The Theremin Textural Expander

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ABSTRACT
The voice of the theremin is more than just a simple sine wave. Its unique sound is made through two radio frequency oscillators that, when operating at almost identical frequencies, gravitate towards each other. Ultimately, this pull alters the sine wave, creating the signature sound of the theremin [1]. The Theremin Textural Expander (TTE) explores other textures the theremin can produce when its sound is processed and manipulated through a Max/MSP patch and controlled via a MIDI pedalboard. The TTE extends the theremin's ability, enabling it to produce five distinct new textures beyond the original. It also features a looping system that the performer can use to layer textures created with the traditional theremin sound. Ultimately, this interface introduces a new way to play and experience the theremin; it extends its expressivity, affording a greater range of compositional possibilities and greater flexibility in free improvisation contexts.

Author Keywords
NIME, theremin, extended instrument, midi pedalboard, digital sound processing, interactive music, live electronics, free improvisation, performance.

ACM Classification
• **Applied computing → Sound and music computing;** • *Applied computing → Performing arts* • Hardware → Sound-based input / output

1. INTRODUCTION
The theremin is one of the oldest electronic musical instruments still actively in use today. While its simple design and intuitive interface made the theremin an initially enchanting and ultimately enduring instrument, many thereminists have overlooked that the theremin can be used in a variety of musical settings. Famous theremin players, like Clara Rockmore and Lucie Rosen, used it to perform popular classical pieces that were meant for other instruments, like the violin or cello. Rosen was one of the first responsible for commissioning new works that would eventually comprise the earliest repertoire for theremin. In contrast, Clara was more hesitant about commissioning new compositions and would only rarely play Romantic-style music by composers who were alive during her lifetime [4]. In recent years, composers have explored the theremin's expressive capabilities in live-processing, augmented reality, and adaptive tuning.[1] These projects demonstrate the renewed potential for the theremin as a new interface for musical expression and the need for further research. Ultimately, the Theremin Textural Expander explores new sonic textures for the theremin while still allowing the performer to play the theremin in a traditional manner. This interface enhances the theremin's expressive capabilities, providing its composers and performers alike with a new set of compositional tools. This project serves to preserve the legacy of the theremin by expanding what sounds the instrument can produce so it can continue to live in today's musical world.

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2. THE INTERFACE
The TTE includes the Moog Standard Etherwave theremin, the MIDI pedalboard, an audio interface, and a Max/MSP patch. The theremin's signal and the MIDI data from the pedalboard are routed through the audio interface and into Max/MSP. The five textures are created through signal processing and can be manipulated within the Max patch by externally controlling a MIDI pedalboard.

2.1 The MIDI Pedalboard
The MIDI pedalboard provides a simple yet effective solution to the need for hands-free control of live signal processing of the theremin by repurposing and extending the familiar model of a guitar effects pedal.
The MIDI Pedalboard features five buttons, two expression pedals on the far left and right, and six slider wheels.[1]

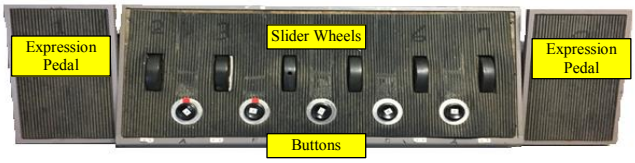

Figure 1. The MIDI pedalboard

This pedalboard sends MIDI data into Max/MSP and controls the two TTE's two performance modes: the looping system and the sonic manipulation mode. In looping mode, holding any one of the five buttons down while playing the theremin initiates a loop of its original sound. The performer can have five loops playing simultaneously. In the sonic manipulation mode, the buttons toggle on and off Max/MSP plugins that process the theremin's signal. Also, when the buttons turn on one of the effects, a gate is opened in the Max/MSP patch to allow specific parameters of the selected effects to be manipulated by the two expression pedals as seen in Figure 1.
The six slider wheels are used to control the volume of the interface. One slider wheel controls the volume of the entire looping system and the others are individually assigned to each texture. This allows for smooth transitions when performing with the interface.

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[1] Composer Lyn Goeringer used programming languages like Max/MSP to explore new sonic possibilities with the theremin [5]. The Theremin Orchestra created custom theremins that manipulate the voices of singers [2]. In addition, David Johnson and George Tzanetakis used mixed reality to create an application called VRMin, which can be utilized to help a performer learn how to play theremin using a virtual environment [6]. Lastly, Alexandre Porres and Jônatas Manzolli simplified the theremin by implementing adaptive tuning and allowing it to trigger sounds from a computer without the support of MIDI [7].

