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The Lungta Projet: Physical Visual Music

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Abstract

Following the democratization of technology that we have seen since the mid-1990s, a new phase of democratization is currently underway with open hardware. After decades of advances within the software paradigm, interfacing with the physical world is currently one of the most prominent trends in creative computing.

Computer music is at the heart of these new developments and many sound artists are part of this movement. In parallel to the development of musical input devices and the use of sensors for artistic purposes, many are working to interface with the physical world through actuators.

The *Lungta* project, an audio-robotic performance, continues this idea of linking computing to the physical world hence propagating musical gestures to actual physical movement.

Keywords

Physical Computing, Computer Music, Visual Music, Physical Pixels, Arduino, Kinect, SuperCollider

Introduction

This article discusses the *Lungta* project, an audio-robotic performance and interactive installation featuring an electromechanical device. The device corresponds to a physical matrix of 192 motor-driven fans activating sheets of common stationary paper along a two-dimensional grid. Acting as a sort of pixel-based video image synthesizer or display, the matrix permits the specification of a rich and complex interaction between sound, video capture and performative gestures.

The project follows a visual music research initiated several years ago. After various works focused on audio-reactive live computer graphics, the *Lungta* project seeks to transpose into physical space the emphasis on form, color and movement traditionally encountered in visual music.

The article discusses the work from different angles, beginning with an historical context. Next is a description of the technological aspects of the project, i.e. the electromechanical device and its software components and the Kinki software, developed for this project. Following a brief descriptive analysis of a section of the work, the article concludes by addressing some issues about the sustainability of works based on digital technologies.

Physical visual music: sounds, images and objects as movement formats

In parallel to visual music, kinetic art, whose roots go back more or less to the early 1910s, is the cornerstone on which another expression of movement has set itself up. Works by Italian futurits or Marcel Duchamp (1887-1968), or works like mobile structures of Alexander Calder (1889-1976) will lay the foundation for an artistic practice whose ramifications are still active.

The kinetic works of 1950s Op Art like those of Victor Vasarely (1906-1997) or Bridget Riley (1931) make use of movement from the perspective of vision related phenomena such as persistence of vision or optical illusion. It is rather to Len Lye (1901-1980) that we owe the first explicit references to movement as a medium. Some of Lye's texts, dating as far back as 1935, clearly express that desire for a Movement Art that began mainly in abstract cinema but whose full expression came later in the 1960s with his sculptural work. "Movement is strictly the language of life. Movement is the unpremeditated being; it is the uncritical expression of life." [2] Like the English painter Alexandre Rimington (Color-Art)[1] and later Lumia artist and lute player Thomas Wilfred[2], the art of movement desired by Lye has many similarities and references to music. Lye talks about composition when it comes to dealing with the organization of movement. For *Harmonic* (1960), he composed the movement by changing the strength and radius of a polished metal rod in rotation. For Lye, all animated materials are one and the same, i.e. movement for-

[1] English painter Alexander Rimington (1854-1918) is the inventor of the Color-Organ, an imposing light instrument standing more than three meters high equipped with colored lights above a keyboard comprising five octaves. The colors are associated with the keys based on a subdivision of the light spectrum for different intervals of the chromatic scale. An interesting fact to note is that Rimington's instrument emits no sound and its author recommends not to add music to its use in order to better appreciate the color and movement.[4]

[2] Thomas Wilfred (1889-1968) is the inventor of the Clavilux, a device that looks surprisingly like modern lighting consoles, where a performer manipulates a series of potentiometers. Like Rimington, Wilfred's works, which he calls himself Lumia, are to be observed without music. This said, Wilfred also gave representations accompanied by music. In 1926, he performed with the Philadelphia Orchestra playing Rimsky-Korsakov's Scheherazade.[3]

mats. Thus sound, kinetic images on film or physical objects exist only to render movement; an abstract movement that is preferably not associated with any narratives.

Figure 1: *Harmonic*, Len Lye (1960). (c) with permission of the Len Lye Foundation Collection, Govett-Brewster Art Gallery.

Many artists are now developing a body of work continuing in some way the work begun by Lye. Among them are many composers and sound artists so the proximity between physical movement and sound remains with the same relevancy today as it was about 100 years ago. In this regard, we should mention the works of the Cod.Act[3] collective with projects like *Cycloid-E* (2009) and *Pendulum Choir* (2010). We should also mention the *Frequencies* series by composer Nicolas Bernier [4] or *Cinetose* by the EVA Project[5] collective. It goes without saying that the *Lungta* project presented here is part of this evolving process.

