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An instrumentation system to estimate kinematic components of the movement

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Introduction

Estimating the development of an athlete's muscular capacities is a subject of interest to many research groups (Joviado, 2000). Tests are frequently given using isokinetics ergometers. Unfortunately, they hide the acceleration component of the applied force, even when performed with high velocity. Nevertheless, the capacity to accelerate loads is, in many cases, a performance factor. Therefore, a potential valuable tool is a system capable of measuring kinematic parameters including the acceleration. Accelerometers, however, often are too sensitive and cannot provide accurate absolute displacement signal. Thus, the objective of this study was to create a new tool to evaluate a the displacement and accelerative capacities of athletes.

Method

In general, ergometers specifically designed for tests are used to investigate muscular capacities (Hawkins, 1999). The present investigation took place in a fitness room using conventional equipments with mobile adjustable weights. This allows a direct access to the velocity of this inertial mass.

Weights and a measurement ruler are made interdependent. The latter freely slides in a low friction gorge. This enslavement is using a nylon feedback loop to be able to measure two-way weights movements. An alternation of black and white stripes was drawn on the ruler and its displacement was quantified through an opto-electronical contrast sensor. The variable period of this square signal yields changes in the ruler and weights velocity. Data collection was achieved using a computer equipped with an analogical acquisition card and a custom designed software written using Lab VIEW.

The sensor signal is recorded as a table of tension versus samples indexes. Consecutives points between each fronts are counted and each peaks and valleys duration are computed. Thus, the average velocity on each strip can be calculated each time a new strip passes under the sensor. Finally the velocity versus time will be displayed. The variable repartition in function of time is the particularity of the computed data. The faster the movement is, the higher the number of strips passing under the optical sensor will be.

All other kinetic and kinematic parameters are computed from velocity signals. Using a 2-point difference approximation, the acceleration can be determined. Weights displacement is calculated by approximating, via the rectangles method, the integral of the velocity versus time. Finally, the exerted and accelerative force and power can be calculated. The previously determined data are displayed as time functions after each acquisition (Fig. 2). Different graphics can easily be understood and described using a manual zoom, an average calculation on chosen intervals, a 5-point average smoothing function, an adjustable filtering function and a maximum and minimum detection functions are also available.

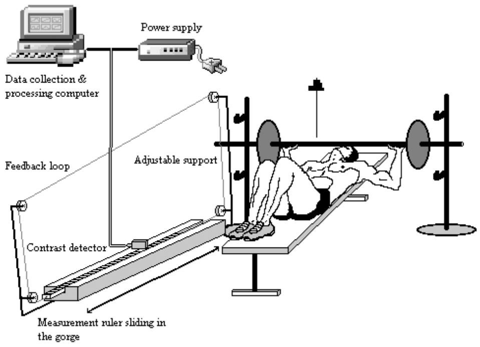


Fig. 1 Schematic diagram of the acquisition equipment and set-up used for evaluating an athlete on a bench exercise.

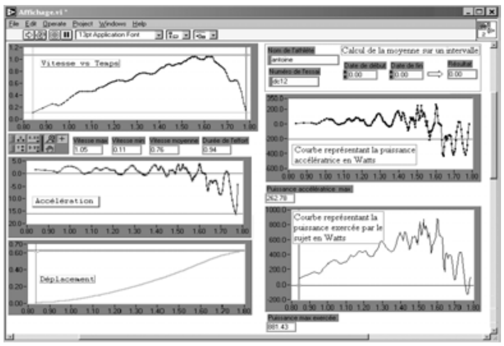
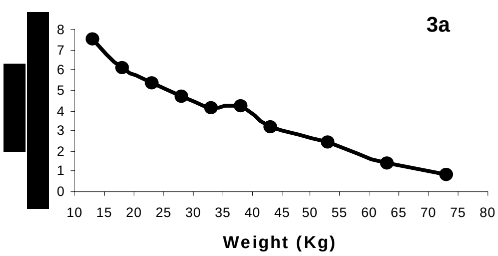


Fig. 2 An illustration of the access panel to the data.

Results

A bench press evaluation was realised to investigate the ergometer ergonomics and utility. It was adapted to the bar (Fig. 1). The athlete's task was to lift, as quickly as possible, a loaded bar starting from the lower position of the bench exercise. Ten loads between 13 and 73 kilograms were applied. The ergometer was used to compute and display each trial kinetic and kinematic parameters. By comparing them, the two following profiles were drawn (Fig. 3a and Fig. 3b).



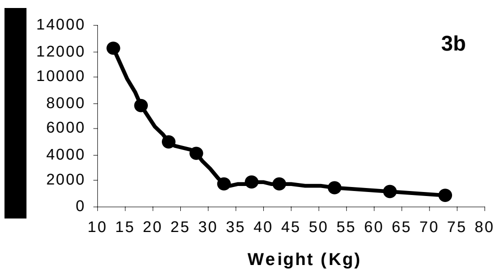


Fig. 3a Average acceleration during the pushing period as a function of the weight. Fig. 3b Coefficient of explosiveness [(acceleration peak value) / (time to acceleration peak)] as a function of the weight.

Discussion

The present approach was developed to provide a flexible and accurate system to investigate movements parameters in weight training. By accessing directly the velocity, computing all common parameters but also acceleration and its derived parameters, the ergometer responds to characteristics expected in terms of evaluation of movement components. The two characteristics presented below would not have been expressed using an iso-kinetic ergometer. Moreover it is adaptable and transportable so it can be easily implemented in weight training environments.

References

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