[2] Built by Bell Labs for the Alles Machine, which Oberlin Conservatory acquired. John Talbert, the former technical director of Oberlin's TIMARA program, retrofitted it with a Miditron board.

3. SIGNAL PROCESSING

The theremin's raw signal is routed via an audio interface directly into the Max patch. This signal is routed into eleven subpatches: five are part of the looping mode, and six are part of the sonic manipulation mode.

In Figure 2, MIDI data from the pedalboard and the theremin's signal are sent into the Max patch. MIDI data can be sent to either "Button Mode 1," which is the looping mode or "Button Mode 2," which is the sonic manipulation mode. The leftmost slider wheel controls the volume of the looping mode and acts as a switch between the two modes. If the gain equals a number that is greater than 1, the looping mode is activated. If the gain equals 0, the sonic manipulation mode is activated. This allows the pedalboard's buttons to be utilized in two different ways. In the looping mode, each button starts one of the loops. In sonic manipulation mode, each button will turn on its corresponding effect. Furthermore, when an effect is selected, MIDI data from the left and right expression pedals is sent to control two of the settings in the plug-in, which manipulate the resulting sound in real time.

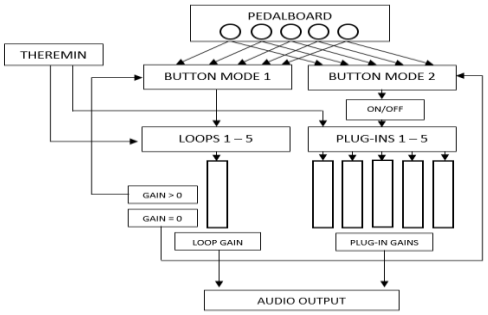

Figure 2. Signal Flow Diagram of Max/MSP Patch

4. SOUNDS

The looping system allows the performer to play the theremin with its original sound. This creates contrast between the new textures for the theremin and its signature sound. The Max/MSP patch only allows the performer to use either the looping system or the sonic manipulation mode – they cannot use both at once. This keeps the resulting sound from becoming too dense.

The effects used for the sonic manipulation mode were chosen from the Max/MSP plug-ins that are included in the program. After experimenting with a variety of the plug-ins, the ones incorporated in the final patch are Feedback Network and Raindrops (grouped as one texture), Granular-to-go, Wheat, Max DelayTaps, and Fragulator. These five textures were chosen because of the stark contrasts they create in comparison to the theremin's original sound. There are five textures to offer a variety of sounds without overwhelming the performer using the interface. Other plug-ins were excluded in the final patch because their expressive range was too limited.

The Raindrops plug-in is combined with the Feedback Network. The former creates pops in frequency and saw wave sounds, while the latter provides a background effect that features high frequencies and water-like sounds.

The Max DelayTaps plug-in includes several delay lines that can be shortened or elongated. The traditional theremin sound can be heard; however, this plug-in can create textures from the notes and glissandos.

The Granular-to-go and Fragulator plug-ins both utilize granular synthesis. The Fragulator plug-in has a much fuller sound than the Granular-to-go plug-in, which has a classic granular synthesis sound.

Lastly, the Wheat plug-in can slow down the pace of playing. This effect sounds like a random note generator, and the performer can simply let the theremin run on its own. They can also incorporate white noise using one of the expression pedals.

5. PERFORMANCE

The diverse collection of effects and hands-free design of the TTE create a simple, intuitive performance tool for thereminists seeking to extend the expressive range of their instrument. The interface can easily assist the performer in exploring the realm of free improvisation as well, a genre explored by too few thereminists. The performer can combine textures and fade them in and out smoothly and can ultimately create an unaccompanied solo performance just by playing the theremin alone. John Cage once described thereminists as "censors" because he believed they only gave the public sounds they knew would please them. Cage thought that audiences were "shielded from new sound experiences" [3]. The TTE helps to solve the problem Cage presented because it lets the theremin produce more sonic textures than ever before, affording new opportunities for use by composers and musicians alike.

6. FUTURE RESEARCH

Ultimately, this interface is the first iteration of a series of project exploring the sonic possibilities of the theremin. The MIDI pedalboard provided a convenient initial solution to my goal of increasing the theremin's expressive capabilities; I therefore designed the Max patch to fit its constraints. However, the interface presents some challenges. For instance, it is difficult for a thereminist to keep the upper body still for performance purposes while juggling five buttons with their feet. Future projects will therefore explore simpler interfaces such as the Myo gesture control armband in conjunction with the theremin to address some of the shortcomings of the current interface.

7. ACKNOWLEDGMENTS

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8. REFERENCES

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9. Appendix

Demo video: https://youtu.be/BKBMWvqRGpM
Full video: https://youtu.be/9ZszTyxZ6D0