Kinesynth: Patching, Modulating, and Mixing a Hybrid Kinesthetic Synthesizer

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ABSTRACT

This paper introduces the *Kinesynth*, a hybrid kinesthetic synthesizer that uses the human body as both an analog mixer and as a modulator using a combination of capacitive sensing in "transmit" mode and skin conductance. This is achieved when the body, through the skin, relays signals from control & audio sources to the inputs of the instrument. These signals can be harnessed from the environment, from within the *Kinesynth*'s internal synthesizer, or from external instrument, making the *Kinesynth* a mediator between the body and the environment.

Author Keywords

Synthesizer, Kinesthetic, Electrical Properties of the Body

CCS Concepts

•**Hardware** → *Electromagnetic interference and compatibility; Analog and mixed-signal circuits;* Digital signal processing; •**General and reference** → Design;

1. INTRODUCTION

The pool of signals that can be generated from the electrical properties of the human body is endless. In music, it started with the Theremin, an electronic music instrument invented by Léon Theremin in 1920, the predecessor of all capacitive instruments[10]. It works through the capacitive technique known as "Loading Mode" by measuring the load formed between an electrode and a capacitively-coupled body. Another mode of capacitive sensing relies on putting the body in very close contact with an electrode, and is known as "Transmit Mode", where electrical signals can flow into the circuit passing through the body connected to a receiving electrode. For instance, touching conductive objects with 110/220 VAC line power nearby can channel a 50/60Hz sine-wave 'hum' through the receiving electrode. The *Kinesynth* relies on that same idea, but instead of just using the 50/60Hz line tone, it also includes a miniature-environment with an array of oscillators each tuned to different frequencies, various control voltages, and a "patchbay" allowing external analog synthesizers to be mixed through the human skin.

The renaissance of the modular synthesizer in today's age of embedded digital hardware raises even deeper questions about the connection between humans and sound. Digital synthesis enables far more sonic possibilities than analog synthesis, yet modulars are more popular than ever[9]. The *Kinesynth* in its turn is a controller as well as a synthesizer, but fits well with modular systems, given their open array of control and audio sources. Although there are too many to enumerate here, the next section describes a few related instruments or controllers that emphasize through-body and related dynamic mixing & control.

Figure 1: Crowd holding hands and connected across patch cords by Paolo Tofani, Area's guitar player and synth wizard who worked at EMS[1].

2. RELATED WORK

Electronic instrument inventor Ivan Eremeeff developed a device called the Gnome circa 1932, that coupled audio from keys touched by a performer through their body and into a receive electrode mounted atop their chair[11]. The left-hand controller of Hugh LeCaine's mid-1940's Electronic Sackbut[12] included a capacitive mixer, where the user's finger rested atop a capacitive input pad that itself rests atop an insulated conductive disk that contains separate sectors with electrodes transmiting different timbres. By moving the disk around, you effectively mix the timbres in real time, each one weighted by the corresponding surface area overlapped by the pickup pad. In the late 1960s, Michel Waisvisz, Dutch inventor of experimental electronic musical instruments, designed and built the very first Cracklebox, also known as kraakdoos, together with Geert Hamelberg, and later in the 1970s the Crackle synthesizer. These circuits do not rely on capacitive coupling, but rather use the body's resistance to control a single oscillator based of the LM709 op-amp[6]. Sal Martirano's early-70s SalMar Construction was a hybrid digital synthesizer controlled by a large matrix of touch buttons[7]. In the modern era of modular synthesizers, many Eurorack[2] manufacturers adopt touch plates in their modules for control (a technique dating at least to Buchla[5]), like the make noise René, Pressure Points, and Teleplexer Modules, shown in figure 2 to name a few[3]. Closer to our approach, the Hyve-synth is a 60-voice polyphonic analog synthesizer that presents cir-

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cuit points from each oscillator at touch pads to enable pitch bend and mixing based on the resistance of the skin[4]. HCI researchers have also made interactive surfaces that work through skin resistance[8].

