InnoTeamS
Innovation in Software

EOS - 3D tracking system

EOS High-precision 6 DOF tracking system

Figure 1: View from one of the cameras with infrared filter. Three passive markers for the hand device (green dot) and one passive marker for the head (yellow dot) are tracked and superimposed with segmentation results (red dots) on the camera image.

System

The **EOS** tracking system is a lowprice solution for highprecision 6 DOF tracking dedicated to wireless interaction in Virtual and Augmented Reality (VR/AR) environments. With a simple and flexible hardware setup, it allows to track several 6 DOF sensors (devices consisting of either active or passive markers) in realtime.

EOS is more than a stand-alone application, but an open framework, that can satisfy the needs of special applications on demand. Extensions are easily supported by the modular software design. All important system parameters like thresholds or definitions of the tracked objects are configurable.

The accurate measurements performed by **EOS** are based on the segmentation of gray-scale images with sub-pixel accuracy and a 3D reconstruction from the images of two calibrated cameras. The calibration process can be performed easily without presumed knowledge in about one minute just by swaying a calibration device.

To verify, that **EOS** is operating correctly, several control monitoring options have been integrated. Every step from the processing of the image data to the 3D reconstruction or the position of the freely defined world coordinate system can be overlaid on the camera images itself. In addition, to control the accuracy of the tracking an evaluation interface is available to allow easy testing at any time.

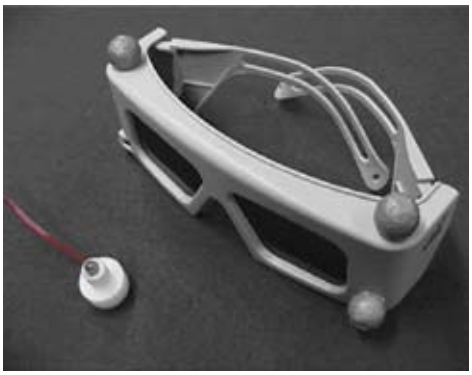

Figure 2: A single infrared diode as active marker and shutter glasses with three retro-reflective passive markers

Components

The EOS system includes two CCD cameras, infrared filters, a standard PC (WindowsTM OS) with an IEEE 1394 Controller (Firewire) and two infrared spots (only if passive markers are used).

The passive markers have a diameter of about 15 mm and reflect the infrared light from the spots to the cameras. Three of them with a fixed geometry define a model that can be tracked and distinguished from other models with different geometries. The software allows the tracking of an unlimited number of such models. Testing with even up to eight different models did not decrease the number of measurements per second. Single markers can be tracked as well (3 DOF tracking).

The active markers are special infrared diodes with a diameter of about 5 mm. Active markers make the infrared spots redundant.

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(EOS is a product of ZGDV e.V. and delivered in association with InnoTeamS GmbH)

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Applications

The field of possible applications of the EOS system covers several domains. Originally, it was designed for interaction in Virtual Reality environments, but it is also most suitable for AR systems dealing with maintenance, manufacturing, repair, medicine or entertainment. The basic system with a setup for passive markers is used in the Starmate project, which is dedicated to training, assembly and maintenance of complex mechanical systems. Another adapted EOS version using active markers to achieve a higher accuracy is used in the Medarpa project, dealing with the design and the construction of an AR-based workplace with special assistance for keyhole surgery.

Specifications

The interaction volume of EOS depends on the positioning of the cameras, which can vary from nearly parallel up to 180 degrees. With a distance of about 3 m from the cameras an interaction volume of around 2m x 2m x 2m can be achieved.

The update rate is about 30 frames per second and independent from the number of models to be tracked. The update rate is not limited by the algorithms.

To assure the quality of the tracking results, EOS has several control monitoring features. Besides the visual feedback of every processing step on the camera images, the evaluation interface allows measurements of positions of single markers and distances between markers. Depending on the setup this feature delivers the results as follows.

Tracking of a fixed marker:
Passive < 1.0 mm RMS
Active ~ 0.5 mm RMS
Distance measurements (free movement):
Passive ~ 1.0 mm RMS
Active < 1.0 mm RMS

In general **EOS** is used together with a rendering system. Therefore EOS provides a standardized communication interface and uses networkbased communication. This allows support of several and different rendering systems simultaneously. Receiver libraries are available in C++ and Java.

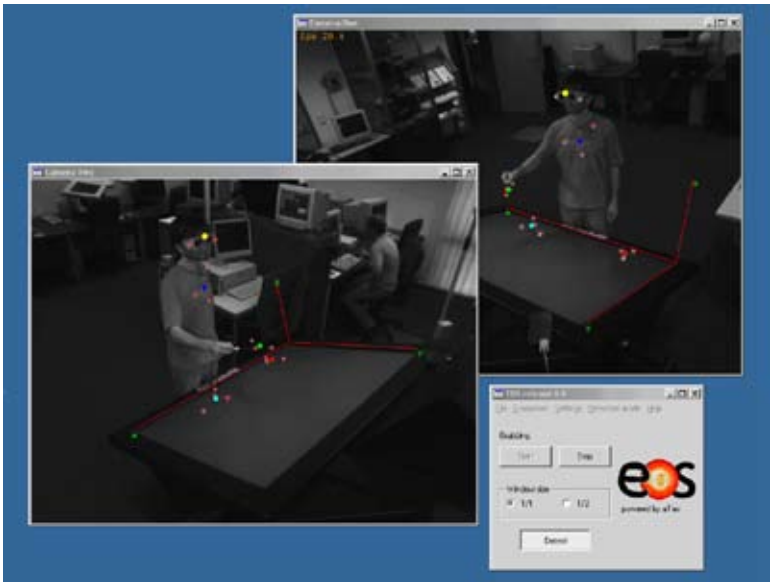

Figure 3: EOS interface with camera images tracking four models and one single point. The defined world coordinate system is visualized as well.

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