THE MUSIC PAINT MACHINE
A Multimodal Interactive Platform to Stimulate Musical Creativity in Instrumental Practice

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Abstract: Interactive music systems offer new possibilities to support instrumental music teaching by providing a corporeally grounded experience as a basis for understanding music and music playing. In this paper we introduce the Music Paint Machine, a device that enables music performers to make a painting on a computer screen by playing their instrument. It is hypothesized that using this application stimulates understanding and creative use of musical parameters.

1 INTRODUCTION

In music education and more particular in instrumental studio teaching, the use of computers to support the teaching and learning process is growing but is nevertheless still in a rather early stage. Computers are used to make and analyse recordings (e.g. intonation, mistakes), the World Wide Web is used to provide information and to communicate outside the lessons (e.g. website, electronic learning environments), and software is developed for student assessment. Furthermore the use of music notation software is widely spread in music education. An important and recent development is the design and implementation of tools that support the learning process by measuring the instrumental gestures and posture of for example string players (e.g. KC Ng et al., 2007) and clarinettists (e.g. Wanderley, Vines, Middleton, McKay, & Hatch, 2005).

Almost nonexistent in instrumental music teaching is the educational use of interactive music systems. Although a variety of these technological applications have been used for quite some time in performances, they have not yet found their way into the domain of musical instrument teaching. Interactive music systems could, however, address current issues regarding motivation and creativity in music education (Bamford, 2007), by providing an experiential basis for learning in which methodically designed learning paths can be combined with more exploratory ways of learning to play a musical instrument .

In this paper we introduce such an educational interactive music system, the Music Paint Machine.

2 THEORETICAL FRAMEWORK

The theoretical background of the conceptual design of the Music Paint Machine is the Embodied Music Cognition paradigm. This research paradigm acknowledges the embodied nature of the musical mind (Leman, 2007). What happens in the mind depends on properties of the body and therefore body and body movement have an impact on meaning formation.

An important aspect of embodied music cognition is the multimodal nature of musical involvement and expression. Visual, auditory and haptic/proprioceptive perception can strongly interact. One modality can, for instance, disambiguate information in another modality; different modalities can provide a means of calibration for one another and a percept from one modality can even override that of another modality (Ernst & Bülthoff, 2004). Most importantly, these interactions are mostly unconscious and they are spontaneous. Music can therefore not be studied as merely sound (Schutz, 2008); it should be studied as a multimodal phenomenon.

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Interactive music systems use sensing technologies and software applications that enable users to explore and creatively exploit the multimodal nature of corporeal intentions and expressive articulations, while being engaged in music. Accordingly, interactive music systems facilitate gestural and multimodal involvement with music. Therefore their use in instrumental teaching can contribute to a more embodied approach to instrumental music education as opposed to a prevailing cognitive-emotional approach. By using applications that stimulate full corporeal engagement in music, students learn to understand the bodily basis of musical meaning.

3 THE MUSIC PAINT MACHINE

3.1 Concept

The Music Paint Machine is an interactive music system that introduces movement and experimentation in musical instrument teaching. It allows music performers to make a painting by simultaneously moving the body and playing music. The painting takes shape by combining musical features (i.e. pitch, loudness, playing style) and body movement (i.e. moving the upper body, trigger sensors with feet on a dance mat).

3.1.1 Learning Goals

1. Stimulate Creativity Through Playfulness with Musical Parameters

An important element of musical creativity is playfulness with musical parameters (Deliège & Wiggins, 2006; Sloboda, 2000). The combination of playing, moving & painting leads to a better understanding of these parameters by providing a corporeally grounded experience as an experiential basis for learning and by stimulating students to experiment with these parameters. The introduction of visual feedback makes users forget the technicalities of playing their instrument and affords them to immerse in an action-perception loop and intuitively respond to what happens on the screen. In this way the Music Paint Machine induces a shift from “controlling” to “experiencing” musical parameters.

