositional or performance technique. While these explorations often require a low-level understanding of hardware and software tools, the growth of Digital Musical Instruments (DMIs) presents an opportunity to incorporate a more abstracted, intuitive form of glitch control. This paper presents the design and development of the TheraGlitch, a novel DMI that explores possibilities for gestural control of glitch through DMIs. With sound generation and control loosely inspired by the Theremin, and design informed by metaphors for musical interaction, the TheraGlitch allows users to control pitch, loudness, and glitch effects through physical gestures: distance sensing, pressure sensing, and striking the instrument respectively. The hardware employs a Bela microcontroller, interfaced with an ultrasonic distance sensor, force-sensing resistors (FSRs), and an accelerometer. Sound synthesis and glitch effects are achieved through an embedded Pure Data patch.

Ultimately, the TheraGlitch was successfully designed and implemented. In its current state, it serves as a very introductory interface for glitch music, allowing users to play with basic glitch sounds. Still, the TheraGlitch requires significant work before it can be used as a genuine tool for glitch music. Its scope and versatility should be expanded, and glitch should be incorporated to a broader and deeper extent. This work is a preliminary step towards a more detailed exploration of gestural control of glitch, and contributes to the field of DMI design by generating insights into how designers may incorporate glitch as a fundamental aspect of an instrument.

Author Keywords

Digital Musical Instruments, Glitch, Gestural Control of Sound Synthesis, Metaphors for Musical Interaction

CCS Concepts

• Applied computing → Sound and music computing;



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MUMT 620, Gestural Control of Sound Synthesis.



Figure 1: A picture of the TheraGlitch.

1. INTRODUCTION

Whatever you now find weird, ugly, uncomfortable, and nasty about a new medium will surely become its signature. . . [It's] the sound of failure.

Brian Eno [4]

The history of experimental music has within it an ever-present desire by musicians to explore the possibilities of sound through not only its message, but its medium as well. From the tape splicing of musique concrete to the prepared CDs of the German ambient group Oval, glitch – usually treated as an unwanted “error and an intrusion of noise into a system” [2] – has been recontextualized, made intentional, and exploited as ripe material for experiment.

In his 2000 paper, Kim Cascone identifies the emergence of “post-digital tendencies” in underground electronic music and lists some of the tools behind the glitch music movement [3]. These range from low-level hardware like “handmade sine wave oscillators” to more abstracted software such as Max/MSP. Despite the continually reduced barrier to entry, Cascone highlights the need for new tools, “with an educational bent in mind,” so that newcomers may familiarize themselves with glitch music before diving beyond abstraction layers.

As a part of the final project for the course MUMT 620:

Gestural Control of Sound Synthesis, a new digital musical instrument (DMI) which allows users to gesturally control glitches was designed and implemented. Control of the sound synthesis was inspired by the Theremin, hence its name – the TheraGlitch. The instrument outputs a continuous tone whose pitch is controlled by distance from an ultrasonic sensor and whose loudness is controlled by grip pressure.

Drawing upon metaphor-guided DMI design, control of the audio glitches will be based on a metaphor: frustration. The difficulty of learning a new instrument can be quite frustrating, and it can be tempting to, say, smack the body of your guitar with a fist when the mastery of a new riff eludes you. The TheraGlitch references this frustration by integrating taking-one’s-anger-out into the essence of the instrument. By striking the device, the output signal will be corrupted in a manner similar to CD-skipping.

1.1 Motivation

Through the TheraGlitch, the primary goal of this project is to investigate the gestural control of glitch – a (seemingly) novel area of exploration for DMI design. While there do already exist glitch effect boxes and VST plugins, these apply effects to a signal post-hoc, and do not employ gestural controls. This project attempts to incorporate glitch as a part of the instrument itself.

Further, the TheraGlitch is an attempt to address Cascone’s [3] recommendation towards the creation of new tools for glitch music which allow for newcomers to familiarize themselves with the glitch paradigm.

More broadly, the TheraGlitch also explores several ideas within DMI design touched upon in class readings. Concepts such as energy [7], self-containment (existing as a “standalone” instrument [1], and metaphors for musical control [12, 11] were incorporated into the project. Results from this paper may inform future designs of gestural controllers for glitch music, and may provide a case study for DMI design based on recommendations from previous work in the field.

1.2 Research Context

While there does not appear to be any previous work in the gestural control of audio corruption, the TheraGlitch draws upon previous work in DMI design, summarized below.

