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Clothing — Digital fittings —

Part 2: Vocabulary and terminology used for attributes of the virtual human body

Habillement — Bien-aller virtuel —

Partie 2: Vocabulaire et terminologie utilisés pour les caractéristiques du corps humain virtuel

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/TC 133, *Clothing sizing systems – size designation, size measurement methods and digital fittings*.

ISO 18825 consists of the following parts, under the general title *Clothing — Digital fittings:*

— *Part 1: Vocabulary and terminology used for the virtual human body*

— *Part 2: Vocabulary and terminology used for attributes of the virtual human body*

Introduction

The virtual human body in the virtual garment system is intended to reproduce the actual shape and size of the human body with known reliability. It is also intended to have attributes applicable to making and wearing clothes. Among these attributes it is essential that the definitions of virtual body landmarks and virtual body dimensions are consistent with those defined for actual humans.

The virtual human body is not defined based on human anatomy. However, since the virtual human body needs to have body dimensions very close to those of the actual human body, virtual body landmarks are closely associated with anatomical landmarks defined on the human body

Definitions and the procedure of body measurement were prescribed in ISO 8559. In addition to this, virtual body dimensions of the virtual human body need to be defined in the three-dimensional virtual space because the surface of the virtual human body cannot be touched in reality. And virtual body landmarks of the virtual human body are detected from x, y, z axes using a visual detective method on the screen. Therefore, virtual body dimensions and virtual body landmarks of the virtual human body need to be modified and defined for use in three-dimensional virtual space while maintaining similarity to existing anthropometric body dimensions.

When a virtual human body of the same size is made with each different virtual garment system, the results of the virtual human body size and shape, etc. are different., not only because the current virtual garment systems have different size changing algorithms, but also because they use different definitions of body dimensions of the virtual human body. This confuses users on the terms related to the body dimensions of the virtual human body, and online sales using unstandardized virtual garment systems could lead to more errors in clothing size. This can be solved by standardizing terms and definitions of body dimensions of the virtual human body and suggesting essential body dimensions of the virtual human body.

This part of ISO 18825 is the second in a series of standards that deal with the virtual human body. The purpose of this series of International Standards is to improve online communication and reliability of fashion products sold online and in-store through visual confirmation of size, shape, fit, and design by standardizing the terms related to the virtual garment system.

Following ISO 18825-1 which deals with composition and attributes of the virtual human body, this part of ISO 18825 defines terms necessary to describe virtual human body, and thus supports online and in-store consumers, fashion designers, product developers, technologists, manufacturers and retailers who have an interest in the style and fit of clothes. Developers of the virtual garment system should use the same terms described in this part of ISO 18825.

Clothing — Digital fittings —

Part 2: Vocabulary and terminology used for attributes of the virtual human body

1 Scope

This part of ISO 18825 defines the terms used to describe the virtual human body which is used in virtual garment systems. Specifically, virtual body landmarks and virtual body dimensions are described.

This part of ISO 18825 mainly deals with vocabulary and terminology of essential virtual body dimensions of the virtual torso, arm, leg, head, face, hands and bones and joints of virtual human body.

Since there are many body landmarks on the head and hand, landmarks on these parts are defined separately from those on other parts of the body.

This part of ISO 18825 is intended for developers of virtual garment systems. Although this part of ISO 18825 does not aim at users of virtual human body in online communication, the improved reliability of virtual human body will benefit them.

2 Terms and definitions relating to the virtual torso, arms and legs

2.1 Virtual body landmark

Note See Figure 2.

2.1.1
virtual top head point
highest point of the head on the midsagittal plane with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.2
virtual neck point
middle point of the front neck between the virtual top neck point and *virtual front neck-base point* (2.1.3) on the midsagittal plane with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.3
virtual front neck-base point
most concave point under the front neck on the midsagittal plane with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.4
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

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.5
virtual back neck-base point
most posterior point at the back neck-base on the midsagittal plane with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.6
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 in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.7
virtual axillia 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

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.8
virtual front axillia point
most anterior point of upper arm at the same level as the *virtual axillia point* (2.1.7) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.9
virtual back axillia point
most postrerior point of upper arm at the same level as the *virtual axillia point* (2.1.7) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.10
virtual bust point
most anterior point of the bust with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.11
virtual underbust point
lowest point under the bust projection with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.12
virtual side waist point
most concave point of the (right) side waist when viewed from the front with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.13
virtual back waist point
point of the back waist on the midsagittal plane at the level of the *virtual side waist point* (2.1.12) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.14
virtual abdomen point
most anterior point of the abdomen on the midsagittal plane with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.15
virtual hip point
most posterior point of the hip with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.16
virtual crotch point
lowest point of the torso on the midsagittal plane with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.17
virtual elbow point
most protruding point of the elbow

2.1.18
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

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.19
virtual middle finger tip point
distal point of the middle finger with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.20
virtual gluteal fold point
most concave point on the sagittal plane passing through the *virtual hip point* (2.1.15) between hip and thigh with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.21
virtual mid-thigh point
point of the (right) side thigh when viewed from the side at the middle level between the *virtual hip point* (2.1.15) and *virtual knee point* (2.1.22) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.22
virtual knee point
centre point of the anterior part of the knee with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.23
virtual calf point
most posterior point of the calf with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.24
virtual lower leg point
most concave point of under the front lower leg above the virtual side ankle point with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.25
virtual outside ankle point
most lateral point of the lateral malleolus with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

2.1.26
virtual landing heel point
lowest point of the posterior calcaneus with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.4.

Note 2 to entry: The virtual landing heel point can reach the floor or the top of the shoe heel.

2.2 Virtual body dimension

Note See Figure 3.

