

“BIOMSOFT”: A SOFTWARE FOR BIOMECHANICAL ANALYSIS OF HUMAN MOVEMENT

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The package “BiomSoft” is a set of MATLAB functions blocked in modules, useful and user friendly which allow the parameterisation of general motor patterns. “BiomSoft” enables to treat digital signal in different ways, calculate kinematic and kinetic magnitudes, provide different anthropometric models and present results graphically, which is useful in teaching. The objective of “BiomSoft” is to provide a complete processing and analysing Biomechanics data system with the possibility of to incorporate new functions and to perform particular applications in sports, medical and occupational Biomechanics, as well as in teaching and learning.

KEY WORDS: biomechanics, human locomotion, signal processing

INTRODUCTION: Biomechanics of Human Movement is an interdisciplinary science that, with the support of other Biomedical Sciences, uses the knowledge of mechanics and different technologies to study the human body behaviour under the mechanical loads that it can be subjected to. The development of Biomechanics, mainly during the second half of the last century, is in consequence to its progressive applications in the medical and occupational fields, and also in sports, analysing sport technique and designing sport gear of high quality. Sport Biomechanics is one of the main fields of Biomechanics of Human Movement and continues to expand and to establish in the wide field of Sport Sciences. Nowadays, many applied research projects are orientated to the evaluation of the performer's technique in the totality of the sports and sport modalities. The major goals of the application of biomechanical methodology and results are to optimise load in training and performance improving the performer's technique in a sport or sport modality. Also, scientific research has contributed to design sport equipment with the high quality standards. Furthermore, the development of better measurement systems and/or instrumentation chains enables researchers to quantify with much more precision the biomechanical efficiency in sport activities, identifying the main characteristics of the most productive individual technique, the trainable factors that influence the performance, and, the mechanical loads on the muscle-skeletal system. Finally, the conception and design of technical solutions and aids for disabled help them to compete, improving their quality of life. Methodological advances in Sport Biomechanics Applied Research concerning the topics of data collection, data processing, experimental and theoretical studies that allow for reaching a considerable level of scientific knowledge with respect to the motor patterns displayed in most sport activities. Data collection methodological advances include optic systems, optoelectronic and other systems for automatic motion analysis, angles measurement, acceleration measurement, force and pressure measurement, EMG and the measurement of inertial parameters. Data processing methodological advances include reconstruction of 3-D coordinates, measurement accuracy and error analysis, automatic motion analysis tracking and image recognition, curve fitting and differentiation techniques, joint angles and segments orientation, segmental inertia parameters, EMG signal process. Experimental studies methodological advances include experimental design, systematic and random errors, inter - and intra - individual results, Hypothetical testing and linear regression, hierarchical modelling, Biofeedback. And finally theoretical studies methodological advances include equipment simulations, human body models and model evaluation, muscles modelling and optimisation (Yeadon and Challis, 1994). The main purpose of this study was the design and development of a package for biomechanical analysis that allows for developing applications in different fields of Biomechanics of Human Movement. One the other hand some parts of the package, especially the digital signal processing module, are very useful for teaching students.

METHODS: The BiomSoft package was developed for the Microsoft Windows Operating System in MATLAB 5.3, accepting as input standard ASCII data files exported from different measurement chains and data collection systems working in our Lab., like the 3D video - photogrammetry system (KINESCAN/IBV), the system of force plates (DINASCAN/IBV) and the EMG/ELG system developed for studies in the field of Occupational Biomechanics (Gianikellis et al., 2000). As someone can observe in the flowchart BiomSoft incorporates the following modules (Fig. 1):

