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PERSONALIZED MUSCULOSKELETAL HUMAN MODELS FOR USE IN DYNAMIC GAIT SIMULATION FOR CLINICAL AND SPORTS APPLICATIONS

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INTRODUCTION

The purpose of this project is to advance the current technology of musculoskeletal modeling as applied to gait simulation into: 1) A general clinical tool for the health care industry, 2) The evaluation of athletic performance and injury reduction, and 3) To provide a validated base for research in muscle activation and optimal control as applied to human locomotion. A novel scaling method is introduced to automatically generate statistically valid gait simulation models for a specific human subject based on a minimal set of input parameters.

METHODS

To derive joint compliances from experiment data, personalized musculoskeletal models were built for a large, varied population sample. Motion data for each subject was used to drive the gait simulations and a hybrid inverse-dynamic/direct-dynamic approach (ref), was used to derive local joint compliances for each of the 52 degrees of freedom in the musculoskeletal model for a full gait cycle. Joint compliance regression equations were developed from the database of local joint compliance, local and global geometric/physical characteristics using Design of Experiment (DOE) techniques to determine the couplings and sensitivities.

A computer system was developed employing localized scaling methodologies, based on the regression equations for joint compliance and model geometry, resulting in the automatic generation of statistically valid gait simulation model for a specific subject based on a minimal set of parameters (clinical measurements).

RESULTS

To assess the accuracy of the models automatically built by the computer system, the gait simulations are compared to motion data and force plate data for a set of human subjects. Figure 1 depicts the correlation of the GRX and the CP travel history for the model v. experiment.

CONCLUSION

At this stage, the analytical outcome agrees considerably with experimental results. The immediate practical application of a scalable gait simulation model is as a tool in conservative foot care, where the clinician can automatically generate a musculoskeletal human model for a specific patient and perform dynamic gait simulations. Orthotic correction can then be introduced to compare the kinematic and kinetic aspects of the uncorrected simulation and the corrected simulation against established norms.

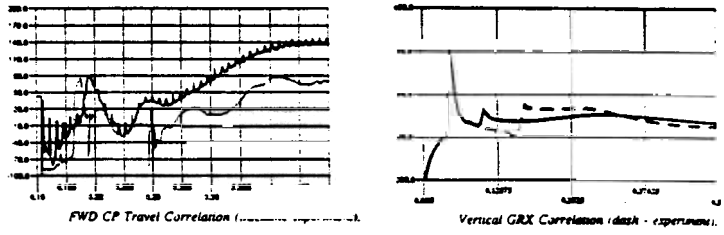

Figure 1 Gait Simulation Results v. Experiment.

REFERENCE

McGuan,S.P. et al (1995) "A Unique Method for Deriving Joint Compliances from Laboratory Data for Lower Extremity Simulation" XVth ISB.