



The Laser Sensing Display

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www.k2.t.u-tokyo.ac.jp/perception/SLP/

Lessons

Summary

The goal of the project is to transform a whole ski slope into an interactive display, where (laser) graphics are drawn in response to the skier's motion. Using laser projection, common in large scale audio visual shows, the graphics can be drawn from a single location onto an uneven surface in varying distance (something impossible to attain with standard projectors). Moreover, snow provides an excellent projection surface, giving high contrast imagery. Various interaction scenarios are being explored, including interaction with virtual skiers and virtual obstacles, animation, competitor scores, motion trails, real-time video, and more. This is a collaborative project between the University of Lapland, the Berlin University of the Arts and the University of Tokyo, and the immediate goal is to showcase the system during the 2011 FIS Alpine Ski World Cup.

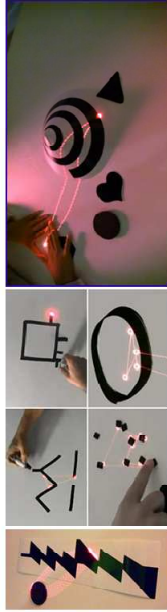


The system combines standard camera tracking and camera-projector calibration (stereo pair or single camera for tracking skiers on a slope with brown topography), as well as the laser sensing display hardware. The system is designed to be used in a variety of ways, from interactive to non-interactive. Possible interaction scenarios range from informative to playful for the audience and for the skiers themselves - including scores, secure perimeter indication of dangerous obstacles in real time, to new forms of competitions and experiences on the slopes (and eventually on all kind of playgrounds regardless of the scale and shape - such as football or tennis, playgrounds, climbing walls, ping-pong tables, or just the street).

scoreLight: laser-based artificial synthesis instrument

Summary

"scoreLight" is a prototype musical instrument capable of generating sound in real time from the lines of doodles as well as from the contours of three-dimensional objects nearby (hands, dancer's silhouette) that move in space. The instrument is designed to be used in a variety of ways, from interactive to non-interactive. Possible interaction scenarios range from informative to playful for the audience and for the skiers themselves - including scores, secure perimeter indication of dangerous obstacles in real time, to new forms of competitions and experiences on the slopes (and eventually on all kind of playgrounds regardless of the scale and shape - such as football or tennis, playgrounds, climbing walls, ping-pong tables, or just 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 can be extremely smooth and fluid. The light beam follows contours in the very same way a blind person uses a white cane to stick to a guidance route on the street. Details of this tracking technique can be found here. When using the system on a table (as in the image on the right), the laser power is less than half a milliwatt - half the power of a not very powerful laser pointer - and does not supposes any hazard. More powerful, multicolored laser sources can be used in order to "augment" (visually and with sound) facades of buildings, tens of meters away - and their "read aloud" the 3D landscape.



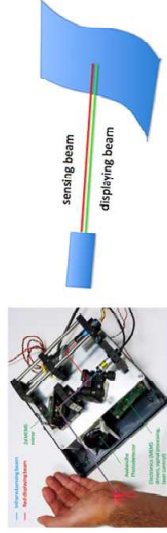
It is still too early to decide if the system can be effectively used as a musical instrument (has it enough expressivity? can we find a right balance between control and randomness?). However, it is interesting to note that "scoreLight", in its present form, already unveils an unexpected direction of (artistic) research: the user does not really know if he/she is painting or composing music. Indeed, the interaction and (real-time) feedback between sound and visual is so strong that one is tempted to coin a new term for the performance since it is not drawing nor is it playing music, but both things at the same time... *scoreplayng*.

A. Cassinelli, Y. Kurihara, A. Zerroug, D. Manabe and M. Ishikawa, *scoreLight: playing with a human sized laser pickup*, International Conference on New Instruments for Musical Expression (NIME 2010), June 2010, Sydney, Australia, pp. 144-146, DOI: [10.1145/1752507](https://doi.org/10.1145/1752507).
A. Cassinelli, Y. Kurihara, D. Manabe and M. Ishikawa, *scoreLight: Digital Content Expo 2009 Symposium* (25 October 2009), Milan - Museum of Emerging Science and Innovation, Tokyo; Site presentation (PPT).
A. Cassinelli, Y. Kurihara, D. Manabe and M. Ishikawa, *scoreLight: a laser-based synthetic experience*, additional documentation for SIGGRAPH ASIA 2009 (Art Gallery), (PDF: 1.7MB).
A. Cassinelli, A. Zerroug, J. Argelave and M. Ishikawa, "Camera-less Smart Laser Projector", Laval Virtual - 12th Virtual Reality International Conference / Revolution Demos, April 7-11 2010, Laval, France. (Additional handout: (PDF: 2.2MB) Poster (PDF: 5.3MB)). (SIGGRAPH E-tech RevolutionAwards: invited to SIGGRAPH E-tech 2010).
A. Cassinelli, A. Zerroug, Y. Watanabe, J. Argelave and M. Ishikawa, "Camera-less Smart Laser Projector", SIGGRAPH 2010 (invited to Emerging Technologies), July 25-29 2010, Los Angeles, One paper abstract: (PDF: 1.4MB), flyer (PDF)

