INTERNATIONAL STANDARD

ISO 20685

First edition
2005-11-01

3-D scanning methodologies for internationally compatible anthropometric databases

Méthodologies d'exploration tridimensionnelles pour les bases de données anthropométriques compatibles au plan international

Reference number
ISO 20685:2005(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20685 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

Introduction

Anthropometric measures are key to many International Standards. These measures can be gathered using a variety of instruments. An instrument with relatively new application to anthropometry is a three-dimensional (3-D) scanner. 3-D scanners generate a 3-D point cloud of the outside of the human body that can be used for clothing and automotive design, engineering and medical applications. There are currently no standardized methods for using 3-D point clouds in the design process. As a result, many users extract one-dimensional (1-D) data from 3-D point clouds. This standard concerns the application of 3-D scanners to the collection of one-dimensional anthropometric data for use in design.

There are a number of different fundamental technologies that underlie commercially available systems. These include stereophotogrammetry, ultrasound and light (laser light, white light and infrared), among others. Further, the software that is available to process data from the scan varies in its methods. Additionally, software to extract dimensions similar to traditional dimensions varies markedly in features and capabilities.

As a result of differences in fundamental technology, hardware and software, extracted measurements from several different systems can be markedly different for the same individual. Since 3-D scanning can be used to gather measurements, such as lengths and circumferences, it was important to develop an International Standard that allows users of such systems to judge whether the 3-D system is adequate for these needs.

The intent of ISO 20685 is to ensure comparability of body measurements as specified by ISO 7250 but measured with the aid of 3-D body scanners rather than with traditional anthropometric instruments such as tape measures and callipers. It is further intended that by conformance with this International Standard any data extracted from scans will be suitable for inclusion in international databases such as those described in ISO 15535.

3-D scanning methodologies for internationally compatible anthropometric databases

1 Scope

This International Standard addresses protocols for the use of 3-D surface-scanning systems in the acquisition of human body shape data and measurements defined in ISO 7250 that can be extracted from 3-D scans. It does not apply to instruments that measure the location and/or motion of individual landmarks.

While mainly concerned with whole-body scanners, it is also applicable to body-segment scanners (head scanners, hand scanners, foot scanners).

The intended audience is those who use 3-D scanners to create 1-D anthropometric databases and the users of 1-D anthropometric data from 3-D scanners. Although not necessarily aimed at the designers and manufacturers of those systems, scanner designers and manufacturers will find it useful in meeting the needs of clients who build and use 1-D anthropometric databases.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7250:1996, *Basic human body measurements for technological design*

ISO 15535: 2003, *General requirements for establishing anthropometric databases*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE In the case of definitions of terms for skeletal landmarks, when there is a separate term for the skin overlying the landmark and another for the landmark itself, the skin landmark term is used. Where there is no separate term, the skeletal term is used and assumed to refer to the skin overlying the landmark.

3.1
three-dimensional
3-D
pertaining to the use of three orthogonal scales on which the three coordinates, x, y and z, can be measured to give the precise position of any relevant anatomical point in the considered space

NOTE Many anthropometric distances can be calculated from the coordinates of anatomical landmarks. Some additional points may be necessary to obtain circumferences.

3.2
3-D body scanner
hardware and software system that creates digital data representing a human form, or parts thereof, in three dimensions

3.3
3-D processing software
operating system, user interface, programs, algorithms and instructions associated with a 3-D scanning system

3.4
3-D scanner hardware
physical components of a 3-D scanner and any associated computer(s)

3.5
accuracy
extent to which the measured value approximates a true value

NOTE Since it is difficult to trace the accuracy of complex hardware and software systems to recognized ISO sources, for the purposes of this International Standard *true value* is taken to mean the measured value obtained by a skilled anthropometrist using traditional instruments such as tape and calliper.

3.6
acromion
most lateral point of the lateral edge of the spine (acromial process) of the scapula

[ISO 7250:1996, 2.2.1]

3.7
anatomical landmark
clearly defined point on the body that can be used for defining anthropometric measurements

3.8
anterior superior iliac spine
most downward-directed point of the iliac crest

NOTE Adapted from ISO 7250:1996, 4.1.6.

3.9
anthropometric database
collection of individual body measurements (anthropometric data) and background information (demographic data) recorded on a group of people (the sample)

[ISO 15535:2003, 3.8]

3.10
cervicale
superior tip of the prominent bone at the base of the back of the neck (spinous process of the seventh cervical vertebra)

NOTE Adapted from ISO 7250:1996, 2.2.5.

3.11
crotch level
distal part of the inferior ramus of the pubic bone on a standing subject

NOTE It is typically marked using the top of a horizontal straightedge.

3.12
Frankfurt plane
standard horizontal plane at the level of tragion and left infraorbitale when the midsagittal plane of the head is held vertically

NOTE Adapted from ISO 7250:1996, 2.2.8.

3.13
glabella
most anterior point of the forehead between the browridges in the midsagittal plane

[ISO 7250:1996, 2.2.9]

3.14
iliocristale
most lateral palpable point of the iliac crest of the pelvis

3.15
infraorbitale
lowest point on the anterior border of the bony eye socket

3.16
lateral malleolus
most lateral point of the right lateral malleolus (outside ankle bone)

3.17
lowest rib
inferior point of the bottom of the rib cage

3.18
menton
lowest point of the tip of the chin in the midsagittal plane

NOTE Adapted from ISO 7250:1996, 2.2.16.

