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Interactive digital techniques for sound generation and control using video technologies

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Abstract: *This paper proposes a contemporary approach to dynamic ways of sound generation and control through motion tracking or other visual methods. The possibilities of creative approaches in audio-visual works of the author's creation will be presented, describing the methods used, the construction of the devices and the algorithms conceived.*

Key-words: *kinect, Max programming, algorithmic composition, interactive music*

1. Introduction

There are many ways to use the electronic medium through new technologies for artistic purposes. Using various techniques in this context, three categories of ways of interacting with sound material can be distinguished:

- real-time triggering of audio processes refers to the realization of on/off actions. These can be done directly – by triggering a physical element connected to the electronic environment - or by presence detection using specific devices (video camera, kinect, proximity sensors);

- the generation of algorithmic processes refers to the creation in real time of structural elements of the work, following the formalization of the artistic concept and its translation into programming languages. In the musical sphere, this could materialize in the creation of musical cells, motifs or sequences that can then be syntactically merged to form, depending on the desired complexity, sequences or superimpositions of monodies, omophonies, polyphonies, heterophonies or textures. These will be 'sounded' by virtual instruments or synthesizers and played through loudspeakers;

- real-time transformation of audio processes refers to the modification, through numerical coordinates, of parameters that control the behavior of the algorithms underlying musical approaches.

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The present approach aims to identify these three types of interaction modalities in own works (multimedia compositions, installations, etc.) and to briefly describe the algorithms used, using as taxonomic criteria the video technologies used: kinect sensor and video camera.

2. Kinect sensor

2.1. Feel the pulsation!

Feel the pulsation is a part of the SenzArt project, initiated by the Orange Romania Foundation and supported by the Association of Friends of the National Museum of Contemporary Art in Bucharest.

The multi-sensorial installation, realized in 2014, offers visitors the possibility to perceive, feel and experience – with the help of interactive artistic means – dynamic pulsating processes and unconventional ways of audio-visual spatialization (for a detailed description see Crețu 2019, 44-48).

It is based on a circular construction made of 12 pillars and 12 orange-colored beams (Figure 1), a white-colored floor, an audio system of 6 speakers arranged circularly on the inner walls of the space, a video projector and a kinect sensor clamped in the center of the beam above the construction and oriented perpendicularly downwards, all connected and controlled by a computer.

A rectangle populated with 88 dynamically colored objects is projected on the floor, and repetitive, pulsating music is played through speakers. All interactive audio-visual processes are controlled using the Max programming environment dedicated to the development of interactive audio-visual projects, the most advanced contemporary computer tool for multimedia artists (for more details see: http://cycling74.com/).

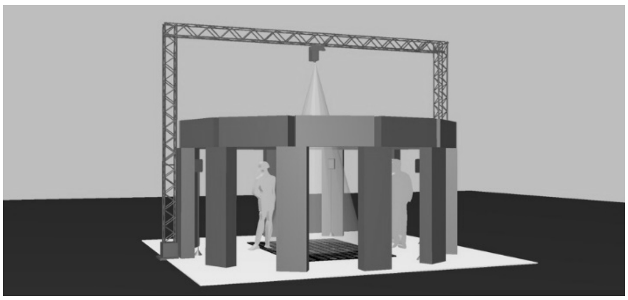

Fig. 1**.** *Circular construction made of 12 pillars and 12 orange-colored beams*

In the absence of visitors, the speakers emit no sound. When a person appears on the projected multi-colored carpet, the audio mechanism is triggered by the kinect sensor that detects the silhouette from above. It is programmed to emit harmonic musical structures based on super impositions of perfect fifths, consonant intervals that allow for complex and balanced mixtures. The visitor's position in space determines the lowest note of the harmonic structure, which can be altered by moving on the carpet. The music generated is spatialized by the 6 circular speakers, according to pre-programmed algorithms controlled in real time by the movement of the visitor's body.

On the visual level, the basic structure consists of a rectangular video projection with 88 colored circular and square shapes, forming a real "virtual macro-table" on the floor, arranged in 8 rows of 11 objects each, corresponding to the 88 keys of the piano. There is a correspondence between them, with a single visual object assigned to each sound. The color of most of the objects is given by the position of the visitor's body (or the position of the center of gravity in the case of more than one visitor) on the projected rectangle and the correspondence with the RGB values conventionally associated with that coordinate. The sound pulse is suggested by rhythmic changes in the colors of the objects that " play ", corresponding to the musical tempo.

The interactive techniques implemented here through motion tracking are manifested on four levels: triggering sound events, controlling the harmonic basis of pulsating chords, controlling the spatialization in the six loudspeakers and changing the color of the shapes projected on the floor.

2.2 A room of your own

The interactive installation, realized in 1 december 2013 (presented at the inauguration of the Pantelimon Water Tower, Bucharest), uses the Kinect sensoral so placed in the ceiling, but the algorithm is different from the previous work. The screen taking the visitors' image is divided into 88 squares (11x8, Figure 2), each of which controls a musical note played on a sampler. A dynamic virtual piano controlled by the projections of the visitors' heads is thus realized. The musical strategies used can be multiple: 88 different sounds according to the keyboard of a real piano, random choice of sounds by the algorithm, choice of tonalities, modes or other sound systems.