2. Develop Confidence and Skills to Improvise

Everybody can paint or draw something. The Music Paint Machine offers the opportunity to learn to “let go” and play something from scratch by translating musical improvisation into a more familiar thing to do, i.e. painting or drawing. It even can become a challenge to paint complex, beautiful or funny pictures by playing the musical instrument. In this way students can gain confidence and audacity to improvise.

Besides lowering the threshold to improvise, the Music Paint Machine can also be used to further develop improvisation skills. According to Welch and Adams (2003) improvisation in music is fostered through encouraging the learning of basic musical elements. Improvisation skills are based on building blocks of simple musical behaviours that should be practiced. The development of these skills starts with exploration of all the possibilities to create sound (Kratus, 1991; Scott, 2007). The Music Paint Machine provides an excellent way to encourage musical exploration but also to help a student developing throughout the different levels of improvisation and thus acquiring the skills to creatively improvise (Kratus, 1991).

3. Develop Embodied Musicianship

Musicianship is in essence procedural knowledge, rooted in practice and invariably embodied (Bowman, 2000; Elliott, 1995). An important aspect of musicianship is listenership (Elliott, 1995). Listening to music (both when performing or not) is a “hearing-as”, the foundation of which is the body (Bowman, 2004). What we hear is translated into a so-called action oriented ontology, i.e. a repertoire of movements that are sedimented in our body schema through an action-perception coupling and provide a reference against which musical meanings can be attributed (Bowman, 2004; Leman, 2007). Listening and musical understanding therefore can be refined trough the use of body movements (Pierce, 2007). Therefore, acknowledging the embodied nature of music cognition means acknowledging the bodily basis of musical knowledge and understanding.

The Musical Paint Machine integrates body movements in its mapping. By using the body to play and paint, music students can explore the possibilities of their instrument and experiment with movement and musical parameters. Through specific drawing tasks, movements can be used to elicit bodily understanding of certain musical elements such as phrasing, dynamics and articulation (transition between notes or not).

Because the Music Paint Machine offers the possibility to represent movement and sound in a common visual stimulus, it accommodates the multimodal nature of musical expression and

involvement. By combining movement, sound and visuals, it can turn learning to play music into a "gesamt-erfahrung", i.e. a multimedia event in which different forms of artistic expression are combined and lead to a multimedia output. Through a creative and playful use of musical parameters, based on the integration of sound, movement and visuals, a proficient user can turn this output into an artistic creation, a kind of twenty-first century "gesamtkunstwerk".

3.1.2 Didactic benefits

1. A Tool for Pedagogic Documentation

Pedagogical documentation is a tool for participatory and formative evaluation (Dahlberg, Moss, & Pence, 1999; MacDonald, 2007). It aims at visualizing and understanding what is going on during a lesson and what the child is capable of without any predetermined framework of expectations and norms.

In view of its pedagogic goals, the Music Paint Machine can be used as a tool for reflective discussion by using the students' artistic creations as pedagogic documentation. The comparison between drawings and music can reveal different aspects of the student' s playing (e.g. how creative a student deals with musical parameters) and of the learning process. Not only is it possible to compare different paintings over a certain period of time, but thanks to the software that is implemented in the Music Paint Machine, it is also possible to (re)view each play session in different representation modes, by including or excluding the time dimension and by changing the view between different angles (see section 3.2.2). This enables teacher and student to discuss features of music playing such as amount of movement (e.g. use of many colours indicating a lot of movement with the feet), ways of moving (e.g. more vertical then horizontal), correlations between sound, visuals and movement and the like. In this way the Music Paint Machine contributes to the development of bodily awareness in the context of embodied music cognition.

2. A Tool for Student Assessment

The Music Paint Machine can be regarded as an "artistic" measurement tool, complementing an analysis based on objective measurement data. However, the fact that it provides both, allows one to compare artistic output and objective measurement. This comparison might reveal interesting aspects of the students learning process by revealing the link between product and process.

