A Flexible Platform for Tangible Graphic Scores

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ABSTRACT
This paper outlines the development of a versatile platform for the performance and composition of tangible graphic scores, providing technical details of the hardware and software design. The system is conceived as a touch surface facilitating modular textured plates, coupled with corresponding visual feedback.

Author Keywords
Score, Notation, Composition, Tangible Interfaces, Design Process, Computer Vision

ACM Classification
H.5.2 [Information Interfaces and Presentation] User Interfaces - Input Devices and Strategies, H.5.5 [Information Interfaces and Presentation] Sound and Music Computing – Systems

1. INTRODUCTION
Composing for new interfaces for musical expression is often not a straightforward process. Not only do NIMEs lack an existing compositional practice, they frequently employ sonic, gestural, and structural principles that are incompatible with conventional notational systems. As the radical variation of timbre available in electronic music is especially difficult to notate effectively, graphic notation can be a useful method for abstractly representing its complexity [2]. Graphic notation can thus be particularly suited to NIMEs, as it has the potential to convey form, gesture, timbre, and other musical properties through non-standardized symbols. Despite the apparent affinity between new interfaces and new notation, it is relatively uncommon for the two to be implemented as one, that is, systems that are conceived as both interface and score simultaneously.

The motivation to develop tangible scores stems from the authors' engagement with graphic notation (Figure 1) and interactive scores in both composition and performance, and builds on a diverse body of creative practice and research. Tomás and Kaltenbrunner propose tangible scores as a new paradigm for musical instrument design, defining tangible scores as "the physical layer that is incorporated into the configuration of a digital instrument with the intention of conducting the tactile gestures and movements" [7].

2. CURRENT DESIGN
In designing a platform for tangible graphic scores we adopted an *iterative* design approach, using a framework by Gould and Lewis [1]. An iterative design process involves a cycle of testing and redesign that

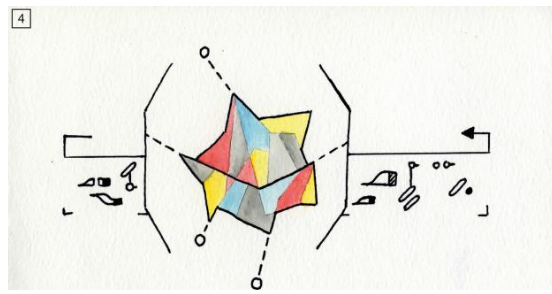

Figure 1. An excerpt from *Seven Systems* by Simon Alexander-Adams.

begins with initial ideation and extends through the development of prototypes and their refinement. The current version is a performance-ready system for in-vivo design experimentation, with the intention of creating a subsequent iteration based upon experiential feedback and critique from ongoing composition and performance practice.

In the case of tangible graphic scores, the performance interface and musical composition are intertwined. Thus, many design considerations pertain to both developing the functionality of the interface, and composing for the system. Scores composed with the system should be able to convey *microscopic* and *macroscopic* ideas, not only suggesting gestures and nuance, but also a larger compositional form. They should be *dynamic*, evolving temporally, and potentially *interactive*, reacting to the performers decisions. Additionally, their composition should be flexible—a platform for the composition of new tangible scores needs a way to develop new material. Tomás describes this as *replicability*, suggesting the use rapid prototyping and digital fabrication technologies in the development of the systems modular components [7].

The final system is conceived as a touch surface facilitating modular textured plates, coupled with corresponding projections to provide visual feedback along with temporal qualities to the composition. The compositions for the system possess a great deal of flexibility—utilizing different modes of interaction through their processing of the input data, textural and visual components and corresponding sound design.

2.1 Hardware Design
The design of this system consists of a raised platform, upon which different textured panels can be exchanged. Four infrared (IR) lasers create a Laser Light Plane (LLP) over a transparent surface, and an IR camera detects the performer's interactions with the surface, as they reflect light down onto a diffusive material below the surface. The desire to texture the surface informed the decision to use an LLP approach, as it does not require the touch surface to facilitate internal reflections [6]. A projector mounted in the base provides the visual qualities of the score and interaction (Figure 2). Further details of this type of low cost multi-touch interface can be found in [3].

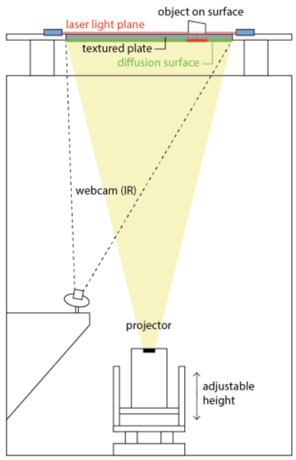

Figure 2. System overview.

