VUZIK: A PAINTING GRAPHIC SCORE INTERFACE FOR COMPOSING AND CONTROL OF SOUND GENERATION

Aura Pon
Interactions Lab
Department of Music
University of Calgary
Calgary, Canada
aapon@ucalgary.ca

Junko Ichino
Graduate School of
Information Systems
University of Electro-communications
Tokyo, Japan
ichino@is.uec.ac.jp

Ehud Sharlin
Interactions Lab
Dept.of Computer Science
University of Calgary
Calgary, Canada
ehud@cpsc.ucalgary.ca

David Eagle
Department of Music
University of Calgary
Calgary, Canada
eagle@ucalgary.ca

Nicolas d'Alessandro
Institute for New Media Art Technology
University of Mons
Mons, Belgium
nicolas@dalessandro.be

Sheelagh Carpendale
Interactions Lab
Dept.of Computer Science
University of Calgary
Calgary, Canada
sheelagh@cpsc.ucalgary.ca

ABSTRACT

Vuzik is an interface for creating and visualizing music through painting gestures on a large interactive surface. It can subsequently act as a graphical score embedded with control messages for facilitating its sonic realization via any networked sound generator or instrument, and serve as a visual reference of the music to possible performers and audience. We present an overview of our motivations, design and implementation of the current prototype of *Vuzik* and discuss its various application in music education settings and computer music performance. We aspire for *Vuzik* to offer the creator, performer and audience an alternative insight into music's construction through graphic score visualization, and open up new ways to create and realize musical ideas.

1. INTRODUCTION

Throughout history, music's intelligibility has benefitted from the tangibility offered by multimodal renderings perceivable by sight and other senses beyond hearing. Visual representations of music such as traditional music notation, graphical scores [8], or musical inspired artwork [7] give this ephemeral medium a more permanent form through which to study, preserve, and recreate it [2]. The temporal nature of music is sometimes a barrier to visualizing, analyzing, and approaching the composition of music even for those who are musically educated. We believe that if one could not only visually see or touch music, but also freeze it in time and hold its representation in stasis for more prolonged examination and contemplation, then one could gain greater understanding of its structure. The design of musical interfaces that leverage a person's existing understanding of basic concepts about the physical world would help build a usable understanding of music's structure and could encourage more intuitive music exploration and creation, in similar reasoning to that posed as a case for Reality-Based Interaction [6]. Mapping features of music to physical properties of objects that can also be experienced through a person's non-auditory senses like sight and touch may make certain abstract aspects of music more concrete and therefore more intuitive to manipulate. Likewise, relating musical features to certain kinaesthetic actions may further embody musical understanding within existing familiar motor skills.

Towards a goal of fostering music understanding and creativity through multisensory tangibility, we created the *Vuzik* interface (Figure 1) which is inspired by these past classic visualization efforts. *Vuzik* is, foremost, an interface designed to empower people to make electronic music using painting gestures and visual representations of music on a large vertical interactive surface [11]. By giving music a lasting form by way of a visualization that people can see in addition to hear that effectively transcends its temporal nature, music can become more accessible and tangible, and therefore more intelligible. Beyond this graphical score facility, *Vuzik* extends its capabilities one step further to allow its score to control and trigger aspects of its sonic realization through network control messages, which enables versatile sound generation, whether through an automated sound engine or performer-controlled instruments. The latter scenario has been found to offer unique capabilities in expanding the live performance capabilities of these instruments, as will be discussed.

We designed *Vuzik* to be simple and playful enough for a child to use, yet also to have capabilities to afford meaningful, complex musical experiences for more experienced musicians. We hope that the *Vuzik* composing interface could open up new creative possibilities for composers and artists that would be engaging for the audience as well. This paper outlines our implementation efforts and describes the current prototype. We also present several evaluation efforts and applications of *Vuzik*, and outline our coming future efforts.

2. RELATED WORK

Although other interfaces exist that support composition of music graphically, such as the Making Music software [13] or Hyperscore [4], *Vuzik* approaches composition differently in terms of its use of freeform painting gestures and physicality, and its focus on the micro elements of music construction, such as timbre, layers of sound, and dynamics. Some aspects of *Vuzik's* appearance may be mistaken with a sequencer, or with interfaces such as The Music Animation Machine [10]. However, *Vuzik* is fundamentally different from a sequencer by its freeform painting-style interaction, importance of stroke direction, and greater integration of visual and sound elements. And unlike The Music Animation Machine, *Vuzik* is interactive.

