

El mapa no es el territorio: sensor mapping for audiovisual performances

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ABSTRACT

We present *El mapa no es el territorio* (MNT), a set of open source tools that facilitates the design of visual and musical mappings for interactive installations and performance pieces. MNT is being developed by a multidisciplinary group that explores gestural control of audio-visual environments and virtual instruments. Along with these tools, this paper will present two projects in which they were used -interactive installation *Memorias Migrantes* and stage performance *Recorte de Jorge Cárdenas Cayendo*-, showing how MNT allows us to develop collaborative artworks that articulate body movement and generative audiovisual systems, and how its current version was influenced by these successive implementations.

Author Keywords

Mapping, audiovisual performance, motion capture, interactive installation

CCS Concepts

•Human-centered computing → Gestural input;
•Applied computing → Sound and music computing;
Performing arts;

1. INTRODUCTION

In the past decade, real-time interaction between body and audiovisual environments has turned into a prolific creative resource for multidisciplinary projects. The constant technological growth has allowed artists to generate these types of environments using commodity hardware. For performance projects, these technologies are useful tools for creating immersive audiovisual expressions, expanding the performers' gestures through real-time computer graphics and audio generation.

In our last projects we have worked on platforms that explore real time physical/digital feedback for disciplines such as video art, expanded cinema and visual music. In the interactive installation *Memorias Migrantes* (2016) we created, in collaboration with a local artist, a sculptural object full of images and sounds from Neuquén, a city we were invited to work in. During the exhibition, visitors could interact with the object's surface, triggering abstract images and sounds based on field recordings, emulating the process of memory and image recollection. As this project was developed on the road, we

needed a swift way to incorporate new sounds and images, and to mount and calibrate the installation. For stage performance *Recorte de Jorge Cárdenas Cayendo* (2018) we needed a customized tool that would be suitable for the requirements of a dance and contemporary circus crew, in order to create responsive audiovisual structures on the fly. The tool had to allow the performers to improvise without an extensive previous training, while they were working with an audiovisual extension of their bodies.

El mapa no es el territorio (MNT)¹ is the result of our decision to formalize the strategies involved in these creative processes, aiming for further collaborative and multidisciplinary works. It is a set of tools which facilitates the design of interactive audiovisual devices for performing arts. It provides solutions to three recurring tasks: sensor feature extraction, mapping strategies design and integration with existing systems. The main component of MNT is MNTm, an application that enables users to perform data filtering and scaling, to apply preset interpolation methods and trigger conditional events. These features are accessed through a GUI, as a way to implement quick mapping strategies. This component connects through Open Sound Control messages to MNTm4l², a Max for Live device that uses the Live API to allow MNTm to perform preset interpolation and event triggering on Ableton Live. In addition to these tools, we have developed several applications that allow MNTm to interface with sensors such as kinect, leap motion and platforms like arduino (MNTk, MNTl and MNTa respectively). Our goal is to both simplify and expedite designing interaction schemes and helping to communicate the needs and nuances of interactive systems in our collaborative artworks

2. RELATED WORKS

Mapping [11] strategies and libraries are a recurrent subject in the NIME community [5, 14]. Preset interpolation systems similar to MNTm's NNI and RGB also have been previously discussed at the NIME conference [4, 7, 13]. Finally, motion capture systems, and frameworks for live performance and interactive real-time environments [2, 3, 9, 12] are an active field of research, while systems similar to the one described in this paper have been presented in recent editions [8, 15]. With MNT, we aim to design a simple, generic and customisable system that is easy to connect to other software and provides access to a limited collection of tools through a simplified layout. These tools are presented as easily understood spatial



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¹ <https://github.com/fsguiglia/MNTm>

² <https://github.com/fsguiglia/MNTm4l>

metaphors, enabling artists to experiment with mapping in the collaborative design of interactive environments for multidisciplinary projects.

3. MNT

3.1 MNTm

MNTm is a cross platform application developed in C++/openFrameworks³ (oF). Its main goal is to centralize data coming from sensors, process it and broadcast the resulting values using the Open Sound Control⁴ (OSC) protocol. The GUI is made of six different windows: ‘Preprocessor’, ‘NNI’, ‘RGB’, ‘Map’, ‘Trigger’ and ‘OSC’. It receives sensor data as a JSON⁵ formatted stream via UDP. This stream of JSON objects is first processed in a feature extraction module, that can be configured through the ‘Preprocessor’ window. This module allows the user to normalize incoming values, as well as to get additional data features as minimum, maximum, absolute value, and to apply a filter that discards objects that contain values outside a desired range. This module’s output is fed to a bus. The output of the remaining modules can provide input to any of the following modules.

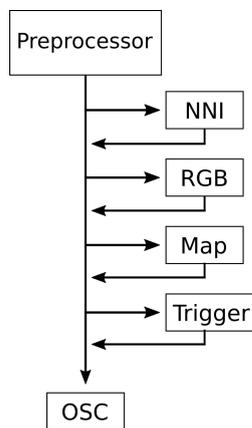


Figure 1. MNTm modules.

