

# Markerless Augmented Reality with a Real-time Affine Region Tracker

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## Abstract

*We present a system for planar augmented reality based on a new real-time affine region tracker. Instead of tracking fiducial points, we track planar local image patches, and bring these into complete correspondence, so a virtual texture can directly be added to them. Moreover, the local image patches can be extracted in an invariant way, even without any a priori information from previous frames. Hence it is possible to use them as natural beacons, that can be used to recognize the scene and to identify the individual patches. This results in a powerful system, that can work without artificial markers or fiducial points and with a minimal amount of user interference.*

## 1. Introduction

Augmented Reality superimposes information – textual or figural – onto parts of the real world. Issues to be resolved are *what* should be shown *where*, and *how*. The latter problem is especially important when the visual appeal of the result is crucial. Then much effort has to go into seamlessly fitting the information into the scene, both geometrically and photometrically (occlusions, shadowing, mutual reflections, chromatic adaptation to scene illumination, ...). In this paper we only deal with the two other issues: what to place *where*. We even simplify the problem further by assuming that planar textures are to be superimposed onto planar parts in the scene (but these planar parts can be small, so, in contradistinction to e.g. Simon *et al.* [13], we do *not* assume that dominant planes are present.)

Yet, even under such simplified conditions these problems do not become trivial. Suppose a field worker has to perform a job somewhere in a building. The engineer has gone through the building the previous day, and has prepared virtual annotations that indicate what is to be done at different locations. When the worker enters a room, his AR system should superimpose this information through a head-mounted display, e.g. a todo list, or a video demon-

strating the expected manipulation. The system should therefore recognize where it is, and which information is to be superimposed where. As mentioned, we assume that planar textures are to be superimposed onto planar surface patches. In fact, the information need not be projected right on top of these patches, but it will be rigidly connected to them. The following tasks have to be solved:

1. recognize the overall position of the user (context)
2. recognize the individual patches
3. track the patches and superimpose their virtual textures

The first two steps can be considered to be a kind of initialization. The first step, finding the user's overall position within a possibly large scene, need not be solved entirely based on visual information. Vision could be combined with GPS and we plan such integration. In our current implementation this step is carried out pure visually. In fact, the first two steps are combined. The joint recognition of a set of patches as a configuration yields the location. This step is not carried out in real-time. Once the patches have been recognized, the system displays their annotations. The user can select a region, and then the system allows to track and augment the selected region in real-time. Hence, the correct, superimposed information rigidly moves with the patch.

Due to the real-time demands of AR, researchers often have to take refuge to putting 'markers' or 'landmarks' into the scene [1]. They are designed in a way that they are easy to detect. Detection may be eased by giving them distinctive photometric characteristics (e.g. colored markers [9, 10], LEDs [6], and retroreflective markers [5, 12]) or special shapes (like squares [9, 15], circles [14], dot codes [8] or even 2D barcodes [11]). The novelty of the proposed work is that we attempt to use patches of the natural scene as landmarks. The extraction of these landmarks is automatic and robust against changes in viewpoint and illumination. A single patch can be tracked in real-time, where out-of-plane rotations as well as major shifts between frames are allowed. During tracking accurate correspondences between points of the landmark patches are established, because the complete affine transformations between frames are recovered

# A Real Time Tracker For Markerless Augmented Reality

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