Interfacing graphic and musical elements in *Counterlines*

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Abstract

This paper reports on initial stages of research leading to the development of an intermedia performance *Counterlines* - a duet for Disklavier and Wacom Cintiq, in which both performers generate audiovisual gestures that relate to each other contrapuntally. The pianist generates graphic elements while playing music and the graphic performer generates piano notes by drawing lines. The paper focuses on interfacing sounds and images performed by the pianist. It provides rationale for the choice of materials of great simplicity and describes our approach to mapping.

Keywords: intermedia, Disklavier, piano, Wacom Cintiq, mapping, visual music

1. Introduction

The project is part of a larger initiative at CCRMA and Department of Music at Stanford to give new impetus to research and education in multimedia. Our experiments were conducted in the Intermedia Performance Lab (IPL) formed as part of this initiative.

Counterlines uses a Yamaha Disklavier piano, Wacom Cintiq 21UX and Mac 2 x 2.8 GHz Quad-Core Intel Xeon with patches programmed in Max/MSP/Jitter (Figure 1). It is a duet for a pianist and a graphic artist each of whom performs dual content in counterpoint to the other.

Music defines counterpoint as two or more melodic lines that are independent in contour and rhythm but interdependent in harmony. In our project, to allow a clear perception of 'linear' and 'harmonic' relationships all graphic elements are projected on a single screen but music is spatially separated between the Disklavier to the left and a virtual piano from speakers to the right.

It is a well-known fact that human virtuosity is often masked by the use of computers in live performance. Maintaining clarity of whom, how and when is in control of a particular material felt really important in a duet based on counterpoint. To achieve it visual and aural elements played by individual performers show strong intermodal coherence. In this paper we report on the investigation of rules that help generate visual elements from the musical input – how the piano material becomes audiovisual.

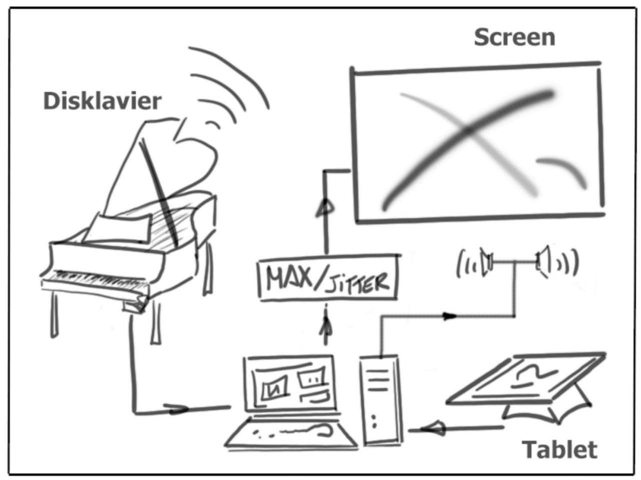


Figure 1. *Counterlines* set-up.

2. Related work

The emphasis on audiovisual coherence led us to draw on research related to mapping images to sound. Artists and researchers have made visualization attempts capturing different aspects of music. Some approaches try to establish a mathematical or geometric analogy between visual space and pitch relationships [1]. The creation of analysis tools to capture the structure of a melodic theme or patterns of form can be found in *Music animation machine* [2] and others [3,4]. Some researchers try to extract the harmonic structure and relationships between key regions in a musical composition [5]. The relationship between music and color has also been studied [6]. Numerous approaches were developed with the intention to capture and visualize musical expression [7-12]. This included the use of virtual objects or characters [8]. Having studied these examples and others we concluded that our approach could use selected elements of mapping to establish an audiovisual causality but no attempt would be made to consistently represent any aspect of music. Audiovisual coherence is only a tool needed to establish performance believability in initial or other crucial moments of the form.

3. Developing the materials

Most musical studies are characterized by an expansive use of a strictly defined, limited and often-simple musical idea or performance technique. Some of the best examples of piano etudes by composers like Chopin, Debussy or Ligeti prove that this approach can be extremely fruitful. In our view the clear presence of a live performer does not have to be based on virtuosity defined as a large number of notes executed in a short time. The refined and skillfully controlled timing and articulation of comparatively simple but highly expressive material is maybe even more impressive. In this regard we were more drawn by the challenging interpretational nuances of Satie than by technical fireworks of Liszt.

With these ideas in mind we decided to limit our musical and visual material to simplest possible elements that show potential for interesting intermedia elaboration. We will begin by shortly describing aural and visual materials by medium then proceed to the combined entities.