Physical Pixels

The *Lungta* project is designed around an electromechanical device of imposing dimensions (2.5 x 7.3 meters). It is composed of 192 small DC motors equipped with a propeller in order to send an air jet that controls individually the vertical elevation of sheets of paper hanging before them. The matrix responds to sound, to a camera capture system and to a 3D interactive environment system making use of Microsoft's Kinect.[6] Each sheet of paper is actually a kind of physical pixel for displaying images rendered at very low resolution.

Figure 2: *Lungta* (2012). (c) Patrick Saint-Denis.

The interactions with the device are framed by two software components made in c ++ (openFrameworks[7]). The first is a graphics-rendering module while the second comprises a video compression algorithm that allows downstream to convert the rendered images in electricity to activate the motors.

Most of the graphic animations are constructed from elementary geometric shapes (circles, rectangles, etc.). Several parameters of the animations involve randomness in order to have, at each renewal of the animated sequences, minor changes while keeping a constant general behavior. These animations rendered within FBOs[8] are fed to an image analysis module which will calculate the overall brightness according to a grid that corresponds to each sheet of paper or "pixel" of the electromechanical device. The result of this analysis can be seen at the lower right of the control interface (see figure 3) with the resulting image based on 16 brightness levels corresponding to 16 positions of elevation of the paper sheets.

[3] codact.ch

[4] nicolasbernier.com

[5] projet-eva.org

[6] The Kinect is an interface initially designed for the video game console Xbox 360. It allows one to control video games without using a controller.

[7] *openFrameworks* is a collection of functions that facilitates the development of creative applications. `www.openframeworks.cc`

[8] An FBO or *frame buffer objects* correspond to virtual canvases where images can be rendered without being necessarily displayed.

Figure 3: Control interface with visual rendering of the transfer module between images and the DC motor array.

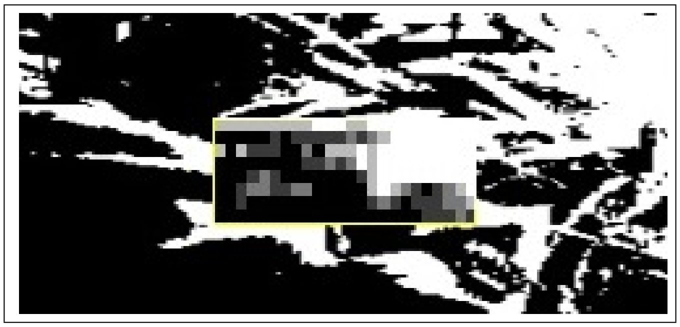

Figure 4: The same image with emphasis on the transfer module.

In fact, the maximum resolution in terms of brightness and voltage levels sent to the motors is 8 bit or 255 different values. This definition not being visually perceptible, a coarser resolution is used. Before being sent, the values corresponding to the individual voltage of the motors are managed by a data compression module that is broadly in line with the principle of the H.264 video codec. This video compression codec is known for greatly reducing the size of video files by deleting the information relative to pixels that remain the same between two successive frames. This principle is adapted here in order to limit the information circulating on the serial ports where three Arduino[9] boards translate the data in electricity.

KINECT KREATIVE INTERFACE (KINKI)

In parallel with the interactions happening on the wall of paper, the musicians are also evolving in an interactive audio environment. This environment makes use of Microsoft's Kinect and a graphical interface developed for the project. This interface is an openFrameworks application based on an implementation of the OpenNI, NITE and SensorKinect librairies. The application facilitates the design of an interactive three-dimensional space. It allows the definition of interactive zones as well as their linkage with different body parts of a user.

[9]Arduino is an API, an IDE and a printed circuit that have been designed for exploration in electronic arts. The set includes a text based programming environment and a printed circuit facilitating the use of microcontrollers.

Microsoft's Kinect

The Kinect is an interface for Microsoft's Xbox 360 game console that was launched commercially in 2010. The principle of the device is to allow users to play video games without a controller via voice and movement recognition systems. Ideally positioned about one meter in front of the user, the device comprises an infrared projector, an infrared camera and a standard camera. The unit is mounted on a motorized base that rotates the optical sensors and infrared projector to adapt the device's field of view depending on the positioning of users. The Kinect was an immediate commercial success with more than eight million units sold in less than two months after its release. The interest that it creates today goes far beyond the gaming industry.

