

An Augmented Reality Laser Projector using Marker-less Tracking

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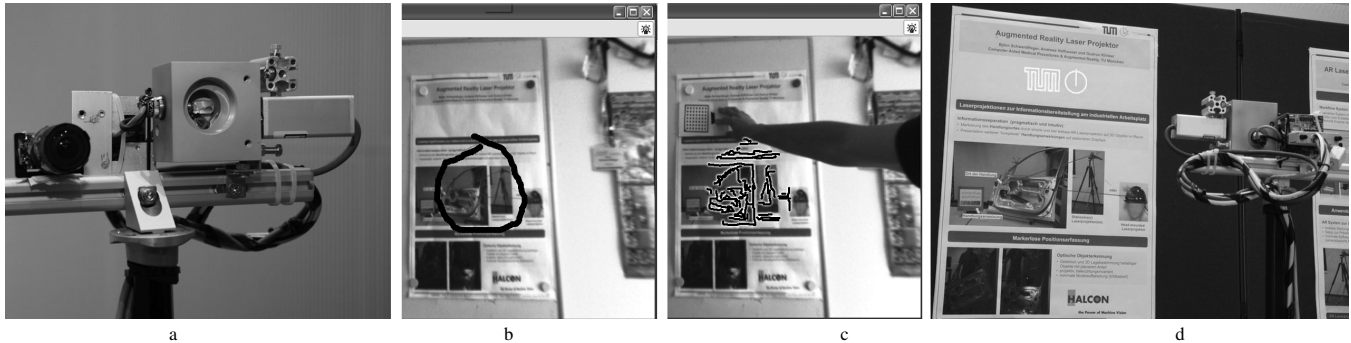


Figure 1: a) Augmented Reality Laser Projector Unit b) Marking of the pseudo planar region to be tracked c) The black lines show the tracked line features and the dotted square marker is placed to define the object coordinate space d) The Augmented Reality Laser Projector is placed in front of the poster: it detects tracks the features defined in b) and augments the logo of our faculty relatively to the object center defined in c).

Abstract

Due to several industrial requirements we were exploring the use of projective displays as an alternative to Augmented Reality user interfaces based on HMDs. This resulted in the development of an Augmented Reality Laser Projector. In this demo we show the laser projector in combination with an easy to use and easy to adapt markerless tracking system. Almost any pseudo planar object can be taught as tracking target within two atomic work-steps. This enables the Augmented Reality Laser Projector to project augmentations on tracked objects, without the need for artificial markers.

CR Categories: H.5.1 [Multimedia Information Systems]: Augmented Reality— [H.5.2]: User Interfaces—User-centered Design

Keywords: Augmented Reality, Laser Projector, Natural Feature Tracking

1 Augmented Reality Laser projectors

A significant number of current industrial Augmented Reality (AR) applications involve the use of head-mounted displays (HMDs) (e.g. in the ARVIKA project [Friedrich 2004]). Up to now, such systems have not been brought to full industrial use. This is due the limitations of current HMDs (users' focus either on the image or real world, fatigue of the eye, small field FOV) [Laramée and Ware 2002] which can not meet the demanding industrial requirements.

As an alternative to HMDs, we have designed and built an Augmented Reality Laser Projector to augment a real environment [Schwerdtfeger and Klinker 2007]. The information that is provided by the system is separated into two aspects: *where-to-act* and *what-to-do*. The laser projector displays simple where-to-act

information directly in three dimensions on any object (with arbitrary surface structure) in the environment while an additional standard screen displays the more complex what-to-do information.

In this Demo we combined our Augmented Reality Laser Projector with our new and robust marker-less tracking approach.

Projector-Camera Unit The Augmented Reality Projector is shown in Fig. 1a. It consists (from left to right) of a fish eye camera (for different optical tracking methods) two X/Y mounted galvanometer scanners (mounted in the cube) and a green laser (1mW). The current setup is mounted on a tripod.

Applications We already evaluated the general concept of our Augmented Reality Laser Projector in a quality assurance scenario, where we highlighted welding points to check on a white raw car body [Schwerdtfeger and Klinker 2007]. Further more we applied it to an maintenance scenario [Schwerdtfeger et al. 2008], where a tripod mounted version of our system is part of the workers' toolbox.

Tracking For robust and efficient detection and tracking we use a template matching algorithm that allows significant perspective shape changes [Hofhauser et al. 2008]. The problem, solved by this algorithm, is particularly difficult, as in contrast to optical flow, tracking, or medical registration, we assume neither temporal nor local coherence. While the location of the objects are determined with the robustness of a template matching method, we avoid the necessity of expanding the full search space as if it was a descriptor-based method.

Demo Application The demo application is intended to show some benefits and drawbacks of our system. Within only two atomic work-steps almost any pseudo planar object (having at least simple features) can be taught as tracking target. For this purpose

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in the first step the object (here a poster) is placed in front of the camera and the region to track is marked using a mouse pointer (compare Fig.1b). In the second step the object coordinate space and scale are defined by placing a simple square marker in the object plane (compare in Fig.1c). After executing the two steps the poster can be detected and tracked in the camera image. This enables us to project different augmentations relatively to the objects center out of different perspectives.

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2 List of Equipment

- Augmented Reality Laser Projector on a tripod
- Control Unit (small suitcase)
- tripod 1.5 m height
- laptop running the demo
- posters DIN A 1

3 Space Requirements

The demo requires about $2 \times 2m^2$ of space with a table for placing a laptop and some papers. We need a wall to hang up the poster to project on. To avoid tracking problems, the demo space should not be in direct sunlight. Further more we need one socket with $< 1kW$.

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Videos, showing the tracking system can be found at:
<http://campar.in.tum.de/Main/AndreasHofhauser>