Digital Signal Preservation using a Logic Analyzer

A case study utilizing an Arduino Due microcontroller documenting the signal output of the sound sculpture "What's wrong with Art?" (1997) by Stephan von Huene

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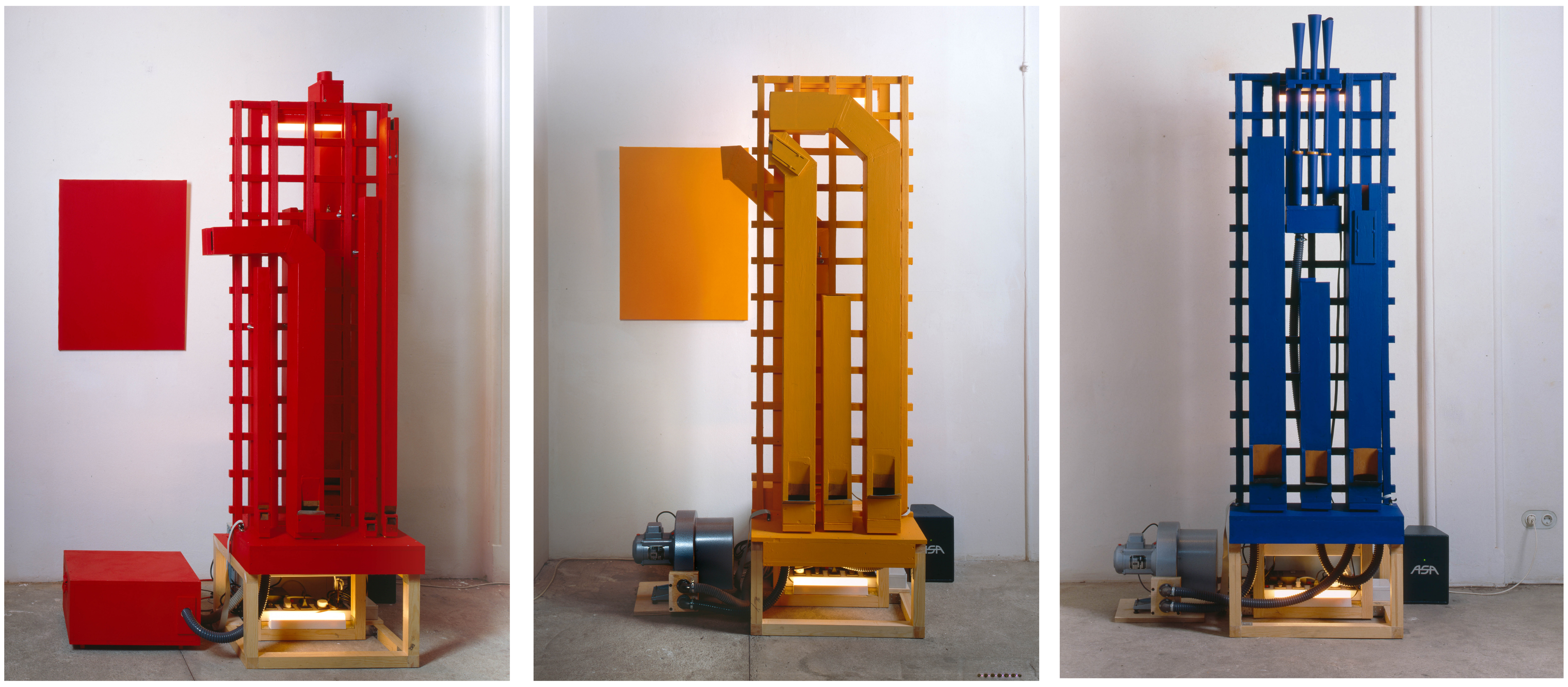
Abstract

"What's wrong with Art?" (1997) by the German-Californian artist Stephan von Huene was subjected a comprehensive acquisition documentation. To counter the risk of loss of the computers specific hardware a low budget logic analyzer was used to record and document the sound sculptures digital signal output. This collaborative project has been conducted by the author during a fellowship at the ZKM | Center for Art and Media Karlsruhe in collaboration with Daniel Heiss, computer scientist and the museums team of electronic technicians.