1.2.1 Energy in DMIs

The discussion of the “accidental Theremin” in [7], a Theremin whose volume was controlled by sensing hand velocity as opposed to hand position, inspired the choices of form and sound control for this project. Requiring a continuous energy input from the user to produce a sound makes for a more engaging DMI and mimics the behavior of a traditional acoustic instrument. The volume of the TheraGlitch output is controlled by the amount of force with which it is held, thereby requiring users to put more energy into the instrument to create louder sounds.

1.2.2 Metaphors for Musical Interaction

Metaphor in DMI design is a powerful tool which has the capability to increase control intimacy [12] and expressivity, and can aid users to understand how to use the DMI [5]. Metaphors, when used as a design tool, may guide DMI design by directing choices of controllers and mappings [5]. For example, the MetaMuse is a DMI based on the metaphor of rainfall for the control of granular synthesis [5, 6].

In the case of the TheraGlitch, the metaphor of musical frustration guided the choice of glitch control. Outside of glitch music itself, glitches are undesirable and can be

frustrating when recording or listening to music, much like an incorrect note in a performance. Therefore, striking the instrument to cause glitches was a natural choice. In reference to the famous instrument-destroyers, the Who, the shape of the TheraGlitch emulates the deodorant tube pictured in the album art for their 1967 release, *The Who Sell Out* [10].

2. METHODS

This section serves to summarize the hardware and firmware developed for the TheraGlitch, and to discuss and justify the design and mapping choices.

2.1 Hardware

The TheraGlitch hardware is based on a Bela microcontroller, selected for its low-latency (in the interest of responsiveness and expressiveness [8]) and ease of prototyping through the Bela integrated development environment (IDE). Bela allows for integrated sound synthesis, thus avoiding the need for a PC connection for external synthesis. Three sensors are interfaced to the Bela – a HC-SR04 ultrasonic sensor, an ADXL355 analog accelerometer, and a force-sensing resistor (FSR).

The ultrasonic sensor is used to control the pitch of the output sound, while the amplitude of the sound is controlled by the FSR, placed on the outside of the tube-shaped enclosure. Initially, this mapping was reversed, with the FSR controlling pitch and the ultrasonic sensor distance. However, initial trials suggested that the former mapping produced a more interesting and expressive DMI.

Digital HC-SR04 data is read by a digital input pin on the Bela, while the FSR is incorporated through a voltage divider circuit with a 2.2 kilohm resistor and read by an analog input pin. Glitches are triggered by the accelerometer, which is suspended inside the enclosure using stiff wires glued to the enclosure wall.

Sound is output through a 3.5 mm TRS connector, chosen for its ubiquity and because it is easy to interface with speakers and headphones.

A tube-shaped enclosure was designed in Fusion and 3D printed. The enclosure includes considerations for easy access to a power port and audio output jack on the bottom, and includes two holes for the ultrasonic sensor at the top.

During initial tests, these sensors were connected to the Bela with a breadboard. However, in the interest of robustness and to ensure good connections, before the electronics were installed in the enclosure, the sensors were soldered onto a protoboard and the connections were strengthened with hot glue.

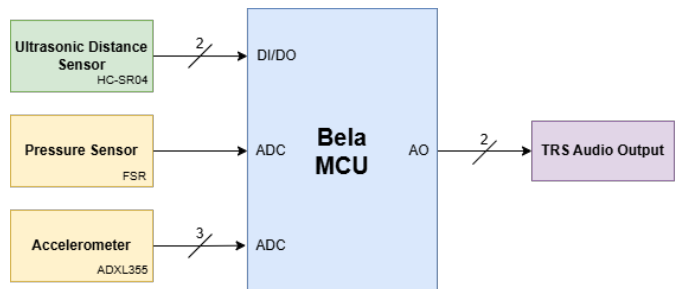


Figure 2: A simplified TheraGlitch hardware block diagram. Note that the colors are such that green represents a digital input, yellow an analog input, and purple the audio output.

2.2 Firmware

Hardware sensing and sound synthesis are achieved through an embedded Pure Data patch. Ultrasonic sensor data is read and converted to a distance value using a patch adapted from sample code in the Bela IDE. This distance reading is then converted to a frequency and sent into a simple oscillator subpatch, also lifted from Bela sample code. Distance-to-frequency mapping was chosen such that 1 cm of distance produced a 110 Hz frequency, while 25 cm produced 880 Hz, with values in between mapped linearly such that each frequency is as easily reachable as any other. A low-pass filter of rolloff frequency 2 Hz is connected to the output of the distance sensor for more stable control, filtering erroneous transients in the HC-SR04 reading. To modulate the TheraGlitch volume, the oscillator output is multiplied by the voltage reading from the FSR divider circuit, and the product is sent to a delay line.