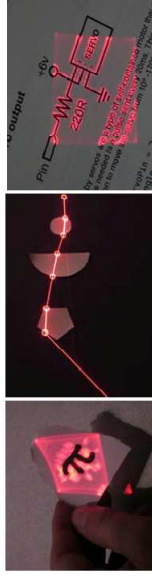
The Smart Laser Projector (SLP): a cameraless 'sensing display'

Summary

The Smart Laser Projector (SLP) is a modified laser-based projector capable of displaying graphics or, at the same time, simultaneously using the beam (at the same or different wavelength or polarization) as a LIDAR probe gathering information about that surface position, orientation and shape, the texture, spectral reflectance and even relative motion. It is therefore possible to synthesize an artificial surface reference, or to correct geometrical warp, all in real time and without the need of calibrating a camera and a projector. We have developed two prototypes, one working in real-time mode, and another in vector graphics mode. Our previous research on the Smart Laser Scanner, scoreLight and StuckyLight can be seen as special applications of the SLP in vector-graphics mode.



Applications of the SLP may include dermatology (enhancement of superficial veins or direct visualization of anomalous polarization induced by cancerous cells), non-destructive control (visualization of microscopic scratches, oily spots or mechanical stress), authentication (visualization of non-fluorescent UV or IR watermarks thanks to artificial fluorescence), and in general all sort of augmented reality applications. The system is designed to be used in a variety of ways, from interactive to non-interactive. Possible interaction scenarios range from informative to playful for the audience and for the skiers themselves - including scores, secure perimeter indication of dangerous obstacles in real time, to new forms of competitions and experiences on the slopes (and eventually on all kind of playgrounds regardless of the scale and shape - such as football or tennis, playgrounds, climbing walls, ping-pong tables, or just the street).



The laser-based 'sensing display' paradigm presents a number of advantages with respect to the more classical 'projector-camera' setup used in sensor-enhanced displays, among which:

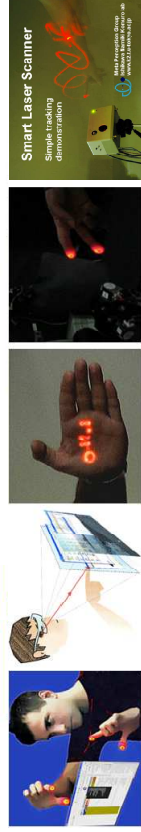
- no camera-projector calibration needed;
- very 'fast' feedback (no image processing required);
- geometrical correction + color and contrast compensation possible;
- variable resolution; the laser scanning step can be finer on regions of interest;
- simple and compact optical system; there is no 2d imaging optics; and hence no aberrations nor bulky optics;
- projection at very long distance in vector graphics mode ideal for outdoor interactive applications

A MEMS based, compact SLP may eventually be embedded on clothes and used as a wearable display capable of transforming on-the-flight any surface nearby into a full interactive 'sensing display'.

Smart Laser Scanner (markerless laser tracking)

Summary

The problem of tracking hands and fingers on natural scenes has received much attention using passive acquisition vision systems and computationally intense image processing. We are currently working on a novel approach, based on a simple and compact optical system, that allows to track a hand or a finger in real time without the need of any image processing at all. Essentially, it is a smart rangefinder scanner that instead of continuously scanning over the full field of view, restricts its scanning area to a very narrow window precisely the size of the target.



Tracking of multiple targets is also possible without replicating any part of the system (targets are considered sequentially). Applications of a multiple target tracking system are countless. Such a configuration allows, for instance, multiple users to interact on the same virtual space; or a single user to control several virtual tools at the same time; resize windows and control information screens, as well as to interact with virtual objects. A further challenge of the proposed system is to project graphics on the target without the need of any image processing at all. This can be used as an alternative to the traditional approach of projecting graphics on a screen. The laser scanner tracks the target and projects the graphics on the target. This approach has been successfully demonstrated, without having to stop the tracking. Finally, hardware simplicity is such that using state-of-the-art Micro-Opto-Electro-Mechanical-System (MOEMS) technology, it could be possible to integrate the whole system on a single chip, making a versatile human-machine input/output interface for use in mobile computing devices.

A. Cassinelli, S. Perrin and M. Ishikawa, Smart-Laser-Scanner for 3D Human-Machine interface, ACM SIGCHI 2005 (CHI '05) International Conference on Human Factors in Computing Systems, Portland, OR, USA, April (2 - 07, 2005), pp. 1138 - 1139 (2005), Abstract: (PDF: 835KB), Video Demo: Good Quality: (MPG: 78MB), Compressed: (MPG: 28MB), Slides Presentation (click on images to launch video demos) (PPT: 10MB).
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S. Perrin, A. Cassinelli and M. Ishikawa, Laser-Based Finger Tracking System Suitable for MOEMS Integration, Image and Vision Computing, New Zealand (IVCNZ 2003), Massey Univ., 26-28 Nov. 2003, pp. 131-136, (2003), (PDF: 239KB), Poster presentation (PPT: 1432KB).