



scoreLight & scoreBots

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Abstract

"scoreLight" and "scoreBots" are two experimental platforms for performative sound design and manipulation. Both are essentially synesthetic interfaces – synesthetic musical instruments - capable of translating free-hand drawings into a sonic language of beats and pitches, all in real time. While scoreLight uses a modified "smart" laser scanner to track the figure's relevant features (in particular contours), scoreBots rely on one or more tiny line-following robots to do the same. We present here some of our latest experimentations in an informal way.

Author Keywords

Synesthesia; sound manipulation; physical interaction; musical instrument; laser; line follower robot.

ACM Classification Keywords

H.5.2 [Information Interfaces and Presentation]: User Interfaces - Interaction Styles; H.5.5 [Sound and Music Computing]: Methodologies and Techniques.

General Terms

Experimentation, Human Factors.



scoreLight: a human sized optical pickup

In scoreLight, a laser spot follows the contours of a drawing as a pick-up head would follow the groove on a vinyl record. 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 (there is no camera nor projector with pixellated sensors or light sources). Tracking and motion is extremely smooth and fluid. The piece is based upon a 3d tracking technology developed at the Ishikawa-Komuro laboratory in 2003, using a laser diode, a pair of steering mirrors, and a single non-imaging photodetector [1].

Related Work

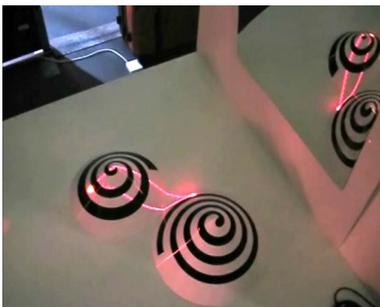
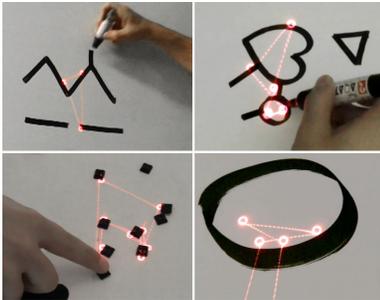
This installation is an artistic approach to artificial visual and sound synesthesia very much along the lines of Golan Levin's works in the field. In particular, it can be seen as the reverse (in a procedural sense) of the interacting scheme of "Pitchpaint" [2], in which the speed and direction of a curve continuously being drawn on a screen is controlled by the pitch and volume of the sound (usually voice) captured by a microphone nearby. The "Rotuni" module from the "Manual Input Workstation" [2] is also a close relative. However, the purity of the laser light produced by scoreLight and the fluidity of its motion make for a unique aesthetic experience that cannot be reproduced by the classic camera/projector setup.

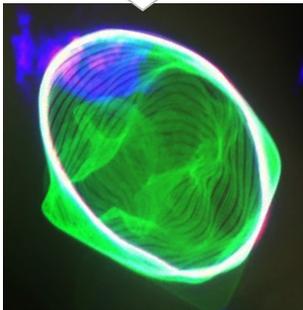
Basic modes of operation

Sound parameters (or filtering parameters in the case of pre-recorded samples) are chosen according to the curvature of the lines being followed, their inclination, as well as their color and contrast. Abrupt changes in curvature trigger discrete sounds (percussion, glitches), thus creating a rhythmic base. The length (of a closed

path) determines the overall tempo. Several laser spots (up to six in the present system) can be generated and controlled by a unique laser scanning head. This produces a wealth of data, potentially large enough for generating interesting and complex sound landscapes (one could equate the spots to strings in a guitar, each supporting a different melodic line). Importantly, the height of the objects on the table can also be measured by the system. Discrete height levels can then be used to *transpose by octaves* (up or down).

An interesting aspect of the modes described above is that *global geometric transformations* can be performed on the drawing, thus affecting the score as a whole. For instance, rotating the drawing will *transpose* the melody to a higher/lower pitch (when the inclination of the lines code for pitch); changing the direction of the scanning spot will produce a *temporal inversion* of the melody; flipping the drawing (it can be printed on a transparent slide or reflected through a mirror) will have a more complex effect (the angles transform onto their own conjugates, and since 360 degrees represents a full octave, every interval with respect to the unchanged line - the flipping line - will be *inverted*); elevating and slanting a flat drawing can produce interval inversions if the height codes the octave (certain notes will be raised or lowered by octaves). Other suggestive graphical transformations cannot be readily described in musical terms (such as the use of flat mirrors to break the drawing and generate kaleidoscopic-like symmetries or curved mirrors producing complex mappings in 2d, or perspective transformations). An intriguing possibility consists on drawing on stretchable supports such as textiles (or directly on the skin!): stretching along different directions will affect spatial frequencies, slowing down





or accelerating the playback speed, very much like in a defective cassette tape. Stretching equally in all directions (i.e., scaling) will affect overall tempo. A more detailed description of this installation and its modes of operation can be found in [3].