In addition to the feature extractor, MNTm presents two preset interpolation systems: a Natural Neighbour Interpolation module (‘NNI’ window), and a module that can be used to create mappings from loaded images (‘RGB’ window). Both modules can be used to control many parameters using a limited number of features, through dimension reduction.

In NNI, data points representing parameter presets can be placed on a plane. The presets can be later interpolated by moving through a surface using a feature vector. This module was inspired by AudioMulch’s Metasurface [4]. Natural Neighbor Interpolation is explained in detail in [6]. RGB, on the other hand, allows the user to use received sensor values to move a cursor on an image, obtaining an average of the RGB values for the surrounding pixels. Through MNTm4l these values can be linked to single parameters (a simple example might be mapping loudness to red channel values) or to parameter combinations, by storing three presets (associated with the red, green and blue channels) and using the ‘RGB’ output to calculate weighted average.

The ‘Map’ window can be used to scale the values on the bus and to group them under a single OSC address pattern. ‘Trigger’ prompts conditional events when the values meet certain criteria. This modules do not only take in features coming from ‘Preprocessor’ but also from ‘NNI’ and ‘RGB’ outputs, allowing the user, for instance, to use the ‘RGB’ module to create triggers by drawing them, or to set off an event as a response to NNI’s output



Figure 2. RGB on Recorte de Jorge Cárdenas Cayendo.

Finally, the ‘OSC’ window allows the user to set multiple ip/port pairs in order to communicate MNTm with other software via OSC messages, using the ofxOsc library. Individual OSC address patterns can be set for each module through the GUI.

3.2 MNTm4l

MNTm4l is a set of Max for Live devices which lets MNTm take control of Ableton Live through Ableton Live’s API. These devices can store track component values as presets which can be later recalled using MNTm preset interpolation modules. The user can also create one to one mapping between incoming OSC messages and Live devices and track parameters.

3.3 Sensor Modules

In addition to MNTm and MNTm4l we have developed a set of applications that allow MNTm to interface with different sensors: MNTa, MNTk and MNTl. MNTa and MNTl simply receive incoming values from an Arduino board and a Leap Motion sensor (through ofxLeapMotion⁶) respectively and format them to a JSON stream compatible with MNTm. MNTk takes kinect’s depth image stream and applies OpenCV blob detection algorithm through ofxOpenCv, permitting the user to set a region of interest, to apply filters (image background subtraction, blob size and distance thresholds, tracking data low pass filter) and to draw an arbitrary coordinate system to perform a change of basis for the blob position vectors.

4. DESIGN APPROACH AND CASE STUDIES

MNT is a direct result of the design and implementation of two works, summarizing previous experiences. We have chosen an heuristic approach, developing tools as a response to specific processes and needs of concrete pieces.

4.1 Memorias Migrantes (2016)

*Memorias Migrantes*⁷ is an audiovisual interactive installation by Pariguayo and Carlos Mustto that abords collective memory

³ <http://openframeworks.cc/>

⁴ <http://opensoundcontrol.org/>

⁵ <https://www.json.org/>

⁶ <https://github.com/genekogan/ofxLeapMotion2>

⁷ <http://paulicoton.com/memorias-migrantes>

by transforming a found object into a tactile interface. This interface allows the visitors to explore its surface and stimulate and manipulate a series of *memories*, composed of audiovisual field recordings captured in the object's immediate surroundings. It was premiered in Museo Gregorio Alvarez in the city of Neuquén, and was deliberately produced 10 days before the opening, as a way to express our immediate experience of the city. The object was an old local carpenter's workbench found and intervened by sculptor Carlos Mustto, a process that turned the traces of its material history into a tactile interface, inviting visitors to retrieve its memories and to explore its biography -following [1]- by searching its surface.



Figure 3. *Memorias Migrantes*.

Together with Mustto, we decided to exaggerate the traces of the carpenter's work on the bench, creating distinctive regions on its surface. An early version of 'NNI' was developed to link these regions with parameter states of a generative soundscape, creating an analogy between sound textures and tactile sensations. The regions were also used to modulate parameters on a video processing software, triggering individual video clips when touching the bolts that held the bench. Movements on the object's surface were recorded using MNTk.

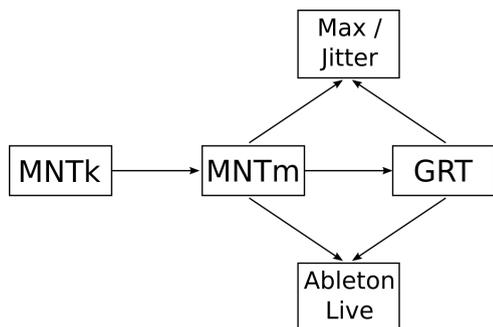


Figure 4. MNT, *Memorias Migrantes*.

Visitors could also go over cracks on the bench. These gestures -detected using dynamic time warping through GRT [10]- would trigger images and sound of the Limay and Neuquén rivers.

