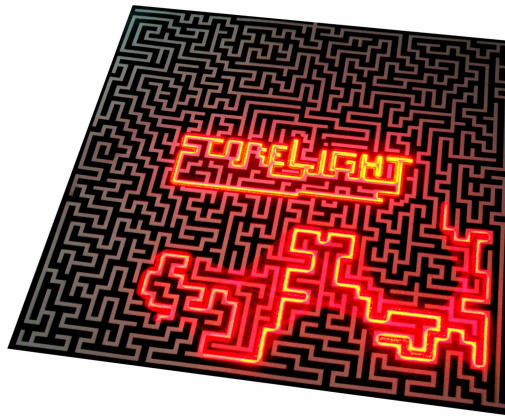


# scoreLight: a laser-based synesthetic experience

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## Abstract

”scoreLight” is a playful musical instrument capable of generating sound from the lines of doodles as well as edges of three-dimensional objects nearby (hands, dancer’s silhouette, architectural details, etc - Fig.1). There is no camera nor projector: a laser spot explores the shape as a pick-up head would search for sound over the surface of a vinyl record - with the significant difference that the groove is generated by the contours of the drawing itself. The light beam follows these contours in the very same way a blind person uses a white cane to stick to a guidance route on the street. Sound is produced and modulated according to the curvature of the lines, their inclination as well as their color and texture. This means that ”scoreLight” implements gesture, shape and color-to-sound artificial synesthesia [2,5]; abrupt changes in the direction of the lines trigger discrete sounds (percussion, glitches), thus creating a rhythmic base (the length of a closed path determining the overall tempo). In turn, the sound being generated affects both the kinematics and shape of the light spot, therefore forming an interesting audio-visual feedback. The result of all this is a spot of light that dances on the surface of the drawing, while singing its secret score.

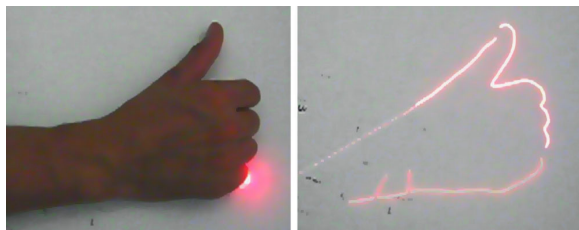


Figure 1: Contour guides the laser beam

## 1 INTRODUCTION

A previous work called ”Sticky Light” [1] called into question the role of light as a passive element when contemplating a painting.

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In fact, illumination is not just a necessary ingredient in the observation process: the quality of the light, its relative position and angle fundamentally affect the nature of the perceived image. The installation sought to amplify this by giving light new ways of interacting with the painting. Drawings are augmented by one or more laser spots that follow contours and bounce on colors. The wanderings of the light spot naturally catches the viewer attention; it actually *forces* his/her sight to follow its path on the drawing. As a result, the role of the scanner is somehow inverted. The laser scanner no longer acquire shapes passively: it *augments* figures by superimposing a moving choreography of light. A clear example of this is the ”Sticky Light” operating over a logo or a maze: the eyes may get the whole picture, but as we follow the motion of the laser spot, we slowly gain a deeper, *sequential* understanding of the figure. When several spots operate at the same time, we may also start better appreciating subtle symmetries and compositional equilibrium on the scanned figure. The new installation presented

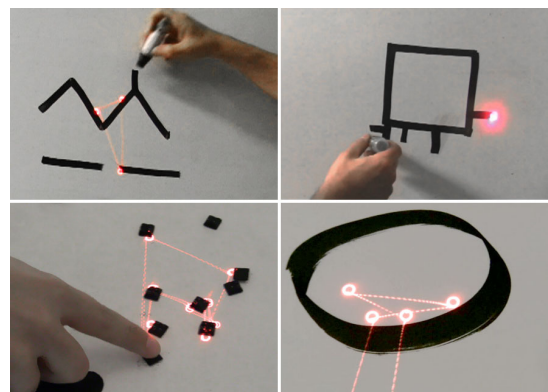


Figure 2: Example of handwritten ’light scores’

here, ”scoreLight”, builds on top of ”Sticky Light” by introducing another sensorial modality. Now, the ”smart” laser scanner not only transform static geometry into motion, but also makes *audible* visible features such as the smoothness or roughness of the artist’s stroke, the texture of the lines, etc. This installation is an artistic approach to artificial sensory substitution research and artificial

