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Mapping the question of mapping

Colloquial Paper

Video of presentation can be found here

Mapping the question of mapping

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Abstract. This paper proposes a method to study the question of mapping: the field between capturing what happens in an environment, the gesture, to what happens in an output medium. While motivations for creating interactive works that involve mapping are very diverse, within these works common techniques and methods are used to achieve unique artistic works. The method proposed provides a way to document these techniques and methods and place them in an aesthetic context. The aim of this method is to provide a basis for a common vocabulary among artists to talk about mapping.

Keywords. Mapping, digital musical instruments, interactive installations, interactive dance.

What is the question?

In interactive works where *gestures* in the environment affect output media, the main question the artist is dealing with is how to make a meaningful connection between the gesture and the output. These interactive works range from digital or augmented musical instruments, dance and technology performances, to interactive media installations.

The field between this capturing of what happens in the environment (the gesture) to what happens with the output medium is often refered to as 'mapping' (see figure 1).

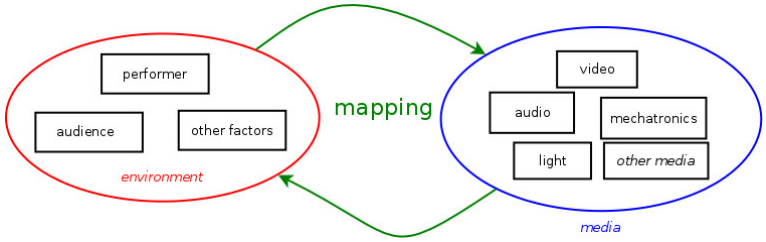

Figure 1: The question of mapping: the connection between a gesture in the environment to output media.

The term 'gesture' is used very broadly: these can be intentional gestures of a performer, but also ancillary gestures that occur, or accidental gestures. They can also be gestures of a phenomenon in the environment: the change of temperature and humidity over the course of a day.

The 'arbitrariness' of mapping is often criticized as 'anything can be mapped to anything' and therefor it is inpenetrable, but in fact this is where a significant part of the artistic expression is. To quote Michel Waisvisz, a pioneer in this field: "the algorithm for the translation of sensor data into music control data is a major artistic area; the definition of these relationships is part of the composition of a piece. Here is where one defines the expression field for the performer, which is of great influence on how the piece will be perceived" (Waisvisz, 1999)[1].

If we can distinguish styles and genres in how musical notes are placed in harmony or disharmony within musical pieces, we should also be able to distinguish styles and genres in how artists create these algorithms, these mappings. And to do so, we need to understand what is going on in these algorithms and the artistic motivations to use them.

[1]http://crackle.org/MW's gestural round table.htm

The answer to the question is manifold and the way artists approach the question for a large part depends on their motivation for creating the artistic work, but also on the technological means that are available to the artist at the time.

The field of HCI (Human Computer Interaction) deals with how humans interact with computers, and the tools and techniques developed in that field find its application in artistic works. There are however also distinctions: the interactions artists pursue are often idiosyncratic: either based on their own artistic needs (and not those of a separate 'user'), or the subject of the artwork is the interaction itself. Thus the validation of what a 'good' interface is, may be quite different than in HCI research, as HCI often aims to design for a large user group (the masses).

In digital musical interfaces, artists look for a performative way to control their electronically produced music: they shape their performative effort that will allow them to make their music. In dance, the motivation lies in creating different ways of experiencing (movement of) the body and space, or exposing and expanding choreographic concepts. In media art, the art might be in the interaction itself, a physical phenomenon might be the subject of the artwork, or the interaction might be used as a means to explore another topic alltogether.

The artistic motivations and the resulting works may be very different from each other; yet they use similar tools to achieve their aims and within these tools, many common methods and techniques are used to process, translate and map data to the output are being used. While the technology that is involved is continuously developing, these methods and techniques might stay the same, or can be transfered to new technologies. Artists have a need for a common vocabulary to talk about these methods and techniques, so that exchange may happen between artists who use different types of hardware and software.

