Camera-less Smart Laser Projector

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1 INTRODUCTION

The 'Smart Laser Projector' (SLP) is a modified laser-based projector capable of displaying while simultaneously using the laser beam (at the same or different wavelength or polarization) as a LIDAR probe gathering information about the projection surface (its borders, 3d shape, relative position and orientation, as well as fine texture and spectral reflectance). This information can then be used to correct perspective warp, perform per-pixel contrast compensation, or even reroute the scanning/projecting path altogether (for tracking, feature discovery or barcode reading for instance). We demonstrate here raster-scan and vector graphics applications on two different prototypes. The first relies on a pair of galvano-mirrors, and is used for demonstrating simultaneous tracking and display on the palm of the hand, depth-discriminating active contours (for spatially augmented reality surveying), and interactive games. The other relies on a single 2-axis MEMS mirror working in resonant mode, and is used to demonstrate edge enhancement of printed material and 'artificial fluorescence' - all with perfect projection-to-real-world registration by construction.

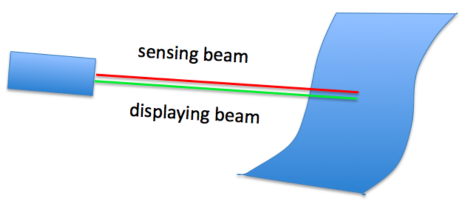

Figure 1: *Collinear beams for display and measurement*

2 DEMONSTRATION

The SLP is a mix between a laser projector and a laser scanner (Fig.1). It is a 'smart projector' in the sense of [Raskar et al. 2005], but presents some significant advantages with respect to a classical camera-enhanced projector, the most important being unnecessary camera/projector calibration (scanner and projector share the same intrinsic and extrinsic parameters), markerless 3d tracking by direct laser rangefinding, and finally possible precise measurement of the surface's spectral reflectance. Additional advantages come from the laser projection technology itself: large depth of field, variable resolution, simple and compact optical system (no imaging optics), energy efficiency for long-range projection (ideal for large-scale outdoor applications). The SLP is also capable of detecting and tracking objects or fingers over the projection surface, making it an interesting platform for implementing ubiquitous interactive displays. The Smart Laser Scanner [Cassinelli et al. 2005] and scoreLight installation [Cassinelli et al. 2009] can be seen as special implementations of the SLP in vector-graphics mode. We present here two new vector-graphic demonstrations highlighting the ability of the SLP to extract geometrical features from images or 3d objects: depth-discriminating active contours for AR surveying and interactive laser games based on the simulation of geometrical optics (Fig.2). A second MEMS-based prototype is capable of

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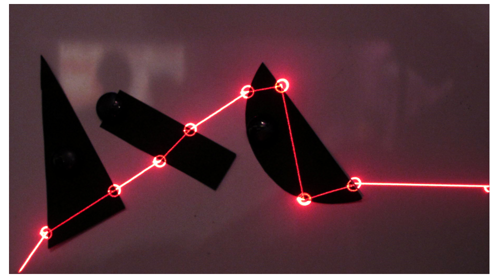

Figure 2: *Simulated refraction by real-time scan rerouting*

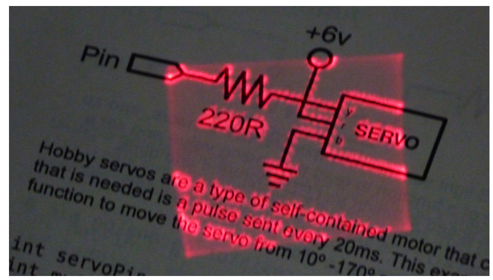

Figure 3: *Edge detection and enhancement in raster mode*

displaying raster-scan images; it uses an infrared laser for sensing, and a collinear red laser for displaying. Fig.3 shows a laser generated 'outer glow' to enhance text legibility. Other applications will be demonstrated during the show, including direct visualization of IR watermarks, vein enhancement (by exploiting the 'artificial fluorescence' principle) and direct visualization of polarization changes. Future applications of the SLP may include dermatology (enhancement of superficial veins, direct visualization of anomalous polarization induced by cancerous cells, and energy-efficient 'targeted' phototherapy), non-destructive control (visualization of microscopic scratches or mechanical stress), authentication (by exploiting artificial fluorescence) and in general all sort of augmented reality applications using any available surface for projecting laser icons but also full-fledged raster scan images when required. In this sense, our short term goal is to develop a wearable MEMS-based prototype capable of transforming the space around the wearer into an interactive laser-based AR environment - a sort of 'laser aura'.

References

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