synesthesia very much along the lines of Golan Levin's works in the field [3, 4]. In particular, it can be seen as the reverse (in a procedural sense) of the interacting scheme of "Pitchpaint" [3], in which the speed and direction of a curve continuously being drawn on a screen is controlled by the pitch and volume of the sound (usually voice) captured by a microphone nearby. It has to be noted that the purity of the laser light and the fluidity of the motion makes for a unique aesthetic experience that cannot be reproduced by the classic camera/projector setup. The installation can also be easily scaled up: by just using a more powerful laser, it would be possible to run it over buildings tens or hundred of meters away - and then "read aloud" the texture of city (this would be a multimodal extension of works such as [7]).

### 1.1 Modes of interaction (work in in progress)

The preferred mode of operation in this preliminary work is *contour following*. In this mode, the drawing as a whole acts as a multi-track sound sequencer. Each connected component of the drawing controls a particular sound track. Depending on the mode of operation (that can be different for each light spot), the drawing can also function as a patch for the generation of complex sounds, or even for modulating sounds produced by figures nearby. Of course, sequences/patches can be recorded and reused in the form of drawings - on stickers for instance. Sound is modulated in the following ways:

- Pitch is controlled by the inclination of the lines. This generates a melody, whose tempo is determined by the length of the contour; rotating the drawing will transpose the melody to a higher/lower pitch.
- Pitch is continuously modulated as a function of curvature of the lines. This mode of operation enables one to hear the smoothness of the figure (then artificially reproducing the 'kiki/bouba' effect [2]).
- Extreme curvature indicates corners and spikes; these can be easily detected to trigger pre-recorded sounds (percussion, glitches, etc) - Fig. 3.

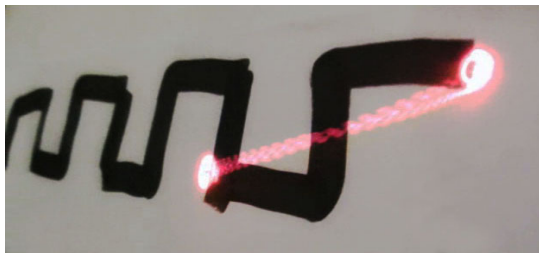


Figure 3: Periodic glitches are produced by a zig-zag

Other modes of operation include:

- Bouncing on lines (with or without artificial gravity - Fig. 4). This may be useful to create a rhythmic base (from a spot repetitively bouncing between lines), or to create instead random pitches (very much like in the "Hanenbow" mode of Toshio Iwai's "Elekroplanton" [5]).
- Interaction between spots and intermodulation. Relative distance between the spots can affect the sounds produced by each other (frequencies can become closer with distance, so as to produce audible intermodulation).

It may be interesting to 'hear' any kind of drawing; however, if one is to use scoreLight as a musical instrument, presumably more con-

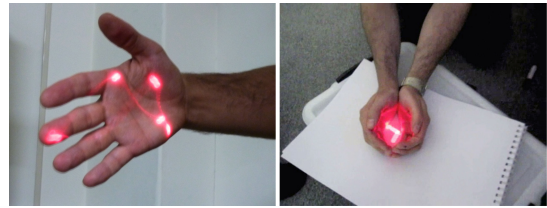


Figure 4: laser spot bouncing on physical contours

trol can be obtained by reusing interesting drawings and rearranging them on the scanned surface. Recording those scores/patches is inherently graphical here: for instance, stickers can be used as the support for interesting sound loops and effects (very much like in the 'reactTable' interface [9]). These can be arranged relatively to each other, their relative distance mutually affecting their sounds (for instance, the drawing on a sticker could be used to modulate the volume of the sound produced by another sticker).

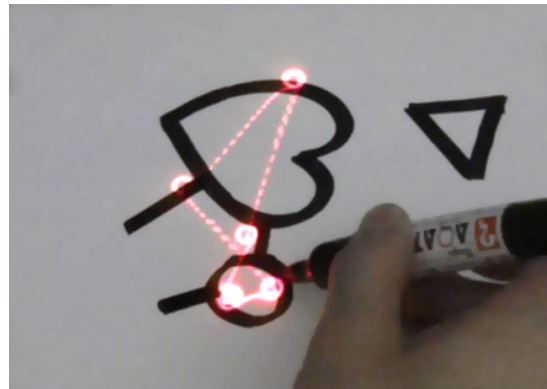


Figure 5: In contour following, tempo is given by the perimeter of the drawing; in bouncing mode, tempo is a semi-random function of the area.

