Articulated Paint: Musical Expression for Non-Musicians

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ABSTRACT
In this paper we present the concept and prototype of a new musical interface that utilizes the close relationship between gestural expression in the act of painting and that of playing a musical instrument in order to provide non-musicians the opportunity to create musical expression. A physical brush on a canvas acts as the instrument. The characteristics of its stroke are intuitively mapped to a conductor program, defining expressive parameters of the tone in real-time. Two different interaction modes highlight the importance of bodily expression in making music as well as the value of a metaphorical visual representation.

Keywords
musical interface, musical expression, expressive gesture, musical education, natural interface

1.INTRODUCTION
To non-musicians, the idea of playing a musical instrument is often just related to controlling the instrument in terms of selecting the right note in the right rhythm in order to translate what is written in the score. In fact, most of the practicing in the beginning years of learning an instrument will be concerned with this necessary evil on the way to artistic expression.

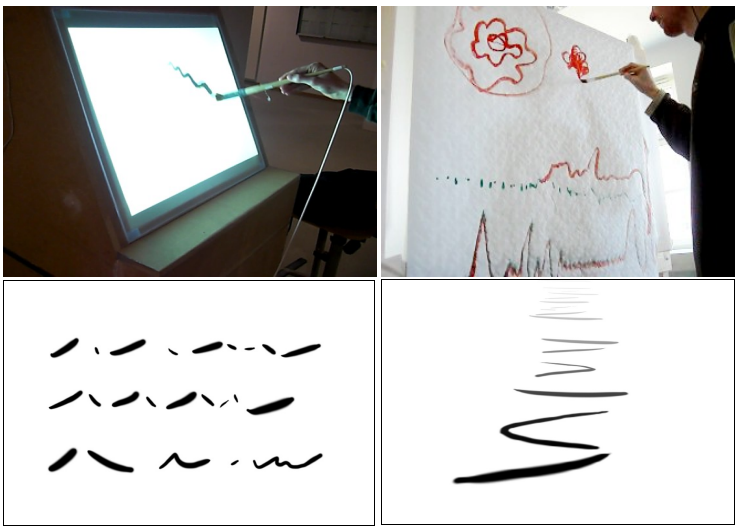
With our novel musical interface called *Articulated Paint*, we want to enable non- and beginning musicians to instantly experience basic aspects of musical expression by eliminating the need to learn how to play the right notes. By giving them a taste of the joy of interpreting music individually, we hope to generate a stronger interest in learning a real musical instrument.

Using *Articulated Paint* is as intuitive as drawing on a canvas. The paint-brush functions as the instrument. The stroke it leaves behind gives expression to the notes that are automatically served from the computer. The computer reads the notes from a MIDI file and sets the frequency of the notes, one after the other, while the handling of the brush determines expressive parameters such as timing, dynamics, articulation, and vibrato. Using this setup, the user can experiment with different expressions for a music piece and refine it, without being burdened by the insurmountable complexity of a classical instrument. We are interested in the effects of such an interface on creative exploration and learning.

2.RELATED WORK
Conductor-like musical interfaces
Articulated Paint falls into the category of *conductor programs* [1], in which the computer handles the playback of the score while the musician conducts the "manner" in which this happens. There are several projects that enable a user to step into the role of a real conductor, mostly using a baton as an interface to direct an electronic orchestra, most recently [2]. Another interesting mapping of bodily gesture on musical expression comes in the form of a car driving simulation [3]. [4] allows a user to control loudness and tempo of a music piece by playing a theremin.

Painterly interfaces for media control
The classical interface of brush and canvas is usually highly abstracted in computer interfaces. [5] tries to bring the physical aesthetics of real painting to animated images. [6] is an interface for kids to paint with their environment as a palette. [7] makes use of an alternative classical painting device, the spray can, to generate music out of images. All of these make successful use of the affordance and intuitive expressiveness of real painting tools.

