NON-LINEAR CAMERA CALIBRATION FOR 3D RECONSTRUCTION USING STRAIGHT LINE PLANE OBJECT

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INTRODUCTION: One critical aspect to 3D reconstruction of human motion using videogrammetry is related to the need for an accurate calibration of large volumes. Most of calibration methods used in biomechanics requires the construction, transportation and measurement of rigid structures and this is more difficult when larger volumes are involved. Recently, alternative approaches have been proposed to overcome this critical aspect (Cerveri et al., 1998; Zhang, 2000). This work presents preliminary results of the proposition and evaluation of a non-linear camera calibration method for 3D reconstruction using a plane object containing straight lines.

METHODS: The non-linear calibration method proposed in Zhang (2000) and implemented as a camera calibration toolbox for Matlab was adapted for video analysis and tested in this paper (named Chess Method). The method uses just a few points (12) distributed over a small volume (2.7x0.9x1.0 m^3) to obtain extrinsic parameters and a model plane contains a pattern of 5x8 squares (chess board) that defines straight orthogonal lines (100 mmx100 mm with 54 corners). The chess board was moved through all the acquisition volume to calculate the intrinsic calibration parameters and distortion parameters. We used four Basler cameras (60 Hz) with wide angle lens (4 mm) covering an acquisition volume of approximately 5x2x2 m^3. The chess board was tracked automatically in 700 frames. We analyzed the accuracy of the method using a rigid bar test. The accuracy was defined by the mean absolute errors of the curves of the distances between two markers (expected value=285.4 mm) obtained in function of time and we also calculated the mean error and the standard deviation of the curves of the distances. The results were compared to the literature.

RESULTS: Table 1 show the variables values: mean error, standard deviation (SD), accuracy found in the literature (Chiari et al., 2005) and using the Chess Method.

Table 1 Variables values compared with found in literature (mm). NA: data not available.

	Elite Plus	Vicon 370	Peak 5	Kinemetrix 3D	Ariel Apas	Chess Method
Mean error	NA	2.3	5.3	3.0	NA	1.1
SD	0.3	1.2	4.2	3.8	5.4	3.7
Accuracy	0.5	2.3	5.3	3.3	11.6	3.0

DISCUSSION: According to Chiari et al. (2005), accuracy in commercial system ranged from 0.5 mm to 11.6 mm. Our preliminary results showed compatible values. However, in our work the rigid bar was moved in a larger volume.

CONCLUSION: The preliminary results of the chess method revealed to be an applicable alternative with good accuracy for non-linear camera calibration and three-dimensional reconstruction using straight line plane object in larger volumes.

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