C3-6 ID205

MONITORING TRAINING LOAD OF ELITE TRAMPOLINISTS; FIRST RESULTS; AN AUTOMATIC ANALYSIS SYSTEM FOR DAILY USE

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We developed a video-based analysis system to monitor and analyze performance in technical sports, the CoachCockPit. The CoachCockPit captures footage of a performance, stores and presents it instantly. Footage can automatically be analyzed and fed back. We show how daily training activity of trampolinists is monitored and parameters like number of routines, number of jumps per routine, or jump height, can be extracted. Over weeks and month these parameters display trends that provide information about training progress in relation to the aimed-for training results. Overtraining and stress fractures are crucial risk factors in trampoline jumping. The deployment of the CoachCockPit in trampoline jumping will, in the future, help to predict these risk factors at an early stage.

KEYWORDS: Video analysis, Monitoring training load, trampoline jumping, feedback

INTRODUCTION: Measuring sports performance in a normal training setting or during competition is, in contrast to a laboratory setting, a challenge. Being able to record and analyze performance and to provide instant feedback during training sessions is even more difficult. We developed a video-based analysis tool called the CoachCockPit, which allows for such analyses without interfering with training or competition.

In elite trampoline jumping, forces exerted on the feet during landing and take off in the trampoline bed can reach well over 10g (Wagner (2012)). Due to the brevity of loading and because of the relatively extended and blocked legs, these immense forces can be withstood. However, overtraining and stress fractures in the lower limbs are lurking, which renders properly balanced training schedules mandatory. To address this problem the CoachCockPit, for the first time deployed at Artistic Gymnastics World Championships 2010, Eb et al. (2012), has been implemented in various training settings on a daily basis.

We sketch the validation of the CoachCockPit and different applications. In particular we illustrate its functioning when monitoring elite trampolinists over several months. We show how our system helps to guide daily training load and minimize risk of overtraining.

METHODS: CoachCockPit automatically captures footage (up to three cameras plus analog data like ground reaction forces collected with a force plate, goniometry, or accelerometry) when athletes perform their routines. Length of footage depends on the routine's duration. Immediately after a routine has been performed, the footage is displayed for mere visual inspection, Boyer et al. (2009). CoachCockPit is fully automated and no action is required of the gymnast or coach. Using a novel algorithm, Eb et al. (2012), CoachCockPit allows for extracting the body's contours from the image background frame by frame. The corresponding 2D-representation can be used to determine the body's center-of-mass, rotation angle, and other physical parameters. Although these kinematic features are derived from a 2D-representation, estimating the center-of-mass turns out to be quite accurate. The frame-by-frame approach yields the trajectory of the gymnast's center-of-mass. From that trajectory the system provides the maximum height, flight-time, jump height, number of jumps, accuracy of landing in the mat, number of acrobatic jumps, and so on. Fitting the flight path of the center of mass with a parabola improves the accuracy of the maximum flight height. This arsenal of performance parameters provides valuable information for the coach as it helps monitoring training performance vis-à-vis the aimed-for training load.

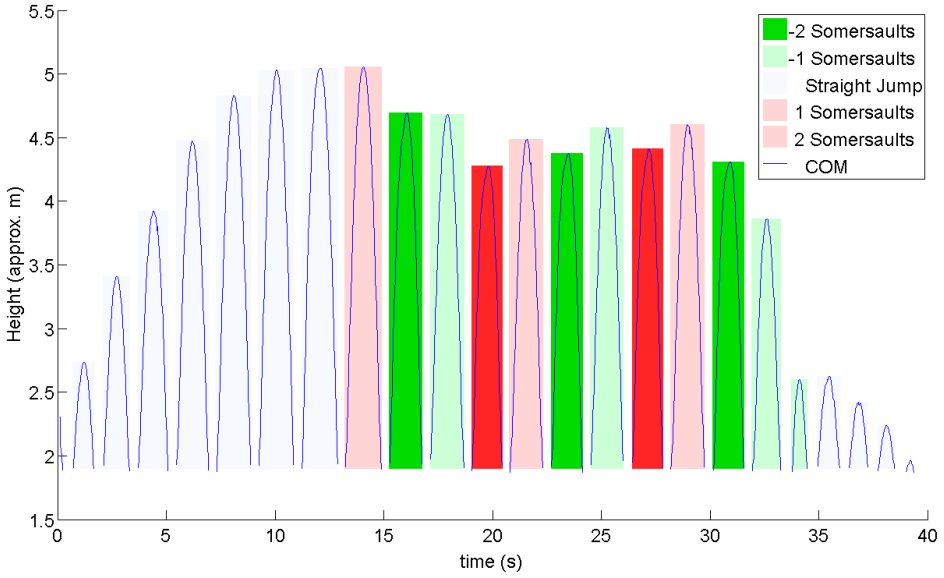

Figure 11. Center op mass plotted against time for a typical trampoline exercise of a Dutch elite female gymnast. First 7 jumps to reach the desired height, then 12 jumps performing the acrobatics and stopping the routine with some small bounces.

Figure 11 depicts the estimated center-of-mass and the number of rotations in the sagittal plane during seven jumps to reach the desired height, followed by ten acrobatic jumps, and finalized with several lower jumps to stop. Visual inspecting readily reveals that the jumps of the double somersaults are lower then the single somersaults. In addition to this single performance analysis our system offers daily overviews of, e.g., number of routines, number of jumps per routine, number of straight jumps and acrobatic jumps, number of somersaults, and height of every jump.

