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A CHEAP AND PORTABLE MOTION ANALISYS SYSTEM

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Abstract: *In this paper we will describe a cheap and portable motion analysis system dedicated to amateur and juniors sports, developed mainly for athletics. We will present the hardware and software components of the system and the way the system works: how the data is collected, stored and analyzed in order to improve the young athletes performances.*
Keywords*: motion analysis, sports, biomechanics*

1. INTRODUCTION

When building a motion analysis system, usually the developers take into consideration domains like sports and medicine. In sports, motion analysis is used in order to improve athletes performance by modifying their motion. That technique is common and it can nowadays should be found in every high-performance sports environment. Unfortunately, the costs of implementing such a system are usually very high for a common sports club which does not train top class athletes: the costs imply buying a professional system (which can reach up to a few hundred thousand Euros) and train and pay dedicated people able to understand the way the system works and able to deliver results based on gathered data. For this reason, many (if not most) sports clubs lack such a system. It is obvious that a cheaper alternative would benefit these clubs a lot, and we are thinking here about juniors and amateurs and any club which does not manage only top performance athletes.

2. MEANS AND METHODS

The system which we designed is a very simple one, having a hardware component and a software component. In order to keep the costs low, the hardware component is composed of only one video camera (any camera able to capture video materials with at least 250 frames per second), fixed support for the camera, long power cables (this is very important, because for many athletic disciplines the recordings should take place on the stadium) and a few markers. The software part, which takes care of analyzing the captured data, will contain one motion capture application and a few MATLAB programs specifically developed for each athletic discipline.
For a better understanding of how things work, let's say we will cover the "long jump" discipline. In brief, the system's capture part works like this:

- An athlete is chosen in order to analyze his performance.
- Markers are attached to the athlete's main joints: knee, ankle, hip, wrists, elbow, shoulder (the markers should be high contrast - if the athlete wears black equipment, we should use light-colored markers).

- The camera is set up perpendicularly to the athlete's running path, so that it captures the athlete's motion from the side.
- As one of the most important points of the discipline is the takeoff point, we will set the camera to primarily focus on that point.
- The athlete starts running, from the starting point. His full motion is captured by the camera. The video is then saved, the performance is measured and noted correspondingly to the athlete's first try (this is not mandatory, but it helps later, making the analysis easier).

In the same session, the athlete jumps again, until we have at least 10 tries (the more, the better).
Now we have 10 videos with the athlete's performances during the session. These videos are then send to analysis. A dedicated software is mandatory here: we strongly recommend Adobe After Effects (mostly because it is a popular application with excellent support), although we also recommend Dartfish or Kinovea as variants. Here, things work like this:

- The motion of each marker is analyzed using the dedicated software.
- A set of frame-by-frame motion coordinates is obtained: let's say the athlete was filmed for 2 seconds at 250 frames per second: now we will have 500 (X,Y) pairs of coordinates for each marker.
- Each coordinate set for each marker is saved in Excel and we will have (if we use 6 markers) 6 Excel tables for each of the athlete's try (one for each marker).
- These tables are analyzed using MATLAB applications developed specifically for analyzing long jump performances (angle of take-off, speed of take-off etc).
- Graphics and tables are offered as results, so that the trainer can see where improvements can be made.

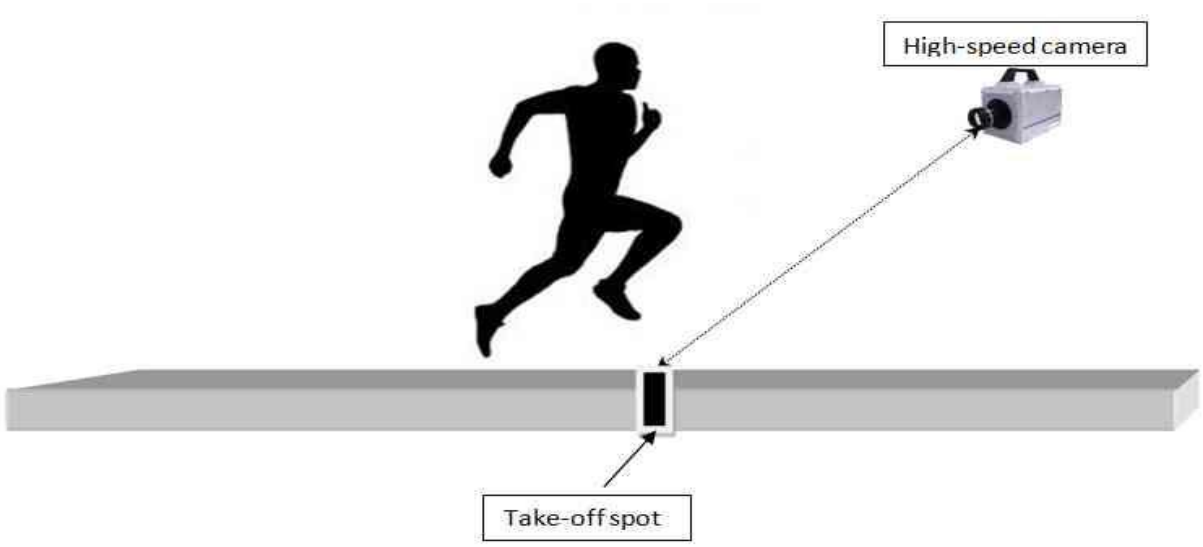

Fig. 1 The way the motion analysis system is set up - the athlete has markers attached on the other side (where the camera captures the motion)

3. BENEFITS

Because of the economical crisis and the huge difference regarding financing between top end sports clubs and juniors and normal clubs, the situation is you either have access to a professional system (which is very rare) or have just the trainer's eye for performance analysis (the most common situation). The most important benefit of using such a system is that you, as a trainer, can have some other data about your athlete's performance besides just the eyes, without having to pay the price of a fully professional system. Also, the system allows the trainer to use

whatever camera he has access to (it has to be able to obtain video material at 250 frames per second at least, obviously, but there are no restrictions regarding the model or developer) and the system is portable (most of the professional systems are not, they are a pain to set up for an outside sports discipline)

4. CONCLUSIONS AND FUTURE WORK

There is definitely room on the market for a cheap portable alternative to the professional motion analysis systems used today in sports. In this paper, we presented the way in which such a system works, both hardware and software, and also we made some recommendations regarding the main components which are likely to be used (a 250+ frames per second video camera, Adobe After Effects, MATLAB). For future work, we will begin the analysis of some popular athletic disciplines such as long jump, high jump, hurdles and others using the system which we described above.

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