16-CdS: A Surface Controller For the Simultaneous Manipulation Of Multiple Analogue Components

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ABSTRACT

This project presents a control surface that combines a grid of photoresistors with a microcontroller to allow a musician to simultaneously manipulate multiple analog components. A brief background on past uses of photosensitive components for music and film composition and instrument-building introduces a few contexts for the controller. Topics such as implementation, construction, performance scenarios of the controller are also discussed.

Keywords

Photoresistor, light-dependent, Max/MSP/Jitter, electroacoustic, audio-visual, performance, Arduino

1. INTRODUCTION

The use of photoresistors for the purpose of sound-production has been fruitful throughout the 1900s. In the work of sound-film pioneers like Oskar Fischinger and Norman McLaren, and optical sound-synthesis innovators like Daphne Oram (Oramics) and Eugene Murzin (ANS Synthesizer) from the 1930s through the 60s, photosensitivity has been an important subject within the music-making world.

This paper starts off with a brief history of precedents to a light-sensitive controller – the 16-CdS. The 16-CdS's design and building specifications are presented along with a few performance possibilities. These include ideas that combine software with techniques for obstructing light on the controller as well as potential adaptations for future projects.

2. BACKGROUND AND INFLUENCES

During the early years of experimentation with sound-film technologies, a few concepts were explored concerning audio-visual relationships and the components that produce them.

Oskar Fischinger experimented with sound-on-film techniques throughout the 1930s, discovering various associations between sound and image that led to a deeper exploration of the light-sensitive components that produce audio signals in film projectors. On the early pioneers of abstract sound-on-film work, Richard Brown mentions that they had "the sudden realization of an entirely synthetic, virtual environment of musical space. Much like the grooves of a phonographic record, the images on the soundtrack were directly linked to the original sound, and this indexical relationship was clearly demonstrated and easily understood." [1] The light-sensitive properties of the optical-sound components of projectors led to the discovery of new vocabularies for different sound-worlds and new ways to create direct interactions between aural and visual elements.

Norman McLaren was another artist who explored the potential of this optical sound interface. His films concerned audio-visual relationships and further experiments with hand-drawn optical soundtracks. On McLaren's first of these films, *Dots* from 1940, Brian Wilson states that McLaren "achieved a level of sophistication using this technique. The musical range is over several octaves and integrates perfectly with the moving blue and white dots that bounce across the bright red background." [2] These synchronized motions and explorations of sonic material further exposed the potential of these components and yielded many hand-drawn films from McLaren and his contemporaries.

Two other innovators that explored the potential for light-sensitive components as music-making devices are Evgeny Murzin with the ANS Synthesizer, and Daphne Oram with the "Oramics" machine. Completed in 1958, the ANS Synthesizer is based on the idea of "synthesizing a sound from an artificially drawn sound wave." In an article on the ANS, Stanislav Kreichi, an engineer and composer who worked on the ANS describes one of the main parts of the instrument consisting of a "photo-optic generator…designed in the form of a rotating glass disk…with 144 optic phonograms of pure tones, or sound tracks. A unit of five similar disks with different rotating speeds produces 720 pure tones." The interactions between visual and sonic materials that the composers for this instrument experienced were meant for musical composition. Kreichi continues his description by describing the process of composition for the ANS. "To select the needed tones, a coding field (the 'score') was designed in the form of a glass plate covered with an opaque, nondrying black mastic. The score moves past a reading device made up of a narrow aperture with a number of photoelectric cells and amplifiers. Scraping off a part of the mastic at a specific point on the plate makes it possible for the light from the corresponding optic phonogram to penetrate into the reading device and be transformed into a sound." [3]

At around the same time in the late 50s, Daphne Oram was working on prototypical schematics for another light-sensitive instrument named 'Oramics.' This project took a number of years to come into fruition and was finished in 1970. The Oramics machine uses a multi-track system that accepts hand-drawn waveforms that are used to determine different qualities of sounds. The waveforms are drawn onto strips of film that are read across light-sensitive scanners devised by Graham Wrench – one of the main engineers in Oram's group. The signals from these scanners are sent to different equipment modules that determine the variables associated with the qualities of the produced sounds. [4]

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3. THE 16-CdS INTERFACE

The device that was built for this project combines some simple woodwork and design with a few photoelectric components, specifically photoresistors, and an Arduino Mega 2560.

