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Performance evaluation protocol for digital fitting systems —

Part 1:
Accuracy of virtual human body representation

Protocole d'évaluation de la performance des systèmes d'habillage virtuel —

Partie 1: Fidélité de la représentation du corps humain virtuel

ICS: 61.020

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Foreword

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This document was prepared by Technical Committee ISO/TC ISO/TC 133, Clothing sizing systems - size designation, size measurement methods and digital fittings.

ISO 20497 consists of three parts, under the general title Performance evaluation protocol for digital fitting systems.

— Part 1 – Accuracy of virtual human body representation

— Part 2 – Virtual garment

The following parts are in preparation.

— Part 3 –Digital fitting

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Digital fitting systems are used for evaluating the fit of a garment without making physical patterns or physical garments. In a digital fitting system, a virtual garment is made using virtual patterns, and the fit of physical garment(s) on a physical human body is assessed by draping a virtual garment on a virtual human body or a virtual fit mannequin (fit form). Such systems are useful for designers and manufacturers, educationalists and retailers of garments because the system helps to improve the fit of garments and productivity. It may also be useful for consumers for assessing the fit of mass-produced garments, for online shopping or for selecting an appropriate size.

The digital fitting system enables examination of the fit of a garment by placing a virtual garment on a virtual human body. Greater accuracy in examining the fit of the virtual garment requires a virtual human body representing the human body accurately. There are several methods for creating the virtual human body. The most popular is the use of a 3D body scan data of a human body, scan data of a fit mannequin representing a specified human form and a parametric model created from body dimensions.

This standard defines the virtual human body system which forms basis of the digital fitting system. Because the virtual human body system is designed to create a virtual human body, the system must satisfy a number of functional requirements specified in this standard. This standard establishes not only the basic functional requirements of the system but the protocol for assessing the quality of the virtual human body. The protocol is expected to enable users of digital fitting systems (designers, educationalists and retailers) to choose the virtual human body system most appropriate for their respective purposes and, at the same time, realize easier performance evaluation of digital fitting systems that make use of the virtual human body(including virtual fit mannequin) model.

Performance evaluation protocol for digital fitting systems – Part 1 Accuracy of virtual human body representation

1 Scope

This first part of ISO 20947 standard focuses on the method of quantifying the differences in body dimensions and visualizing shape differences between the human body and a virtual human body model. The standard provides performance evaluation protocol for virtual human body representation systems, which creates a virtual human body (including virtual fit mannequin) model based on 3D body scan data and/or body dimensions data of a human body. The required accuracy of a virtual human body depends on the purpose and use of the digital fitting system.

Since the accuracy of scan-derived measurements and surface shape depends on the accuracy of 3D body scanner system used, manual measurements are used for quantitatively evaluating the accuracy of a virtual human body. Accuracy of scan-derived measurements should be evaluated according to ISO 20685.

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 18825-1: Clothing — Digital fittings — Part 1: Vocabulary and terminology used for the virtual human body

ISO 18825-2: Clothing — Digital fittings — Part 2: Vocabulary and terminology used for the attributes of virtual human body

ISO 8559-1: Size designation of clothes - Part 1: Anthropometric definitions for body measurement

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

ISO/DIS 20947-2: Performance evaluation protocol for digital fitting systems Part 2 - Virtual garment

3 Terms and definitions

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

3.1 Digital fitting system

Digital fitting system provides qualitative and/or quantitative evaluation of overall and/or specific simulation garment fit through analysis of the distribution of surface strain, gap between body and garment, heat map, cross section, surface wrinkles, seam drop, garment balance, etc.

3.2 Virtual human modelling system

System for creating a virtual human body for a specific market or individual.

Note: Asymmetrical shape assumed to match the body shape of the individual.

3.3 Virtual human model

Three-dimensional model in digital format.

[source: ISO 18825-1: 2016,2.1.1]

3.3.1. Parametric human body

Virtual human model with changeable parameters such as size and shape, etc.

NOTE 1 Parametric human body is created by modifying the parameters of the exemplar model imported from the 3D model library. The exemplar models differ with countries as they are based on a database. Therefore, a parametric human body can be made on the basis of height variations, BMI (body mass index) and so on.

NOTE 2 The parameters of the parametric human body are presented in the parametric human body software. The parameters of the parametric human body can be added depending on the purpose of users.

NOTE 3 See Figure 1.