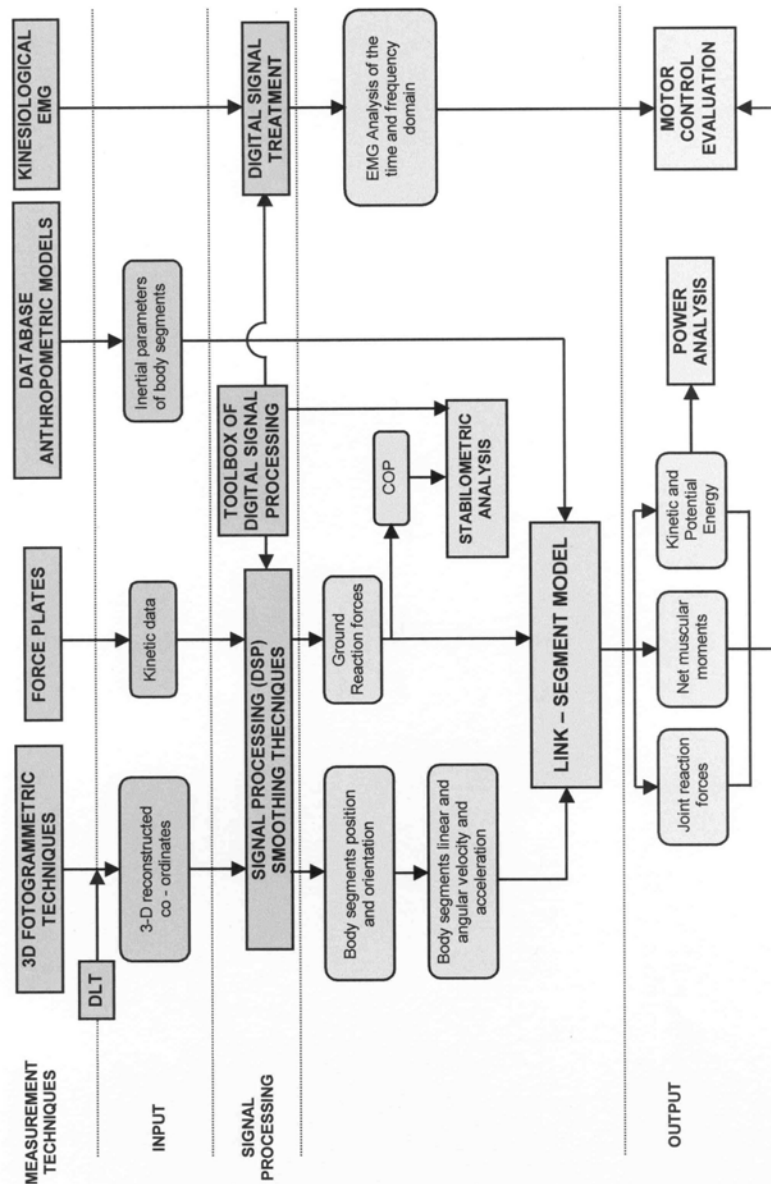


Figure 1 - The BiomSoft flowchart.

- "Smoothing" techniques for 3D kinematic analysis
- Kinematic analysis
- Database of inertial parameters based on the most common anthropometric models
- Inverse dynamics analysis
- Toolbox for digital processing of signals coming from EMG, Force Plate
- Stabilometric analysis
- Graphics and animation of alambic models

RESULTS: "BiomSoft" (Fig. 2) enables:

- "Smoothing" and differentiation using the package for Generalised, Cross-Validatory Splines algorithm or polynomial fitting using least squares.
- Calculation of all known linear and angular kinematic parameters with emphasis to the attitude vector and Euler angles specially for small angles ($< 10^\circ$). This facility is very important in order to evaluate posture and postural stability (Fig. 3). Besides all time parameters (instants, phases, frequencies, etc.) are "saveable" for posterior analysis.
- Use of a variety of antropometric models to obtain inertial parameters (Zatsiorsky - Seluyanov, De Leva, Hanavan, Yeadon, Vaughan and Clauser). Possibility to obtain subject's anthropometric parameters by means of 3D video photogrammetry.

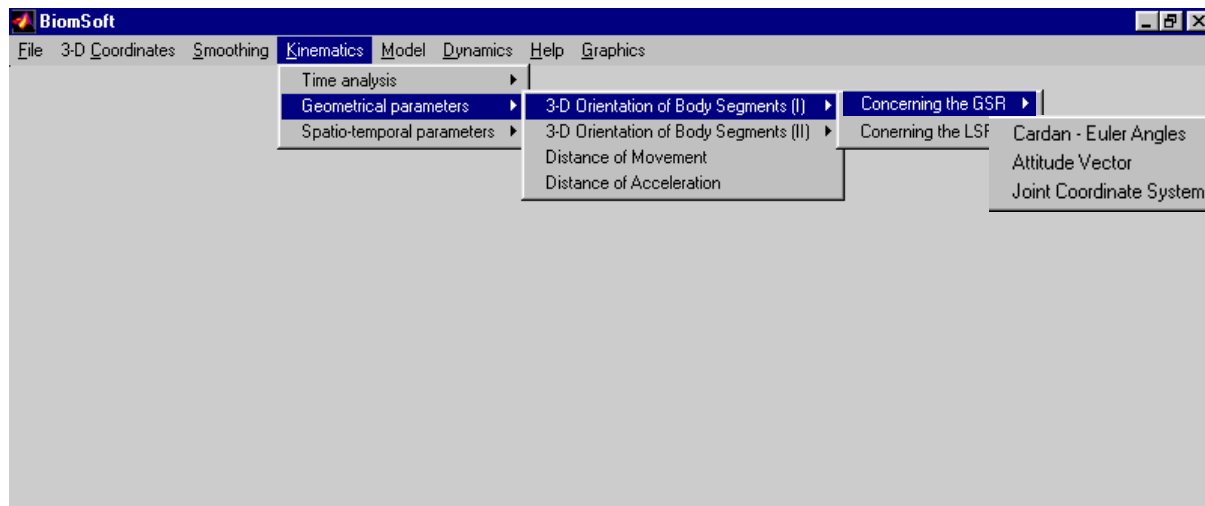


Figure 2 - Main menu of BiomSoft.

