THE HYPERVIOLIN IN *DALLA SUA ORBITA*

Marco Marinoni
Conservatorio "G. Verdi" – Como
marco.marinoni@virgilio.it

ABSTRACT

Dalla Sua Orbita is a piece for hyperviolin written in 2007 and revised in 2011 in which the hyperinstrument system produces modifications of sound and structure starting from incoming data. The musical data is encoded through processes of feature extraction and pre-processed by a limiter, then routed to algorithms for sound transformation/generation, which produce a musical result which varies, according to process intensity, from morphologically independent sound material (e.g. sound materials generated by the granulators [Patch 5] and pitch transposers [Patch 3]) to a reinforcement of the starting instrumental materials (spatialisation), timbre modifications (ring modulation with distortion of negative sideband output signal [Patch 2], live-sampling subsequent reading of fragments varying rate [Patch 4]).

The instrumental performer must be aware of how the hyperinstrument system interprets his actions instant by instant, so to provide significance to his technical and interpretational choices, in connection with the performance of the live-electronics interpreter.

The mapping is directly applied to the traditional musical instrument, implemented by specific hardware designed by professor Matteo Ricchetti and realized by InfoMus- Lab of Genoa.

1. INTRODUCTION

I composed *Dalla Sua Orbita* in the spring of 2007 specially for the "Primo Concorso di Composizione per Iperviolino, where it has been awarded the First Prize. The première took place in Genoa at the Auditorium Casa Paganini on Wednesday October 17th 2007 H 9pm, during the Festival Paganiniana 2007, with the following performers: Diana Jipa, hyperviolin; Marco Marinoni, live-electronics and sound direction.

The research at the basis of *Dalla Sua Orbita* was aimed to transform some aspects of instrumental technique, such as the position, pressure and motion of the bow on the strings or the motion of the left hand along the fingerboard following positions, fingering and gestures indicated in the score, in encoding engines for the hyperinstrument system, in order to make the musician not only responsible for the performance of the instrumental part but also, through his interpretative choices, directly and significantly involved in the building of the process of transformation/generation of sound and of the spatialisation paths of sound materials through the diffusion system.

Figure 1. Bracelet for the encoding of the parameter right wrist's tilt angle.

The right hand holds the bow. The bracelet (see Figure 1) fastened to the wrist encodes the parameter right wrist's tilt angle, detecting the tilt angle of the bow on the violin (indicated in the score as PARAM 1).

The left hand shifts along the fingerboard. A microled (see Figure 2) is placed under the scroll of the violin and encodes the parameter distance of left hand from the sensor (position of the hand on the fingerboard, indicated in the score as PARAM 2).

Figure 2. Microled for the encoding of the parameter distance of the left hand from the sensor.

The analogic data is converted in number values on scale MIDI 0÷127 and then sent to the processing units.

The instrumental signal is recorded by a super-cardioid dynamic microphone [indicated in the score as MIC 1] and a condenser cardioid microphone for close recording [indicated in the score as MIC 2]. Sound materials are sent to the processing units through a digital audio interface (MIC 1 to Patches 1, 3, 5; MIC 2 to Patches 2, 3, 4).

2. LIVE-ELECTRONICS

The processing unit implements five algorithm chains for sound processing.

Patch 1 [0'00' – 0'30''] (see Figure 3): includes eight pitch transposing modules PTR. Each unit receives audio signal from MIC 1 processed by a limiter/dynamic compressor and routes it to a specified loudspeaker, so to obtain a spatialisation of the sound materials which includes interconnected pitch and length fluctuations controlled by the performances of both the musician wearing the hyperviolin and the live electronics performer. The features of a PTR unit are shown in Figure 4.

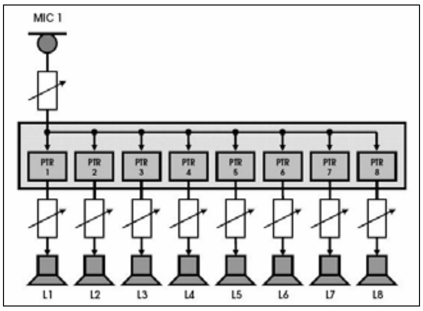

Figure 3. Patch 1.

