A MODEL-BASED IMAGE-MATCHING TECHNIQUE FOR 3D MOTION RECONSTRUCTION FROM UNCALIBRATED VIDEO SEQUENCES – APPLICATION TO WC FREESTYLE SKIING

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INTRODUCTION

Various injury mechanisms have been proposed for alpine skiing, both for ACL injuries and other ligament injuries (Natri et al. 1999), but most of the emphasis so far has been put on traditional recreational skiing. During the last years, off-piste skiing seems to be growing in popularity. Many Skiing resorts leave trails ungroomed – giving rise to natural mogul courses that make jumping and "trick-skiing" possible, and so challenging the more advanced recreational skiers. In our opinion, several biomechanical characteristics of these new trends of skiing compare well to those of freestyle skiing. *We therefore consider freestyle skiing (moguls and aerials) as a suitable model for extreme skiing.*

So far, interviews and visual inspection of videos have been the most common way of extracting biomechanical information from injury situations. Although other approaches, like mathematical modelling and simulation (e.g. Gerritsen et al. 1995) have been undertaken, it still is a significant problem that reliable kinematic information from the actual injury situation is lacking

The purpose of this project is to arrive at better and sufficient 3D descriptions of knee injury mechanisms in elite freestyle skiing through analysis of 2D video sequences, and to describe the events leading up to injury situations.

METHODS

Questionnaires were handed out to all WC teams prior to this season to give an overview of the serious knee injuries. We have a representant at each WC-meeting who is registrating the injuries and collects videos retrospectively and prospectively. So far we have received … videos (mostly from prior seasons), but we are expecting to have at least … videos at the end of the season.

An interactive model-based image-matching method will be used for the estimation of 3D motion from 2D video sequences. The commercially available 3D modeling program POSER® provides the environment for image matching. The matching procedure consists of the following steps:

- Measuring the anthropometry of the subject and building a customized computer-model (e.g by changing segment dimensions of an existing model).
- Measuring landmarks (e.g. floor, walls, lines, objects) in the background and building a virtual environment similar to the original.
- "Calibrating" the Poser-cameras at each timestep (e.g. make the translation, orientation and focal length parameters similar to the original).
- Matching the model to the background person.

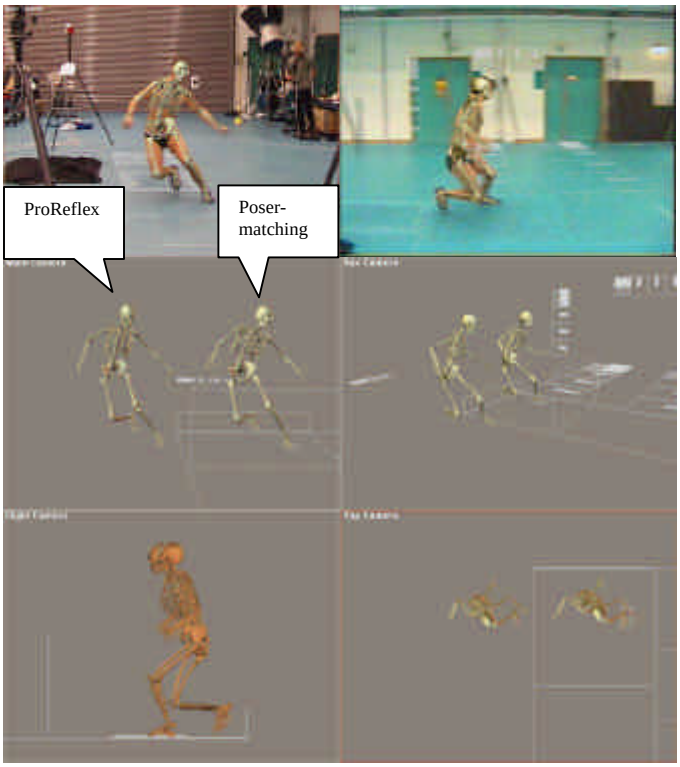

Figure 1: A Poser model matching the video sequences, and the comparison with the recorded ProReflex motion.

RESULTS

At present, we are comparing results from the method with a 7 camera infra-red 240Hz marker based system (ProReflex, Qualisys, Inc.). Preliminary results indicate that we get a reasonably good match when 2 camera views are available. When only one camera view is available, it is, however, more difficult to make a reliable matching.

REFERENCES

Gerritsen, K. G. M., Bogert, A. J. van den, Nachbauer, W. (1997) *Skiing Trauma and Safety: Eleventh International Symposium, ASTM STP 1289*, R. J. Johnson, C. D. Mote, Jr. and Ekeland A. (Eds.), 133-140

Natri, A, Beynnon, B. D., Ettlinger, C. F., Johnson, R. J. And Shealy, J. E. (1999). *Sports Med.* **28**(1), 35-48

ACKNOWLEDGEMENTS

The Oslo Sports Trauma Research Center has been established at the Norwegian University of Sport & Physical Education through generous grants from the Royal Norwegian Ministry of Culture, the Norwegian Olympic Committee & Confederation of Sport, Norsk Tipping AS, and Pfizer AS.