Figure 5: The Kinect, a peripheral for the Xbox 360 game console from Microsoft. (c) CC-BY-SA-3.0, via Wikimedia Commons.

The movement recognition system of the Kinect, developed by Israeli company PrimeSense, is based on a range imaging system. The Kinect's infrared projector emits light patterns that are invisible to the naked eye. These patterns are then captured by the infrared camera and this uptake is analyzed. A series of information can be deduced from this analysis such as the depth of the pixels or the recognition of a human figure.

Figure 6: Infrared light patterns projected by the Kinect. (c) CC-BY-SA-3.0, via Wikimedia Commons.

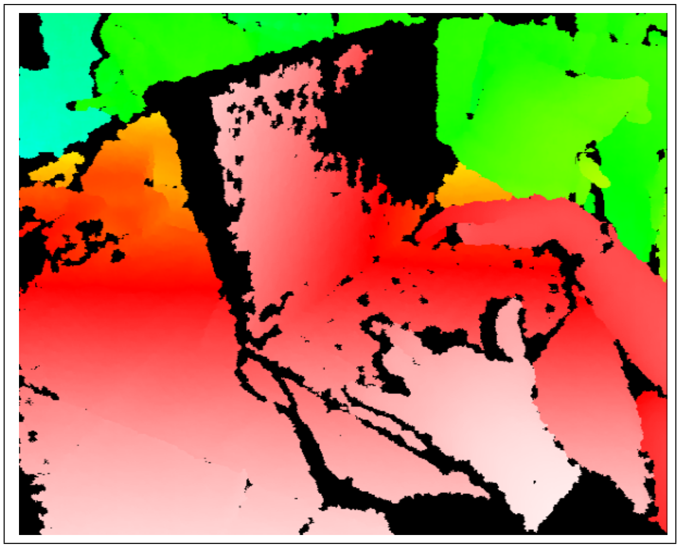

Figure 7: Depth image acquired by structured light. (c) CC-BY-SA-3.0, via Wikimedia Commons.

kinki (Kinect Kreative Interface)

Kinki is an openFrameworks application that helps defining tridimensional zones of interaction and their relation with different parts of a performer's body. By using the Open Sound Control protocol, the application allows one to connect a performative gesture to any software or programming environment that handles OSC communication.

The application is built on OpenNI's software architecture and includes two operating modes: *edit mode* and *performance mode*. *Edit mode* lets one add or modify objects that consist of interactive zones that can be fixed or attached to a user. Objects are grouped into scenes, enabling rapid object configuration changes. By default, the application is calibrated for a single user but it is possible to increase this number up to 8 simultaneous users.

The interface includes various controls for modulating the objects (position, size, etc.) and the body part of the user that will activate the interaction zone.

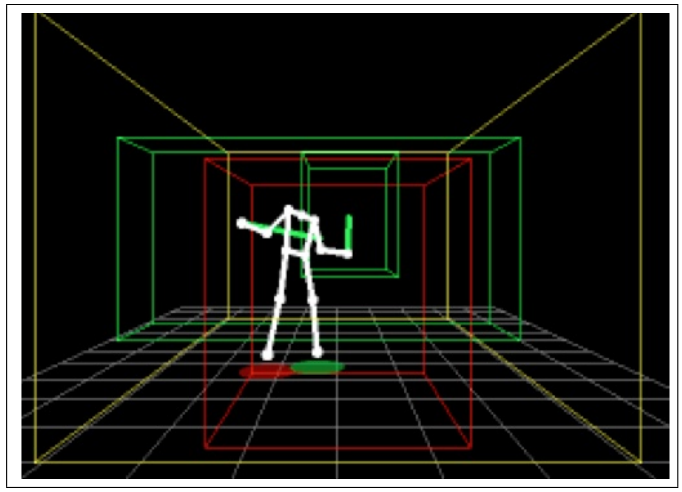

Figure 8: kinki (Kinect Kreative Interface).