## 2 TECHNICAL STATEMENT

The piece is based upon a 3d tracking technology developed by one of the authors in 2004 called the "smart laser scanner" [10]. The system uses a laser diode, a pair of steering mirrors, and a single *non-imaging* photodetector. The laser beam is able to follow contours in the very same way a blind person would use a white cane to stick to a guidance route on the street. The hardware is very unique: since there is no camera nor projector (with pixelated sensors or light sources), tracking as well as motion is extremely smooth and fluid. Moreover, several laser spots can be generated and controlled by a unique scanning head. The scanned material does not need to be black and white nor a flat figure; it can be virtually anything (a colorful tissue, a moving volume). What it's needed is that the scanned object presents enough contrast for the spot to know its whereabouts, allowing it to follow or bounce on contours. Presently, the scanner head is fitted with one red and one green laser (the red being used both for scanning and for drawing, while the green laser is only used for drawing). In the near future, we plan to integrate a 'white' laser capable of reproducing the full visible spectrum (it could be interesting to change the wavelength according to the pitch of the sound). Data collected by the scanner is pre-processed on a PC, and immediately used for steering the laser(s) spot(s) over the figure, depending on the mode of interaction. Simultaneously, the information is sent via OSC over Ether-

net to another computer (running MAX/MSP and Supercollider) in charge of generating sound, but also capable of sending commands back to the control PC to modify in real time the shape and dynamic of the laser spot.

### 3 INSTALLATION SETUP

The system can be easily configured on a table (as was done for 'Sticky Light' - see Fig.6), or function on a vertical surface such as a wall or a white board for people to doodle freely. Alternatively, the installation can be site-specific (and used for real time augmentation of sculptures or architectural landscape). Also intriguing is the possibility of augmenting stage performances in real time (for instance by projecting the laser over the floor or even over dancer's clothes or tattooed skin - Fig. 7). When using the system on a table, the laser power can be less than half a milliwatt - half the power of a not very powerful laser pointer - and does not suppose any hazard. More powerful, multicolored lasers can be used to augment (visually and with sound) facades of buildings tens of meters away.

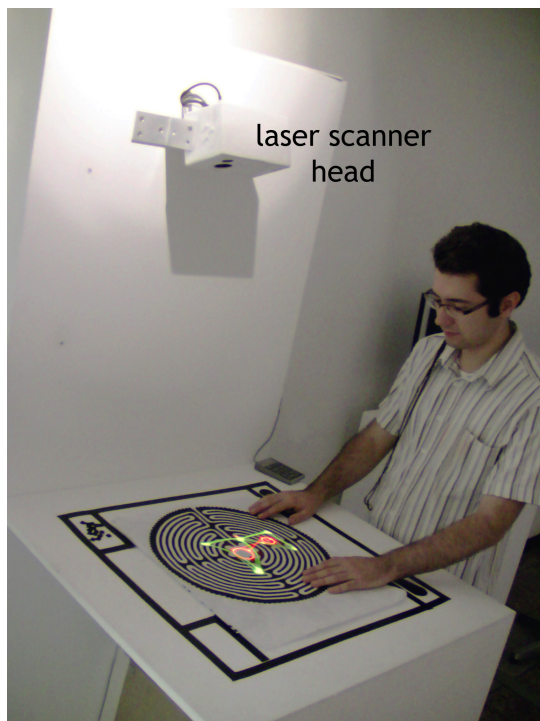


Figure 6: scoreLight in 'table' configuration

### 4 CONCLUSION

We have presented here an experimental device capable of generating rich sound (synchronized with moving light) from the shape of drawings or from the edges of three dimensional objects. It is too early to decide whether "scoreLight" can be effectively exploited as a musical instrument (in the vein of 'reacTable' for instance), but we believe that the platform is interesting per se: with a few strokes, anyone can produce enjoyable, hypnotic rhythms of light and sound. For video demos, check here: [www.k2.t.u-tokyo.ac.jp/perception/scoreLight](http://www.k2.t.u-tokyo.ac.jp/perception/scoreLight)

### 5 ACKNOWLEDGEMENTS

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Figure 7: scoreLight can augment clothes with light and sound

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