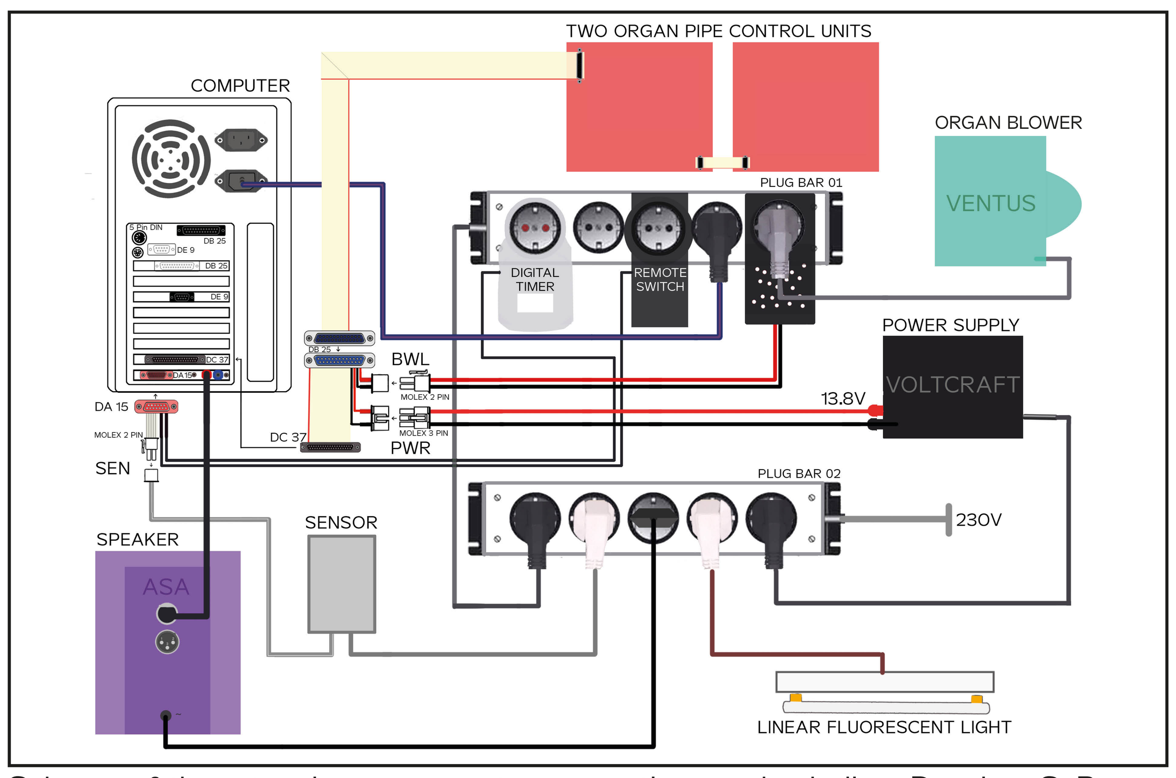
The three sound sculptures of "What's wrong with Art?" (1997) by Stephan von Huene, first Iteration at Galerie Renate Kammer in Hamburg, 1997. Photo ©: Estate of Stephan von Huene ↔

Introduction

Collecting institutions are faced with several obstacles when aiming to preserve either functionality or future access to time-based media art. Particularly when dealing with compiled code and obsolete hardware. The aspect of time – is especially relevant for computer and software-based art, where hardware and software define the timing score. The computer-controlled sound sculpture "What's wrong with Art?" by Stephan von Huene (1932–2000) is a particular example where compiled code and custom-built, dedicated hardware counteract preservation or complicate emulation attempts. Additional documentation methods need to be performed to preserve the core of its inner logic.

What's wrong with Art? – A case study

The installation consists of three wooden sculptures with organ pipes in the colors red, yellow and blue. Stephan von Huene realized the technical set up by self-assembling a computer equipped with specific plug-in cards (e.g. SMARTLAB, 8 Channel Relay Output Adapter) and MS-DOS 6 operating environment. Batched scripts and compiled code are operating an organ blower and the electric tone valves of each organ pipe inside the sculptural tower. Moreover voice recordings (WAV audio files) are played out to prelude the organs tones. Each score, with a playtime of about four and a half minutes, is triggered by the viewer through a radar sensor.