Perhaps the most classic example of a drawing based composition tool was Xenakis's UPIC system from 1979 [1], which consisted of a digitizing tablet linked to a computer that allowed the user to draw waveforms and volume envelopes. The system also allowed for real time performance as well by moving the stylus across the tablet. Another UPIC inspired piece of software is HighC [1], which is a graphical music sketching tool consisting of a built-in synthesizer, sequencer and sound mixer, though does not allow gestural sketching beyond what can be achieved with a mouse or artist tablet. *Vuzik* takes inspiration from the UPIC system while striving for increased intelligibility in the relationship of visuals to sound, and in its open-platform nature that allows for use with a variety of sound generation methods through control messages.

A number of other music visualization tools exist that employ the use of control messages sent via network to trigger or control sound from within the music visualization display. In particular, *IanniX* [5], inspired by the UPIC system, is a graphical open-source sequencer which syncs via Open Sound Control messages and curves to a real-time sound environment like Max/MSP or PD. Although the graphic music visualizations that trigger the control messages are visually engaging, their complexity may render them unintended for use as a score from which live performers can play instruments, and the visualizations are created with a typical mouse controller, not gesturally as *Vuzik* promotes. The music notation software *Notability Pro* [9] also allows OSC messages to be embedded in a notated score, for the purposes of triggering sound events in real-time environments like Max/MSP when the score is scrolled to those points, either through "score-following" responding to input from a live acoustic musician, or manually. *Vuzik* takes inspiration from these interfaces while remaining distinct in its simple graphic notation and gestural painting interaction style.

3. *VUZIK* INTERFACE

Named with reference to "viewable" music (and pronounced similarly to *music*), *Vuzik* allows a person to compose electronic music graphically by full-scale painting gestures through a mapping of sound to visuals that effectively allows people to "see" their music as they hear it, using a vertical interactive surface, paintbrush, and icon palette (Figure 1). Use of an interactive surface provides direct freehand painting input of the sound with a tangible paintbrush (as well as alternate tools or possibly fingers), which additionally nurtures the connection of physical gestures to the resultant sound and visuals. The brushstroke is the performance and creation gesture that is both seen (as an action and in creating a visual representation) and heard.

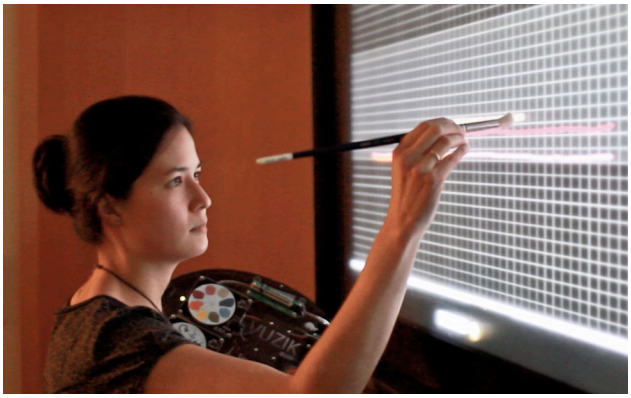

Figure 1. The *Vuzik* interface consisting of large vertical interactive display, paintbrush, and icon palette, in use.

3.1. Sound-Visuals Mapping

Vuzik currently employs an explicit mapping of visual elements to sound elements, such that the sound produced is consistently related to what is painted on the canvas. In supporting freeform painting, each brushstroke is played back in the stroke direction in which it was created. Otherwise, our mapping principles used thus far are quite simple: the y-axis position corresponds to pitch; horizontal length corresponds to the time duration of the stroke; each colour is paired to a unique instrument timbre; and the thickness of the line reflects the loudness. A special remark should be made about time continuum: while the x-axis length of the brushstroke running from left to right represents its duration in time, the stroke plays back in the direction in which it was created, designed intentionally to capture some of the user's intention. Thus, a stroke is free to be vertical, overlapping or retrograde, but the playback duration of the entire stroke corresponds to the length of the stroke on the x-axis. In general, the mapping underlying *Vuzik's* design aims to leverage people's understanding of common physical concepts while maintaining consistency with most of the basic graphic principles employed in traditional music notation and certain metaphorical phrases commonly used by musicians, such as "tone colour." This capability of *Vuzik* to directly link sound to visuals lets people visualize the music they are creating.