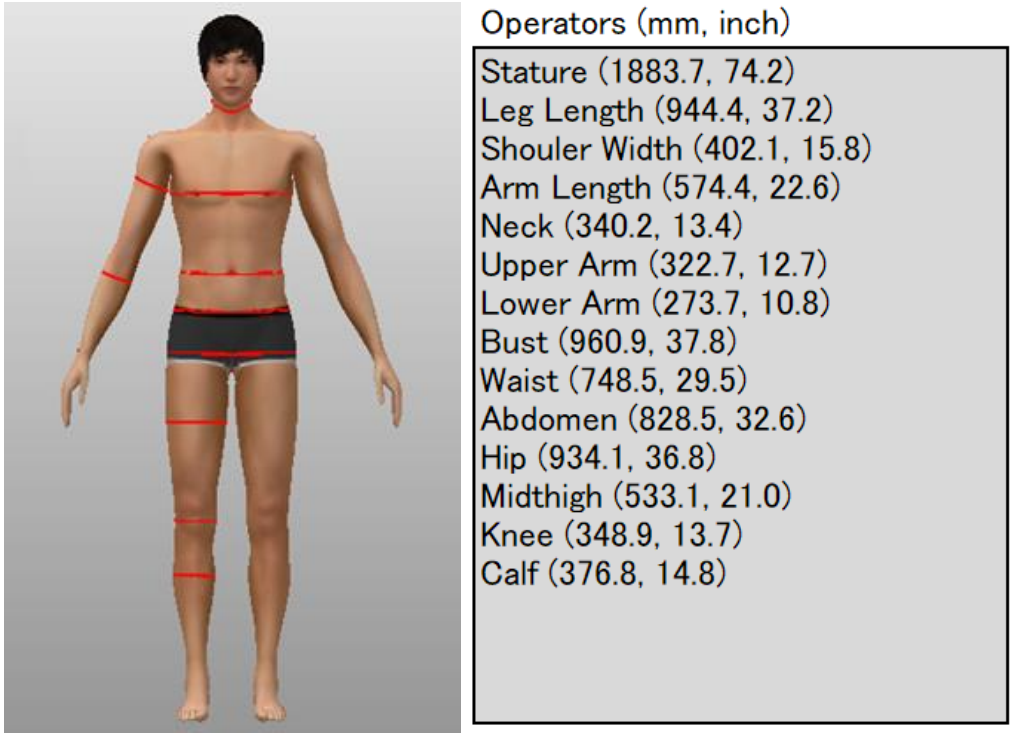

Figure 1 — Examples of parameters of a male adult body

[source: ISO 18825-1: 2016,2.1.1.1]

3.3.2. Virtual human body

Virtual clone (Virtual shape) Virtual human model for digital fitting in the apparel industry, including information such as size, shape, cross section, body texture and skeletal structure.

NOTE 1 Also called “fashion avatar”. In computing, an avatar is the graphical representation of the user or the user’s alter ego or character.

NOTE 2 The virtual human body is classified into two key types – virtual clone (virtual shape) and virtual twin (virtual size).

[source: ISO 18825-1: 2016,2.1.1.2]

NOTE 3 In this standard, virtual human body includes at least virtual clone, virtual twin and virtual fit mannequin model.

3.3.2.1. Virtual clone

Virtual human body that is created by forming three-dimensional surface data from a 3D body scanned point cloud (see ISO 20685:2010, 3.21), using surface modeling processes including noise elimination, hole -filling and mesh generation.

NOTE 1 It is essential that a user gets scanned first to create a virtual clone (virtual shape).

NOTE 2 The virtual clone (virtual shape) is identical to the body shape of the user.

NOTE 3 See Figure 2.

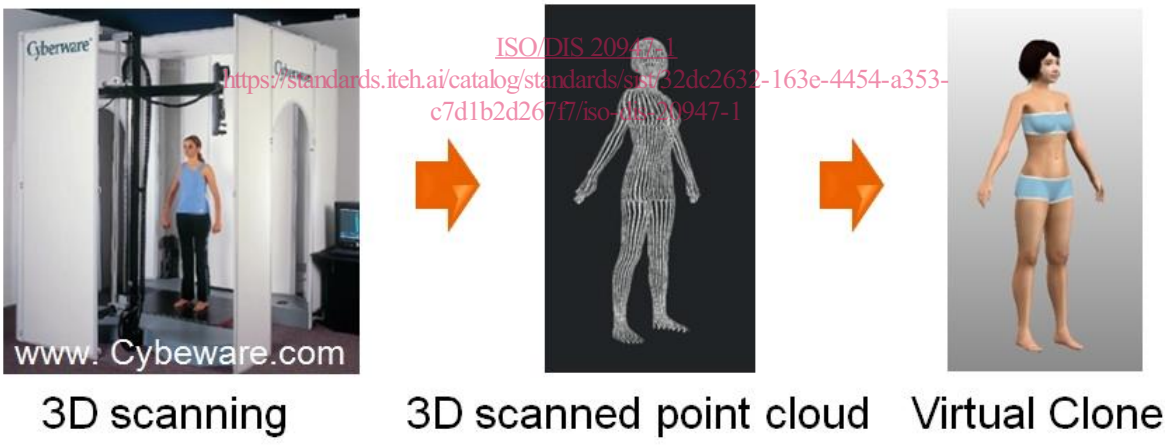

Figure 2 —Process of creating a virtual clone (virtual shape)

[source: ISO 18825-1: 2016,2.1.1.2.1]

3.3.2.2. Virtual twin (Virtual size)

Morphed virtual human body that is applied body dimensions acquired either through manual or automatic measurements

NOTE 1 The virtual twin (virtual size) is a *parametric human body* (3.3.1) as it can be altered with parameters.