Scheme of the artworks components, connections and cabeling. Drawing: S. Bunz

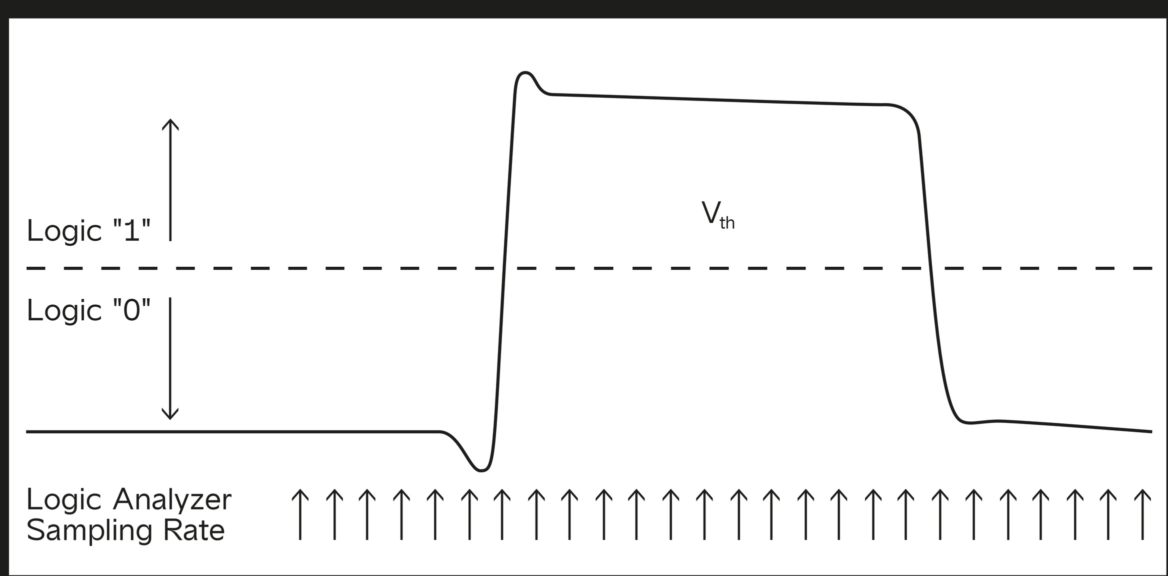
Assessing the risks of loss, future access and preservation options it became apparent, that the computer, with its individual plug-in cards and compiled code, once failing could not be reactivated, reproduced or emulated. For this reason a documentation of the full score of the 8 controlling signal computer output was carried out with the aid of a logic analyzer.

Logic Analyzers

Logic analyzers can sample multiple digital signals, or channels at the same time, recording every channels state (low or high) respectively bit (0 or 1). Logic analyzers are used in software engineering to test complex circuits, to detect glitches and to de-bug digital systems.

Logic analyzers bring along a number of key specifications including: channel count, sample rate, trigger modes and memory depth. In general two clocking and sampling modes are used in practice: asynchronous (timing) and synchronous (state) acquisition. Asynchronous clocking uses the internal clock of the logic analyzer while the state mode may be synced with another timing source.

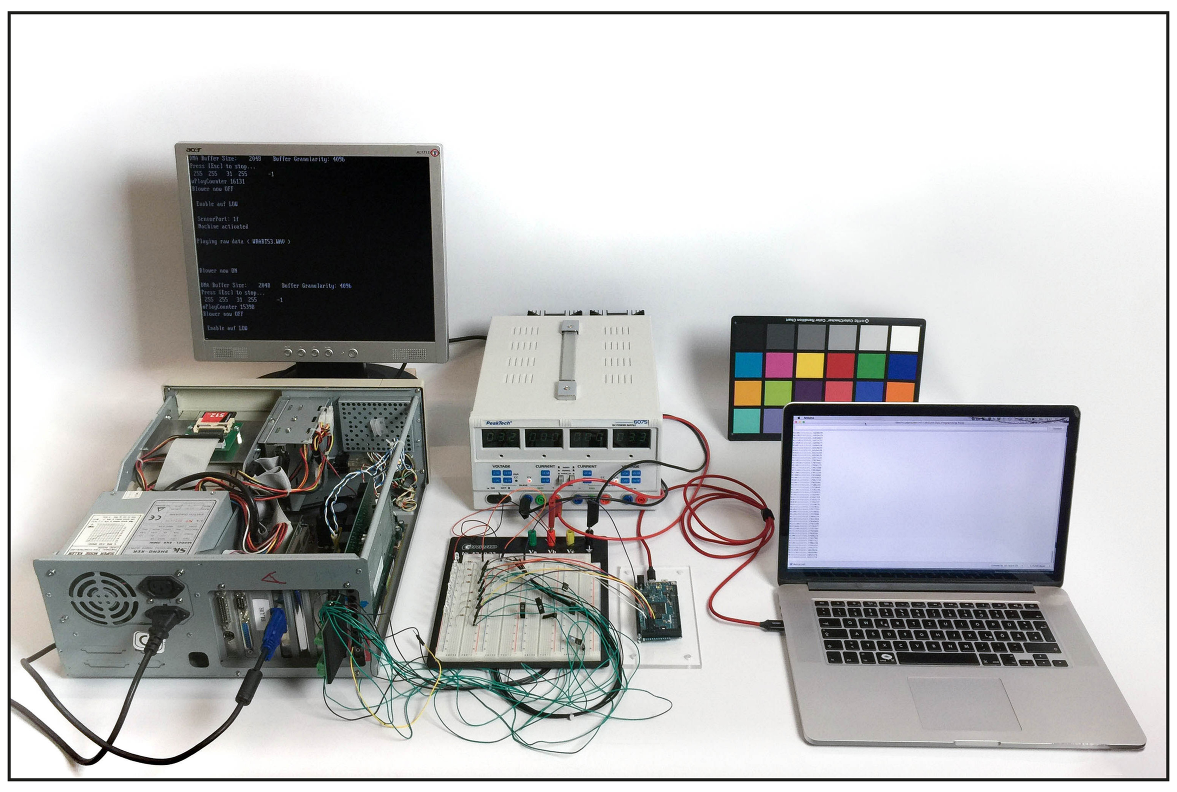
The gathered data can be visualized and assessed as a waveform respectively time / voltage level graph (e. g. utilizing an open source processing script). The obtained data can be used for hardware emulation as well. For instance to replace a systems functionality/signal by a printed circuit board and a microcontroller.



