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VizScore: An On-Screen Notation Delivery System for Live Performance

Seth Shafer
University of Nebraska at Omaha, sethshafer@unomaha.edu

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Seth Shafer
University of North Texas
SethShafer@my.unt.edu

ABSTRACT

VizScore is an open-source, on-screen notation delivery system designed with the performer's strengths in mind. By harnessing a performer's learned skills of reading traditional paper notation and practice of interpreting time from a conductor's gestures, VizScore creates a notation environment that can integrate seamlessly into any performance situation and help musicians play in time with other instruments, live or computer-generated. The paper reviews some general design principles of on-screen notation as put forth by current experts in the field and offers a new model for on-screen notational display. The paper then assesses results from a comparative study between VizScore and related on-screen notation software, before describing future goals. Software like VizScore can help push both performers and composers to stretch the current paradigmatic boundaries while yielding accurate results in the concert environment.

1. INTRODUCTION

The evolving world of interactive computer music has, in recent years, witnessed a trend of using an on-screen display for communicating directions to the performer. Not surprisingly, this is mirrored in the larger musical context with a growing number of both performers and conductors preferring to use tablets or displays rather than printed parts or scores. For young composers, the screen and associated computing power has been present during their entire compositional development making the integration of such devices into the concert environment natural. Likewise, many young performers are willing to explore new paradigms of notation.

This paper considers the general design principles of on-screen notation and demonstrates how they are practically applied in a new piece of open-source, on-screen notation software called VizScore. Design principles from Lindsay Vickery's article, "The Limitations of Representing Sound and Notation on Screen," [1] are compared with Richard Picking's article, "Reading Music from Screens vs Paper," [2] resulting in a practical application and explanation of VizScore. Finally, the strengths of this new piece of software are demonstrated in a comparison between VizScore and other on-screen notation applications.

2. THE PROBLEM OF THE CLICK TRACK

One of the primary problems in works requiring synchronization with an electronic source is the predominant strategy for synchronization: the in-ear click track. While reasonably reliable, the inherent weakness of the click track is the necessary aural distraction of the click and the lack of location-specific information. Given the importance of the auditory sense to a musician, on-screen notation offers a less distracting, information-rich synchronization method that allows the performer to visually track the location of the music.

3. GENERAL DESIGN PRINCIPLES

Vickery's "The Limitations of Representing Sound and Notation on Screen" lays out several general design principles for presenting notation on a computer display. The two critical features of an on-screen display system are the delivery of the notational content and the time-location tracker. The most common notational delivery paradigms used in works relying on on-screen displays are the segmented score and the scrolling score (see Fig. 1). According to Vickery, a segmented score comes the closest to mimicking a traditional paper score experience by breaking a musical staff into multiple lined systems much like a printed part. A segmented score allows the performer to look ahead to future musical events and to see their current position in a larger context.

The scrolling score best approximates the linear experience of time as an unbroken continuum. As a single stream of notation smoothly traverses the display, the temporal nature of sound is imbued on the notation itself. The scrolling score can present many challenges to a performer trained in traditional concert practices. Extrapolating from eye-movement research during music reading, one of the

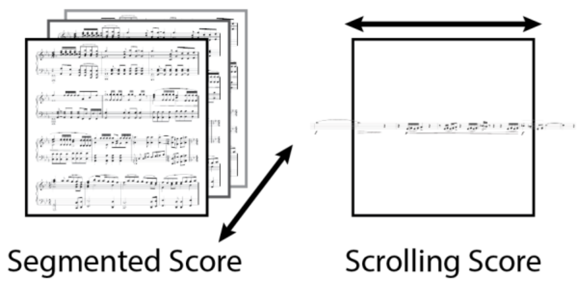

Figure 1. Two common on-screen notation paradigms.

primary limitations of the scrolling score is the fixed perceptual frame representing the current "now." This is quite unlike the experience in the segmented score model where the performer's eyes scan a complex pattern across the notation, keeping the perceptual frame in constant motion. [3] The fixed perceptual frame in a scrolling score works against the traditional left-to-right and top-to-bottom reading of music, a deeply ingrained and highly-trained skill employed by performers. In addition, Picking shows that animated scrolling movement of the notation above a certain tempo threshold has negative effects on the readability of the score. The ideal layout for on-screen notation appears to be the segmented score as it increases readability by remaining stationary and allowing the performer to control the perceptual frame.