With interactive technologies becoming more ubiquitous in our surroundings (e.g. Internet of Things and wearables that use biometric technologies), along with apps that promise us insight from the data that these 'smart' systems produce, the question of mapping also gains importance on a societal level: where is the border between providing insight from data through sonification and visualisation and artistic interpretation?

Related work in the artistic field

Miranda & Wanderley (2006)'s book provides a good introduction to the topic of mapping, though mainly focuses on the first part of mapping: gestures and how to capture the gestures and get the data into computers. The question of how this data is then used within the computer to map it to sound is only discussed in broad terms: explicit mapping strategies or implicit strategies making use of neural networks or pattern recognition tools. The book cites that the discourse in the literature on explicit mapping strategies "generally considers mapping of performer actions to sound synthesis parameters as a few-to-many relationship".

The proceedings of the NIME conference[2] are a valuable resource for publications about the topic, though as it is an academic conference there is a lack of publications on artistic work done outside of the academic world. Technical novelty tends to dominate over extensive artistic performance with the instruments. In particular papers on digital musical instruments that artists have built and developed and performed over many years (say 5 or more) are lacking in the discourse here. Other conferences of interest are the International Computer Music conference (ICMC)[3], and the International Conference on Live Interfaces (ICLI)[4]. ICLI also expands beyond music and takes a more philosophical, performative approach.

Kwastek (2013) presents an elaborate discussion on the aesthetics of interaction in digital art, which she places in the context of interaction as an aesthetic experience and the aesthetics of play. She provides an insightful method to evaluate interactive works, by identifying the actors, space, time, rules, phenomology, and materiality. These are then illustrated in several case studies. Other overviews of and reflections on interactive art are found in Wilson (2002) and Bianchini & Verhagen (2016).

Kozel (2007) gives a great insight into phenomonological aspects of performance incorporating technology, and how (interactive) technologies can change and question the perception of the body. Karreman (2017) writes about the use of motion capture in dance, and notes the contradictory desires from this technology: recognition and newness. The work on Motion Bank (deLaHunta et al. 2015) is aimed at using motion capture

[2]Available via http://www.nime.org
[3]Proceedings available via https://quod.lib.umich.edu/i/icmc
[4]Proceedings available via https://live-interfaces.github.io/liveinterfaces2020/proceedings/

technology to capture choreographic traces, that allow to study and transfer dance, and through that create new choreographies. Related conferences are organised by the Movement+Computing Community[5].

The references above provide great resources, though mostly stay within their disciplines (music, dance, media art), while many practicitioners move between these artistic disciplines, especially in collaborations. A cross-disciplinary approach would help the practicitioners (and those that study their practices) to support awareness of common methods and previous work, and insight into differences in aesthetic motivations in creating the works.

I find that there are still questions that need further study:

1. What is the connection between the aesthetic motivations of the artist and how is this aesthetic realised in the work?
2. How is this aesthetic implemented with the technology?
3. How do technological and aesthetic choices in this process influence each other in the artistic practice?

I believe that, by bridging the gap between the aesthetic and technological, important new insights can be gained and it would be made easier for artists entering this field, to build up on previous work (generated knowledge) from other artists.

A method for studying mapping

The methodology that I am proposing is a combination of interviews with the artists who created the instruments/works and an in-depth analysis of how the works are built.

In the interviews with the artists (and/or the engineers that are involved), I attempt to get an understanding of the artistic concepts that are behind the development of the work, how the idea evolved throughout the process of development and what choices were made along the way. I also discuss with them how the work is performed and how this relates to the artist's practice in general and how it changed their practice. In the analysis of the work I make note of what physical elements the work consists of, how these are interconnected and how they are positioned in space. How the work functions: which algorithms are used and what musical/visual/choreographical concepts is the work based upon. Which hardware and software is involved in the work, tracing how gestures are translated to output media.

I am currently applying and further developing this method both in case studies for the forthcoming book "Just a question of mapping" as well as in work sessions with artists (selected from open calls) under the title "Mapping my mapping". The outcomes of both will inform the other chapters in the book to describe these methods and techniques, both from an artistic and an technical perspective. I will work with graphic designers on creating a visual language to aid in documenting mappings.