3.DESIGNING THE INTERFACE
Bodily expression
The physical form of the interface (brush on canvas) is chosen deliberately. Motivated by a larger research theme that is concerned with the role of the body in creativity [8], the idea is to create an interface that makes this connection more explicit. As there seems to be a conditioned link between bodily movement and music, the design of a gestural musical instrument seems particularly fruitful. A conventional graphic tablet does not



Figures 1-4 (clockwise): User drawing a vibrato; Preliminary user study; Bodily Mode; Notational Mode

suffice. Initial ideas based on tracking the body movement of a musician similar to [9] were set aside in favor of the more intuitive and instantaneous brush interface which also provides haptic feedback.

The importance of bodily expression is preserved: As with an instrumental musician - who has to move the whole body, including breath, in an artistic conjunction with the parts controlling the instrument in order to achieve a convincing aural expression – the artist in our interface needs to engage in the interaction with the whole body. We assume that for a non-musician trying out *Articulated Paint*, this is a joyful and revealing experience.

Playing Modes

As there is no innate way of painting musical expression, we conducted an informal user study prior to building the system, in which subjects were asked to draw the expression of the melodies they were hearing. The result was a mixture, ranging from rather conventional waveshape-like drawings to freestyle (see Figure 2). From this study we condensed two alternative modes of playing the instrument. The basic setup, however, is the same. A session starts with an empty screen. The music is played to the user in advance so that she can memorize the melody. She then applies the brush strokes to play the same melody by herself. Only a little amount of instructions are given in the beginning, increasing with the learning of the user.

Bodily Mode - The first mode is more focused on the movement of the brush rather than the image it creates. In fact, the user is encouraged to play it blindly. The user is painting on a virtual "conveyor belt" that moves in a steady tempo in the direction of the z-axis. This way, she is actually painting on the same vertical position over again and can concentrate on the expressive movement of the brush (Figure 3). Another advantage here is that the resulting image conveys the tempo of the brush movement.

Notational Mode - This mode is closer to the conventional notational system. The user paints line-by-line from left to right (Figure 4). Handling of the instrument becomes more complex, while the room for expression is a bit diminished, as movement is now restricted to left-to-right. However, this comes at the benefit of a more powerful representation. It is easier to interpret and is suited to be revised and improved on. The gestural mapping we employ offers some freedom for giving each music its characteristic look and be used to develop individual notations.

Gesture Mapping

The mapping of brush movement to acoustic parameters is very direct and happens in real-time. Note timing is controlled by either removing and reapplying the brush to elicit the next note, or by changing the direction of movement in legato (horizontally in the bodily mode, and vertically in the notational mode). The intensity of brush movement (pressure and velocity) is mapped to the dynamics. Articulation is also related to dynamics. The style of legato depends on how quickly the direction of brush movement is changed, while the style of accentuation results from the temporal distribution of pressure. Vibrato can be achieved by moving the brush in a wiggly line. This mapping has so far been experienced as rather natural, but the optimal mapping is still being explored. The starting coordinates (x- and y-value) of a brush stroke currently have no additional meaning, but it would be interesting to use it to vary the timbre of the tone.

4. IMPLEMENTATION

The physical part of the interface consists of a custom-built brush and canvas. The flat brush contains bend sensors for sensing pressure and infrared-LEDs for determining its position via camera tracking on the rear-projection canvas.

The software side is composed of a mixture of open-source electronic arts software. Video tracking is accomplished by *vvvv* [10], the visualization is done with *Processing* [11]. The central part of the application was created in *PureData* [12]. It analyzes the brush movement and maps it, together with the frequency of the current note obtained from a MIDI file, to the simulation of a physical wind instrument, provided by the *PeRColate* [13] library.

5. FUTURE WORK

As this work is still in its infancy, there are several directions which we would like to pursue. The individual components related to the expressiveness of the interface need more refinement for a more powerful and reliable effect. For an educational setting, we would like to design and evaluate an instructional program that teaches the different aspects of musical/gestural expression with progressive complexity, from solist controlling just the dynamics, to an ensemble situation. Furthermore, we will implement functions to revise one's performance and provide the ability to correct and annotate it.

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