All OSC messages of a project are sent over a single port using the following nomenclature:

If an object is not activated[10]:

```
/oscTag 0
```

If an object is activated:

```
/oscTag 1 xPosition yPosition zPosition
 rho phi teta distCenter
```

The arguments corresponding to the position in x, y and z (xPosition, yPosition and zPosition) vary between 0 and 1 while the arguments associated with spherical coordinates (rho, phi and teta) are reported between 0 and 360. The last argument (distCenter) corresponds to the distance from the center of the interaction region and is always between 0 and 1.

Summary chart

The diagram at figure 9 summarizes all the hardware and software components of the work. The different data acquisition interfaces are in yellow boxes. Digital manipulation modules (audio, computer graphics) are in white while output devices (the wall, speakers) are in green boxes.

[10]i.e. if the body part associated with the object is outside of it.

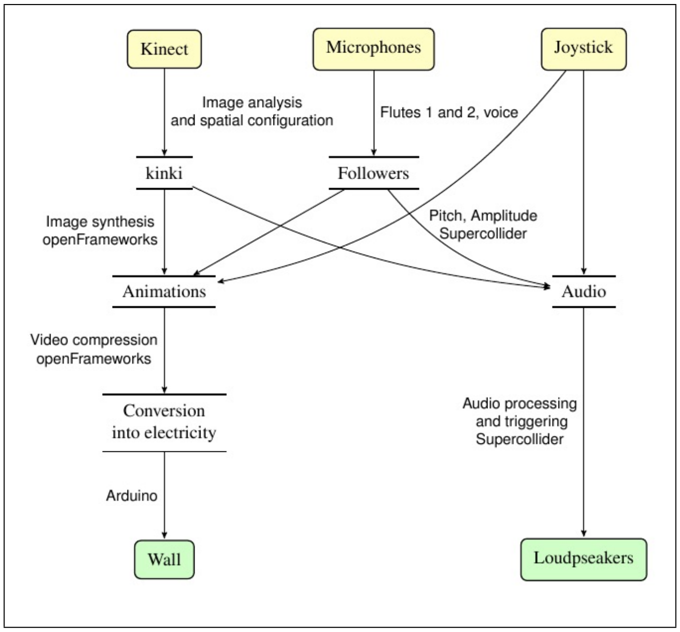

Figure 9: Summary of the work's components

Descriptive analysis of the central section

The central section of *Lungta*[11], designed for female voice and audio-robotic interactions, offers a concentrate of all the project's components over four minutes. Some short audio clips (4-8 seconds) are generated live and triggered by the performer according to amplitude thresholding. The sound of the breath is also manipulated live. First, an FFT treatment separates the noisy signal of the breath from the more periodic sound of the singing voice. The amplitude of the noisy signal is modulated by an LFO whose frequency involves elements of randomness. The result is then mixed back to the continuous signal and send to the loudspeakers. Amplitude thresholding of the voice also triggers a series of movements on the machine. These physical movements correspond to graphic animations initiated from the center where 12-20 rectangles translate to the sides. The traveling speed, the number of rectangles and direction of displacement involve randomness so that the movement is continually renewed while keeping similar mass profiles.

[11] `www.vimeo.com/87890177`

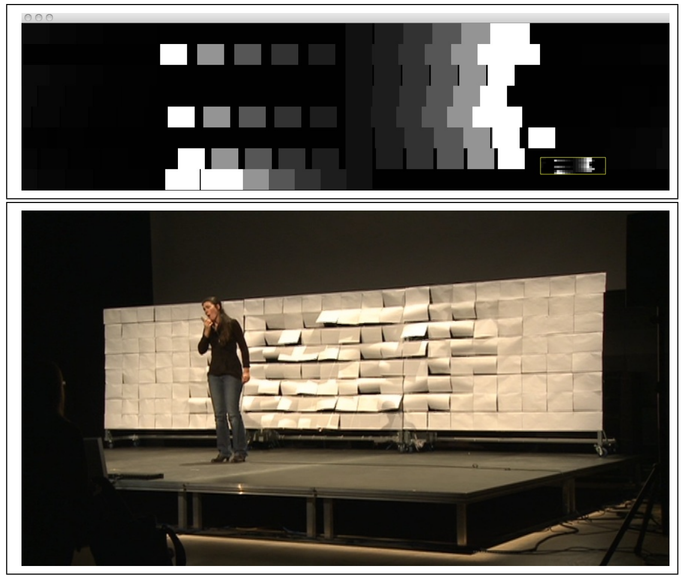

Figure 10: Animations and resulting effect on the wall of paper.