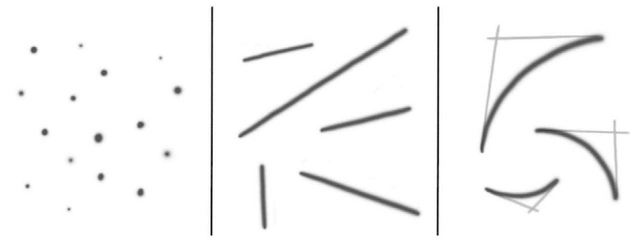
Ideally all elements would be balanced in a way that neither sound nor image dominates. We are looking for an audiovisual gesture composed equally of aural and visual content. We not only find this equilibrium necessary to serve the needs of contrapuntal development but also as a potentially most idiomatic characteristic of intermedia in general.

3.1 Melodic elements

The basic expressive unit of melody is an interval of two notes. At the start we decided to see if it was possible to create a piece with such limited material. Using MIDI a two-note motive can be represented by two events of given pitch, velocity and timing. The time and the interval between events can be measured and used as input. Within the pitch domain the expressive potential of intervals seemed to mostly come from the dissonant or consonant characteristics, which are related to harmonic content (ex. a perfect fifth is consonant, while a tritone is dissonant) and the relationship to a tonal center (ex. an minor second motion that moves away from the tonal center). As a result we decided to add a slightly more complex unit of three notes, in which the third note functioned as a tonal center and was repeated in a sequence of consecutive motives. With a tonal center established even the use of individual notes became a valid option. Ultimately our musical material consisted of single notes and two or three-note motives.

3.2 Graphic elements

The visual material generated by the piano should also be simple and expressive. We believe that what is important in animation is not the complexity of images that are set in motion but expressivity of the motion itself. Figure 2 shows the basic graphic entities that are animated in our research.



(a) (b) (c)

Figure 2. Basic graphic entities. (a) points (b) line segments (c) Bezier curves

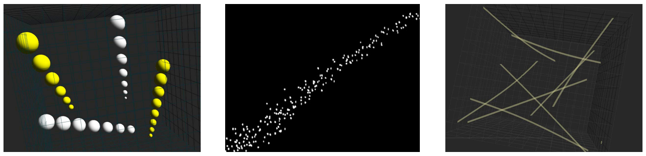
The point is the simplest spatial entity and the fundamental constituent of geometry. Kandinsky calls it a ‘zero (…) which in relation to the greatest possible brevity, i.e., to the highest degree of restraint, nevertheless, speaks’ [13]. Setting points in motion and imbuing them with different attributes such as color, shape and size one can produce interesting results. Despite its simplicity, even a point can be very expressive.

Another fundamental element in geometry is the line segment. It is constructed with two end points, which shows useful similarity to a two-note motive. Two or more line segments can be combined freely to create larger graphic structures analogous to a larger structure of a melodic line. Geometrically, a line segment can be seen as a special case of a Bezier curve, which has only length and direction. Curves seem to have an even stronger potential for dramatic tension through great richness of possible shapes.

In the restrained aesthetics of our project the three basic graphic elements (point, line segment and Bezier curve) seem to provide enough variety and expressive power. The added advantage of their simplicity is that from the computational point of view they can be easily generated in real time within the Jitter visual programming environment.

Finding an aesthetic and programming definition of the line that would match the aesthetic characteristic of the music was of great interest to us. Figure 3 shows three ways of representing a line in three-dimensional space. The first one (fig 3a) represents lines made of spheres. In the next example (fig 3b) the line is a strand of particles. The last method (fig 3c) shows continuous lines.

The results convinced us that for our project there is no need for a 3D space. Most of the expressive power of lines can be seen in two dimensions. In a flat video projection lines do not seem to show a clear sense of depth. An additional advantage of working in 2D is the savings in computational time, which can be used for real time rendering of more refined effects.



(a) (b) (c)

Figure 3. Line representation using (a) spheres (b) particles, (c) continous lines

The parameters of a graphic line that we decided to experiment with are shown in Figure 4.

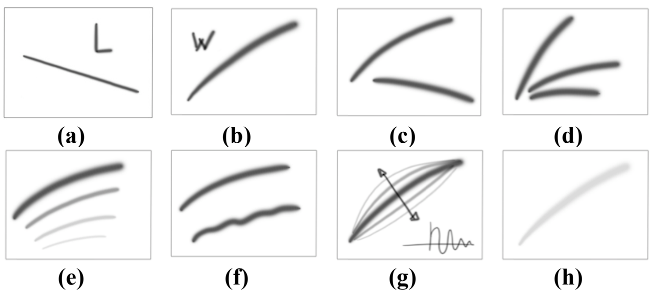


Figure 4. Line segment definition. (a) length (b) width (c) orientation (d) line group configuration (e) gravity effect (f) shape characteristics (g) vibration effect (h) transparency

3.3 Audiovisual entities

The central reason for our research was the interfacing of melodic lines and graphic elements to create expressively engaging audiovisual entities. Since we are accustomed neither to seeing a piano generate imagery nor to hearing drawings generate sound this kind of causality had to be established anew. As mentioned earlier, for that purpose certain elements of mapping seemed to be useful. Limited quasi-synaesthetic correspondences were applied to establish audiovisual entities that otherwise preserve a lot of independence.

