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Bi-manual mapping experimentation, with angular fundamental frequency control and sound color navigation

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Abstract
In this paper, we describe a computer-based solo musical instrument for live performance. We have adapted a Wacom graphic tablet equipped with a stylus transducer and a game joystick to use them as a solo expressive instrument. We have used a formant-synthesis model that can produce a vowel-like singing voice. This instrument allows multidimensional expressive fundamental frequency control and vowel articulation. The fundamental frequency angular control used here allows different mapping adjustments that correspond to different melodic styles.

Keywords
Bi-manual, off-the-shelf input devices, fundamental frequency control, sound color navigation, mapping.

INTRODUCTION
Throughout history, people have recycled objects belonging to their environment into musical instruments. The computer industry has developed low-cost manual controllers devoted to graphic or entertainment applications. Artists and musically-inspired researchers have taken advantage of those "off-the-shelf" controllers for music, in may different and interesting ways [2], [3], [7], [9], [10]. Here, we experiment on a mapping strategy, which allows simultaneously melodic expressive control and spectral manipulation (like navigation in sound color [6] or timbre spaces [8]). The use of incremental angular fundamental frequency and transfer function for fine tuning controls has been explored.

CHARACTERISTICS OF THE TOOLS
The peripherals used here are the A6 Wacom graphire2 graphic tablet, the Thrustmaster Fox2pro joystick. The x, y and pressure data and the three-position lateral button (released, down pressed, up pressed) of the stylus have been used to drive the instrument (simultaneous sensing of two devices, orientation, tilt, rotation estimates are not available on this implementation of the honourable and honoured "artist's tablet"). We have used x, y data related to the joystick. This instrument has been programmed using the real-time musical software environment Max/MSP [11] completed by the *Insprock*, *Wacom, MTCcentroid* and *Vtboule* objects, on a macintosh imac G3 500 MHz (7% CPU).

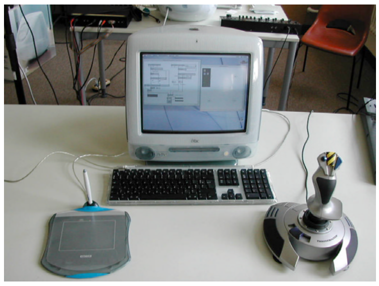


Figure 1. The users interface.

THE SYNTHESIS MODEL
The model we have used is inspired by the one used by Daniel Arfib in his musical work "Voyelles d'éveil", realized in 1978. This is a model well documented in the literature, whereby a signal with a rich and regular spectrum is filtered through three second-order all-pole filters in cascade. Our aim is not to simulate a hyper-realistic voice, but to build up an efficient and expressive control for a soloist. The synthesis model's choice was based on aesthetic and historical criteria, but also in consideration of future evolutions (a source signal using a non linear distortion [1] is interesting). We have distributed the French vowels in the plane of the parameters-list interpolator (which is the *Vtboule* Max object), according to the openness and acuteness perceptive attributes of sound color defined by W. Slawson [6]. The joystick x, y data are assigned to the position of the cursor in the interpolator plane.

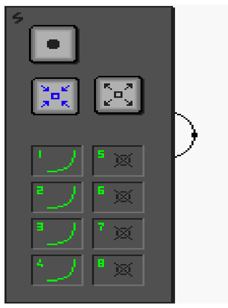
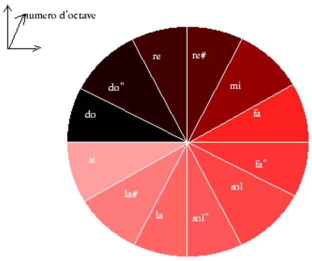


Figure 2.A part of the interface of the *Vtboule* object interpolator.

In the interface of the *Vtboule* max object, the user can choose the attraction function for each circle or "bowl" (the French word is "boule").

A WAY TO CONTROL FUNDAMENTAL FREQUENCY WITH THE WACOM TABLET

To permit a control of fundamental frequency within one octave and from one octave to the other, we divide the tablet's active space into 12 equal angular parts, every part corresponding to a semitone of the chromatic scale. Turning clockwise changes pitch from low to high. We can go from a note to its lower or higher octave by pressing up or down the stylus lateral button. Incremental angular control has been added: when one has made a whole turn, the fundamental frequency still grow up in the higher octave, and inversely in the inverse gesture. It appears more logical for us to use incremental control and it can also be seen like a new musical possibility with a boundless range. This fundamental frequency control was inspired by the works of R.N Shepard [4] and J.C Risset [5] on musical pitch. To help the neophyte in the learning process, we added a drawing representation of the fundamental frequency control on the active surface of the tablet.



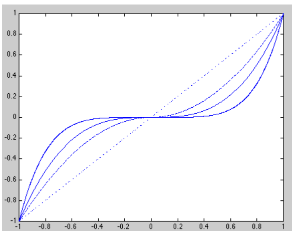


Figure 3. " Portions de Camembert " representation of the fundamental frequency angular control.

Figure 4. Four examples for transfer function that can be used for fine-tuning (linear, sign (x)*x^2, x^3, x^5).

To allow pitch bending or more precisely in our case fine-tuning control, we are using transfer function locally applicable on each semitone angular part. The transfer functions are designed to allow the user to have stable and efficient control of tonal pitch accuracy and force him or her to make a conceptual effort to have fine tuning variations. The choice of the transfer function allows the performer to customize his instrument. This is a way to specify a melodic expressive personality. It could be compared to the choice of neck touch, fret style or whammy bar for electric guitar.

GESTURE AND FEEDBACK

The use of a mapping layer from the sound color attributes to the filter coefficients permit to get a good sound feedback when one acts on these attributes. The mapping, associating the x and y joystick positions to the two sound color attributes, is effected by the use of the interpolator (*Vtboule* object) and the choice of the interpolation function. This mapping preserves the sound feedback while adding some strength and relief to the control. The choice of the tools provide some visual feedback; indeed, when one plays with the joystick one can see a cursor moving in the visual interface of the interpolator. Haptic feedback can be seen in the use of the joystick, because it has a springiness resistive force and returns automatically to the neutral position. We have also tried the use of the MTC Tactex multi-touch controller instead of the joystick in the same mapping principle, by using the x and y coordinates of the Tactex touch unique centroid. In this case, the feeling seemed less pleasant to us, especially because of the absence of an automatic return to a neutral position and a resistive force.

AKNOWLEGMENTS

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