DEVELOPMENT OF A THREE-DIMENSIONAL SIMULATION MODEL OF THE HUMAN WHOLE BODY

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INTRODUCTION

It is widely recognized that computer modeling and simulation provide valuable contributions to the research of biomechanics. Using forward dynamic computer simulation, it is possible to predict influences of such biomechanical interventions as injury, surgical operations, strength training and so on in quantitative terms.

However, it is also true that the methodology of computer modeling and simulation has not been utilized handily by all researchers / research groups who are interested in using it. One of the reasons is that the procedure of modeling requires very complex technical treatments. Although there are several commercial software packages to help this procedure, even with the aid of these tools, this methodology is not being conveniently utilized by many researchers. This is disadvantageous for the whole society as high-impact contributions can be made by many researchers if this methodology is utilized by more researchers in biomechanics.

We thought that it would be meaningful to present a code (computer program) of a human whole body model to the society of biomechanics for further development of this field. By simply copying the code, interested researchers can easily run a computer simulation. The purpose of this study was to present a three-dimensional linked segment model of the human skeletal system that has large degrees of freedom.

METHODS

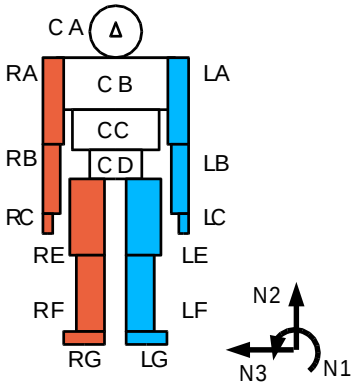

Figure 1: The skeletal model developed in this study.

The model was coded to be processed with a modeling and simulation tool AUTOLEV [1]. The code will be posted on the internet for public access by the time of conference. The model has sixteen rigid body segments in total: head, chest, mid-trunk, lower-trunk, right and left upper arms, right and left lower arms, right and left hands, right and left upper legs, right and left lower legs, right and left feet (Figure 1). The degrees of freedom of the model was thirty-five. Anthropological parameter values were derived from [2-4].

For an example, a hanging motion was simulated using this model. The body was tilted in the forward direction by 45 deg. The upper endpoint of the head segment was fixed in the global coordinate system. Thereafter, a hanging motion was simulated in which the whole body swayed back and forth with an effect of the pull of gravity.

RESULTS AND DISCUSSION

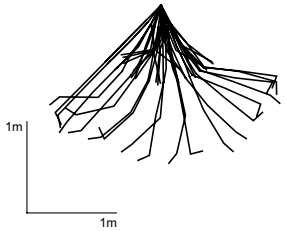

Figure 2: The hanging motion simulated in this study.

It was shown that the code developed in this project can be utilized for simulation of human whole body motions (Figure 2, hanging motion). The following four factors need to be taken into account to simulate a wider range of phenomena that researchers in biomechanics are interested in. Those four major factors are: (1) muscles, (2) ground reaction forces, (3) detailed joint motions and (4) addition or removal of segments. Currently we are trying to address these points utilizing built-in functions of AUTOLEV, and making a steady progress.

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