3.19
mesosternale
point on the union of the third and fourth sternebrae

[ISO 7250:1996, 2.2.17]

3.20
nipple
centre of the nipple

3.21
opisthocranion
most posterior point of the head in the midsagittal plane, when the head is held in the Frankfurt plane

3.22
point cloud
collection of 3-D points in space referenced by their coordinate values

NOTE A point cloud constitutes the raw data from a 3-D scanner and needs to be translated to a human axis system.

3.23
radial styloid
protuberance of the radius at the wrist

NOTE Adapted from ISO 7250:1996, definition 2.2.26.

3.24
repeatability
extent to which the values of a variable measured twice on the same subject are the same

3.25
sellion
point of greatest indentation of the nasal root depression

3.26
stylion
distal point of the radial styloid

NOTE Adapted from ISO 7250:1996, definition 2.2.26.

3.27
suprapatella
superior point of the patella (kneecap)

3.28
thyroid cartilage
prominent cartilage on the anterior surface of the neck

[ISO 7250:1996, 2.2.28]

3.29
tibiale
point at the upper inside (medial) edge of the proximal end of the tibial bone of the lower leg

[ISO 7250:1996, 2.2.29]

3.30
top of head
highest point of the head with the head oriented in the Frankfurt plane

3.31
tragion
notch just above the tragus

NOTE Adapted from ISO 7250:1996, definition 2.2.30.

3.32
tragus
small cartilaginous flap in front of the ear hole

NOTE Adapted from ISO 7250:1996, definition 2.2.30.

3.33
ulnar stylion
most distal point on the ulnar styloid

NOTE Adapted from ISO 7250:1996, definition 2.2.26.

3.34
ulnar styloid
protuberance of the ulna at the wrist

NOTE Adapted from ISO 7250:1996, definition 2.2.26.

3.35
vertical plane
geometric plane tangent to a point on the body and orthogonal to the mid-sagittal plane

3.36
x, *y*, *z* **coordinate system**
axis system
system for measuring the body with respect to the standing or sitting human where X refers to the fore-and-aft direction (the sagittal axis), Y refers to the side-to-side direction (the transverse axis) and Z refers to the top-to-bottom direction (the longitudinal axis)

See Figure 1.

NOTE Researchers establish their own origin for the axis system, convenient to their research, while keeping the direction of the axes as indicated and reporting the origin in the data base and any publications.

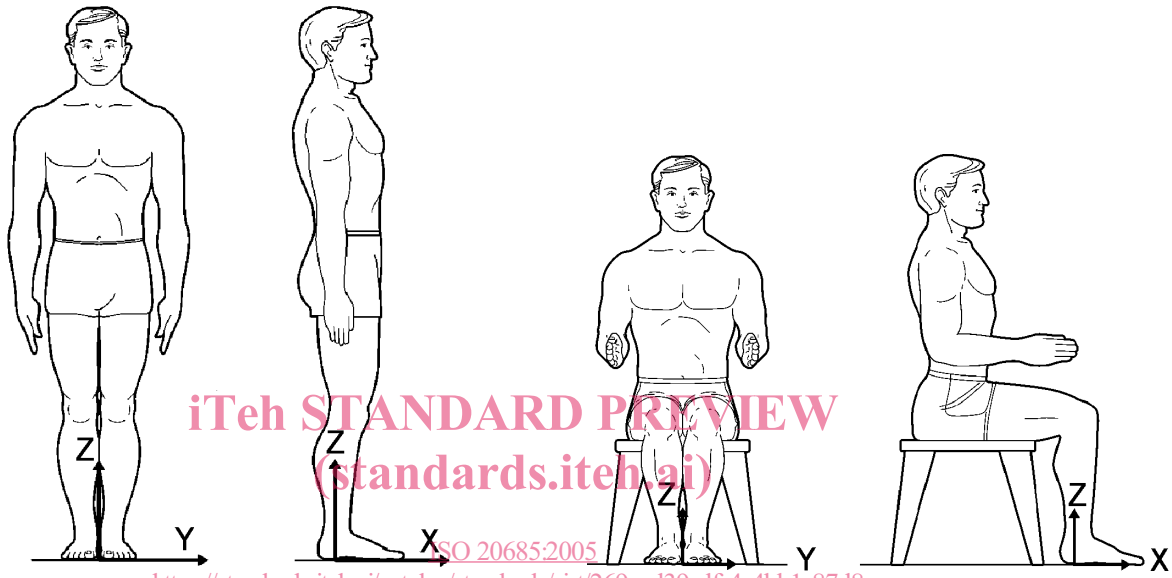

Figure 1 — *x*, *y*, *z* coordinate system

4 Accuracy of extracted measurements

4.1 Selection of extracted measurements

In order to use data from 3-D scanners in internationally compatible databases, dimensions should be drawn from ISO 7250. However, not all of those measurements are well suited to extraction from 3-D scanned images. In particular, the resolution from whole-body scanners might not be sufficient to allow accurate extraction of measurements from smaller body parts such as the hand. Tables 1 to 3 give measurements according to the type of scanner most likely to produce the best results. The numbers indicate the measurement number in ISO 7250.