Neon Drums: An Audiovisual Musical Instrument

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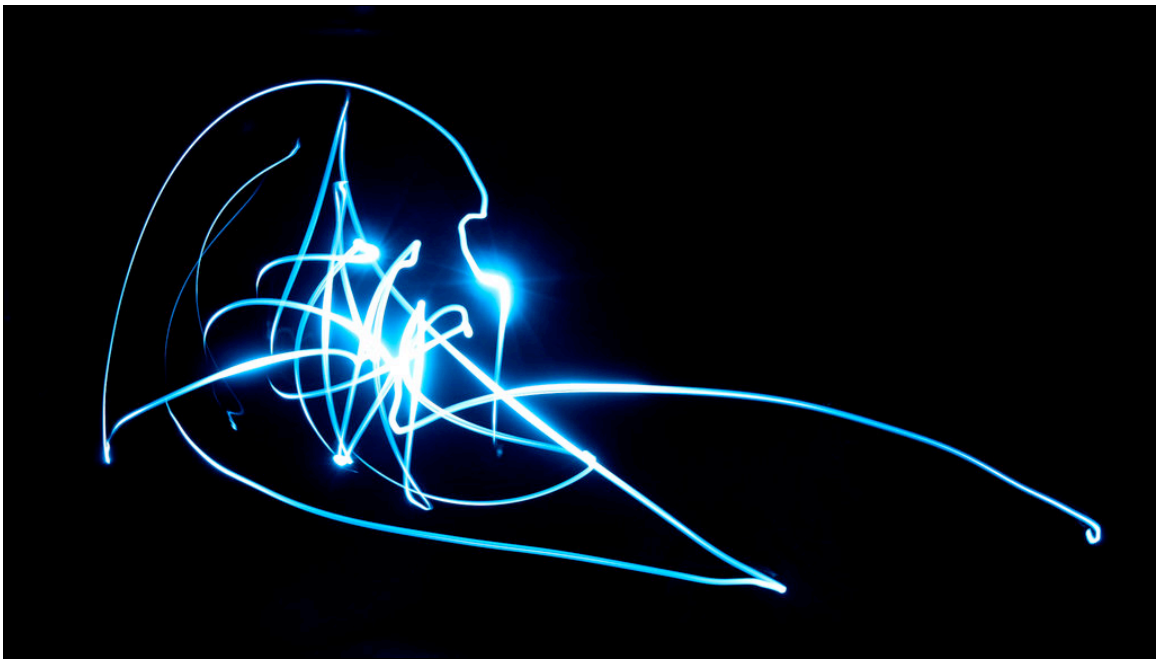
Purpose

The purpose of this project is to design and implement an audiovisual musical instrument that translates the hand motions of a musical performer into sound and graphics. The translation will make the motion appear like the real time drawing of a light trail in midair (see figure below). The direction of the motion will simultaneously control and define the timbral characteristics of the generated sound (i.e. frequency, amplitude) and the geometry and various attributes (i.e. color, brightness, rotation) of the generated graphics. This project builds upon state-of-the-art computational media research and introduces a novel approach for the creation of multimedia forms.



Background

Examples of audiovisual musical instruments date back as early as the first color-organs, the first of which was Castel's Ocular Harpsichord in 1734. This audiovisual harpsichord had each of its keys connected to a shutter that let candlelight go through colored lenses when a key was pressed. During the eighteenth and early nineteenth centuries, color-organs predominated the realm of audiovisual musical instruments. Advances in optics and film in the early twentieth century introduced new opportunities for the audiovisual realm including several audiovisual instruments used in experimental art and film. Some examples include: The Clavilux by Thomas Wildfred, The Lumigraph by Oskar Fischinger and Charles Dockum's MobilColor Projector.

With the advent of digital technologies and computing, the possibilities for audiovisual musical instruments rapidly expanded. Modern computing provides the opportunity for generating sophisticated sound and graphics in real time. This opportunity gave rise to many audiovisual systems in recent years, among which three systems in particular inform the conceptual framework of this project.

The first is AVSynthesis[1], a system that combines techniques of sound synthesis and image texturing to produce abstract cinematic images. The user interacts with the system through a graphical user interface. The second is The Shape Synthesizer[2]: a medium for 3D modeling based on principles of sound synthesis. The third is The Audiovisual Environment Suite (AVES)[3] that consists of a set of five interactive systems allowing people to create and perform abstract animation and synthetic sound in real time.

