LASER BEAM SCANNING ANTHROPOMETRY FOR DETERMINING BODY SEGMENT PARAMETERS IN LIVING HUMANS

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INTRODUCTION

Segmental anthropometry, which measures segment masses, segment lengths, segment center-of-mass locations, and segment moments of inertia can be determined by a number of different means. They have been derived from cadavers [1, 2], from direct measument [3], from regression equations, and from mathematical modelling [4]. The choice of body segment parameters determined from such means might be based on the population being studied and level of accuracy sought by the researcher. Recently, another approach to estimating body segment parameters involves scanning the living body with various techniques such as gamma mass scanning, photogrammetry, MRI and DEXA. Whole Body Measurement System for humans “Bodyline Scanner" which has functions such as a high speed measurement and high resolutions are required by many industrial and academic areas such as apparel and digital technology.

The purposes of the present study were to develop 3D anthropometry by optical triangle method using laser beam system and to determine feasibility of segment parameter measurements such as lengths, circumferences, body surface and body/segment masses with comparing to previous studies.

METHODS

As shown in Fig.1, newly developed Bodyline scanner (BLS) was capable of digitizing whole body shape as three dimensional coordinates in the order of 2.5mm intervals in space (normal adult body shape put in ~500,000 points). The principle of the measuring method was optical triangle measurement, in which light source was using a laser diode. The color information was used to detect the position of land mark seals which was pasted on the skin according to the anatomical basis in human anthropometry.

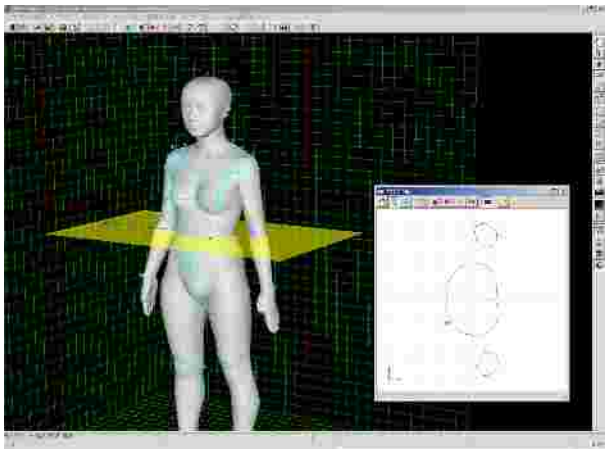

Figure 1: Laser beam sheet scanning during human standing posture for determining 3D anthropometric data. Inserted graph shows cross-section, which can get every 2.5mm interval for vertical axis.

Subjects were 20 young Japanese sedentary peoples including 12 males (23.8yrs, 171.5cnBH, 68.7kgBW in averages) and females (27.4yrs, 156.7cmBH, 54.4kgBW in averages). Scanning whole body data were dissected into each segment as the same manner as Clauser CE, et al. [1]. After segmental length, circumference and volume were calculated, segment masses were determined by multiplying segmental volume to respective segmental density obtained from previous study [1].

RESULTS AND DISCUSSION

Differences of lengths and circumferences of the limbs between BLS and TAPE were within 4%. Relative segment mass to body weight in each segment was very similar to previous studies except for the segments of trunk and thigh (Table 1). Previous relative segment mass values have a tendencies for overestimation in trunk, whereas underestimation in thigh. This should take into account for calculating mechanical parameters in biomechanical research.

Table 1: Relative segment mass to body weight (unit: %) for each segment and comparison to previous studies.

	Present	Dempster	Clauser	Cheng
	2008	1955	1969	2000
# of subj.	12	8	13	8
Methods	BLS	Cadavers	Cadavers	MRI
Head	7.3	8.1	7.3	7.7
Trunk	45	49.7	50.7	46.2
U-arm	2.7	2.8	2.6	4
F-arm	1.7	2.2	1.6	1.5
Hand	0.6	0.6	0.7	0.7
Thigh	12.9	9.9	10.3	13.6
Calf	4.8	4.6	4.3	4.4
Foot	1.1	1.4	1.5	2

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