The XT Synth: A New Controller for String Players

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ABSTRACT

This paper describes the concept, design, and realization of two iterations of a new controller called the XT Synth. The development of the instrument came from the desire to maintain the expressivity and familiarity of string instruments, while adding the flexibility and power usually found in keyboard controllers. There are different examples of instruments that bring the physicality and expressiveness of acoustic instruments into electronic music, from "Do it yourself" (DIY) products to commercially available ones. This paper discusses the process and the challenges faced when creating a DIY musical instrument and then subsequently transforming the instrument into a product suitable for commercialization.

Author Keywords

NIME, Human Computer Interaction, MIDI Controller

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**; Interaction devices;

1. INTRODUCTION

The XT Synth is a new controller with continuous polyphonic pitch control using soft potentiometers, augmented with force sensitive resistors, potentiometers and rotary encoders. It has a 3D printed body and LED lighting on a transparent top acrylic layer. It began as a synthesizer, but is now a MIDI controller. The instrument features familiar fingerboard techniques translatable from string instruments, specifically the guitar and violin family. Its visual component adds another level of expressivity, where light patterns are created in addition to the sonic elements. While some of its technique can be translated from string instruments like guitar and violin, it adds novel features with their own techniques for expressive control. The XT Synth is an ongoing project, currently in the design stage of its third iteration.
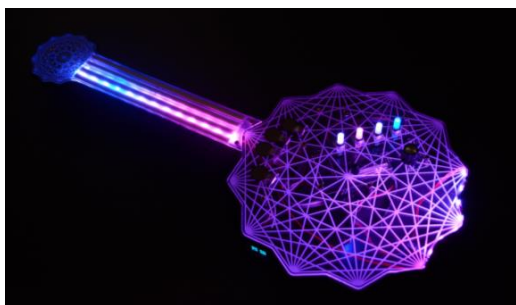

Figure 1. The XT Synth, the second prototype.

In recent years, novel instruments with continuous pitch control have been found great success, such as the Continuum [8] and the ROLI Seaboard [11] Additionally, augmented guitars like the Sensus [12], from Mind Music Labs, are in production. Such augmented guitars feature a variety of sensors to affect onboard audio processors, but don't attempt to provide MIDI control over synthesizers. The XT Synth seeks to fill the gap between these two ideas. That is, the XT Synth is a continuous pitch controller for string players, augmented with sensors. While most closely aligned with augmented guitars, the focus on continuous pitch control intends to make the XT Synth a familiar instrument to other fretless instruments as well.

2. BACKGROUND AND MOTIVATION

The main motivation in designing the XT Synth was to create an instrument that could feature a fingerboard performance technique that is easily translatable from string instruments, like guitar, mandolin and violin; that could have the expressiveness of non-fretted instruments, like a violin, or theremin; and that could be a synthesizer[1] and a MIDI controller.

The XT Synth was designed to be an instrument with MIDI Polyphonic Expression (MPE) [9] capabilities and with continuous control for pitch and other parameters. It uses hardware and software technologies to enable the translation of fingerboard performance techniques of string instruments into an electronic instrument, with all the possibilities it holds. There are several MIDI instruments on the commercial market that feature the continuous control of pitch. These include the Continuum and the ROLI Seaboard, in a form factor that is familiar to keyboard players. There are also instruments like the Linnstrument, which is played in a similar manner to a keyboard, but with the form factor of a guitar. These instruments allow full MIDI Polyphonic Expression for continuous control of pitch, pressure, etc., allowing great expressiveness over vibrato, glissandos, volume, and any other control that can be MIDI mapped. However, these instruments are designed with a keyboard technique in mind, making it hard for string players to adapt quickly to it. Closely related instruments to the XT Synth, employing violin techniques or violin-inspired techniques, include Dan Overholt's Overtone Violin [3], Suguru Goto's Super Pal [10], and Charles Nichols' vBow [2] and the Dan Trueman's BoSSA [4]. Those instruments have a known technique, like the violin's, but also have a variety of augmenting sensors. This allows for violinists to perform with electronic sounds, but still using a familiar performance technique.

There are also a variety of MIDI guitars, which feature performance techniques that are closely related to electric guitars. One of the first MIDI guitars to find great commercial success was the Bill Aitken's SynthAxe [7]. The SynthAxe could be played like guitar using fret and picking techniques, but also featured pressure sensors, adding another level of expressivity that guitars don't have. Starr Labs [7] has a variety of MIDI guitars models that are commercially available

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[1] After the first prototype, the synthesis engine was abandoned. While the name XT Synth is still temporarily in use, it is now solely a MIDI controller.

today. They feature models with strings, or buttons instead of strings, pressure sensors, whammy bars and other augmenting sensors.