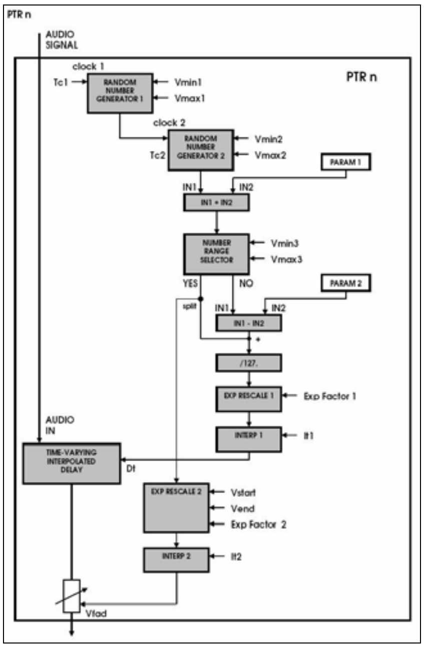

Figure 4. PTR module.

Patch 2 [0'30'' – 1'45''; 4'15'' – 5'30'']: audio signal from MIC 2 processed by a limiter/dynamic compressor is sent to a single sideband ring modulator (FREQUENCY SHIFTER module). Only the negative sideband is considered for further processing. The signal is split and routed directly to the spatialisation unit SPAT 2 x 8 and to a distortion unit (DISTORTION module). The signal from the DISTORTION module is then processed by FFT FILTER which provides equalization aimed to remove hiss and noise brought into the process by the distortion. Audio signal from FFT FILTER is then routed to the spatialisation unit, which is PARAM 1 and PARAM 2 sensitive.

Amplitude controls 1 and 2 are performed in real time by the live-electronics performer.

The algorithms included in Patch 2 are shown in Figures 5-9.

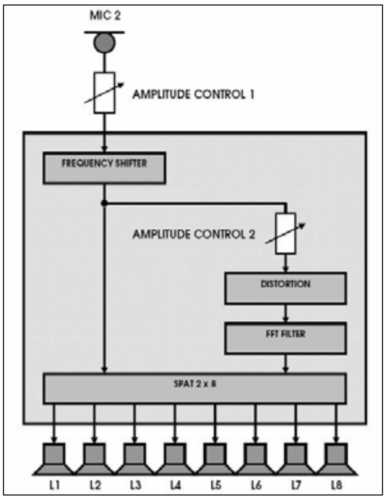

Figure 5. Patch 2.

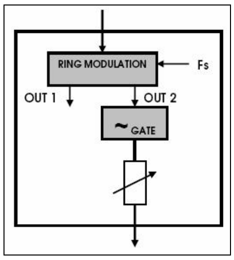

Figure 6. Frequency shifter module.

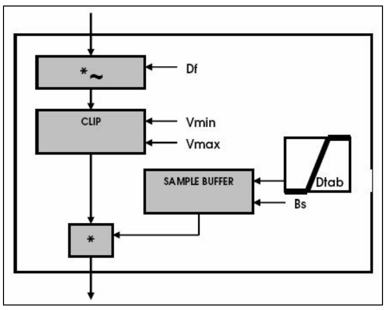

Figure 7. Distortion module.

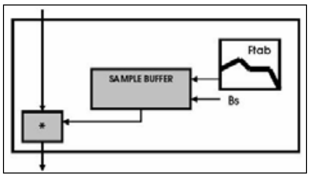

Figure 8. FFT filter module.

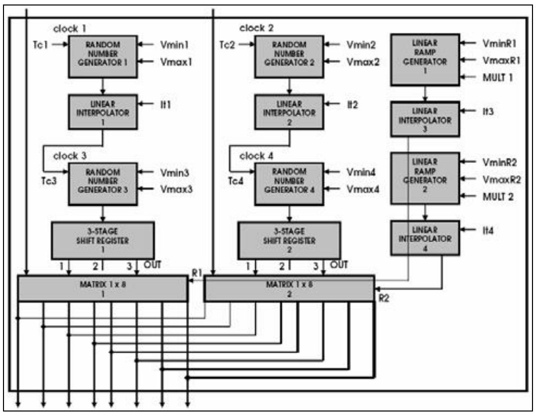

Figure 9. Spat 2x8 unit.

Patch 3 [1’55’’ – 3’00’’; 6’05’’ – 6’32’’] (see Figure 10): fifteen Pitch transposition modules (see Figure 11) in which PARAM 1 and PARAM 2 determine the range of values for the transposition factor.