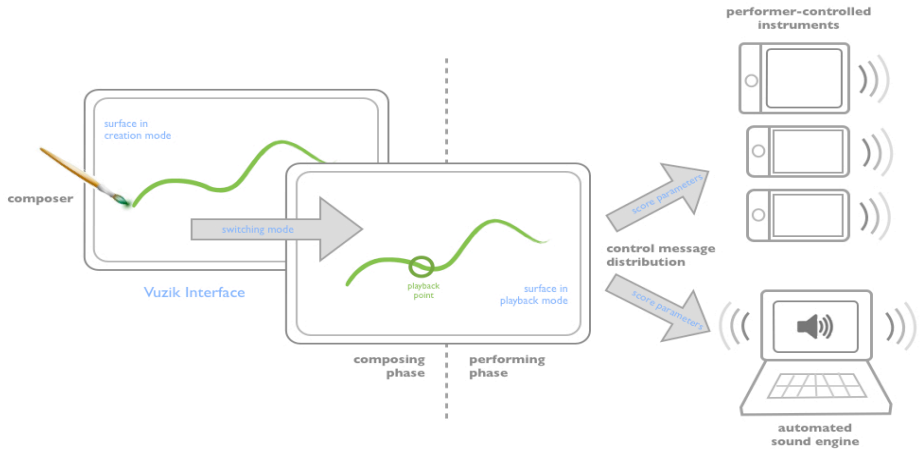

Figure 2. This diagram represents the function of *Vuzik* as first an interface that allows the creation of a graphic score through painting interaction, then as switched for use in a performance setting to playback the score and distribute OSC control messages embedded in the score to listening performer-controlled instruments or sound engines.

3.2. Modes of Operation and Control Messages for Sound Generation

Vuzik's two modes of operation, creation mode and playback mode, offer both immediate, spontaneous play with homophonic sound, and reflective, creative construction of more complex polyphonic music. Creation mode is the initial mode of operation where a person can paint in input and hear corresponding sound feedback in real time that is related to the visual features of what is painted. At any time, at the tempo of their choosing, a person can use playback mode to hear a single selected stroke, or they can play back the entire canvas and hear all the strokes sounding polyphonically as the composition scrolls and plays from left to right, with highlighting circles following each stroke as it being played.

It is in this mode that *Vuzik* is most effective in live performance. It will stream Open Sound Control protocol messages corresponding to components of the music's graphic score wirelessly over the network to listening sound generators, whether it be a sound synthesis engine on a computer, or devices or instruments being played by live performers. The scrolling motion of the score as it generates sound in real-time can serve both as a visualization for audience members, and as a score for visual instructions to any live performers participating in the realization of the piece.

3.3. Implementation

The graphical user interface (GUI) is currently implemented using Microsoft Windows Presentation Foundation (WPF) with Visual Studio 2010 C# and .NET Framework 3.6, and utilizes the Open Sound Control protocol for messaging to the listening sound generator.

Through these interactive elements of combined tangibles, visual-music metaphors, and open-platform nature of its control messaging aspects, *Vuzik* attempts to offer people informative and engaging mechanisms for composing music and flexibly performing or realizing it with a variety of sound generation possibilities.

4. APPLICATIONS AND EVALUATIONS

Vuzik was originally envisioned as a tool for children to explore music and sound, while still offering the capability for more advanced music composition. We propose that *Vuzik*'s audio-visual integration and gestural input style invites child interaction and promotes understanding of some more abstract aspects of music.

Towards evaluating this aspect, we are currently undergoing a user study with 16 or more school children of grades 4-6 for investigating *Vuzik*'s ability to facilitate music composition for children. The evaluation incorporates a between-subjects comparison of *Vuzik* and Hyperscore with the goal of understanding the strengths and weaknesses of the former and how it compares or contrasts to similarly motivated interfaces. Over two sessions, subjects were to learn the interface, explore example compositions, complete a composition which has beginning and ending provided, receive brief training in composition on the interface, complete a composition by adding melody to a provided accompaniment, and finally compose their own music.