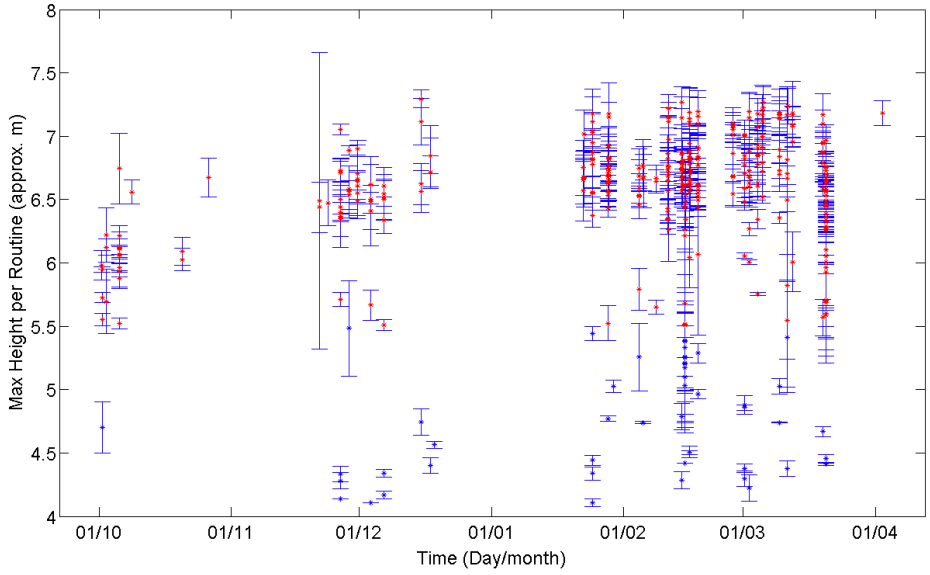

Figure 12. The average maximum height of the 3 highest routines per training session plotted against time for one subject. Error bars indicate the standard deviation of the 3 maximum heights. Not all training sessions data is available, as the gaps in the graph show.

RESULTS: Figure 12 shows an example of one athlete over the course of half a year. After the summer break (~ September) the maximum flight-heights increase gradually until about the end of the year. After that, the maximum height seems to stabilize or even to slowly increase. Figure 13 shows the total number of jumps for the same period. A change can be found around the turn of the year as from January onwards the training volume has increased significantly.
Unfortunately, data contain many missing values due to problems with acquisition because of, e.g., training periods that athletes spent abroad. Moreover, not all routines within one training day could be analyzed properly. Reason for this was, for instance, that two trampolinists practice their routine in parallel leading to object obstruction which, of course, hampers contour tracking. In consequence, statistical assessment of parameters like total number of jumps per day became limited.

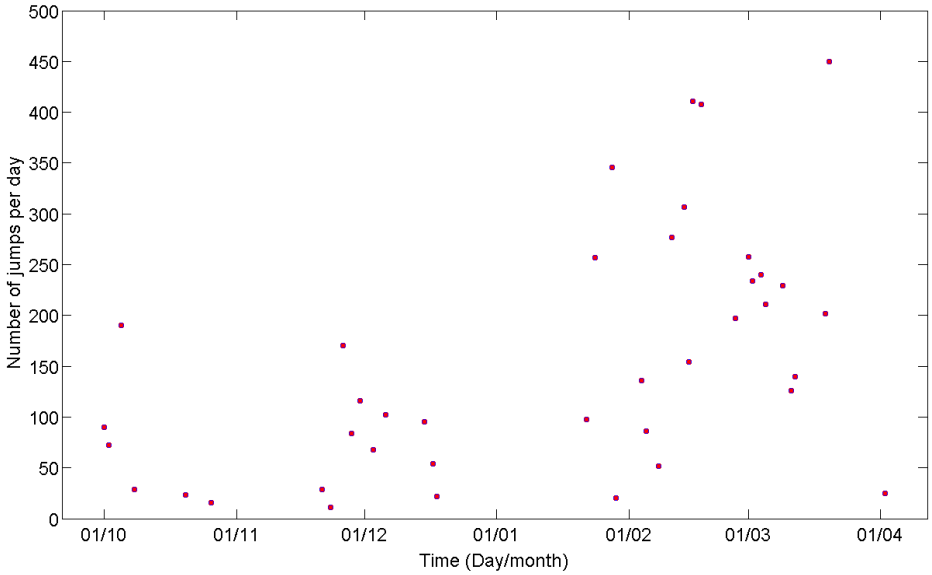

Figure 13. Total number of jumps per training day for the same athlete as Figure 12.

DISCUSSION & CONCLUSION

CoachCockPit is developed to be used daily in a real training setting. It can measure performance without intervening with the gymnast and, by this, it allows for monitoring training activity. In trampoline jumping dosing training load is of crucial importance for optimizing training efficiency and lowering risk of overtraining and chance of stress fractures. In elite trampoline jumping forces exerted on the feet during landing and take off in the trampoline bed can reach well over 10 kN. Our body can only withstand forces of this magnitude if they appear very briefly. That is, due to the very short duration of the loading, the relatively extended and blocked legs 10 kN force can be withstood. However, overtraining and stress fractures in the lower limbs are lurking. Using a well-balanced training schedule and a well-kept diary, such profound risks might be kept within bounds.
The number of jumps up to the start of the routine (to reach the desired height and position) as well as the routine itself does provide information about training load and about the possibility to adjust training strategy. In a learning phase of difficult new acrobatics, a large number of straight jumps might be expected preceding the acrobatics. This can indicate anxiety or lack of stability. If no new elements are learned the coach should ask why this increase of straight jumps happens. Ideally, that number should be kept low – certainly against the background of overtraining.

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