Breaking down the process of mapping

Interactive works can often be broken down into various elements that are interconnected (see figure 2): (1) a gesture is performed in the environment, (2) which is captured by a sensor that translates the gesture into an electronic signal, (3) the signal is processed by an electronic circuit, often to digitize it, (4) after which it enters some sort of computational model that translates the data to parameters that control (5) an output medium such as sound, light, video or mechatronics. This is a simplification of the steps involved, and there may be various modifications to this general scheme. Nonetheless, breaking down the process of mapping in these steps may be a good start to understand these works.

One of the first stages in gaining an understanding of the mapping is identifying which physical elements are involved in the work and how they are interconnected. Which sensors or control interface elements are used, how they are mounted or placed in space, which circuitry is involved, what computers are involved and what software runs on these computers, which output media are involved and how are they controlled. Then identification of how these elements are connected: which cables run between them, what protocols are used for these connections, what kind of data flows through the elements.

After this physical exploration, the signals themselves are traced: how at each of these elements is the signal or the data translated to other ranges, gated, or compared with thresholds, combined with other data streams,

[5]Proceedings available at https://www.movementcomputing.org/proceedings/

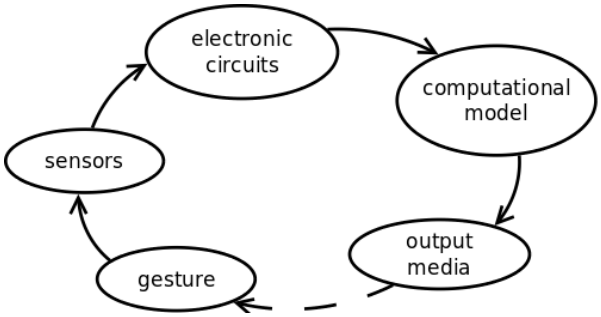

Figure 2: Steps in the mapping process.

feeding into computational models that generate new data, and eventually connected to one or more parameters of the output medium.

Computational model

The computational model can exist of several intermediate steps interlinked in various ways. These often include data processing methods like:

- translation between ranges (e.g. MIDI range of 0-127 to a standardized range of 0.0 to 1.0 to an exponential frequency range of 400 to 6000 Hz),
- the use of thresholds (e.g. for triggering or changing states), processing button presses and releases
- modal control or different states of behaviour
- deriving data or features (e.g. the mean or variation of a signal, spectral properties)
- combining various datastreams (e.g. gating a datastream with a button, or merging data from different axes of motion).

These can also include more sophisticated methods like programmed computational behaviours that are controlled by data derived from sensors, or various machine learning methods and/or gesture recognition algorithms.

Artist's choices and motivations

The choices at any of the steps above are based on artistic, technical and practical motivations, often coming forth out of experimentation. This is not always a linear process where an artist starts with a concept and ends up with an instrument according to this concept. Ideas may be discarded along the way, if they are not interesting to play. Technical options may prompt new ideas and directions. And throughout the process an artist may go back and forth between the different steps.

Choices made along the way are often based on accessibility: in cost, availability and familiarity to the artist. Or they may be based on coincedence: two ideas that just happened to come to mind around the same time and seemed interesting to combine.

Example: Erfan Abdi's NoteSaaz

As an example, the NoteSaaz from Erfan Abdi (Abdi & v/d Heide (2013)) uses the following main components (see figure 3):

- The physical controller consisting of four tubes with five five potentiometers and 8 buttons mounted on them. This controller is held and manipulated by the performer.
- An Arduino reading out the data from the sensors on the physical controller and sending this to Processing.
- A visual (computational) model of bows and strings programmed in Processing, that is controlled by the data readings from the sensors. From the visual model new data streams are derived from the

