EXPERIMENTAL STUDY OF THREE-DIMENSIONAL KINEMATIC DATA COLLECTION OF ON-BOARD HIKING TECHNIQUE

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INTRODUCTION

Yachting is a popular sports and Olympic events. Hiking is a main technique of yachting especially for single handed sailing, it is considered as contributing factor towards back and knee injury of sailors. The injury study needs the kinematic data for analysis of sailor's on-board movement. Thus the multple view video images from at least two cameras are needed to obtain three-dimensional knimetic data by common-used video digitization and computing of Direct Linear Transmission (DLT).

The aim of this experimental study is to develop a method and related equipment to collect kinematic data of on-board hiking technique of laser sailors. It is a part of the study of hiking simulation and injury analysis.

METHODS

A waterproof video collection system was developed to capture video on board. Two waterproof video cameras (TS-6020) were applied to capture on-board video footages at 50 frames per second in this study. They were fixed on a laser boat with special designed stainless steel frame, indicated as C1 and C2 in figure 1. The frames are strong enough to avoid vibration of the cameras during sailing. One camera was set as front view and another as rear-right view, and the angle between their optical axes was about 110 degrees. The analog video signal from the cameras was recorded on DV tapes by two waterproof recording units which were separately placed in the cockpit and connected with the cameras through waterproof extension cables.

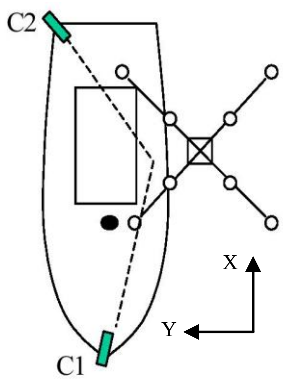

Figure 1: Setup of cameras and calibration frame (top view)

A calibration frame (17 points) of PEAK motion analysis system was used and the three-dimensional calibration was completed on shore before putting the boat into water. The calibration frame was placed at left side of the boat (see figure 1), where the sailor performs hiking skill. The recording units kept recording during sailing on sea and then the recorded video footage was selected, converted, cropped and transferred into a computer. A PEAK MOTUS version 7.2.4 motion analysis software was used to process, digitize and compute data. The two view of video was synchronized by a synchronization event. The Dempster model was applied to calculate the center of mass.

RESULTS AND DISCUSSION

The direction of the coordinate axes is shown as Figure 1. The range of mean square values of calibration errors are respectively not more than 8.6mm in x direction, 9.8mm in y direction and 8.7mm in z direction. This calibration accuracy is satisfactory for DLT and computing three-dimensional kinematic data. The errors mainly come from the image distortion caused by the short-focal-length lenses of the video cameras which was adopted because the short distance from cameras to sailor.

A selected video session, from sitting position to maximum hiking position, was digitized and calculated. Figure 2 shows a data example of knee angles. The kinematic data has been applied in a comparison study of the sailor hiking on a simulator on-shore. As the cameras were set up on board, the reference system is non-inertial and the data would not be directly applied in kinetic analysis.

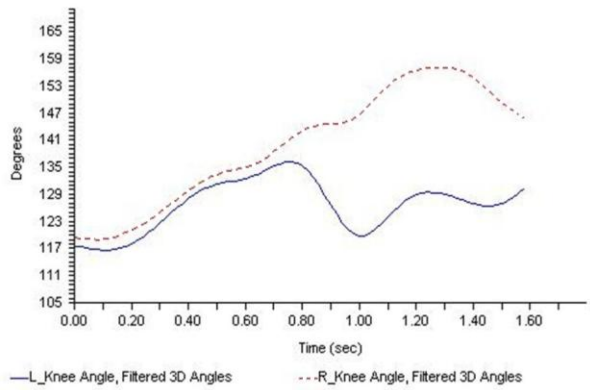

Figure 2: The data curve of knee angles (in degree) versus time (in second). Contours represent knee angles.

CONCLUSIONS

In this study the two view of on-board video was captured with the developed waterproof video collection system. The accuracy of calibration is satisfactory for computing of three-dimensional kinematic data. The three-dimensional kinematic data of on-board hiking was collected. The on-board reference frame is a non-inertial system.

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