Furthermore, students can store their creations and include them in a portfolio. Or they can be put on the wall of the classroom. This enables peer evaluation which is an underestimated but very valuable component of an efficient evaluation system (Nijs, 2008). In this way it is possible to map the progress of the student as visualized in his artistic creations.

3. A Motivator

The Music Paint Machine contributes to the development of intrinsic motivation to play the instrument by increasing the fun factor of instrumental music lessons or practice sessions at home. It provides an opportunity to part with the schoolish character of musical instrument lessons.

It can be used to offer challenges that can easily be adapted to match the skills of the player. Moreover, by introducing body movements into the game, it addresses the whole body thereby enhancing the corporeality of the experience. This has a major influence on the probability of having a flow experience. The Music Paint Machine enables events that increase the body's capacity to act while playing music and thereby it can bring joyful experiences (Massumi, 2002).

3.2 Description of the System

3.2.1 Hardware

Colour Dance Mat

The hardware of the multicolored dance mat consists of 12 pressure sensors (contact switches), 4 extra switches (situated on top of the mat) and a USB interface which are all integrated in the MDF floor plate. A cover presenting a twelve-colour wheel hides the hardware and makes choosing colours in the game clear. Stepping on a colour activates a pressure sensor underneath. The USB interface is a hacked numeric keypad. The twelve contact switches replace the button switches of the original keyboard matrix.

Motion Sensors

The movements of the user are captured by a Wii motion plus attached to the torso, with a flexible strap that doesn't hinder breathing.

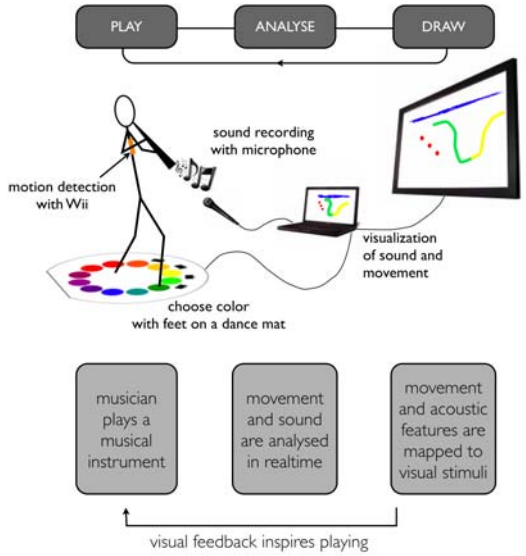

Figure 1: overview of the system.

3.2.2 Mapping and Feature Extraction

The software for The Music Painting Machine is developed in MAX/MSP and the visualisation is done in jitter, using the integrated OpenGL engine.

Mapping Body Movement

The canvas that is either portrayed on a display or projected on some surface, reflects the player's movement and choices of colour. The pressure sensors, embedded in the dance mat, give the player the opportunity to choose the drawing colour. A set of 12 basic colours is available and this initial colour's saturation can be dynamically controlled by moving the torso either forward (more saturated) or backwards (less saturated). The movement of the torso also determines the X-position of the paintbrush on the screen. The Wii remote, strapped to the chest, is used to capture leaning forward and backward (pitch) and turn left or right (roll).

Mapping Musical Features

All other drawing commands are determined by musical features. The vertical position of the paintbrush on the canvas is determined by pitch. A sustained note produces a horizontal line, while a melody produces a curved line that follows the melodic contour. The thickness of the paintbrush is determined by the loudness of what is played. The louder a user plays, the thicker the brushstroke becomes.

Loudness and pitch are currently tracked by an object of the CPS programming environment (see: cps.bonneville.nl).