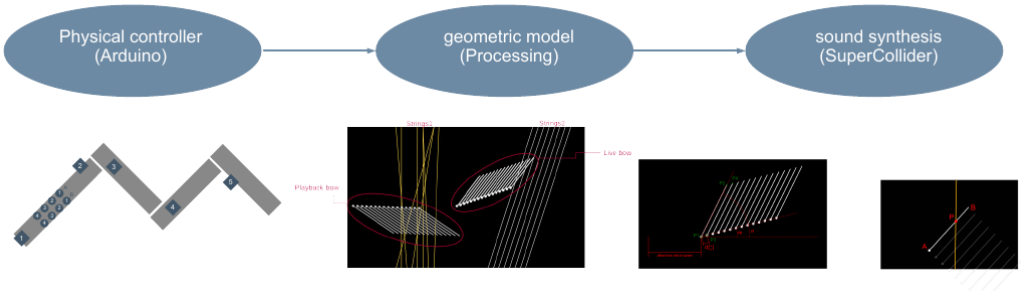

Figure 3: The three components in NoteSaaz (graphic created by Erfan Abdi during the work session in October 2019).

intersections of the bows and strings. The visual output is shown on a screen visible to both the performer and the audience.

- A sound synthesis engine running in SuperCollider that is controlled by the datastreams generated by the visual model. The sonic output is heard both by the performer and the audience.

The sensor data is scaled with linear or logarithmic range mappings, and the data from the visual model is again transformed to data ranges suitable for pitch, filter frequency, bandwidth and panning parameters of the sound synthesis (a formant synthesis algorithm).

The buttons allow for additional control over the visual model, and also enable the control over a second (visual and sonic) layer where movements of the bow can be recorded and played back.

The two elements of the visual model and the physical controller came together as Abdi had already been experimenting with visual models for controlling sound synthesis algorithms, but found himself in his studio without internet, and started to play around with some found sticks that were interconnected in an interesting way. Playing around with this object, he found that the object afforded a high dimensionality of movement, controlled just by two hands. This inspired him to create a similar object to sense all these dimensions and be used as a controller for his visual model.

First observations

From initial literature research and processing the first interviews for my case studies and the first two work sessions, I have made some observations, with which I want to conclude this paper.

The artists participating in the work session generally found this a really useful way of reflecting on their work: finally 'finding ways to talk about this'. One participant compared it to literary workshops, where the approach is that you 'first need to read in order to be able to write'. Another participant remarked that it helped to 'point out the blind spots in my project'. For several participants the work session gave prompts for further development, improvement or revision to the project, or provided the basis for a manual on the work, to enable troubleshooting in the future.

In the case study on Roosna & Flak I made an interesting observation: they stated that their use of a wireless accelerometer to control sound, has simply become one of the tools in their toolkit for making dance performances, rather than a novelty, interactive approaches are sometimes just an easier way of doing things.

From several of the projects (both in the case studies as in the work sessions) 'tourability' is an important aspect in the design of an instrument: this puts constraints on the amount of devices, replaceability, sturdiness, cost, size and weight of the elements that are used in a particular instrument, and sometimes result in the use of (surprising) workarounds for specific limitations that may give.

In several of the artistic projects analyzed, components have a long life and are used in a multitude of performative works. In some of the works analysed some of the components were exchangeable (like the physical controllers, or the sound content), and other components were put to new uses in new contexts with each new artistic project, thus becoming part of the artists' instrumentarium. Boundaries between instruments, performances and composition are sometimes hard to distinguish (see also Baalman 2016).

Conclusion

The process of mapping is an interdisciplinary effort and requires both engineering and artistic skills. While common strategies, tools and elements are used, each work is highly individual and often changing over time. New strategies, tools and elements are continually invented, embraced and (in some cases) abandoned again. The process is situated in time and relates to the available technical means and current artistic practices: it is connected to the music and other artistic paradigms embedded in available software and hardware, and how artists adopt, change, break and transcend these paradigms.

As such it is an enactive process of codevelopment of artistic concepts and technology. The resulting work may be seen as embodiments of the artistic concepts and performative expression of the artist. Conversely, the instruments are physical objects that allow the exploration and development of these aesthetic concepts (Magnusson, 2019).

In disciplines such as music (across genres), dance, media art and interactive art similar methods and approaches are used and artists often move between these disciplines. Therefore, it is necessary to look at these practices across disciplines, while at the same time discerning the different artistic concepts of interaction and embodiment in these different discplines and how these may influence choices for particular methods and techniques.

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