NOTE 2 The virtual twin (virtual size) is not identical to the user; but is a close approximation that can be altered by entering parameters retrieved from a population database.

NOTE 3 See Figure 3.

a) Body measurements b) 3D model library c) Virtual twin

NOTE Body measurements are necessory to create a virtual twin. The actual text in a) is not important.

Figure 3 — Process of creating a virtual twin (virtual size)

[source: ISO 18825-1: 2016,2.1.1.2.2]

NOTE 4 Virtual twin can be created directly from the person being scanned or as in case of most digital systems from an existing library.

3.3.2.3. Virtual fit mannequin

Virtual fit mannequin model is an abstracted human body model in digital format used for garment visualisation. The model is used for draping simulation (3D form and design realization e.g.) and examining silhouette and fit of a garment.

Figure 4 —Process of creating a virtual fit mannequin

3.4 Virtual/Physical standing position

The head is in the Frankfurt plane, the long axes of the feet should be parallel to one another and 200mm apart. The upper arms are abducted to form a 20° angle with the sides of the torso and the

elbows are straight. But the palms face toward the torso. This position shall be used for evaluating the fit of garments.

[source: ISO 18825-1: 2016,2.2.3 Note 1]

NOTE For a virtual fit mannequin model, a simulated virtual standing position can be used.

3.5 Virtual cross section

Closed contour extracted from the plane cutting a virtual body segment perpendicular to its main axis or the three principle axes.

NOTE 1 See Figure 5.

NOTE 2 The main axis is the axis that connects the joints on either side of the virtual body segment.

Figure 5 — Examples of virtual body cross sections

[source: ISO 18825-1: 2016,2.2.2]

3.6 Virtual/Physical body landmarks and levels

Points which define the characteristic of the body shape of the user in the virtual standing position. For example, points of bone prominence, peak points on a convex or concave surface, or points like the bust point can be virtual body landmarks.

[source: ISO 18825-1:2016,2.2.4]

NOTE 1 On a physical body, a virtual fit mannequin or a physical fit mannequin, the landmarks and the levels are defined in the same manner.

NOTE 2 Some of the landmarks are evaluated in terms of their levels in this standard (see Table 1).

NOTE 3 When a physical body or a physical fit mannquin is 3D scanned, markers for the landmarks can be put on it to extract their positions.

Table 1 Virtual and physical body landmark points and levels

No.	Virtual body landmark points	Male/female
1.	Virtual back neck-base point	both

2.	Virtual shoulder point(Right and Left)	both
3.	Virtual axilla point	male
4.	Virtual bust point	female
5.	Virtual underbust point	female
6.	Virtual midriff level	female
7.	Virtual side waist point(Right and Left)	both
8.	Virtual back waist point	both
9.	Virtual top hip level	both
10.	Virtual hip point	both
11.	Virtual crotch point	both
12.	Virtual gluteal fold point	both
13.	Virtual elbow point(Right and Left)	both
14.	Virtual wrist point(Right and Left)	both
15.	Virtual side neck-base point(Right and Left)	both
16.	Virtual landing heel point	both

3.6.1. Virtual back neck-base point

Most posterior point at the back neck-base on the midsagittal plane with the virtual human body/human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.5]

3.6.2. Virtual shoulder point

Most lateral point of the shoulder ridge line passing through the cross section covering the middle plane of the torso and arm with the virtual human body/human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.6]

3.6.3. Virtual axilla point

Lowest point under the axillary passing through the cross section between the torso and arm with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.7]

3.6.4. Virtual bust point

Most anterior point of the bust with the virtual human body in the virtual standing position. This point is used for a woman.

[source: ISO 18825-2:2016,2.1.10]

3.6.5. Virtual underbust point

Lowest point or its level under the bust projection with the virtual human body in the virtual standing position. This point is used for a female.

[source: ISO 18825-2:2016,2.1.11]

3.6.6. Virtual midriff level

Midway between the underbust and waist levels. This level is used for a female.