If the notation is statically fixed in place, another crucial element is necessary for time-synchronization: a time-location tracker. Picking describes three types of animated trackers: the smooth tracker, the stepper tracker, and the jumper tracker. The smooth tracker shares many similarities and problems with the scrolling score system described above. As the smooth tracker glides across the display, the location of "now" is clearly visible at the point where the tracker moves over the notation. While a sense of forward motion and anticipation is clearly embedded in the smooth tracker paradigm, it lacks any downbeat preparation or rhythmic integrity. In this way, the smooth tracker is analogous to the play head of an open reel tape machine, continuously feeding musical information to the performer at an even pace regardless of the content. The stepper tracker shares some similarity to the smooth tracker with the exception that the even rate of motion is rhythmically quantized so as to visually snap to every bar, beat, or subdivision. While this improves on the rhythmic information communicated to the performer, the stepper tracker's jerky movements caused it to be the least favorable among Picking's study participants. Finally, the jumper tracker uses a different method entirely by providing the performer with a bouncing ball that leaps from beat to beat in an arcing motion. This improves upon the previous strategies by imparting both location and tempo in a fluid gesture. In Picking's study, the jumper tracker was the most preferred method of tracking time-location.

In summary, the preferable design of an on-screen notation delivery system as advocated by Vickery, Picking, and others is one that utilizes a performer's skill of reading traditional paper notation. While a scrolling score with a smooth tracker might appear to be an idiomatic use of the computer display, it counteracts the benefits of on-screen notation by freezing the location of the performer's perceptual frame and impeding the readability of the score. In contrast, a segmented score with a jumper time-location tracker allows the performer to retain free control of the perceptual frame and reduces unnecessary motion of the notation. The net effect of these designs should therefore improve accuracy in both music reading and time-location tracking in a performance.

4. VIZSCORE: AN OVERVIEW

4.1 Introduction to VizScore

VizScore is an open-source, on-screen notation delivery system designed with the performer's strengths in mind. By harnessing a performer's learned skills of reading traditional paper notation and practice of interpreting time from a conductor's gestures, VizScore creates a notation environment that can integrate seamlessly into any performance situation and help musicians play in time with other instruments, live or computer-generated.

VizScore is a suite of externals for the Max environment and is compatible on both Windows and Mac. The suite uses all native objects and presents a very low processor overhead. VizScore includes a score display, a score editor, and a tempo management system with transport functions. The design and function of each of the components is described in detail below.

4.2 Design Goals of VizScore

VizScore is designed with several crucial goals in mind. The first is to create a system that allows for clear notation display and tracking. To this end, VizScore implements the most successful design principle advocated by Lindsey and Picking: a segmented score display and a highly customizable jumper time-location tracker. The second principle design goal is to create a flexible system that can be implemented across a wide range of notational styles. The final design goal is to provide the user with a simple, but powerful interface to create new scores and incorporate VizScore in their work.

4.3 Creating a Score in VizScore

With VizScore, a user can create a segmented score with a jumping location tracker from any graphic notation file. Any style of score can be used with VizScore including computer engraved notation, scanned handwritten music, symbolic graphics, or any other raster image. Upon loading the notation file, either as a PNG or JPEG, the score editor allows the user to align page and system elements as well as adjust margins and zoom level. For best results, the minimum segmented score display layout should include one previous system of music, the current system, and one or more subsequent systems (see Fig. 2). This configuration is ideal because it allows the performer to place their current location in a larger context and anticipate future musical events. However, because the score alignment settings are completely user-definable, this means that one could choose to let the performer view only one staff at a time, the entire score at once, or any possible configuration in-between.

Figure 2. A suggestion for a minimum segmented score layout showing previous, current, and future systems.

VizScore uses the best features from both the scrolling score and segmented score paradigms to create a fluid, natural music reading experience. Vickery's model of a segmented score involves turning virtual "pages" of a score, limiting the performer from looking beyond the current segment of notation. Instead of flipping from one "page" to the next, VizScore's comprehensive tempo management system tracks time-location and quickly slides to the next system when the end of the current system is reached. This brief scrolling motion has a user-definable speed and provides the performer with a sequential stream of staff systems.

In order to correctly track time-location, the jumper tracker in VizScore must visually align with every beat in a bar. Bar width and beat placement within a bar is notoriously variable due to meter changes and differing amounts of rhythmic complexity. VizScore allows the user to define the span of individual bars of music and the layout of the beats within the bar (see Fig. 3). Options to properly configure a bar include bar size, meter, and a map matching each beat within the bar. These settings determine the placement of the jumping time-location tracker. This tracker takes advantage of the performer's sense of anticipation typically placed in a conductor. An arcing gesture designed to mimic the momentum of a ball bouncing or a conductor's baton provides not only an accurate sense of the tempo, but also the ability to anticipate tempo changes, give preparatory cues, and help the performer parse rhythms inside the bar (see Fig. 4) [6, 7]. As stated above, this was the preferred time-location tracker in Picking's study and is perhaps the single-most important feature of VizScore.

