Online camera pose estimation in partially known and dynamic scenes

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Abstract:
The demo shows the result of a camera pose estimation framework presented in the paper with the same title. The tracking approach does not depend on any preprocessed data of the target scene. Only a polygonal model of an object in the scene is needed for the initialization of the tracking. A line model is created out of the object rendered from a given camera pose and registrated onto the image gradient for finding the initial pose. In the tracking phase, the camera is not restricted to the modeled part of the scene anymore. The scene structure is recovered automatically during tracking. Point features are detected in the images and tracked from frame to frame using a brightness invariant template matching algorithm. Several template patches are extracted from different levels of an image pyramid and are used to make the 2D feature tracking capable for large changes in scale. Occlusion is detected already on the 2D feature tracking level. The features' 3D locations are roughly initialized by linear triangulation and then refined recursively over time using techniques of the Extended Kalman Filter framework. A quality manager handles the influence of a feature on the estimation of the camera pose. As structure and pose recovery are always performed under uncertainty, statistical methods for estimating and propagating uncertainty have been incorporated consequently into both processes.

Keywords:
marker-less tracking, real-time camera pose estimation, reconstruction

Storyboard:
For the initialization of the tracking a line model of an object is generated to a user defined camera pose. The line model is projected into the image and the user has to move to camera until the projected line model gets close enough to the object in the image. The tracking is initialized by the registration of the line model onto the image. From now on only feature points are used for tracking. The geometry of the model is used to get the 3D position of features on the model. Other feature points are tracked in 2D and continuously reconstructed. Therefore the camera has to be translated to make it possible that feature points can be triangulated. When enough feature points have been reconstructed, the tracking is very robust against occlusion and modifications of the scene. It is even possible to remove the object of the scene with which the tracking was initialized. Virtual objects are placed in the scene to visualize the camera pose estimation result. By request of the user the 2D point features and the reconstructed 3D points together with their covariances can be visualized.

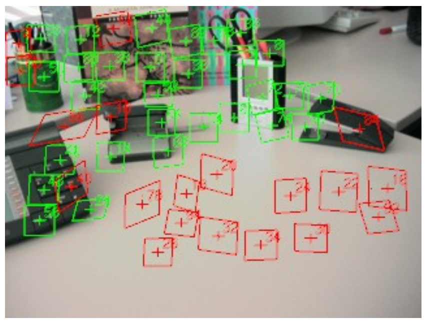
Demo requirements:

- one table (2x1 m)
- some space (1m) in front or aside for a camera tripod
- 2x power outlet (laptop, firewire hub), works with 110V
- reasonably good lighting conditions

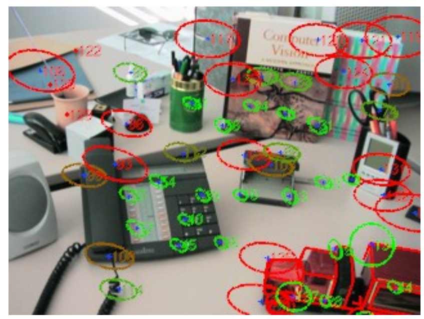
Our equipment:

- laptop
- firewire camera and firewire hub
- some objects to track

(a)

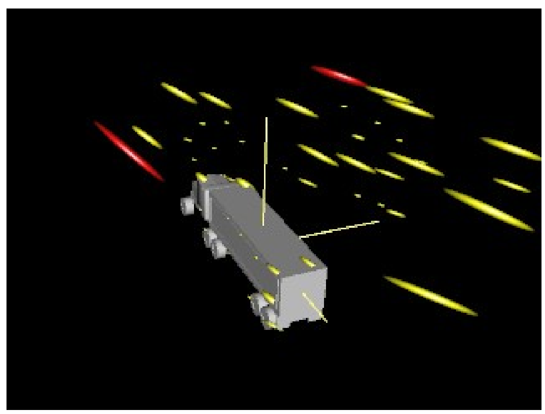


(b)



(c)

(d)



(e)

(a) The generated line model before the initialization of the tracking.
(b) Illustration of valid and invalid 2D features. After the object has been removed, the feature point on the object become invalid.
(c) Illustration of the projected 3D covariances of the reconstructed points.
(d) Augmentation in the scene.
(e) Illustration of the 3d covariances of reconstructed feature points. The viewing camera can be defined by the user.