EyeMusic: Performing Live Music and Multimedia Compositions with Eye Movements

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ABSTRACT
In this project, eye tracking researchers and computer music composers collaborate to create musical compositions that are played with the eyes. A commercial eye tracker (LC Technologies Eyegaze) is connected to a music and multimedia authoring environment (Max/MSP/Jitter). The project addresses issues of both noise and control: How will the performance benefit from the noise inherent in eye trackers and eye movements, and to what extent should the composition encourage the performer to try to control a specific musical outcome? Providing one set of answers to these two questions, the authors create an eye-controlled composition, EyeMusic v1.0, which was selected by juries for live performance at computer music conferences.

Author Keywords
Computer music, eye tracking, new media art, performance.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces - input devices and strategies, interaction styles. J.5 [Arts and Humanities]: Fine arts, performing arts.

1. INTRODUCTION
Eye tracking continues to hold great promise, not yet fully realized, for human-computer interaction, both to analyze and understanding how people interact with visual displays, and to provide an alternative means of interacting with a computer in real time [2]. Somewhat analogously, computers hold great promise for reshaping our notions of art, music, and performance, as seen in this conference, but this is a "new" enterprise. Massive exploration is yet to come. This paper discusses what may be the current "state of the art" in using eye movements for real-time computer-mediated creative expression.

The project emphasizes musical and multimedia compositions that can be performed live by one person using an eye tracker in front of an audience. The project is in part inspired by the art and performances of Andrea Polli [3]. One major departure, however, is that Polli's work incorporates the parsing of the video image of the eye as part of the creative process, whereas we use a commercial eye tracker which provides a much more accurate report of where the eye is looking on the computer screen, thus permitting more precise visual-interactive control.

2. EYEMUSIC SYSTEM ARCHITECTURE
Figure 1 shows an overview of the EyeMusic system. EyeMusic uses an LC Technologies Eyegaze 60 Hz remote (off the head) pupil-center and corneal-reflection eye tracker. Sixty times per second, the eye tracker sends the location of the performer's gazepoint on the computer screen (in *x, y* coordinates) to Max/MSP/Jitter, which is running on a Macintosh computer. Technical details on the EyeMusic system are in [1]. This paper presents new work in which we create EyeMusic compositions for live performance.

As shown in Figure 1, the Max/MSP/Jitter video output is displayed on the performer's video monitor, completing both an auditory and visual feedback loop analogous to

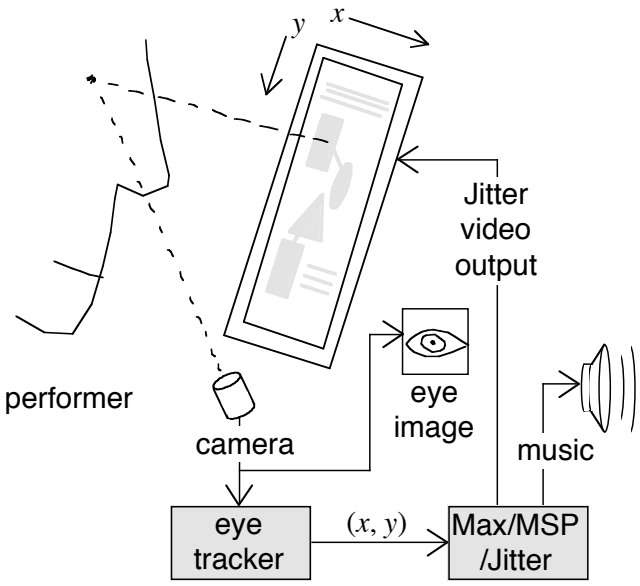

Figure 1. The EyeMusic system architecture. Arrows indicate the flow of data.

playing a physical instrument. This video output is also projected behind the performer so that the audience can see how the performer is interacting with the display. The eye tracker uses a camera that is positioned just below the performer's computer monitor. The video camera's output is run through a splitter so that the audience can view, in a separate video monitor, the same image of the eye that is used by the eye tracker.

