INVESTIGATION OF THE SIMULATION OF THE MASS MOMENTS OF INERTIA FOR THE TRUNK

László Kocsis, Budapesti Müszaki Egyetem, Budapest, Hungary

INTRODUCTION: The growth of computer technology helps us to understand and analyze human movement patterns, equally important for both the biomechanist and coach.

To carry out exact investigations the applied model has to use correct kinematical and kinetic characteristics of the human body. With manually performed image processing the application of the number of necessary key-points will affect the error of the measurement. The Applied Mechanics Department of the Technical University of Budapest has developed a suitable model for determining the elements of the mass moments of inertia for the different segments of the human body.

The model is a refined Hanavan model representing the human body with 16 simple geometric solids determined by the spatial co-ordinates of 20 key points, and only 6 further data are used, compared with 242 data used in Hatze's model and 45 data used in Barton's model.

The minimization of the necessary key points reduces the number of digitalization errors.

METHODS AND PROCEDURES: The trunk was substituted by 3 elliptical cylinders (Fig. 1), and parameters

(λ_{14}, λ_{16}, and λ_q) were applied for adjusting the elliptical cylinders. [1]

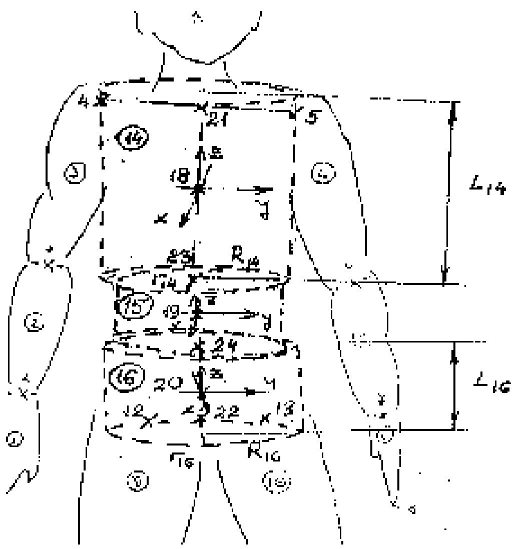

Fig. 1

here:

$$L_{14} = 2\lambda_{14}\left|\left(\bar{r}_{18} - \bar{r}_{21}\right)\right|$$

and

$$L_{16} = 2\left|\left(\bar{r}_{20} - \bar{r}_{22}\right)\right|\lambda_{16}$$

$$R_{16} = \frac{1}{2}\left|\left(\bar{r}_{13} - \bar{r}_{12}\right)\right|\lambda_q$$

This paper investigated the effects of the parameters (λ_{14}, λ_{16}, and λ_q) on the values of the mass moments of inertia of the segments of the trunk and, comparing the calculated mean values with the measured mean ones [2], determined a maximum error of the alternations of less than 15 % within the range of the measured values.

RESULTS: In the following figures (Fig. 2 -Fig. 5) the 3 components of the principal moments of inertia (I_x, I_y and I_z) are shown. The first 2 columns are the measured minimum and maximum values [2], and the following 7 columns show the calculated values using the appropriate coefficient from 1.00 to 1.30 in steps of 0.05.

