Segment inertial parameters of Korean adults estimated from three-dimensional body laser scan data

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ABSTRACT

In this study, body segment parameters of Korean adults were estimated using the three-dimensional (3D) body scan data from the SizeKorea database. Mass-inertial parameters and segment dimensions of 40 male subjects and 40 female subjects (18–59 years old) were estimated using a 16-segment model under the assumption that each segment has a constant density distribution after reconstructing the scan data. Therefore, several sets of linear regression functions based on gender, stature, and weight were established, which provided a convenient method for estimating body segment parameters of Korean adults. The obtained mass ratios of body segments were compared with those for Russians reported by Zatsiorsky and Seluyanov (1983) and for those for Chinese and Germans reported by Shan and Bohn (2003), in which the same 16-segment model was used. In addition, the results were compared with the Korean data results reported by Jung (1993), Lim (1994), and Park et al. (1999). These comparisons revealed that Asians have larger head mass ratios and smaller lower limb mass ratios than Caucasians, while the differences in the head mass ratios between males and females from the same ethnic groups were not significant. Females were found to have larger mass ratios for the lower torso and smaller mass ratios for the upper torso, middle torso, upper arm, forearm, foot, and hand, as compared to males from the same ethnic groups. In addition, the data obtained by different researchers were compared, thereby showing high reproducibility of our method.

Relevance to industry: The obtained segment parameters can be used to define digital human models and applied to the fields of ergonomics and biomechanics, such as for workspace design, furniture design, vehicle interior design, and human movement analysis.

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1. Introduction

Anthropometry is the science of measurement and the application of this measurement for establishing the physical geometry, mass properties, and strength capabilities of the human body. Anthropometric data are of key importance in digital human modeling, human movement analysis, ergonomic design, and biomechanical studies. Since the anthropometric data differ in race, region, gender, age, etc., many anthropometry surveys for different populations have been and will have to be continuously conducted to provide up-to-date anthropometric data. The recent surveys conducted among Asian populations include the anthropometries of the populations of Singapore and Indonesia (Chuan et al., 2010), Thailand (Klamklay et al., 2008), India (Dewangan et al., 2008, 2010), China (Hu et al., 2007), Sri Lankan university students (Thariq et al., 2010), and Filipino manufacturing workers (Prado-Lu, 2007).

Recently, the 3D body scanner has become a notable tool for anthropometry. Over the past decade, large-scale three-dimensional (3D) anthropometry surveys have been conducted using 3D body scans in many countries. 1D anthropometric data can be efficiently derived from 3D scan data. The accuracy of the scan-derived dimensions compared to the manual measurements, the various factors that affect this accuracy, and the methods that can be employed to enhance the accuracy have been studied (Lu et al., 2010; Park et al., 2009; Han et al., 2010; Witanaa et al., 2006; Robinette and Daanen, 2006). Moreover, 3D surface anthropometric data contain considerably more anthropometric information than 1D data and can thus have wider applications. Different

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