A New Software for Biomechanical Modeling and Simulation of Musculoskeletal System for Ergonomics Research

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ABSTRACT

In this presentation, new software for biomechanical modeling and simulation of the musculoskeletal system is introduced and applied to the a few sample motion analyses as examples. The software, HMWORKS®, was developed for the estimation of the joint kinematics, kinetics and the muscle forces during human motion with graphic animation and result reporting functions. The present software is very easy to use and applicable to any kinds of motion data which can be obtained by the motion capture system. The presented software can be now ready to be utilized for ergonomics research. The author would like to receive the valuable advices and comments from the ergonomics community.

Keywords: Musculoskeletal system, Inverse Dynamics Analysis, Ergonomics, Biomechanics, Joint load, Muscle forces

1. Introduction

Recently, musculoskeletal biomechanical modeling and simulation technology has been widely utilized in ergonomics and biomechanics research. Currently, a few commercial software have been introduced, however, in my opinion, these SW are not fully utilized due to some limitations, such as high cost or lack of user-friendliness. In this presentation, new software for biomechanical modeling and simulation of the musculoskeletal system is introduced and applied to the a few sample motion analyses as examples.

2. Key features

The software is tentatively names as HMWORKS® to represent the human motion related works. This software has five main modules; "Data Input", "Visualization", "Analysis", "Result", "Report". In "Data Input" module, the marker data of the major conventional motion capture systems and the ground reaction force can be integrated to the graphical musculoskeletal model and automatically scaled to fit the subject-specific motion visualization. In "Visualization" module, the 3D graphic simulation of the human motion according to the motion capture data can be performed and recorded as a movie file. In "Analysis" module, the inverse kinematics analysis, the inverse kinetics analysis and the muscle force prediction optimization analysis are provided to estimate the joint angles, the joint forces and the moments, and the muscle forces during the given motion. "Result" module, the figures of all the analyses results are generated with and without concurrent graphic simulation module. In Report" module, the user-defined reporting capabilities are provided to generate the MS-PowerPoint slides and MS-Excel data sheets of the analysis results.

3. Simulation example

Figure 1 shows the sequential graphical motions of four motion capture data. The software successfully depicted the joint kinematics, the joint kinetics, and muscle forces of full body motion during a normalized cycle of walking, squat, baseball pitching, and golf swing motions, respectively. The results were consistent with the previous published studies in terms of its magnitudes and waveform shapes.

4. Conclusion

The presented software can be now ready to be utilized for the biomechanical modeling, analysis and simulation in sport biomechanics research development. In addition, the author would like to be all years to receive the valuable advices and comments from the ergonomics community. Furthermore, the author would like to create research collaboration network with those who would like to apply this software for their own sports biomechanics research.

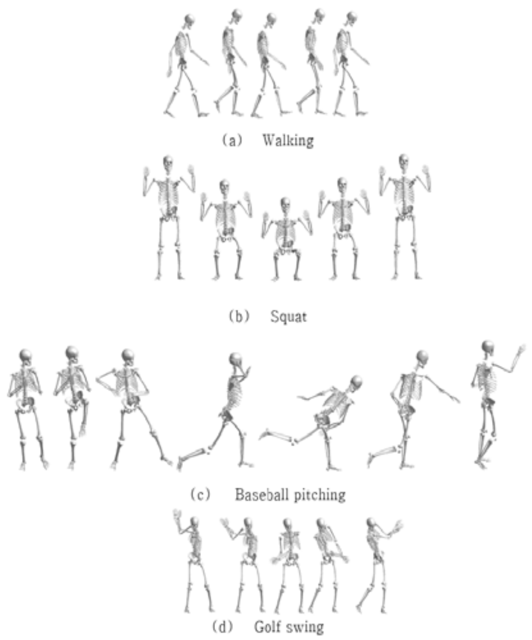

Figure 1. Sequential graphical visualization of the motions: walking (a); squat (b); baseball pitching (c); golf swing (d).

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