850 nm infrared (IR) lasers, along with corresponding laser line generators (for splitting the laser into a plane) are used to create the plane of IR light over the surface. Custom laser-cut acrylic pieces fixture premade aluminum laser mounts to the MDF surface, allowing the height of each laser to be adjusted for calibration purposes. Figure shows the final system, with a textured plate in place.

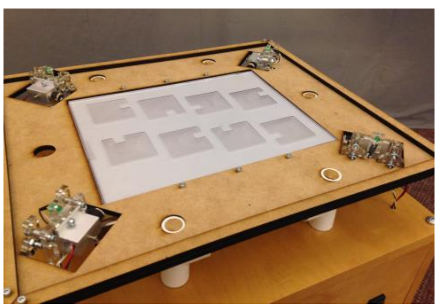

Figure 3. A photo of the system.

The interchangeable textured plates are generated by CNC routing ¼" polycarbonate sheets. The plates serve as the "physical layer" or tangible aspect of the score. The plates are transparent to avoid disrupting the IR tracking (Figure).

Figure 4. An example of a textured plate.

2.2 Software Design

The system uses for Max and TouchDesigner for processing input and the generation of sonic material and visual content. Figure 4 illustrates the communication between the software, and input and output devices.

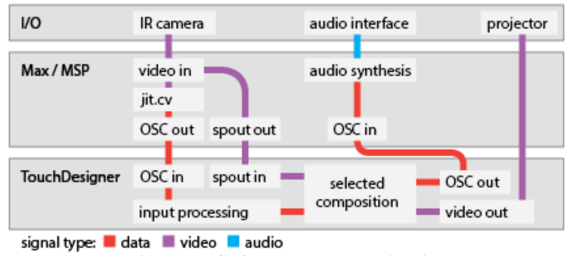

Figure 5. Software communication.

Incoming IR video data in processed in Max using cv.jit computer vision externals [5]. The resulting data is sent to TouchDesigner over open sound control (OSC) [8], and can include information ranging from blob centroids, areas, bounding boxes, direction and orientation, and inertial movements. Raw video is also sent to TouchDesigner through Spout, to facilitate alternative visual processing methods, and project visual feedback onto the surface. Input data is routed to the composition corresponding to the current textured plate on the system. Each compositional system overlays additional visual content on top of the raw IR camera input to be projected onto the textured surface, and sends OSC data to Max to control audio synthesis. Our current system uses Max to control a modified version of Håkon Nybø's *77_GS* granular synthesizer [4]. Compositions for the system can take many forms. Figure shows the visual components one existing compositional system where the user interacts with various animated snakes acting as autonomous sequencers.

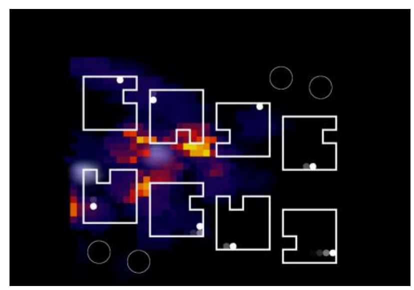

Figure 6. Composition with the plate pictured in Figure 3.

3. REFERENCES

[1] J. D. Gould and C. Lewis, Designing for Usability: Key Principles and What Designers Think, *Communications of the ACM*, 28(3):300–311, 1985.

[2] C. L. Krumhansl, Why is Musical Timbre so hard to understand. In S. Nielzen and O. Olsson (eds.), *Structure and Perception of Electroacoustic Sound and Music*. Elsevier, Amsterdam, 43–53, 1989.

[3] M. Montag, S. Sullivan, S. Dickey, and C. Leider, A Low-Cost, Low-Latency Multi-Touch Table with Haptic Feedback for Musical Applications. In *Proceedings of NIME*, pages 8–13, 2011.

[4] H. Nybø, *77_GS*, 2014. http://hakonnybo.com/

[5] J. Pelletier, cv.jit–, *Computer Vision for Jitter*, 15, 2013. http://jmpelletier.com/cvjit/

[6] S. Sandler, Multitouch How To. http://sethsandler.com/multitouch/

[7] E. Tomás and M. Kaltenbrunner, Tangible Scores: Shaping the Inherent Instrument Score. In *Proceedings of NIME*, pages 609–614, 2014.

[8] M. Wright. Open sound control-a new protocol for communicating with sound synthesizers. *Proceedings of the International Computer Music Conference*, 1997.