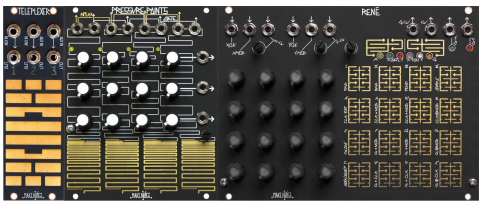

Figure 2: Make Noise's touch modules, from left to right, the Teleplexer, Pressure Points and René.

3. DESIGN AND IMPLEMENTATION

The current version of the *Kinesynth* includes some inputs and several outputs. The instrument is played through bridging the inputs to the various outputs through the fingers. The body is coupled to the circuit through an electrode that connects to the inverting pin of an op-amp configured as a relaxation oscillator, shown in figure 3. The

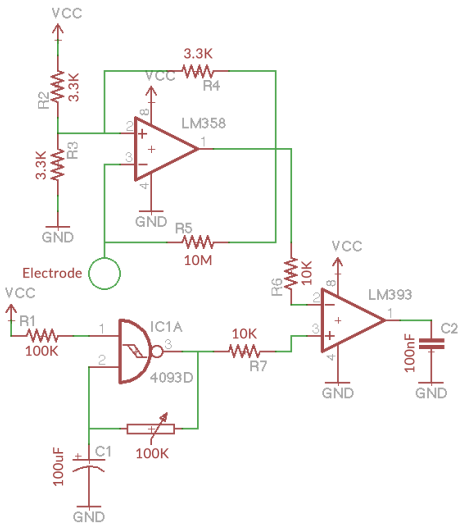

Figure 3: Schematic of the *Kinesynth*'s input, showing a relaxation oscillator compared against an LFO.

simplest way to generate a sound is by making contact with conductive appliances sitting near 110/220 VAC power lines that will modulate the oscillator at a rate of 50/60Hz. Increasing the amount of skin in contact with the modulating surface can lead to an increase on the op-amp's input impedance, resulting in a faster drop of the oscillator's frequency. At the second stage, both the relaxation oscillator and another low frequency oscillator, generating a square-wave at the rate of 1Hz-1kHz, connect to the input pins of a comparator, adding a tremolo effect to the final output. In addition, the instrument provides touch pads connected to four oscillators, two low frequency oscillators (LFO), three cascading oscillators (FM), two 8-step sequencers, and a patchbay with 18 outlets that can be used as either inputs or outputs to be wired to external sources like function generators, and/or other synthesizers. These oscillators are made from a 74HC14 Hex inverting Schmitt trigger, and each generate a pulse wave. The 3-stage FM synthesizer is designed through three cascading oscillators, built using the CD4093, a quad dual-input NAND Schmitt Trigger chip. The 8 step sequencers are implemented via two dividers using the CD4022 chip. The patchbay connects electrodes in our matrix to both inputs and outputs of external synthesizers via 3.5mm mono jacks. The output impedance across these circuits is matched with 10K resistors.

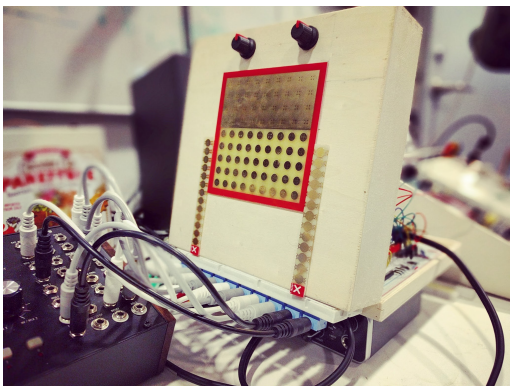

Figure 4: The *Kinesynth* wired to a Moog Mother-32 semi-modular synthesier via patchbays connections and patch cables.

4. CONCLUSION

In this paper, we presented the *Kinesynth* instrument, a kinesthetic synthesizer, that uses the capacitive and resistive properties of the human body to mix and modulate analog signals coming from the environment, from on-board audio sources, or from external eurorack synthesizers.

5. REFERENCES

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