3. THE EYEMUSIC V1.0 COMPOSITION

The most recent major milestone of the project is the creation of *EyeMusic v1.0*, an eye-controlled musical and interactive visual composition that builds on the ideas discussed in the previous section. Figure 2 shows the physical configuration of the stage when performing EyeMusic v1.0, with the performer facing the audience, a 17" video monitor showing the video image of the eye, and a large video projection displayed behind the performer that matches what the performer sees. One of the goals of the composition was to insure that the audience could easily and directly understand that the composition was performed with eye movements. This was accomplished by using extremely simple visual effects, and with great consideration of the physical staging.

EyeMusic v1.0 is roughly five minutes long, and starts with the appearance of a single gazepoint eye cursor appearing on the rear-projected screen. The eye cursor is a large white dot, drawn on a black background. Throughout the performance, quiet, scratchy, jittery noises play near the gazepoint, using stereo panning to move the sound from left to right as the eyes moved left and right. The composition moves forward using the closing and opening of the eyes, each of which is expressed as sudden, loud, slamming sound. When the eyes are closed, the screen is blank.

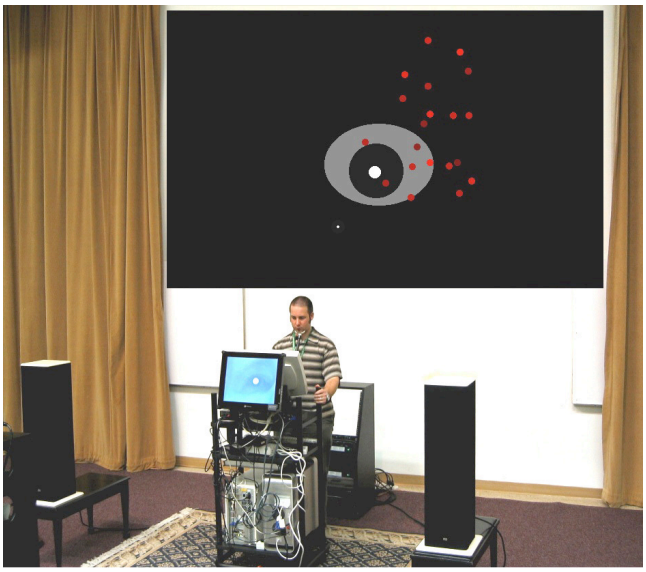

Figure 2. Troy Rogers performing EyeMusic v1.0 at SEAMUS 2006, and (pasted above him) a screenshot of the video image that was projected behind him during the performance.

As the composition progresses, red circles appear on the display. The performer approaches and eventually touches each circle with the eye cursor, at which point the circle starts bouncing between the left and right edges of the display, first in a somewhat subdued manner, but eventually in a frenetic, over-energized manner, all controlled by gaze. Each bounce produces a bouncing sound, with smaller balls creating a higher-pitched sound. The balls are eventually replaced by a cartoonish eye that mimics the eye image used by the eye tracker (see Figure 2). The eye cursor plays with a swarm of red dots that first avoid, and are then attracted to the eye cursor. The entire piece is punctuated with the loud, sudden blinks, which dramatically increase in frequency near the end of the performance.

4. CONCLUSION

This paper discusses the exploration of new interaction techniques for real-time eye-controlled music and multimedia performances. Though designing any human-computer interface requires attention to the intended context of use, the user's expectations, and the intended outcome of the interaction, these requirements are perhaps even greater for eye-controlled interfaces. Two of the "problems" of eye tracking that continue to keep it from its great promise are issues pertaining to noise and control. Working with computer musicians who routinely deal with these issues with a wide range of sensor technology provides a refreshing perspective. When working with eye tracking data, rather than trying to remove all the noise, whether it comes from the eye tremor or the eye tracker, the musicians embrace and want to work with the noise. Regarding control, the musicians are comfortable creating a composition that cannot necessarily be played the same way every time. Though one goal is to enable the performer to perform specific compositions, another is to explore the expressive potential of naturally occurring eye movements.

A video of EyeMusic v1.0 and other EyeMusic files are at <http://www.cs.uoregon.edu/research/cm-hci/EyeMusic/>.

5. ACKNOWLEDGMENTS

Dr. Jeffrey Stolet contributed extensively to this project. The project was funded in part by the National Science Foundation and Office of Naval Research, though the opinions, findings, and conclusions are those of the authors.

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