ADVANCED TECHNOLOGIES AND METHODOLOGIES FOR REHABILITATION IN SPORT

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INTRODUCTION

Frequently athletes are affected by lesions to muscles, joints, bones and nervous system. The medical treatment and the subsequent rehabilitation in most cases are able to lead to a complete recovery.

Two points should be considered:

a) the designing of most appropriate training and rehabilitation procedures should take into account the specific characteristics of the athlete and of his specialization.

b) The recovery, which could be considered acceptable for a "normal subject", not always is completely appropriate for an athlete who has to face superior motor performances.

c) A detailed solution is needed in order to decide when and how to restart the normal activity of training and full performance.

In this frame, the traditional analysis of correlation between the localisation of the lesion and the deficit of function appears insufficient to obtain the maximum potential recovery, given a certain damage.

Only by taking into account a quantitative multifactorial analysis of the motor function in relation with the lesion and the expected recovery, optimal results could be reached from medical rehabilitation and training.

This implies several steps:

- a detailed functional evaluation of each athlete;
- a continuous monitoring of the athlete's progress and consequent adaptation of training itself.

MULTIFACTOR ANALYSIS OF MOVEMENT

In this context, a detailed multifactor analysis assumes a central role. The traditional evaluation performed by visual inspection appears insufficient for these purposes. Kinematics, dynamics, neuromuscular events and correlations among these variables must be considered in a quantitative way.

The use of advanced technology (transducers, microprocessors, etc.) can provide useful means, because it is possible to develop very complex instrumentations (complex in terms of variables measured and data processing), which require relatively easy tests, feasible also in clinical environment or gymnasium.

At the beginning of eighties we assisted to a great technological development in the field of VLSI chips, in computer vision and pattern recognition techniques as well as of parallel computation architecture and therefore the necessary conditions were ready for the development of new systems for motion analysis able to meet in a better way the needs present in this field (accuracy, reliability, friendly user, flexibility, etc.).

To this new generation of systems belongs the ELITE developed at the Bioengineering Centre of Milan, where the advanced competences of microelectronics image processing techniques have been combined with the needs coming from practical application (Ferrigno et al. 1990, Ferrigno et al. 1985)
Small hemispherical passive markers are placed on the relevant points af the body, and two ar four TV cameras take the subject during movement.
Two levels of intelligence characterise the processing system (see figure 1).

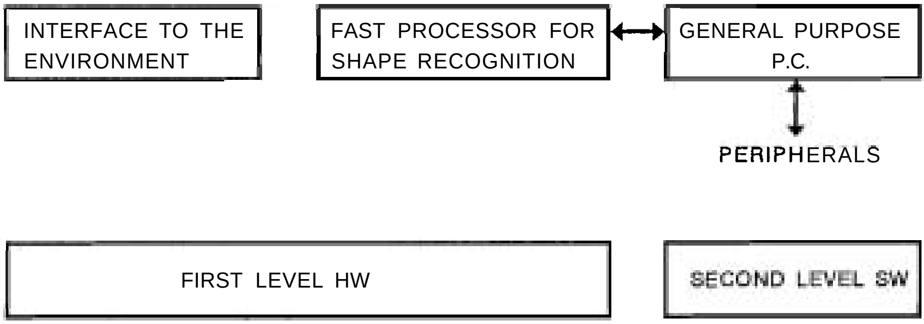

Figure 1 - Scheme of the ELITE system for motion analysis. Two levels of intelligence have been implemented by dedicated hardware for parallel computation and by special software on a PC computer (see text for further explanation).

The first level includes a specially designed processor that is the core of the system and uses very fast VLSI chips arranged in a parallel architecture. This level provides in real time a bidimensional cross correlation processing of TV signal, so that the markers are automatically recognized only if their shape matches a predetermined "mask". The procedure allows far a great reliability of the marker detection and for a high accuracy in the computation of the coordinates.
The second level of intelligence is implemented on line on a general purpose computer. Basic operations as kinematic data enhancement, tracking and reconstruction of the hidden markers, correction of distortion and three dimensional (RD) reconstruction by stereometric techniques belong to this level. This stage receives also additional input from the electromiographic system and from the force plate (which measures the ground reactions), and computes a set of variables related ta dynamics and muscular kinematics. This includes trajectories of the various points, angles between links, their first and second derivatives, mechanical moments acting at various joints, internal loads, power interchange at different joints, instantaneous muscle length, etc.

CONCLUSIONS

These new technologies are opening new perspectives for differential diagnoses and evaluation of performance in sport.

They can be used in order to choose the optimal training for the most appropriate recovery of the subject after a lesion and to evaluate the results in a quantitive way.
Recent works (McKinley et. al, Mouchnino et al. 1992, Pedotti et al. 1989, Pedotti 1991) have also shown that athletes of high level are performing movement by using specific motor programme which could be the result of a long term training as well as of the "predisposition" of the athlete himself.
These results suggest the possibility of new fascinating attitudinal tests.

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