Reading the delay line with different delay times produces a CD-skipping glitch effect. Delay time is modulated by the accelerometer data, using the Bela’s analog input pins to read each of the three acceleration axes which are then combined to find the overall acceleration magnitude. If this value is outside a “neutral range”, it is sent to the `delread` object to change the delay time.

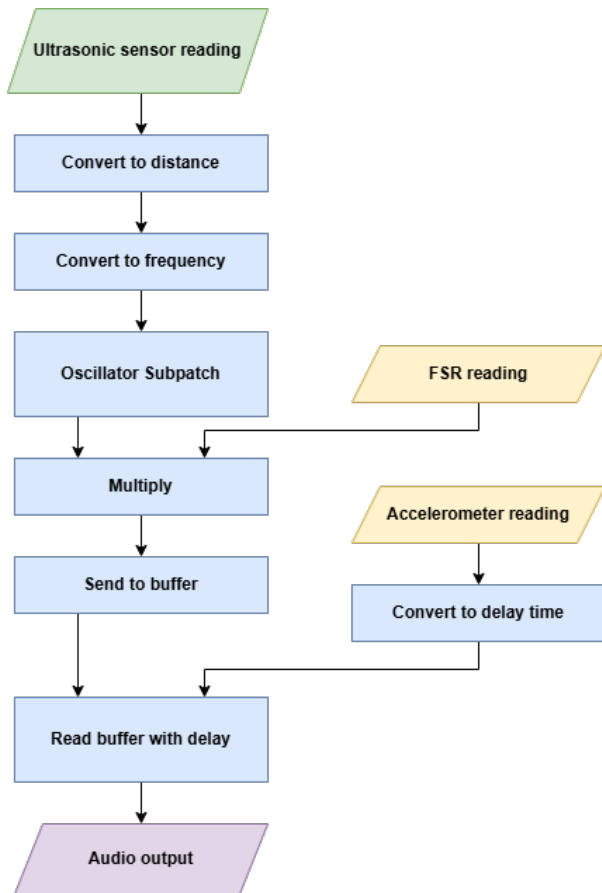


Figure 3: A simplified TheraGlitch firmware flowchart diagram. The color coding is the same as in figure 2.

3. DISCUSSION

Overall, this project successfully investigated the gestural control of glitch music and created a new DMI which allowed for such control. While certainly not in its final form, the TheraGlitch works as a DMI and allows users to explore

glitch music. The following section provides discussion on the project, highlighting successes and failures, as well as possible future work.

3.1 Results

The primary result of this project was the TheraGlitch. Currently it is in a fully functional state, though it is still more of a prototype than an instrument ready for wider distribution.

Use of the Bela microcontroller allowed for straightforward hardware interfacing with the three sensors, and for rapid debugging of the firmware through easy uploads in the Bela IDE combined with Pure Data for editing the device patch. Because sound synthesis was embedded within the instrument, and it did not rely on a separate PC to produce sound, the TheraGlitch is fairly self-contained – it can be picked up and played as soon as it is connected to power and an audio output.

As an instrument, the TheraGlitch is limited in the same ways a Theremin is – it produces a single voice and the continuous nature of the controls makes it difficult to perform common musical actions such as playing scales or any consistent melodies (though this could be a skill issue). However, the use of FSRs for amplitude control adds a novel playing technique. By tapping the FSR pads instead of continuously pressing on them, users can generate discrete tones. This seemed to inform how users held the instrument in informal testing, holding the base of the device with one hand and using the fingers to tap or press on the FSRs instead of holding the tube like a glass as initially envisioned.

Informal evaluations also indicated that the attempted inclusion of frustration as a metaphor for musical control had been mostly unsuccessful. While striking the device did produce glitching, it was difficult to strike while holding the instrument in one hand and controlling pitch with the other. It was found that shaking the TheraGlitch was not only an easier way to generate glitches, but also produced more consistent glitching. The effect itself worked well, though at times it felt somewhat unresponsive and unpredictable, likely due to the spring-like nature of the stiff wires causing the sensor to bounce around while being moved.