While these three systems translate elements of sound synthesis and human motion into graphics, they do not fully integrate 3D gestural input, 3D graphics and sound synthesis. Glassner's Shape Synthesizer fully uses techniques of sound synthesis to model 3D shapes, but this is not done in real-time and gestural input is not involved. AVSynthesis fully incorporates sound synthesis with the generation of graphics, but the graphics are not 3D and no form of real-time gestural input is involved. Finally, AVES combines sound synthesis with graphics and the processing of gestural input, however both the graphics and the gestural input consist of a 2D device. None of these systems fully integrate 3D graphics, 3D gestural input and sound synthesis in real-time. The current project addresses this gap. Drawing upon these existing systems, the current project seeks to formulate a novel approach to the design of an audiovisual musical instrument that integrates 3D graphics with 3D gestural input and sound-synthesis.

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[1] AVSynthesis: blending light and sound with OpenGL and Csound5, Dave Philips, Linux Journal archive, Volume 2008 Issue 169, May 2008

[2] Glassner, Andrew S., "A Shape Synthesizer", IEEE Computer Graphics & Applications, May 1977, volume 17, number 3, pp. 40-51.

[3] Golan Levin, Painterly Interfaces for Audiovisual Performance, unpublished master's thesis, Massachusetts Institute of Technology

Present Project

Expanding state-of-the-art research on the topic, the present project aims to generate a dynamic and mutually constitutive relationship between visual and sonic forms as a novel means of artistic expression. To achieve this goal the project will develop new software: Neon Drums. Neon Drums will consist of three different but intricately interwoven modules: an audio synthesizer, a graphics synthesizer and a gestural input processing system. The interaction of the three modules will allow the system to draw the path of the performer's hands moving through space in time and generate sounds that are descriptive of the motion.

Gestural Input Processing System

This module captures the movement of a performer's hands in midair. It uses the dynamics of the gestures (i.e. displacement, velocity, rotation) to control the generation of sounds produced by the sound synthesizer and the graphical output produced by the graphics synthesizer.

Sound Synthesizer

The sound synthesizer generates an array of continuously modifiable percussive sounds. The percussive sounds will imitate acoustic percussive instruments (e.g. bass drum, snare drum, cymbals). The gestural input will continuously modulate the sonic characteristics of the sound output. The design of the sound synthesizer is based on a set of software musical instruments designed by Hans Mikelson.

Graphics Synthesizer

The graphics synthesizer generates curves that take the form of light trails. A light trail is the effect generated when the lenses of a camera are left open while a bright object is moving. The movement of the light trail will depend on the movement of the performer's hands and different characteristics of the light trails will be modeled by elements of the sound synthesizer. For example, the frequency of the sound can manipulate the brightness of the instrument or the amplitude of the instrument can manipulate the cross-sections width of the light trail.

Through the integration of these modules, the present project addresses various shortcomings of existing approaches in the field. The first shortcoming deals with the use of a performance friendly gestural input device. The current project addresses this issue through the implementation of the Gestural Input Processing System which uses a video game motion controller to capture the movement of the performer's hands in midair (3D) as opposed to many other systems that uses the mouse or graphic tablet with a pen (2D). The second shortcoming deals with the integration of 3D graphics, 3D gestural input and sound synthesis in real-time. The current project achieves this through the development of these three interwoven modules, such that, the gestural input generates graphics and sound while the timbral characteristics of the sound manipulate generated graphics.

As such, the current project not only expands existing approaches in computer graphics by providing a new method for 3D modeling in real-time through the use of sound synthesis and 3D gestural input, but further contributes to music and the visual arts by providing a new form of creation and performance. The project also contributes to the field of human computer interaction since it presents a rich set of techniques to interact with the computer through 3D graphics and sound.

Project's Methods and Timeline

I have been working on the project since the beginning of the semester under the advisement of Dr. James Miller in the Department of Electrical Engineering and Computer Science and Dr. Kip Haaheim in the department of Electronic Music and Composition. So far, I have completed the implementation of the sound synthesizer and the graphics synthesizer. During the rest of this semester I plan to finish and test the integration of these two modules. Next semester I will work on the development of the gestural input processing system and the integration of the whole system. To fully test the project, I plan to write a musical composition that will be performed by music students at the KU School of Music.

I will finalize the project by the end of Spring 2012. I intend to present the preliminary findings of the project at the KU Undergraduate Research Symposium in Spring 2012. Moreover, I hope to present the project at various professional conferences and prepare a manuscript for submission to academic journals.

Personal Significance of the Project

The interdisciplinary nature of this project reflects my joint interests and studies in music and computer science for the past 10 years both within the United States and Paraguay. After completing a degree in Music Composition at the University of Kansas, I began my second degree in Computer Science, which I plan to complete in Spring 2012. My training in and passion for these two fields provide the inspiration and background for the present project. I believe this project promises to be the most comprehensive and novel work I have yet to create. I look forward to building on this work in the years to come, both within the context of graduate studies and multimedia performance and design.