The notation-like mapping of pitch to position in space found in some of the earlier listed research did not seem valuable to us. We perceive musical continuity as relative to context and absolute frequency does not seem to carry the principal expressive value. It had to be avoided also because it would have constrained the graphics too strongly, limiting the possibility of difference based on a longer context. The freedom to adjust the visuals from performance to performance, even when the pitches remain the same seemed to be a more enticing approach. We decided even that a level of randomness in establishing the position of initial points could be of interest.

One of the basic parameters of a line is its length. In an early experiment we linked the length of segments to the size of intervals. We tried different scaling of the elements but found it not to be very intuitive or expressive. It seemed that the correlation of velocity of notes and size of the visual entity were definitely a more convincing linking.

Further positive results involved linking:

- orientation with pitch direction,
- line group configuration with melodic phrase,
- shape characteristics with level of dissonance,
- gravity effect with tempo, and
- width, vibration effect and transparency with dynamics.

In all cases it occurred to us that just as musical parameters are perceived relative to context we should be able to adjust the range of change within the visual domain based on preceding events as well.

One of the challenges of the project was that music played on the piano consists of discreet events while graphical lines are continuous. Figure 5 shows symbolically the basic correlations of melodic notes and visual elements as they were linked in our research. Notes appeared as graphic points (fig.5a), note intervals turned into line segments (fig.5b) and three-note motives generated curves (fig.5c).

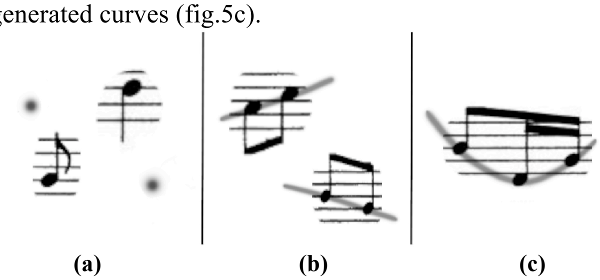


Figure 5. Linking melody and graphics. (a) notes = points (b) two-note motives = line segments, (c) three-notes motives = Bezier curves.

When does the computer interpret the piano material as individual notes and when does it treat it as a motive is an important element of composition and programming that will not be fully explained here for lack of space. It is important just to say that the project is not intended as an environment for free improvisation but a system that allows flexible performance of a pre-composed form involving different kinds of events. Both the performers and the computer will be aware of the possible rules of ordering of the three kinds of material.

It was important to us also to consider that even though individual notes or motives of a sequence appear and disappear, they build up in viewer's memory to larger structures. We felt strongly that as much as the visual elements can follow the individual sounds in their physical oscillations we should allow them at times to stay visible beyond the duration of aural gestures that generated them.

4. Conclusions

The attempt to find a convincing and expressive relationship of causality between melodic and visual lines has lead to a new understanding what each of these entities are in themselves. Even though there are many parameters in music that can be represented with numbers it was our experience that using algorithmic mapping has lead to audiovisual gestures that were maybe logical but not very expressive. Such techniques can reveal interesting, musically relevant, and at times highly sophisticated information but it is always reductionist and serves better the purpose of analysis than creation. The intermodal relationships are more engaging when based on context-dependent relative values rather than on absolute measurements.

The typical approach to interfacing sounds and images is synchronicity. In our case the two participating elements did not have to start exactly together or be of equal duration. It seemed to us that even if they profited from happening in temporal proximity with some overlapping part, in a relationship of cause and effect an action in one modality might precede reaction in the other modality. This is particularly evident in the case of an imitation relationship, in which one modality can be recognized to repeat what the other modality has shown before.

Interfacing melodic and graphic lines can happen on various formal levels. Depending on artistic need the visual 'reaction' caused by music can relate to single, short motives or much longer phrases. Ultimately, the formal duration and structure of audiovisual entities is a synergetic combination of durations and structures of composite layers.

Lastly, to create works with structurally integrated sounds and images their development must be worked out empirically in the constant presence of both layers. Because the expressive value of one layer is dependent on the other the experiments that involved both dimensions were crucial, most productive and decisive for our project.

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