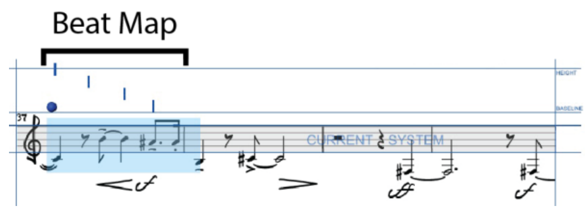

Figure 3. Mapping beats within a bar in VizScore.

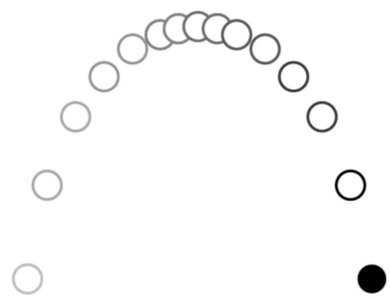

Figure 4. The momentum of the jumping time-location tracker in VizScore allows the performer to anticipate downbeats and construct an accurate sense of tempo.

The tracker is a raster graphic, meaning that its shape and color are user-definable. In addition, the tracker's arcing path can be altered by changing the amount of gravity in the trajectory algorithm. Altering the tracker's gravity imparts a variety of characteristic styles in much the same way a conductor indicates style by varying the fluidity or rigidity of their physical movements. [8] A high gravity setting, for instance causes the ball to move from one beat location to the next in a type of staccatissimo gesture, while a low gravity setting causes the tracker to move as smoothly as possible from one beat to the next. The gravity setting can also be disabled causing the tracker to cease from bouncing and instead act as either a smooth tracker (ideal for proportional notation) or a stepper tracker. In addition, the height of the tracker above the notation is set on a system-by-system basis, meaning that it can be programmed to move out of the way for notational elements in one system and stay close to the staff lines in the next.

The comprehensive tempo management system gives users access to tempo and meter maps as well as transport controls. The tempo and meter maps dictate changes in both parameters over the course of the piece. Tempo can be set to abruptly change, increase or decrease linearly, or change according to any user-definable path. Support for fermati means that the tempo can arbitrarily stop and start again with visual pick-up beat cues from the time-location tracker. Finally, the transport controls allow the user to fast-forward, rewind, or play from any point in the score.

5. SOFTWARE COMPARISON

Several other software packages serve as appropriate comparisons to VizScore. Many of these fall into the category of computer-assisted composition (CAC) tools such as FTM, PWGL, and Bach: Automatic Composer's Helper. These CAC tools generally have a wide breadth of features with the expressed purpose of aiding the composer but not necessarily the live performer. Bach, for example, uses the paradigm of a stepper tracker that traverses a scrolling score. [9] In addition, Bach's support for articulations is scant and many other expressive devices like dynamics, slurs, and textual indications are missing altogether.

Another category is generalized computer engraving software. Candidates here include Finale, Sibelius, Lilypond, and many others. The primary focus of these engraving tools is print music. While these programs certainly excel in the area of making expressive scores, they fail to provide compelling models for visual time-location synchronization.

Several applications do focus specifically on on-screen notation. Some notable pieces of software include MaxScore, INScore, and an assortment of tablet apps facilitating the reading of PDFs or MIDI files. INScore is perhaps the closest comparison with VizScore. [10] INScore supports MusicXML, raster, and vector graphic files as score data. It operates as a separate piece of software controllable through Open Sound Control (OSC) messages. Finally, it supports a robust time synchronization engine for location tracking. The primary drawback is the lack of an animated jumper tracker to convey rhythmic anticipation, style, and other attributes described above.

6. CURRENT USES AND FUTURE GOALS

VizScore is used in two compositions by the author: *Pulsar [Variant II]* for trumpet and computer (2014) and *Ursa Minor* for euphonium and computer (2015). Both works use live interactive electronics that involve a combination of real-time processing and synchronized fixed media.

There are a number of planned improvements and feature additions for VizScore. One key feature is synchronization of multiple instances over a network to facilitate ensemble performances. Long-term development goals include a standalone package accessible via OSC messages and an app for tablets.

By all accounts, on-screen notation appears to be just entering its adolescence. [11] The latest generation of composers and performers are children of the computer age and therefore have complex and meaningful working relationships with the computer display. The performer-display relationship has largely only just begun to be explored. Software like VizScore can help push both performers and composers to stretch the current paradigmatic boundaries while yielding accurate results in the concert environment.

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