Two of the closest examples to the XT Synth's implementation of continuous pitch control are David Vorhaus' Kaleidophone [6], invented in the 1970's, and the Artiphon's Instrument 1 [5], launched in 2015. The Kaleidophone has four ribbons, mounted on a drainpipe. These four ribbons are played using the left hand technique of a guitarist. This instrument controls an analog synthesizer by sending voltages associated with the position of the fingers upon the ribbons. The Kaleidophone never became a commercial product. The Artiphon's Instrument 1, however, became a successful example of a commercial MIDI controller that combines the playability of string instruments with continuous controllers and MIDI Polyphonic Expression. The Artiphon has sensors that act like strings, and actuators that can be used to "pluck" the strings, plus other features. It is an instrument that was made to be functional, with a simple design. While the Artiphon and the XT Synth share several characteristics, the Artiphon looks to be more of a music production tool, while the XT Synth is a performance tool, although both can do both.

Non-fretted instruments are known for being difficult to play and not providing instant gratification. This steep learning curve can cause a great deal of frustration for beginners. However, instruments that are hard to play can offer a high ceiling for virtuosity, given time. Instruments that are simple to play, on the other hand, often sacrifice flexibility for certainty. The XT Synth leans to the side of flexibility, giving room for expressivity and virtuosity [7].

3. THE INSTRUMENT

The XT Synth uses soft potentiometers to sense the left hand position on the neck. While has no frets, in its software it has a quantization method that allows the performer to hit the right notes the first time the finger touches the neck, while still allowing vibratos and slides. This way, playing in tune is easier than with fretless instruments, easing the learning curve. The quantization can be switched on and off, leaving to the player to decide.

With the adjustments mentioned above, the instrument proved to be harder to be played in tune than a fretted instrument, but easier than a fretless one. The physicality of performing vibratos, glissandos, and playing the strings in general, felt surprisingly similar to an acoustic instrument. While sharing similarities with acoustic instruments, the XT Synth presented some different possibilities, which could be only possible with an electronic instrument. Each string can control a different instrument, and, thus, be played with different expressions at the same time. This allowed some interesting experimentations with two hands techniques.

The XT Synth has four RGB rotary encoders, which can send MIDI CC. The values of these encoders can be stored in different banks. It also features four Force Sensitive Resistors (FSRs), which can be used to send MIDI CC, aftertouch, or to trigger the strings, like one plucks a string, with velocity sensitivity. Additionally, there is one slide and one rotary potentiometer. These controllers enabled different possibilities with the right hand technique. One can use the slide potentiometer similar to a guitar pick and control a filter cutoff, and use the FSRs for continuous multidimensional control, for example.

The XT Synth was designed to not only be functional tool, but also a visually interesting instrument. An interest in the visual aspect of the instrument is not uncommon. Electric guitars, for example, come in a wide variety of shapes and have their own "personality". While MIDI controllers tend to be neutral, being visually similar to each other. It was decided that the XT Synth should have its own visual "personality". It should have its own unique form factor. The visual design of the instrument is created with stage performance in mind [1].

The first prototype of the XT Synth was built rapidly. The prototype featured the typical weaknesses of prototypes, such as: components soldered with wires on solderable breadboards; a fragile enclosure; various elements were not structurally secure. The second prototype featured a 3D printed model for the enclosure; custom Printed Circuit Boards (PCBs), and a reimagining of its sensors and features.

At the time of writing this paper, the XT Synth had three public performances. The first performance was made at the Root Signals Festival, at Georgia Southern University, on February 22nd of 2018, with its first prototype. The second prototype had its first performance at the finals of the Guthman New Musical Instrument Competition, at Georgia Tech, on March 8th of 2018.

The XT Synth has not yet been fully tested by any other musician besides its creator; however, some considerations regarding its playability can be made. Taking into account that the performer has played the electric guitar professionally, and the violin as a hobby, it took no more than a couple weeks so the XT Synth could be performed comfortably in a concert situation.

However, some issues are present. The main issues were due to the physical aspects of the soft potentiometers, used for the continuous control of pitch. The soft potentiometers don't have a linear response; the performer can't touch two places at the same time on the same sensor soft pot; there's a lack of tactile feel between the strings [11], etc. Some of these issues were already solved and some are to be solved in the next prototype.

A much more in depth analysis of the XT Synth will soon be available as a Master's thesis. Videos and more information about the XT Synth can be found at the following webpage: www.musiconerd.com/xtsynth

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