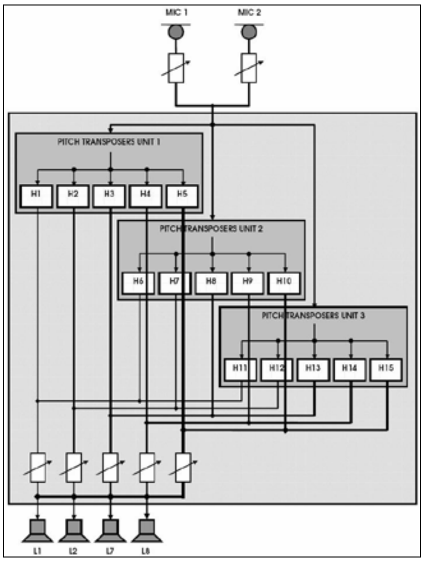

Figure 10. Patch 3.

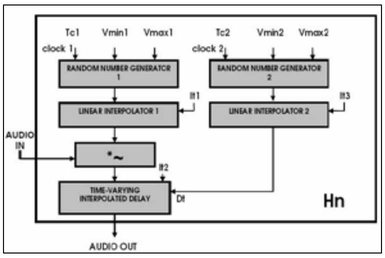

Figure 11. Pitch transposition module Hn.

Patch 4 [3’00’’ – 3’45’’; 5’50’’ – 6’05’’] (see Figure 12): audio signal is recorded in a buffer and then read by four engines graphically controlled in real time dragging the pointer inside a window: the engine reads the selected part. The velocity of reading depends on the length of the window: reading slower or faster a fragment causes pitch transposition. Inverse proportionality is suggested. The sound materials out from READ modules are routed to four spatialisation units PTR (see Patch 1).

Patch 5 [3’55’’ – 4’15’’] (see Figure 13): eight granulation units (see Figure 14) in which PARAM 2 determines the fluctuations of minimum grain duration values and PARAM 1 the fluctuations of the maximum grain increase values calculated on the basis of the grain duration values.

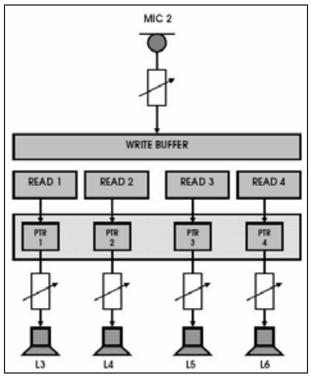

Figure 12. Patch 4.

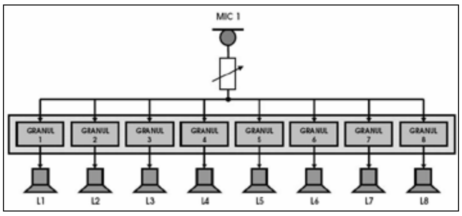

Figure 13. Patch 5.

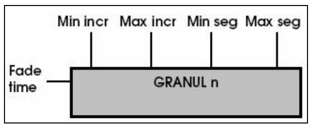

Figure 14. Granulation unit n.

For what concerns the right hand, the parameters are:

- bow direction;
- bow velocity;
- bow pressure;
- bow position;
- bow inclination;
- bow portion.

Different parameters are controlled by the live-electronics performer, in order to assure a real "four hand" performance.

The parameters controlled by the live-electronics performer are:

- input level for microphones' signal;
- output level from the five sound processing algorithms;
- input level to the distortion unit and output level from ring modulator and from distortion unit (Patch 2);
- output levels from stereo dynamic compressor (Patch 1);
- fade time for the spatialisers.

The sound materials performed by the musician are specified in the score [7], where the assignment of the patches to the sections of the piece is indicated.

3. DIFFUSION

The diffusion system requires eight independent channels and a sub-woofer. The diffusion point sources are placed around the audience, orientated toward the audience as shown in the Sound Projection Scheme (see Figure 15). The processing algorithms distribute the sound materials to the eight diffusion sound sources as explained below:

- Patch 1, 2 and 5 to 360° diffusion (L1-8);
- Patch 3 to front diffusion (L1, L2, tilt 0°) and rear diffusion (L7, L8, tilt 180°);
- Patch 4 to side front diffusion (L3 tilt 270°, L4 tilt 90°) and side rear diffusion (L5 tilt 270°, L6 tilt 90°).