The singer then begins to perform a series of rotations with the right hand. The Kinect, placed on the floor in front of the stage detects the three-dimensional position of the right hand. The data collected is then used to power a synth composed of noise generators. The amplitude of the synth is controlled by the distance of the hand relative to the central point of rotation when it is in the forward half of the circle. Spatialization of the sound is determined by the position of the hand performing the rotations. These data also generate movement on the machine. When the hand is in the back half of the circle, a graphic animation is activated according to the hand's position enabling a wave movement initiated by the singer's hand movement to be seen on the wall.

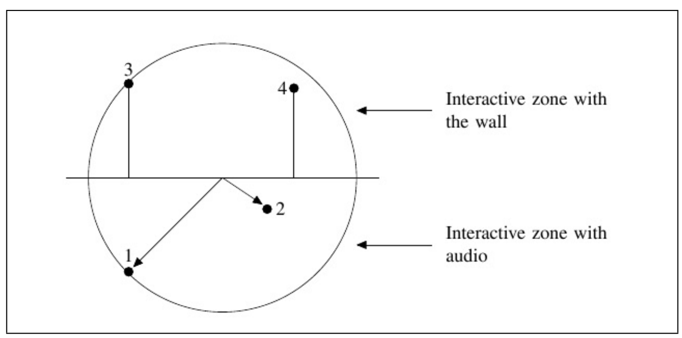

Figure 11: Visualization of spatial interactions. Top view. 1 = audio interaction, maximum volume and panning on the left side. 2 = audio interaction, low volume and panning on the right. 3 and 4 = Audio volume 0. Interaction with the wall, the graphic animation follows the normal relative to the diameter line.

The performer sings continuously so that her voice is only amplified when the microphone comes close to her mouth. This intervention will last for a moment before building up in rotation speed. Towards the end, the voice becomes less airy and more pitched. A long note in the high register is heard. This is the only pitched material of the work.

Aesthetic of the ephemeral

True generosity toward the future lies in giving all to the present. -Albert Camus

Lungta is necessarily destined to an ephemeral existence. The tools developed for the work are subject to the evolution of computing technology. For example, as we wrtie these lines, the Kinki software is already in need of two major updates. Microsoft has just launched the Kinect 2, which is not compatible with the OpenNI modules on which the application is based and Apple, which recently just bought the PrimeSense firm, is to conduct a complete shutdown of OpenNI. It took only one year for the obsolescence inherent to new technologies to catch up on this work.

Similar observations can be made on the wall. Handling and use of the latter require maintenance before each performance and its dimensions cause many storage challenges. Maintenance activities concerning the software components of the machine will have to be undertaken eventually. The pattern of re-performance of musical works, to which classical traditions associated with written music have accustomed us, simply doesn't apply to this project. The performance requires the presence of the composer as well as that of the musicians who contributed to its creation. A user manual does not exist and, considering the ephemeral nature of its hardware and software components, it can't exist. The *Lungta* project does not respond only to ephemeral art, it is a work in constant transformation because it evolves and is modified every time it is performed.

We are now thousands that create digital works necessarily linked to the tools and computing languages that constitute them. If digital art resolutely generates new practices, it also questions our commitment to the notion of the work-monument as a legacy for future generations.

In an interview with the composer and pianist Michael Levinas, Danielle Cohen-Levinas notes the following:

> "It is hard to imagine that in future times to come one will take out the famous 4x of the museum (IRCAM's early computer) to run it. There is a real transfer here. Technology is such that there is a transfer capability of a number of discoveries that have happened in relation to a specific technology. This does not prevent the obsolescence phenomena that new technologies impose. This is not the case for the instruments you speak about, like the harpsichord, the pianoforte or the piano. They may be in the museum, but they are also in concert halls. "[1]

The musicologist notes here the difference between the way transmission (transfer) in computer science operates and the idea of inheritance to which the musical tradition has accustomed us. The composer answers this assertion by pointing out that technological media fail to standardize, that their deaths are inherent to the economic and industrial agenda.[1]

It is true that the evolution of computing is mainly driven by the requirements of the market and digital art is often found in the wake of changes imposed by the industry. But in the same spirit, we must recognize that market forces can lead to great changes and developments in artistic practices. Perhaps one should interpret this transformation of the notion of inheritance brought about by computing as a new relationship between the realms of industry and culture.

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