scoreLight II: vibrating strings of light

In a recent variation of this work (presented at "Dancing Machine", Monaco Dance Forum in Dec. 2011), the laser scanner/projector generates an *elastic loop of light* instead of a fixed, circular spot. This blob can "feel" and react instantly when touched in any part of its perimeter. Different sections of the contour react differently to the touch: some are attracted, some repelled in a slightly slanted direction (with respect to the contour), thus producing a driving force along the contour. No precise computation is performed in order to track the contour: the fact that the blob "attaches" and moves along the contour is an emergent, quasi-organic phenomenon (the repulsive/attractive regions function very much like a zipper, attaching the blob to the contour). From the point of view of the sound generation, the metaphor here is that the blob is a *closed loop of string* whose modes of vibration will produce different sound patterns. Geometrical accidents of any particular contour will "excite" the modes in different ways, sometimes resonating with the blob's fundamental modes, sometimes not. We also worked a variant in which the blob shape represents a mouth, and depending on its axis of elongation produces different voice formants. The results very much resemble human overtone singing.

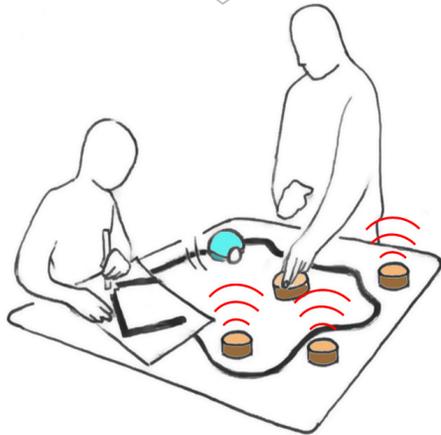
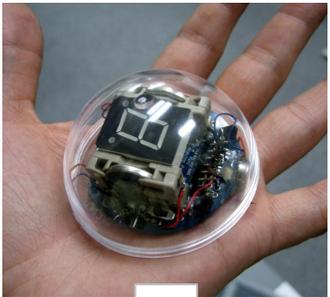
scoreBots: from light to matter

Interacting with scoreLight is extremely intuitive because people naturally attribute *intentionality* to the

laser spot (or blob). Interaction becomes then a personal dialogue with a moody luminous "creature". Indeed, people's attention seems to focus solely on this ghostly entity, disregarding the rest of the machinery and they interact with *a robot made of pure light*. With this observation in mind, we recently began developing "scoreBots", as an interesting *tangible* instantiation of the scoreLight principle. A *scoreBot* is a physical, untethered "pick-up head" (in the form of a tiny line-follower robot), that can be grasped and repositioned anywhere in the drawing/score at any time. We are currently developing two versions, one precisely copying the sound production rules used in scoreLight (with the difference that the sound is produced by the robot itself, and becomes therefore *spatialized* by construction). We are also working on a version in which the line-following robot triggers sound when it passes near a "sound puck" (an object with its own speaker, or capable of sending a wireless signal to a computer). Each puck can be placed anywhere along the trajectory of the robot; the puck's sensing range (triggered by the magnetic field of the robot), the sampled sound, as well as the effect robot proximity has on the playback is fully programmable, though it can be useful to have a pre-defined set of effects when performing (not dissimilar to the Reactable setup [4]).

Reflections

The works presented here are all different takes on a simple idea: that of placing an essentially linear score into a two (or three) dimensional space, and using the geometry of the path to control sound parameters. This is of course motivated by well known synesthetic effects, such as the "kiki/bouba" effect [5].



From 2d to 3d and body surfaces

scoreLight works well as a “table interface” accessible from all sides and enabling collaborative play. It can also function on a vertical surface such as a wall or a white/blackboard. scoreLight (and to a certain extent also scoreBots) can be highly site-specific, and effectively augment sculptures or architectural landscapes with sound. When using the system on a table, the laser power is less than half a milliwatt - half the power of a conventional laser pointer. More powerful, multicolored laser sources can be used in order to (visually and aurally) augment the facades of buildings tens of meters away, thus enabling the readout of the city landscape as a musical score. By reversing the scoreLight readout process, it is also possible to carve precise three-dimensional structures (resembling a reduced model of a city) encoding complex musical scores.

Also intriguing is the possibility of augmenting stage performances in real time (for instance projecting the laser over the floor or the dancer’s clothes, or tattooed or painted skin). Since there is no need to perform any camera/projector calibration (the reading beam and the projecting beam are constructed to be collinear) setup is extremely simple, opening the door for on-the-spot, performative experimentation with stage musicians, choreographers and dancers. A beautiful byproduct of the scoreLight scanning routine is that the laser spot reflects and shines over certain surfaces, or diffuses on translucent volumes. (We have recently used a triple color laser head, including a violet laser that can leave a luminous trace on phosphorescent paper, thus momentarily “painting” the score and its reflections). From afar, one can see a repetitive sequence of flashes and reflections projected all over the place (as if the

machine was performing some arc-welding work on the music), while at the same time hearing a tune tightly in synch. The effect of this synchronized light “extension” (of a moving body) is an explicit research direction also explored in the Light Arrays project [6].

For more details on these works and exhibition history, refer to www.k2.t.u-tokyo.ac.jp/perception/scoreLight/

Acknowledgements

Thanks to Benjamin Maus for suggesting and creating interesting 3d “sonic sculptures” such as the “musical cones” seeing in the videos.

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