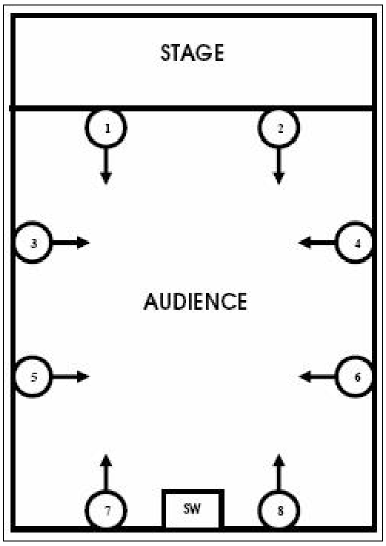

Figure 15. Sound Projection Scheme

4. THE INSTRUMENTAL MATERIALS

The choice of musical materials to be included in the score, especially the alternation of two opposite typologies of musical events (point-dynamic and linear-static), was aimed to support the processes of sound transformation/generation and their differentiation (diegetic function) with regard to the position on the timeline of performance (mimetic function). The experience of a musical time shared between the violinist and the live-electronics performer, in which events of different types find a common ground of evolution pertains to the character of *mimesis*, while the course of the musical materials from time to time generated or processed through the separate gestures of the two performers, in their particularity and different parametric connotations pertains to the character of the *diegesis*. The reference to an archaic time shared allows the occurrence of that particular type of interaction that Weinberg described as an Interconnected Musical Network where "live performance systems that allow players to influence, share, and shape each other's music in real-time" [11]. Together, the two connotations of *mimesis* and *diegesis* intensionally inform a number and quality of sound objects, which organize the spectro-morphological texture of the composition.

The musical materials are mainly constituted by:

- Point musical objects featuring variable pitch but undergoing to crystallization and characterized by micro-variation processes and iterative rhythm structure; the range is generally high or extremely high (Typology 1, see Figures 16-18);
- simple (one line) or stratified (two or more lines) linear musical objects featuring the possibility of internal rhythmic subdivision and variable range (Typology 2, see Figures 19, 20).

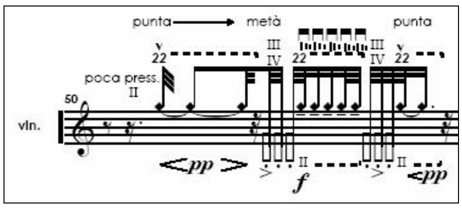

Figure 16. Typology 1; example 1.

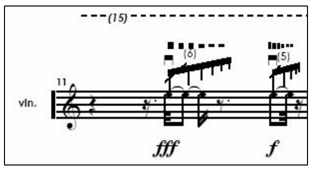

Figure 17. Typology 1; example 2.

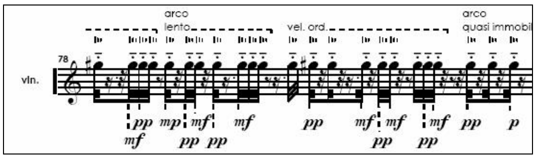

Figure 18. Typology 1; example 3.

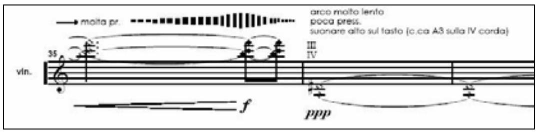

Figure 19. Typology 2; example 1.

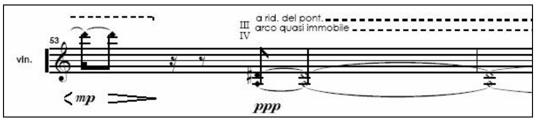

Figure 20. Typology 2; example 2.

For what concerns linear objects, the degree of intelligibleness of pitch varies on a continuum axis including white noise (e.g. bow on the bridge and strings muted with the left hand, 0’00’’ – 0’30’’, see Figure 21), single note (e.g. bow tremolo as light as possible close to the bridge at 2’40’’, see Figure 22), bichord (e.g. low range natural harmonics with bow almost motionless close to the bridge at 3’30’’, see Figure 23), trichords (e.g. high range natural harmonics with light bow in ordinary position around 2’00’’ and maximum bow pressure with high distortion of the sound resultant at 2’24’’, see Figures 24 and 25).

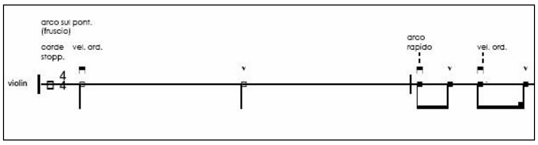

Figure 21. Bars 1, 2.

Figure 22. Bars 39-41.

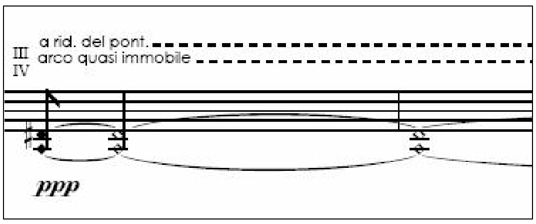

Figure 23. Bars 53, 54.