3.1 Design and Layout

The framework for this device is made up of two different materials: A 9¾" x 11¾" x ⅛" sheet of clear acrylic and a 9¾" x 11¾" x ½" slab of birch plywood.

The acrylic is screwed onto the wooden slab, creating a slim solid frame for the circuit and the Arduino. There is a grid of sixteen holes in the main part the structure. A slot on the upper-left corner of the wood allows the microcontroller to sit within the frame of the device.

The photoresistors are laid out in a 4"x4" grid near the lower-right portion of the surface of the device. The grid is small enough so that a performer can manipulate a large portion of the photoresistors with one hand. Its size also accommodates simple implementations of objects that obstruct light and add another layer of interaction with the interface – a subject discussed later in this document.

3.2 The Circuit

The components used for this project consist of sixteen photoresistors of varying resistance ranges, sixteen 10k Ohm resistors, and an Arduino Mega 2560. The photoresistors communicate with the microcontroller via the analog pins of the Arduino. Each photoresistor has one pin connected to the 5-volt pin of the Arduino and the other pin going to its corresponding analog pin as well as to the ground with a 10k resistor in series.

The choice to exclude other variable components in the circuit was made to keep the controller as simple as possible. The point is to have all of the interaction on the photosensitive level, allowing the performer and/or programmer to find a new ways to interact with light and the controller. Any data scaling or shaping is done on the software end in the Max/MSP programming environment.

4. IMPLEMENTATION

4.1 Scaling and Calibration in Max/MSP

Once the connection between Max and the Arduino was established, we scaled and interpreted the data. It was important to keep in mind that the controller would be used in different performance spaces. Therefore, a method for calibrating, or tuning, the instrument to different lighting conditions was implemented. To allow the user to quickly calibrate the controller, two visual elements were put into the patch. A series of number boxes display the scaled values and the object, "nodes", was used to visualize a grid of sixteen circles that expand and contract depending on the values that they are receiving.

4.2 A Visual-Performance Implementation

Apart from the audio patch that was created to test the controller, a quick, generative visual system was developed to see what the possibilities were of using this controller for audio-visual performances. The system divides the projection screen and photoresistor grid into four quadrants, assigning a relative position on the screen to each group of photoresistors. The program runs analyses to determine mean intensity values for each quadrant. These values then determine the rate of generation of pixels within each quadrant's corresponding space on the final screen. A running transformation and feedback loop of these pixels displace them. The rate of displacement is another variable tied to the mean intensity values for each quadrant, creating different patterns of moving pixels depending on the amount of light shining onto the controller.

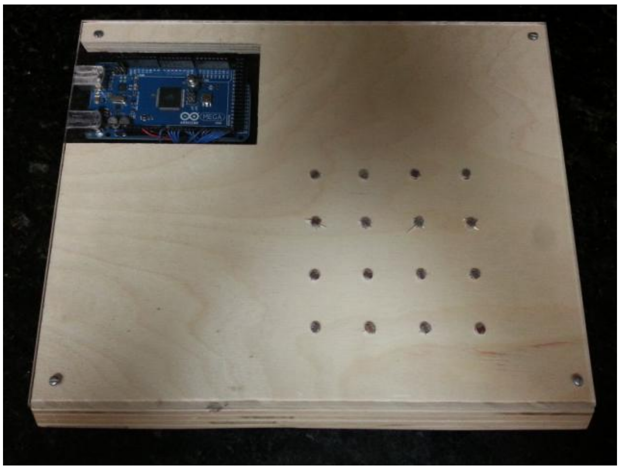

Figure 1: The first version of the controller

For the Max Patches described in the above sections, audio examples, and further documentation regarding the controller, visit http://charlossound.wordpress.com/16-CdS.

5. FUTURE POSSIBILITIES

One important thing to remember about the 16-CdS is that there are many different ways of obstructing or shining light onto it. Ideas that have been discussed and partially implemented include the following:

- Using small squares of materials that can cover photoresistors independently. The material can be slightly translucent, allowing for the possibility of stacking squares to create different amounts of opacity.
- Creating a small, three-dimensional, rectangular structure that sits on top of the photoresistor-grid. The structure would have slits on its sides, allowing for the placement of other objects through the structure that will obstruct light in different ways.
- Using the digital pins on the Arduino, one idea is to create a grid of LEDs that are in communication with the software and shine light on the controller, allowing for a higher level of interaction between the performer and the controller.

6. ACKNOWLEDGMENTS

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