3.6.7. Virtual side waist point

Most concave point or its level of the (right) side waist when viewed from the front with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.12]

3.6.8. Virtual back waist point

Point of the back waist on the midsagittal plane at the level of the virtual side waist point (3.6.7) with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.13]

3.6.9. Virtual top hip level

Midway between the waist level and hip level.

3.6.10. Virtual hip point

Most posterior point or its level of the hip with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.15]

3.6.11. Virtual crotch point

Lowest point of the torso on the midsagittal plane with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.16]

3.6.12. Virtual gluteal fold point

Most concave point on the sagittal plane passing through the virtual hip point between hip and thigh or its level with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.20]

3.6.13. Virtual elbow point

Most protruding point of the elbow.

[source: ISO 18825-2:2016,2.1.17]

3.6.14. Virtual wrist point

Most concave point of the extended line of the little finger passing through the cross section between the arm and hand with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.18]

3.6.15. Virtual side neck-base point

Intersection point of the concave contour line at the neck-base passing through the shoulder ridge line with the virtual human body in the virtual standing position.

[source: ISO 18825-2:2016,2.1.4]

3.6.16. Virtual landing heel point

Lowest point or level of the posterior calcaneus with the virtual human body in the virtual standing position.

NOTE 1 The virtual landing heel point can reach the floor or the top of the shoe heel.

[source: ISO 18825-2:2016,2.1.6]

3.7 Virtual body dimensions

Size information on virtual body segments of the virtual human body that corresponds to measured anthropometric dimensions of the user in the virtual standing position.

[source: ISO 18825-1: 2016,2.2]

NOTE 1 See 6.2.

4 Basic requirements of Virtual human modelling system

4.1 General

The virtual human modelling system has the following functions.

4.2 Data import function

The system shall have the function to import body surface shape data and/or body dimensions data of any human body. It is recommended that the system is able to import the location of landmarks.

4.3 Data export function

The system shall have the functionality to export a virtual human body in a format which is available to digital fitting systems, such as Wavefront .obj format. Namely, the virtual human body is a closed polyhedron consisting of triangular elements without self-intersections, and the two sides of each triangle are consistent for the entire body. The order is fixed for the three vertices of each triangle, and the side appearing to be counterclockwise in direction is defined as an exterior side.

4.4 Landmark extraction and export function

The system shall have the functionality to extract the virtual body landmarks when they are not imported. It is desirable that the system has functionality to export landmarks listed in Table 1 on the virtual human body.

4.5 Function to take body dimensions data

The system shall have the functionality to measure body dimensions listed in Table 2 of the virtual human body according to ISO 18825-2 or ISO 8559-1. For a virtual fit mannequin model, the system shall have the function to measure body dimensions corresponding to those of a human body if the virtual fit mannequin model has the landmarks to define the dimensions.

4.6 Cross section creation function

The system shall have the function to create the virtual cross sections listed in Table 3 of the virtual human body according to ISO 18825-2. The system also shall have the function to create cross sections of the imported human body data. For a virtual fit mannequin model, the system shall have the function to create cross sections of the virtual fit mannequin model corresponding to virtual cross sections of a virtual clone.

The system shall have the function to create the virtual bounding rectangles of the cross sections. The virtual bounding rectangle is the minimum rectangle containing the cross section, and whose edges are in the lateral or anteroposterior direction

4.7 Visualization function

It is desirable that the system has the function to visualize the virtual human body in 3D form. Additionally, the system should be able to show the specified body dimensions and cross section positions over the model.

4.8 Symmetrisation function

It is desirable that the system has function to create symmetrical virtual human body even if the imported 3D body scan data is asymmetrical.

5 Selection of subjects

Subjects shall reflect approximately the same range of body sizes and shape variations expected in the population for which the virtual human body system is intended. The subjects shall also include a variety of body types — not just people of average height and weight. If children are included in the intended population, it is particularly important that the subjects cover the age range of the intended population.

At least three persons shall be selected for men and for women, including three levels representing the distribution (near the 5th percentile, near the average, and near the 95th percentile levels) in height, and bust or chest girth. Nine persons are desirable to be selected including combinations of the 3 levels in each of height, and bust or chest girth. In case of virtual fit mannequins, the subjects of at least three sizes also shall be selected according to the distribution in height, and bust or chest girth of the intended population of the persons.

6 Evaluation protocol for the virtual human body based on body dimensions

6.1 General

The accuracy of the virtual human body in representing the body dimensions of a specific human body is quantified with the following method (Figure 6). Particularly a virtual clone and a virtual fit mannequin model are evaluated with the method. In addition, when the accuracy of a virtual fit mannequin to a physical fit mannequin is evaluated, the method is also applicable substituting a human body with a physical fit mannequin. On the other hand, a virtual parametric body model and a virtual fit mannequin model are evaluated with the method described in clause 6.2 and 6.3.