4.2 Recorte de Jorge Cárdenas Cayendo (2018)

Recorte de Jorge Cárdenas Cayendo (RJCC)⁸ is a contemporary dance and circus piece by Compañía Terceto and Pariguayo, directed by Juan Pablo Gomez. It reflects on Argentina's 2001 crisis and the traces on our bodies left by this period of rioting and civil unrest that involved the killing of 39

civilians by security forces and caused the resignation of President De la Rúa. The play presents these events through a physical narrative that uses the image of Jorge Cárdenas agonizing in the Congress stairway -an iconic photograph of these events- as a direct reference. The audiovisual design was developed within the LIC residency (cheLA-REMAP⁹), and premiered in the *Noviembre Electrónico* festival. The main difficulties with this design was creating a framework which was efficient in responding to spontaneous changes in the choreography as well as to constraints arisen from the physical risks involved in some stunts. We were motivated by these difficulties to perfect MNT's GUI so that it would allow us to easily add, edit, and remove modules, and added the RGB module to allow us to swiftly draw stage maps.



Figure 5. *Recorte de Jorge Cárdenas Cayendo*.

When starting the residency, the piece had a first choreographic script, an early original soundtrack, and a minimal scenography consisting of a 4x2,25 m. wall, a shopping cart, and two metal stands with bowls containing magnesium-filled cloth balls. The agreed approach for the audiovisual design was to develop a "fourth character" for the piece (besides the three acrobats), embodied by the wall.

Since one of the main topics of the play is institutional violence, the wall's behaviour was modeled considering the stereotypical relations between institutionality and the people under its influence. The wall was already symbolically robust, since monumentally constructed monoliths and defensive ramparts are typical architectural features of state and state-like social organizations throughout history [16].

We approached the stage as a terrain, with the basic features of a city-state: a nearby watercourse, zones of popular housing and workshops, public space (surrounding the wall, the place of central authority and administration), and wilderness beyond its limits. This map employed different audiovisual resources throughout the play: first developing a sound map, then an audiovisual one. On the opening scene the map was suggested by overlapping soundscapes that were transformed using MNTm's NNI to modulate parameters of different layers of granular clouds. As the play progressed, the map became increasingly literal, ending with a projection of a topographic map on the floor. The performers warped this image by moving over it.

Regarding the evolution of the play, we agreed on representing the timeline of a work-day, starting at 5 AM, and finishing at midnight. This was expressed by using lighting and by projecting different clips that acted as shadows cast by the wall. These shadows were used to modulate sound and image parameters using 'RGB' in combination with 'Trigger' to create

⁸ <http://www.sguiglia.com.ar/rjcc.html>

⁹ <http://remap.ucla.edu/>

irregular interactive hotspots. Performers would also affect a series of surveillance systems through the play, designed using fluid simulators and particle systems driven by the performers' positions and velocities. In the final scenes, audiovisual 'defensive reactions' were triggered by cloth balls soaked in magnesium -a necessary prop throughout the play, as the acrobats used them to secure a firmer grip on difficult stunts-hitting the wall.

To control the interactive audiovisual environment, we used a ceiling mounted kinect and a set of piezoelectric sensors on the wall, connected to an arduino board. RJCC's sound was the result of a dialog between a generative sound piece that used MNTm4l on Ableton Live and an on stage live electronic music performance that used hardware synthesizers and standard commercial controllers. Generative visuals were created with an oF application and routed to Resolume Arena through syphon. The audiovisual system was controlled by the movements performed onstage, the impact of the cloth balls against the wall, and offstage performers playing MIDI controllers. Parameters on the oF application were broadcasted using OSC and affected sound on Ableton Live.

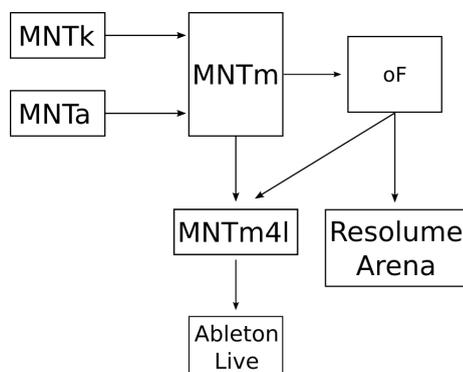


Figure 6. MNT, Recorte de Jorge Cárdenas Cayendo.

RJCC had a warm reception, and performances have been booked for 2019. For this season, we are planning to include wearable sensors -such as EMG sensors, gyroscopes and accelerometers- to better capture acrobatic movement, a request often made by Compañía Terceto.

5. CONCLUSIONS

This paper presents MNT, a set of tools for designing interactive audiovisual devices. By showing two specific works, an installation and a performance, we have examined how this application can be used in concrete scenarios, providing definite solutions to artistic needs. Because it is employed in multidisciplinary and collaborative pieces, one of MNT's advantages is that it provides simplified approaches to mapping schemes, through intuitive GUI and simple spatial metaphors. This is particularly relevant as it allows us to cooperate with choreographers, directors, performers and other artists, by simplifying communication of mutual needs.

MNT is still being developed, solving specific artwork needs of artist collective Pariguayo. Our goal is to expand these tools, suggesting new ways of designing audiovisual performances, in partnership with other artists.

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