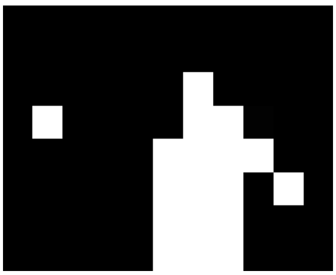

Fig. 2**.** *A room of your own*

2.3. Bells and mechanisms

During the performance produced at Zona D in Bucharest in 2013, it was realized an algorithm by which a dancer changes the playback speed of an audio file. The concept was implemented using Max cv.jit.centroids extensions (for details see: https://jmpelletier.com/cvjit/), which allow real-time control of the center of gravity of the image surface (visible on Figure 3). Thus, the silhouette becomes the symbol of a human potentiometer moving from left to right. When he is in the center, the music stops (speed 0), on the right is playing at normal speed (+1), and on the extreme left (-1) the music is heard completely reversed. Between the sestates there are intermediate speeds. The acoustic effect is that of touching a rotating LP record, i.e. changing its speed in real time by means of body movement.

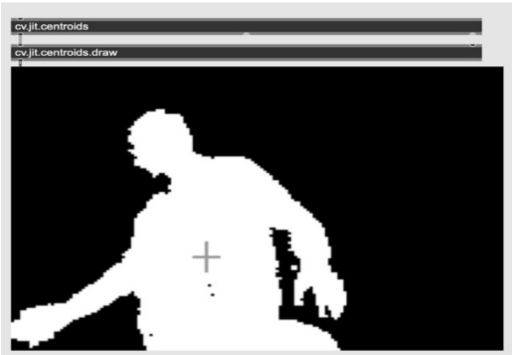

Fig. 3. *Real-time control of the center of gravity of the image surface*

Based on the technique described here, I further developed an algorithm for real-time control of music, alsoby a dancer. Four different pieces of music were assigned to four zones of the dance space, and by moving his body he could choose one of the mand mix it with the one nearby, like a dj, this time with the kinect placed in the ceiling. The interactive modes described here relate exclusively to modifying or controlling pre-existing sound events by tracking movement.

3. Video camera

3.1 AquAcusTectonium

The installation, realized in 2016, was presented in the preamble of the Visualizing the Sound series, a cultural project by WASP STUDIOS Bucharest (2016), then at BINAR (2019) and Clujotronic (2021). It contains algorithms for the visual control of sound, represented by a dynamic, interactively modified sound spectrum (for a detailed description of the installation see Crețu 2016, 147-150). A low 23-hertz sound is emitted through a low-frequency loud speaker and propagates in the aquatic environment through direct contact with a container containing a thin layer of water, the vibration of its surface (Figure 4a) – which is dynamically picked up by a video camera – becoming the source for the generation and control of a permanently modified sound spectrum that is spatially emitted through four suspended louds peakers. A video projector amplifies the dynamic image of the water surface on the floor.

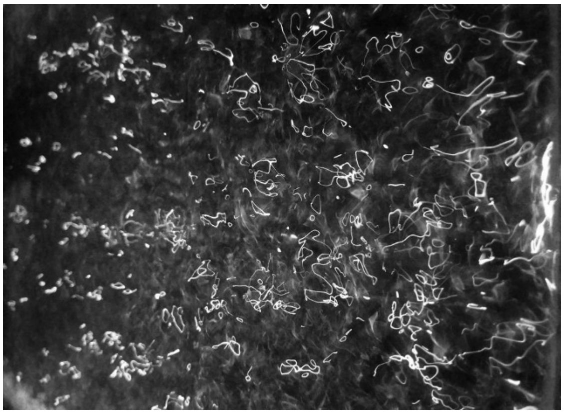

Fig. 4a**.** *The dynamic image of the water surface on the floor*

The algorithm decomposes the video format into a stream of numerical data with the help of which a sound spectrum consisting exclusively of sinus sounds is constructed and dynamically controlled. Changing the resolution of the image captured by the video camera into 8x4 rectangular areas (Figure 4b), is accompanied by the extraction of three numerical matrices corresponding to the three Red-Green-Blue planes (Figure 4c).

The data thus obtained are processed for the generation and control of the 32 odd harmonic fundamental frequency sounds. The end result is a virtual instrument, a kind of “invisible piano” emitting sine harmonic sounds of different intensities, the “pianist” being the visual environment.

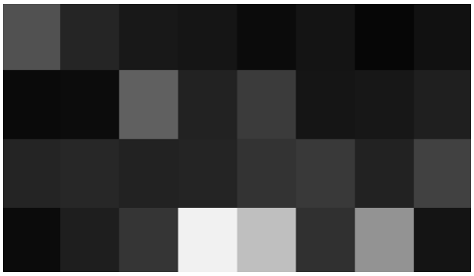

Fig. 4b. *The image captured by the video camera into 8x4 rectangular areas*

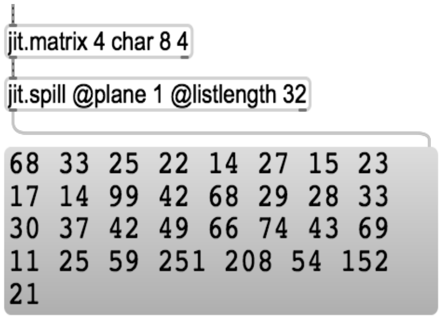

Fig.4c. *The extraction of three numerical matrices corresponding to the three Red-Green-Blue planes*

4. Conclusions

The techniques presented in this study outline a flexible framework, offering the possibility of approaching hybrid audio-visual and multimedia projects that can incorporate new technologies, thus developing sound processes that are difficult to realize by other means. Starting from the proposed innovative ways of generating music, more and more complex approaches can be initiated, which emphasize the potential of contemporary technology.

5. References

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