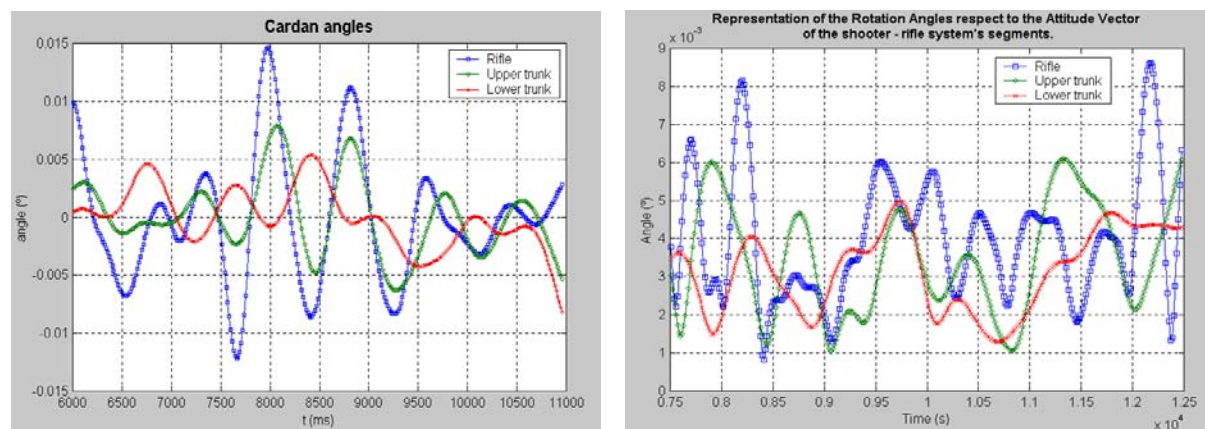


Figure 3 - Cardan angles (left) and rotation angles respect to the attitude vector for small angles in studies of postural stability (right).

- Calculation of the net muscular moments and mechanical work. "Power analysis" is possible giving information respect to the functioning of biokinematic chains
- Analysis of EMG determining muscular intervention (Fig. 4)
- Graphical representations and animations (Fig. 4)
- Developing of applications in sports, medical and occupational fields
- improve teaching for biomechanical signal processing methods including signal rectification, normalisation, windowing and padding, filtering factor determination, filtering methods, Fourier transformation, spectrum analysis, etc.

CONCLUSION: “BiomSoft” is a user friendly package enabling the description, analysis and evaluation of motor patterns in different fields of Biomechanics of Human Movement. Besides this software is very effective for teaching and practice in the laboratory.

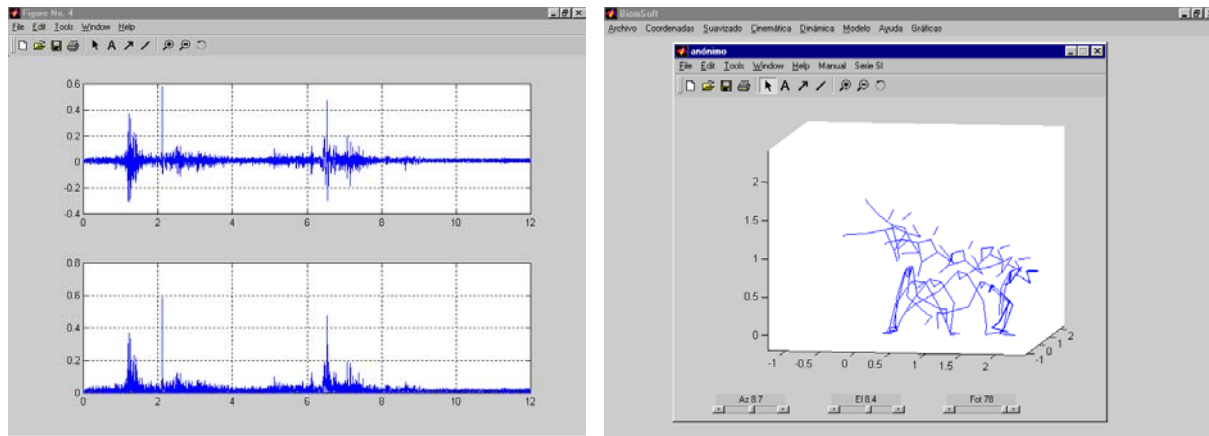


Figure 4 - EMG rectification (left) and animation (right).

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