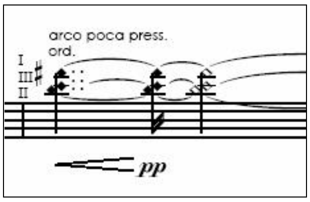

Figure 24. Bar 29.

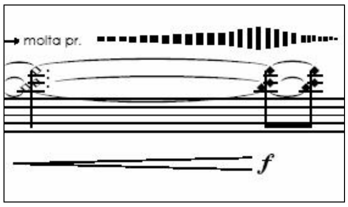

Figure 25. Bar 35.

5. DISCUSSION

From the point of view of language, it is useful to refer to a hyperinstrument as a hypertext constructed from an acoustic instrument, such as the violin. In this sense, the hyperinstrument is a “multidimensional structure simultaneously organized in a network of a multiple interconnections” (my translation) [1]. This conception of the hyperinstrument is consistent with that of Interconnected Musical Network, where “the use of technology […] pushes the tension between structure and process music further into an experience where predetermined rules and instructions, combined with improvised interdependent group interactions, lead to evolving musical behaviors, giving a new meaning” [10]. For further discussion of this issue, please refer to my contribution about the hypersampler in *Il grifo nelle perle nere* [8].

The choice of instrumental materials was made taking into account Cadoz’s “Instrumental Gesture Typology” [2] which is based on gesture’s function. Cadoz distinguishes between Excitation, Modification and Selection Gestures; Excitation gestures (see Section 4, Typology 1) can be Instantaneous (sound starts when gesture finishes: see Typology 1; example 3, Figure 18) or Continuous (gesture and sound coexist: see Typology 1; example 2, Figure 17); Modification Gestures (see Section 4, Typology 2) can be Parametric (continuous variation of a parameter: see Typology 2; example 1, Figure 19) or Structural (modification is related to categorical difference: see Typology 2; example 2, Figure 20); Selection Gestures describe the category of micro-variation (see Typology 1; example 3, Figure 18) which plays the role of parameter of formal organization.

The hyperviolin system developed for *Dalla Sua Orbita* is a multimodal interface controlled by both “the perceptual features […] extracted from the audio stream of the controller instrument” and the musical gestures: an “*interface* between a musical sound controller and a musical sound output of arbitrary timbre” [4] which gives meaning to the musical gestures of the performers. It includes "high-level extensions toward integration of gesture and audio processing, aimed at music performance analysis and expressive information processing" [3] which effectively measures "aspects of the physical performance that describe the interaction of the player with the instrument" providing "possibilities for the real-time alteration of acoustic or electric sound though gestures familiar and learned by the player" [12].

The role of the technology implemented by the hyperviolin is consistent with that suggested by Tarabella and Bertini, according to which sensors" should leave the body completely free from whatsoever electrical and/or mechanical link with the main system, for giving the performer(s) maximum freedom of gesture and to hide technology away from the stage" [9]. No other gesture is required in addition to the violinist's musical gestures implicit in the performance of the score [7], through which it becomes possible to "evoke and control a greater – even unlimited – range of sounds and textures by simply interpreting the music in the most natural way"[6]. Provided that the parameters involved in a violin performance are many more of those taken into consideration in this research, and often difficult to quantify, the decision to focus on two macroscopic parameters such as PARAM 1 and 2 was a forced choice to "refine this multitude of possibilities into a new and meaningful unity, and the beautiful and tenuous fragility, and expressive possibility, of the new instrument, once it exists" [5].

6. CONCLUSIONS

In the light of the performances accumulated in recent years, including one by Carlo Lazari which took place on July 7, 2011 in the SMC – Sound and Music Computing Conference 2011 in Padova, we can say that *Dalla Sua Orbita* can be considered one successful effort to combine research in technology with the study of musical expression.

As previously specified, the effort was to match the parameters related to the musician's expressive gestures to those related to computer processing of instrumental material, in order to build a chain of meanings around the movement and energy that characterize the expressiveness of a violinist during a performance. This effort provided results from time to time changing, even in relation to the architectural space in which the performance took place, and significantly related to the design and implementation of the hyperinstrument system.

This is consistent with Machover, according to which a hyperinstrument must be able to capitalize on the continuous feedback mechanism that is created during performance, assuring "that intuitive musical intent is transmitted throughout the system" [5] and coherent with Weinberg, who emphasizes the flexibility to allow a true interaction "to stir the musical output into unpredictable directions, leading to an experience that is based on evolving and dynamic social contexts" [11].

Future developments will include the attempt to experience the extension of this paradigm to other more complex hyper-instrumental combinations.

7. REFERENCES

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