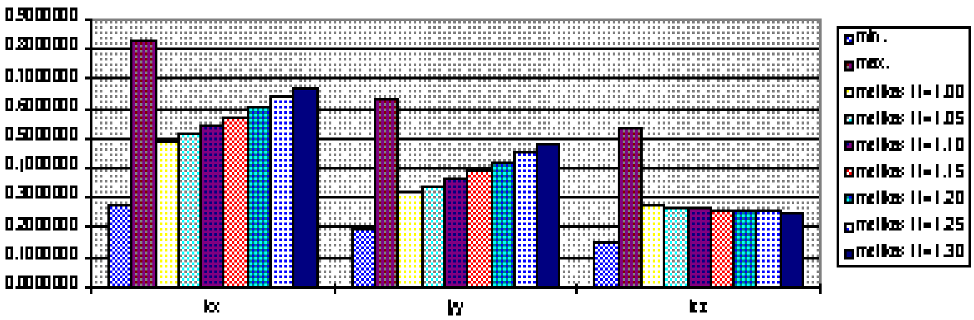

Fig. 2. The effect of λ_{14} for the mass moments of the thorax

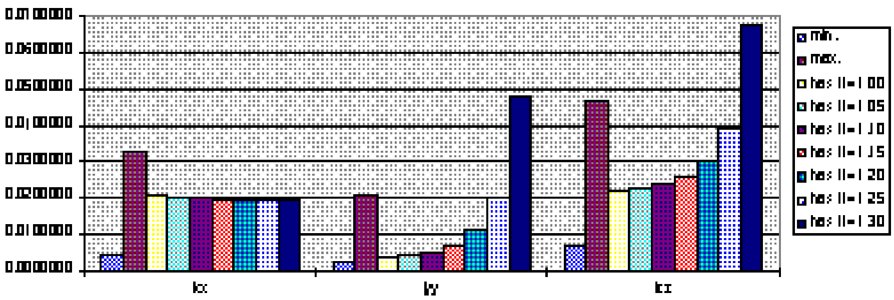

Fig. 3. The effect of λ_{14} for the mass moments of the abdomen

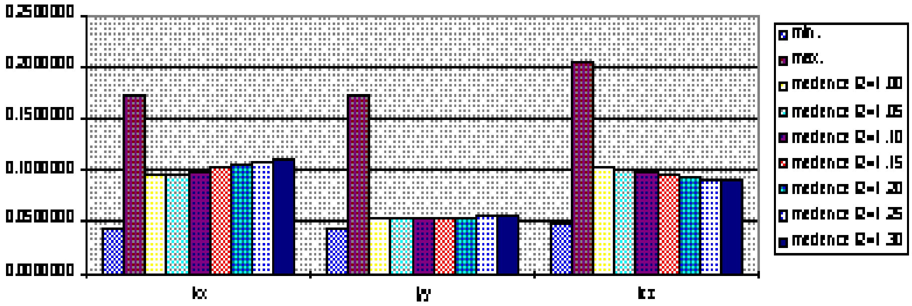

Fig. 4. The effect of λ_{16} for the mass moments of the pelvis

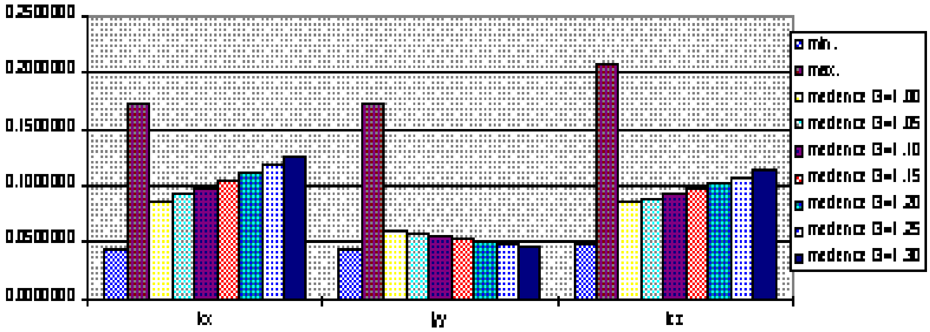

Fig. 5. The effect of λ_q for the mass moments of the pelvis

CONCLUSIONS: The reviewed mechanical model of the torso is suitable for calculating the elements of the mass moments of inertia with negligible error, if the positions of the local CG-s are correct. The effect of the alternation of the local CG-s is more significant on the values of the mass moments of inertia than the effect of the introduced coefficients. This method is suggested for calculations of athletes', motion even if there is a torsion or bending of the trunk.

The recommended values for the coefficients for analyzing the motion of athletes are shown in Table 1.

.	Minimal value	maximal value	suggested value
λ_{14}	1.05	1.17	1.13
λ_{16}	1.00	1.15	1.15
λ_q	1.10	1.25	1.13

Tab. 1. Range of coefficients

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