Presentation Modes: Visualizing the time Dimension

As already mentioned, the X-position and Y-position of the painting brush are determined by feature extraction, leaving the Z-axis untouched. In the Music Paint Machine, this Z-axis represents the time you spend playing. While playing, the player is presented with a two dimensional view, without any indication of time, giving him the opportunity to explore his musical painting to the fullest. When he's done playing, one of the additional top switches on the dance mat enables the player to change his viewpoint, to gain access to the third dimension, representing time that is plotted on the Z-axis. For instance, rotating the presented image by 90 degrees over the Y-axis reveals a coloured melodic contour over time. This kind of representation can be used to further analyse the performance. One of the other available representation modes is an animated replay of what is drawn, either playing alongside the music or with the music muted.

4 DISCUSSION

4.1 Sound and Images

Interactions between auditory and visual processing can occur regardless of the level of relevancy between them (Hidaka et al., 2009), so presenting congruent visual feedback maximises the possibilities of visual feedback augmenting the process of musical creation. Despite growing evidence that supports the effectiveness of visualization as a didactic tool, traditional instrumental music teachers remain sceptical towards the integration of visual feedback. They often argue that visual feedback interferes with listening and with learning to audiate (i.e. the ability to hear and comprehend in one's mind the sound of music that is not or may never have been physically present (Gordon, 1997). Existing objections against the use of visual feedback are grounded in some misconceptions or a misunderstanding of the nature of music and musical understanding. Besides interfering with one another, visual and auditory stimuli can reinforce each other (Ernst & Bülthoff, 2004; Lipscomb, 2005). Their combination can enhance learning processes (e.g. Forsythe & Kelly, 1989; Rogers, 1991) and musical experience (e.g. Davidson, 1993; Frego, 1999). This is in line with findings that the connection between auditory, visual and tactile stimuli is essential for the development of musical perception (Gembris, 2006).

Therefore we believe the Music Paint Machine in many ways can fulfil a complementary role to existing systems or didactic methods. Firstly, it complements the traditional use of visual feedback that most often limited to the score and personal annotations in it (e.g. to mark important passages, to stress expressive features). Secondly, by providing a combination of artistic visualization and objective data, the Music Paint Machine complements existing educational applications that are based on visualizing objective data (Bevilacqua, Guédy, Schnell, Fléty, & Leroy, 2007; Ng, Larkin, Koerselman, & Ong, 2007). As has been explained in this article, this is valuable for music education. But it also has an important benefit for using it as a research tool.

4.2 A Tool for Research

The Music Paint Machine is an application that is tailored to the embodied music cognition research paradigm. It enables to investigate tool related experiences (shift from subject to user), it can easily be used in a classroom or at home (shift from lab to ecological setting) and when used in a classroom setting it will reveal aspects of the role of social interaction with teachers and peers (shift from individual experience to social interaction). An important aspect of the Music Paint Machine that contributes to the ecological validity of experiments in which it is used, is its potential to engage users in a strong sensation of immersion and make them forget they are doing an experiment. Moreover, due to a focus on artistic creation by playing and moving, users do not have the impression of being measured and analysed, which can lead to non-representative measurements. What appears on screen is nor a visualization of objective data, nor an exact capturing of movements and posture. It is, on the contrary, a creative output that appeals to imagination.

Because of its combination of artistic and objective measurement data, the Music Paint Machine also contributes to the expansion of methods that accompanies the aforementioned paradigm shift. It enables the combination of subjective and objective measurement through the implementation of state of the art monitoring technologies. Furthermore it deals with the transfer between modalities. Experiments with the Music Paint Machine can contribute to existing research on cross-modality and the precise coupling of different modalities (Naveda & Leman, 2009).

5 CONCLUSIONS AND FUTURE WORK

In this paper we have outlined the theoretical framework and the conceptual design of the Musical Paint Machine, an interactive music system that enables students to create real-time visualizations of the music they play. Furthermore we discussed possible didactic benefits and our expectations regarding the use of this application.

From the theoretical point of view, this interactive music systems holds promising potential. Of course, empirical validation of the theoretical elaboration is necessary. In the near future we start a series of experiments that probe the users' experience. Based on these experiments and on a close collaboration with instrumental music teachers, specific tasks will be designed for a series of experiments that test the didactic efficacy of the Music Paint Machine.

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