A logic analyzer determines logic values relative to a threshold voltage level. The accuracy of the data sample depends on the logic analyzers sampling rate.

Method

The 8 digital signals were captured with an Arduino Due microcontroller using 8 of 54 digital input channels and a sampling rate of 1 MHz.



Capture process of the 8 signals of the computers 37 pin bus out with an Arduino Due. Technical realization by Daniel Heiss and Christian Nainggolan. Photo: S. Bunz

For the Arduino set up the artworks voltage level of 13.8 Volts had to be replaced by 3.3 applied voltage. The 8 signal streams (all events from high to low, from low to high) were captured through event based interrupt triggering, and were logged in parallel with Δ time stamps in microseconds resolution.

Discussion

For any signal sampling the sample rate plays a key role for timing accuracy. A fundamental rule for analog signal sampling is defined by the Nyquist-Shannon sampling theorem, which says that a signal can only be reconstructed lossless if the sampling took place at least twice as fast as the highest-frequency of the signal:

$$f_{(sample)} > 2 \cdot f_{(max)}$$

Nevertheless much higher sampling rates are recommended in practice also for digital signals. Therefore it is important to determine the specific characteristics of the signal. Because its frequency influences the required sample rate of the analyzer.

In the present case the captured signals of the 8 channel relay plugin-card are based on milliseconds (ms). Due to the shutter speed of the magnetic relays on the plug-in card.

However the signal is sampled with a sample rate of 1 MHz. Which leads to the conclusion that the sampling rate is thousand times higher than the signal under test. Therefore the logic analyzer Arduino Due solution with its specific sample rate was sufficiently suitable for the present case.

Conclusion

Logic analyzers are useful tools for documenting digital signals in the field of electronic media art preservation.

Recording the digital signal output can be a complementary documentation method, both as a supplementary visualization and a record of the logical signal stream. Furthermore the sampled data can be used for active preservation measurements e.g. hardware emulation.

Nevertheless it is essential to consider the appropriateness of a logic analyzer for a specific application. In the present case a low budget open source logic analyzer was a suiting solution. However a more advanced logic analyzer might be necessary when dealing with contemporary systems, which reach higher signal speeds.

Acknowledgment

Special thanks to Daniel Heiss → (heiss@zkm.de)

ZKM | Center for Art and Media Karlsruhe:
Christian Nainggolan, Dirk Heesakker, Marc Schütze, Mirco Frass, Nahid Matin Pour, Katrin Abromeit, Morgane Stricot, Rainer Gabler, Benjamin Miller, Simone Logos.
Petra Kipphoff von Huene, Jesús Muñoz Morcillo, Martin Obrist, Christoph Noetzli, Nicholas Popovic.

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Sophie Bunz completed her studies of Conservation-Restoration of Modern Materials and Media at the University of the Arts Bern, Switzerland in 2016. Her MA thesis was dealing with the preservation of the computer- and software-based installation "Green Plant Entertainment" (1994-95) by Swiss artist Hervé Graumann. After her graduation she held an fellowship at the ZKM | Center for Art and Media Karlsruhe. Subsequently working as an assistant for her home university's media conservation-restoration program.