15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
CMBBE 2018
P. R. Fernandes and J. M. Tavares (Editors)

Abstract ID-66

3D GEOMETRICAL MATHEMATICAL STUDY AND VISUALIZATION OF THE HUMAN UPPER LIMB MANIPULATOR MASS MOMENTS OF INERTIA

Daniel Dantchev, Gergana Nikolova, Alexander Kazakoff

Bulgarian Academy of Sciences, Bulgaria
danieldantchev@gmail.com, gergana1973@gmail.com, alex_kazakoff@yahoo.co.uk

Keywords: Human movement, Links between robotics and human modeling, Mass moments of inertia, human upper limb model, three-dimensional geometrical mathematical modelling manipulation system, body segment parameters

Summary: Two joints upper human limb manipulator is designed and its mass properties are investigated, by using a 3D geometrical mathematical modeling of the human upper limb. In principle, the computer realization of the model can provide data for upper limb's mass, volume, surface area, center of mass coordinates, principal axes of inertia and principal moments of inertia, as well as moments of inertia taken at the origin of the laboratory coordinate system.
In this paper, if z is the vertical and x the horizontal axes, we take that the upper arm can move in the (z, x) plane with angle α with respect to the z-axis characterizing its position. The lower arm then moves in the plane formed by the upper and the lower arm with angle β between the both determining their mutual positio. Within the computer model developed, we determine and present data how the center of mass of the upper limb changes when it moves so that its end reaches, say, the area of the mouth of the human. In addition, we present corresponding data for the changes of the moment of inertia along such movement.
Visualisation of the motion of manipulator's mass center is performed under the variation of both investigated angles generating a particular saddle-like surface in the original laboratory coordinate system. Based on this graphics, mass moments of inertia are visualized. Ellipsoids of mass moments of inertia are generated and visualized.
The presented study can be helpful in the design of manipulation systems with application in rehabilitation. More generally, the method provides a handy opportunity to calculate the mass-inertial parameters of the upper limb of a given individual, provided the anthropometric easily measurable data for that individual are known.