

## PLANE-BASED CAMERA CALIBRATION FOR 3D-VIDEOGRAMMETRY FOR CANOEING AND ROWING

Volker Drenk, Falk Hildebrand  
Institut for Applied Training Science, Leipzig, Germany

**KEY WORDS:** videogrammetry, calibration, 3D, canoeing, rowing.

**INTRODUCTION:** 3D kinematic analyses are normally based on calibration procedures using the DLT algorithm. Therefore, a calibration frame recorded in the center of the field of view works as reference frame for the reconstruction of the 3D object. Due to the conditions of water sports, this proceeding is not applicable to sports disciplines like canoeing or rowing. For such events, the recording with pre-calibrated cameras from a catamaran that follows the object has been proven (Hildebrand et al., 1998). It seems to be more appropriate to apply especially under the condition of competition calibration techniques which do not require a spatial calibration frame. Here, several methods have been published; these calculate the camera orientation from two or more observations of the same planar scene from different perspectives (e.g. Sturm & Maybank, 1999; Zhang, 1999), but only few applications deal with sports related tasks. Instead of these general approaches, a calibration method for 3D analysis in water sports has been developed, that uses the specific conditions of tripod based camera panning. Buoys that define the borders of the race lanes and therefore are placed in exactly measured distances serve as a planar system of control points.

**METHOD:** The calibration procedure consisted of three steps: 1. The cameras are placed on the bank with their panning axes arranged perpendicularly. Moreover, cameras' principal points must be known. Each camera takes three frames of the buoys, each with different panning angles and constant interior orientation. 2. By geometric evaluation of 2D DLT parameters of all frames the location of the panning axis can be calculated. The location of the panning axis provides further information about the position of the center of perspective in the plane of buoys. On account of the large area distribution of the buoys, a large range of panning angles can be scanned, this assures a high precision of these parameters. 3. The height of the projection center is calculated by simple geometric evaluation using the projection of the principal point in the plane of the control points. Therewith, the orientation of the camera can be completely determined.

**RESULTS:** The new calibration technique was applied at the regatta course of Duisburg, Germany. By panning a pair of cameras, several canoeing cycles were filmed. The exact distances of the buoys were surveyed and a minimum of 10 control points (buoys) per frame was used for calibration. Due to the number of control points the estimated error for the calculation of 3D landmarks is less than 0.05m. Further, the reliability of the calibration procedure will be verified by comparing the reconstructed and original length of the boats.

**DISCUSSION:** The application of 3D calibration methods that simply based on various views of the same plane enhances the spectra of calibration methods used for kinematic analyses in sports. Furthermore, it is now possible to perform kinematic analyses under competitive conditions that do not allow to enter the site of competition for the reason of calibration.

### REFERENCES:

- Hildebrand, F., Drenk, V. & Kindler, M. (1998). 3D video technique for the analysis of rowing in a natural element. *Proceedings of the XVI ISBS Symposium 1998*, 477-480, Konstanz.
- Sturm, P. & Maybank, S. (1999). On plane based camera calibration: A general algorithm, singularities, applications. *Proceedings CVPR*, 432-437, June 1999.
- Zhengyou Zhang (1999). A flexible new technique for camera calibration. *Technical Report MSR-TR98-71, Microsoft Research*, 1999. Updated version of March 25, 1999.