MARKERLESS ANALYSIS OF SWIMMERS' MOTION: A PILOT STUDY

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INTRODUCTION: Regular laboratory-based motion analysis with skin surface markers is not always feasible. In particular, when studying swimmers kinematics, traditional motion capture techniques cannot be adopted. Although video recordings from swimmers often exist, current methods for biomechanical analysis of these are inadequate. They usually rely on manual digitization of joints' position on a single sagittal view of the subject. Therefore, in this study a method for three dimensional (3D) markerless motion capture of swimmers is presented. The method adopts the markerless motion capture system developed at Stanford University.

METHODS: An elite swimmer performing free style was acquired employing 5 synchronized subaqueous CCTV colour cameras and Canopus ADVC-55 A/D converters (PAL interlaced video, 25frames/sec). Cameras calibration was performed with Bouguet method; intrinsic parameters were obtained with a dry calibration, then corrected for underwater application. Silhouette extraction (Fig.1) was performed employing a Gaussian mixture algorithm implemented in the Intel OpenCV library, which creates an adaptive model of the background; a priori information, in terms of an extra "white" Gaussian component of the model, was included in order to deal with the presence of the foam. From the intersection of these silhouettes' back-projections in space, a visual hull of the subject was obtained at each frame. The joints' position was reconstructed by means of matching the visual hull with a subject-specific mesh model (obtained from a dry and static visual hull of the subject), based on rigid-segments, employing the articulated-ICP algorithm. Only a manual initialization step is required, in which the initial positions of the joints are determined by digitizing their positions on each view, and triangulating them. Finally a comparison was performed with joints' positions obtained by means of manual digitalization.

Fig.1: Silhouette extraction

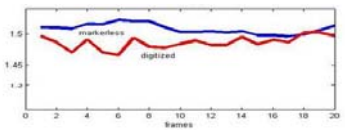

Fig.2: Shoulder z axis

RESULTS AND DISCUSSION: Trajectories of right shoulder, elbow and wrist joints were estimated automatically for a free-style stroke sequence (Fig.2). The constraints in the space available for placing the cameras is one of the main drawbacks of this methodology: using images obtained from only lateral views in the visual hull reconstruction makes this process very hard. Furthermore trying to overcome this problem by placing cameras on the bottom of the swimming pool makes calibration procedures so difficult, and reduces the calibration volume. Finally the presence of reflexes and foam, compromises the foreground extraction process and a rigid body model affects the accuracy of the joint's position.

CONCLUSION: The developed technique for swimmers 3D markerless kinematic analysis allows athletes quantitative and objective evaluation that can help improve their performance.

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