More broadly, while glitch was successfully incorporated into the instrument, the degree of incorporation felt thin. It was entirely possible to use the TheraGlitch without glitching, so it would be fair to argue that glitch was not a part of the essence of the instrument, as was originally intended.

A requirement for continuous energy input was integrated through the FSRs – louder sounds required greater pressure. This made the TheraGlitch more engaging and expressive. Initially, loudness was supposed to be modulated by hand velocity (like in the “accidental Theremin”), but this was changed when the sensor to pitch/volume mappings were flipped.

The enclosure design process was straightforward thanks to the quick prototyping capability of 3D printers. Subjectively, the aesthetic homage to The Who Sell Out contributed to the visual appeal of the TheraGlitch and made it more interesting. The PLA plastic which made up the enclosure gave the device a robust feel, and could certainly withstand the striking involved in using the instrument.

The insights generated from this project may help guide future designs of gestural controllers for glitch music.

3.2 Future Work

While this project successfully explored the gestural control of glitch and produced a new DMI, the current implementation of the TheraGlitch serves more as a preliminary step in

the investigation of glitch-focused DMIs than a final product ready for musical use.

From a hardware point of view, for increased chances of adoption by a wider audience, and to improve ease of use, the TheraGlitch could be further self-contained by adding a battery and a speaker into the enclosure. This would make it possible for users to simply pick up and play, especially useful if they wish to jam with other instruments. Additionally, the output could be changed to a standard quarter-inch tip-sleeve cable so that it can be plugged into guitar rigs, allowing users to employ effects units and modulate the TheraGlitch sound to their liking. A battery could replace the USB cable currently used to power the device, thereby making the TheraGlitch less tethered with wires and allowing users a greater range of motion while playing the instrument - further achieving self-containment.

The enclosure itself has much room for improvement, partially because the design is currently based on aesthetics and a humorous reference. The internals are not properly secured inside the enclosure, resulting in a rattling sound during playing. Design of a new and improved enclosure could include a review of existing DMIs and more broadly of interface design and ergonomics literature. Any new enclosure must be sufficiently robust to handle the beatings required for playing the instrument.

While the Bela proved useful for prototyping, a more complete version of the TheraGlitch should incorporate a custom PCB with an appropriate microcontroller selected to replace the Bela. This would require translating to patch into C/C++ code, but would reduce the cost of production.

There is considerable space for revision as far as sound generation is concerned as well. Glitch effects should be incorporated to a greater degree. Instead of simply allowing users to trigger CD-skip glitches with strikes, an ability to choose between glitch types (e.g., noise, harmonic distortion, etc.) should be added, as should new controls that allow for improved control of glitch depth. Better, more interesting and dynamic oscillator patches should be developed, and users should be able to switch between presets or design their own sounds.

Broadening the use cases of the TheraGlitch with new features would further improve its versatility. These could include an option to discretize pitch, allowing users to more easily play notes and scales, or to use the instrument to control the playback of a sample, like the “scrubbing” interfaces described in [12]. Both of these additions would require more sophisticated patches and synthesis (and resynthesis in the second case) algorithms.

Additionally, the TheraGlitch would benefit from a more thorough investigation into mapping. Certain mapping choices made for this project were somewhat arbitrary, and should therefore be probed and justified, if not changed. For example, user experience might improve with a non-linear mapping of distance to pitch.

Finally, any new design would benefit from incorporating user feedback. This could be done in a design workshop setting like that of [9], though necessarily more structured.

4. CONCLUSIONS

This MUMT 620 final project explored the gestural control of glitch by designing and fabricating a new DMI, the TheraGlitch, as an introductory tool, inspired by discussion on glitch music by Cascone in [3]. In order to create an expressive and intuitive instrument, the TheraGlitch design was informed by concepts from DMI design literature - particularly energy in DMI controls and metaphor-driven design.

While the TheraGlitch achieved its goal as a tool for the gestural control of glitch, it remains a functional prototype and should be enhanced through improving its enclosure, incorporating glitch to a greater extent, expanding its sound capabilities, and refined mapping strategies. To address the limitations of the TheraGlitch, future work could include integrated speakers, discrete pitch control, and a sample-playback control mode, among others. Revisions to the design could be informed by user feedback through design workshops.

The TheraGlitch is ultimately a first step towards a deeper investigation into the gestural control of glitch – an underexplored research area in DMIs, with potential to expand the possibilities for musical expression by allowing musicians to manipulate not only the message of sound, but the medium of sound generation, in a novel way.

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