SLOVENSKI STANDARD
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Ergonomija - Metode 3D-skeniranja za mednarodno združljive baze antropometrijskih podatkov - 2. del: Protokol ovrednotenja površine telesa in ponovljivosti relativnih merilnih točk (ISO/DIS 20685-2:2022)

Ergonomics - 3-D scanning methodologies for internationally compatible anthropometric databases - Part 2: Evaluation protocol of surface shape and repeatability of relative landmark positions (ISO/DIS 20685-2:2022)

Ergonomie - 3-D-Scanning-Methoden für international kompatible anthropometrische Datenbanken - Teil2: Bewertungsprotokoll der Oberflächenform und Wiederholbarkeit der relativen Positionen von Orientierungspunkten (ISO/DIS 20685-2:2022)

Ergonomie - Méthodologies d'exploration tridimensionnelles pour les bases de données anthropométriques compatibles au plan international - Partie 2: Protocole d'évaluation de la forme extérieure et de la répétabilité des positions relatives de repères (ISO/DIS 20685-2:2022)

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Ergonomics — 3-D scanning methodologies for internationally compatible anthropometric databases —

Part 2: Evaluation protocol of surface shape and repeatability of relative landmark positions

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

Partie 2: Protocole d'évaluation de la forme extérieure et de la répétabilité des positions relatives de repères

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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.

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The committee responsible for this document is ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

ISO 20685 consists of the following parts, under the general title *3-D scanning methodologies for internationally compatible anthropometric databases*:

— *Part 1: Evaluation protocol for body dimensions extracted from 3-D body scans*

— *Part 2: Evaluation protocol of surface shape and repeatability of relative landmark positions*

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 in a number of situations including clothing and automotive design, engineering and medical applications. Recently, digital human models are created from a 3-D point cloud, and used for various applications related to technological design process. Quality control of scan-extracted anthropometric data is important since required quality can differ according to applications.

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, methods to extract landmark positions are different between commercially available systems. In some systems, anthropometrists decide landmark locations and paste marker stickers, and scanner system calculate locations of marker stickers and identify their names, while in other systems, landmark positions are automatically calculated from the surface shape data. Quality of landmark locations have significant effects on the quality of scan-extracted 1-D measurements as well as digital human models created based on these landmarks.

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

The intent of this part of ISO 20685 is to ensure the quality control process of body scanners, especially that of surface shape and locations of landmarks as specified by ISO 7250-1.

Ergonomics — 3-D scanning methodologies for internationally compatible anthropometric databases —

Part 2: Evaluation protocol of surface shape and repeatability of relative landmark positions

1 Scope

This part of ISO 20685 addresses protocols for testing of 3-D surface-scanning systems in the acquisition of human body shape data and measurements. It does not apply to instruments that measure the 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). This International Standard applies to body scanners that measure the human body in a single view. When a hand-held scanner is evaluated, it has to be noted that the human operator can contribute to the overall error. When systems are evaluated in which the participant is rotated, movement artefacts can be introduced; these can also contribute to the overall error. This part of ISO 20685 applies to the landmark positions determined by an anthropometrist. It does not apply to landmark positions automatically calculated by software from the point cloud.

The quality of surface shape of the human body and landmark positions is influenced by performance of scanner systems and humans including measurers and participants. This part of ISO 20685 addresses the performance of scanner systems by using artefacts rather than human participants as test objects.

Traditional instruments are required to be accurate to millimetre. Their accuracy can be verified by comparing the instrument with a scale calibrated according to an international standard of length. To verify or specify the accuracy of body scanners, a calibrated test object with known form and size is used.

The intended audience is those who use 3-D body scanners to create 3-D anthropometric databases, the users of these data, and scanner designers and manufacturers. This part of ISO 20685 intends to provide the basis for the agreement on the performance of body scanners between scanner users and scanner providers as well as between 3-D anthropometric database providers and data users.