In addition to a formal user study motivated for music education applications, we also explored its use in more advanced music composition and performance. Through the generative and creative process of composing music using *Vuzik* and realizing it live using an ensemble of musicians to rehearse and perform with it in a live concert setting, we were able to gain valuable insights into the application, success of design choices, and best performance practices for this interface.

We utilized *Vuzik* to extend the capabilities and complexity of music performance possible for an ensemble of artificial voice ChoirMob mobile device-based instruments [3] in several essential ways. Seven

of the ten participants in the ensemble had some formal musical training, while three would be considered music novices. Its role in this ensemble was a medium for communicating a composer's composition, amounting in a score for reading and understanding the music, and a "conducting application" for coordinating ensemble participants and their instruments. All participants regardless of musical background were able to use the rudimentary stroke-based graphic notation of *Vuzik* to inform them of the rhythms and timings of the phrases they were to play, and it fostered a level of awareness of what other ensemble parts were doing and what the pitch contour of their phrase was. A 13-minute, 3 movement composition for 4 independent voices, entitled *Intertwine,* was composed for this ensemble using the Vuzik interface. *Vuzik's* control messaging served the integral function of shifting the central reference pitch and recentering the range of semitones available on each instrument's small playing surface based on the needs of the composed music, thus extending the instrument's range and making difficult pitch changes for the performer. It did this independently for each vocally inspired iteration of the instrument (soprano, alto, tenor, bass). This piece incorporated strictly notated material as well as controlled improvisation sections, each conveyed graphically through the score. Four members of the ChoirMob ensemble performed this piece in a live concert setting at the East Vancouver Cultural Centre on November 7, 2011, to an audience of over one hundred people, following personal practice time and several ensemble rehearsals. The *Vuzik* visual score was projected for audience viewing, while displayed for the performers for reading and ensemble coordination on a smaller display.

Although this performance was the most thoroughly documented, others followed using the same system and setup, including a repeat performance of the same piece by different performers, a performance of a 2 minute work with *Vuzik* controlling a mixed-phase synthesis sound engine, and a performance of a 3 minute work using one solo ChoirMob instrument accompanied by the mixed-phase sound engine controlled by Vuzik. Finally, this combination system of *Vuzik* and the ChoirMob instruments was successful in being chosen as a finalist in the 2012 Guthman New Musical Instrument Competition held at Georgia Institute of Technology, for which the quartet performed *Intertwine* again.

In these instances, *Vuzik* enabled the gestural painting creation of an original graphic score that, through its simple graphical notation and control messages broadcasting parameters of the composed music, enabled performers with networked digital instruments to realize the music to a high level. The experience was anecdotally reported to be satisfying for the composer, performers, and audience.

Figure 3. The *Vuzik* interface used in a performance setting where it is serving to control the available pitch range of 4 mobile device-based instruments, as well provide a visual score for performer reference and coordination.

5. FUTURE WORK AND CONCLUSION

In augmentation of the current ongoing user evaluation with children, we will endeavour to further inform our design of an effective music education tool by consulting elementary school music teachers about the unique challenges and processes in their music classrooms and how *Vuzik* could support them. Such discussions could contribute towards the design of curriculum that incorporates *Vuzik* as an illustrative tool for music educators in support of their curriculums. In addition to further development and understanding of *Vuzik* as a music education tool, we intend to further validate *Vuzik* as a composition tool for musicians by continuing to create and perform musical works with it. Such exploration will aim at discovering what type of composing and musical style is possible and idiomatic for the interface, what varieties of sound generation methods could be used with it, and different approaches for the interface to be used in performance either for real-time composition, in collaboration with other instruments, or as a standalone system for presenting complete compositions using an automatic sound engine. We would like to continue to explore how the creation of a dual-modality artwork of sound and visuals, and the gestural interaction style, could be engaging for both audiences, performers, and composer in unique ways. In summary, our ongoing work will aim to determine the interface's unique capabilities, shortcomings, and strengths as applied to composition, performance, and music education.

We have introduced *Vuzik* as an interface that combines music visualization with a painting interaction paradigm for exploring sound and creating music on an interactive surface. The marriage of visuals, sound, and gesture of this open OSC based platform offers new expressive potential in music education and computer music composition. Our continued work in progress strives to determine the interface's affordances for these purposes and demonstrate the creative musical potential it promises.

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