2 Normative references

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

ISO 7250-1, *Basic human body measurements for technological design — Part 1: Body measurement definitions and landmarks*

ISO 10360-8, *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring systems (CMS) — Part 8: CMMs with optical distance sensors*

ISO 20685-1, *3-D scanning methodologies for internationally compatible anthropometric databases — Part 1: Evaluation protocol for body dimensions extracted from 3-D body scans*

3 Terms and definitions

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

3.1
error of spherical form measurement
error within the range of the Gaussian radial distance, determined by a least-squares fit of measured data points on a test sphere

Note 1 to entry: Error of spherical form measurement is associated with the performance of the body scanner and the sphericity of the test sphere.

3.2
spherical form dispersion value
smallest width of a spherical shell that includes *n* % of all the measured data points

Note 1 to entry: See Figure 1, right.

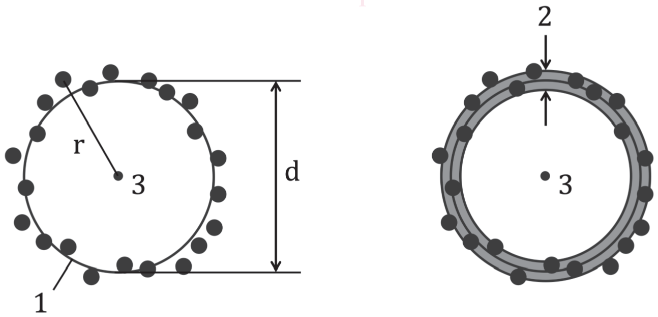
3.3
standard deviation of radial distances
standard deviation of radial distances from measured data points and best-fit sphere

Note 1 to entry: Standard deviation of radial distances is an indicator of error of spherical form measurement and is highly correlated with error of spherical form dispersion value (90 %)

3.4
error of diameter measurement
error of the diameter of a least-squares fit of measured data points on a test sphere

Note 1 to entry: See Figure 1, left.

Note 2 to entry: It is calculated by subtracting the calibrated diameter described in 4.2 from the measured diameter.



Key

1 best-fit sphere

2 spherical form dispersion value (*n*)

3 centre of the best-fit sphere

d diameter of the best-fit sphere

r radial distance of a measured data point from the centre of the best-fit sphere

NOTE Spherical form dispersion value (*n*), in which *n* % of the measured data points are located, is shown as the radial thickness of the shaded area of the right figure. Spherical form dispersion value (*n*) is calculated as the 100 – $n/2$ percentile value minus $n/2$ percentile value of the radial distances of the measured data points from the centre of the best-fit sphere.

Figure 1 — Error of diameter measurement and spherical form dispersion value

4 Test protocol for evaluating surface shape measurement

4.1 General aspects

The environmental conditions shall correspond to the operating conditions of the 3-D body scanner. When operation mode needs to be modified to measure the test object, it shall be specified in the report.

4.2 Test sphere

Sphere made of steel, ceramic, or other suitable materials with diffusely reflecting surface are used to determine the quality parameter spherical form dispersion value and error of diameter measurement. It is desirable that the diameter of the sphere is close to the size of a part of the human body, such as the head.

The diameter and form of the test sphere shall be calibrated using a precision measuring equipment such as a coordinate-measuring machine that has traceability to the international standard of the length, and a calibration certificate shall be available.

The surface properties of the test sphere may significantly affect the test results. The material of test sphere shall be reported.

The reference sphere supplied with the body scanner for the calibration purposes shall not be used for this test.

Example of sphere is shown in Annex A.

4.3 Procedure

4.3.1 Measurement of test sphere

The sphere shall be measured at least nine different positions within the scanning volume. Measurement positions shall include the following nine positions (Figure 2): position 1 is the centre of the scanning volume on the floor; position 2 to position 5 are 500 mm, 1 000 mm, 1 500 mm, and 2 000 mm off the floor, above position 1; position 6 and position 7 are 250 mm anterior to or posterior to the centre position and 1 000 mm off the floor; position 8 and position 9 are 400 mm right or left to the centre position and 1 000 mm off the floor.

When the sphere cannot be measured at positions described above due to a smaller scanning volume, measure the sphere at a position closest to the intended position, and record the exact position.