2.2.1
virtual height
vertical distance between the *virtual landing heel point* (2.1.26) and *virtual top head point* (2.1.1) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.2
virtual bust height
vertical distance between the *virtual landing heel point* (2.1.26) and *virtual bust point* (2.1.10) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

Note 2 to entry: When the value of the *virtual bust height* (2.2.2) based on the relation between parameters through data analysis of classified virtual human bodies is set in the virtual garment system, value input is not necessary. When the value of the virtual bust height can be acquired through measurement of an actual person, value input is recommended.

2.2.3
virtual waist height
vertical distance between the *virtual landing heel point* (2.1.26) and *virtual side waist point* (2.1.12) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

Note 2 to entry: When the value of the virtual waist height based on the relation between parameters through data analysis of classified virtual human bodies is set in the virtual garment system, value input is not necessary. When the value of the virtual waist height can be acquired through measurement of an actual person, value input is recommended.

2.2.4
virtual hip height
vertical distance between the *virtual landing heel point* (2.1.26) and *virtual hip point* (2.1.15) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

Note 2 to entry: to entry When the value of the virtual hip height based on the relation between parameters through data analysis of classified virtual human bodies is set in the virtual garment system, value input is not necessary. When the value of the virtual hip height can be acquired through measurement of an actual person, value input is recommended.

2.2.5
virtual crotch height; virtual inside leg length
vertical distance between the *virtual landing heel point* (2.1.26) and virtual crotch with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.6
virtual knee height
vertical distance between the *virtual landing heel point* (2.1.26) and virtual knee point with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

Note 2 to entry: to entry When the value of the virtual knee height based on the relation between parameters through data analysis of classified virtual human bodies is set in the virtual garment system, value input is not necessary. When the value of the virtual knee height can be acquired through measurement of an actual person, value input is recommended.

2.2.7
virtual calf height
vertical distance between the *virtual landing heel point* (2.1.26) and *virtual calf point* (2.1.23) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

Note 2 to entry: When the value of the virtual calf height based on the relation between parameters through data analysis of classified virtual human bodies is set in the virtual garment system, value input is not necessary. When the value of the virtual calf height can be acquired through measurement of an actual person, value input is recommended.

2.2.8
virtual shoulder width
horizontal distance between right and left *virtual shoulder points* (2.1.6)

Note 1 to entry: In case of using 'virtual shoulder width' which refers 'the surface length', it is marked that there has been a change in meaning.

2.2.9
virtual back waist length
surface distance between the *virtual back neck-base point* (2.1.5) and *virtual back waist point* (2.1.13) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.10
virtual arm length
sum of the distance of the straight line between *virtual shoulder point* (2.1.6) and *virtual elbow point* (2.1.17), and the distance of the straight line between virtual elbow point and *virtual wrist point* (2.1.18) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

Note 2 to entry: to entry In case 'virtual arm length' is used to mean 'surface length', it is marked that there has been a change in meaning.

2.2.11
virtual neck girth
perpendicular girth to the neck axis passing through the *virtual neck point* (2.1.2) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.12
virtual neck-base girth
girth of the contour line passing through the *virtual front neck-base point* (2.1.3), *virtual side neck-base point* (2.1.4) and *virtual back neck-base point* (2.1.5) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.13
virtual armscye girth
girth of the contour cross section between the torso and arm passing through the *virtual shoulder points* (2.1.6) and *virtual axillia points* (2.1.7) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.14
virtual upper arm girth
maximum girth of the upper arm perpendicular to the main axis of the upper arm and passing through the *virtual axillia points* (2.1.7) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.15
virtual elbow girth
girth of the arm perpendicular to the main axis of the upper arm and passing through the *virtual elbow point* (2.1.17) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.16
virtual wrist girth
girth of the forearm perpendicular to the main axis of the forearm and passing through the *virtual wrist point* (2.1.18) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.17
virtual chest girth
horizontal girth of the torso passing through the *virtual axillia points* (2.1.7) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.18
virtual bust girth
horizontal girth of the torso passing through the *virtual bust point* (2.1.10) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.19
virtual underbust girth
horizontal girth of the torso passing through the *virtual underbust point* (2.1.11) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.20
virtual waist girth
horizontal girth of the torso passing through the *virtual side waist point* (2.1.12) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.21
virtual abdomen girth
horizontal girth of the torso passing through the *virtual abdomen point* (2.1.14) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.22
virtual hip girth
horizontal girth of the torso passing through the *virtual hip point* (2.1.15) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.23
virtual thigh girth
horizontal girth of the leg at the level of *virtual crotch point* (2.1.16) gluteal fold point with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.24
virtual mid-thigh girth
horizontal girth of the leg at the level of *virtual mid-thigh point* (2.1.21) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.25
virtual knee girth
horizontal girth of the leg passing through the *virtual knee point* (2.1.22) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.26
virtual calf girth
horizontal girth of the leg passing through the *virtual calf point* (2.1.23) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.27
virtual lower leg girth
smallest horizontal girth of the leg passing through the *virtual lower leg point* (2.1.24) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.2.28
virtual ankle girth
horizontal girth of the leg passing through the *virtual outside ankle point* (2.1.25) with the virtual human body in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.3.

2.3 Virtual skeletal structure — Virtual bone

2.3.1
virtual neck bone
hypothetical bone connecting the middle point between the two virtual tragion points (see 4.1.2) and the centre point of the cross section of the *virtual neck-base girth* (2.2.12) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.2
virtual upper arm bone
hypothetical bone connecting the centre point of of the cross section of the *virtual armscye girth* (2.2.13) and the centre point of the cross section of the *virtual elbow girth* (2.2.15) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.3
virtual forearm bone
hypothetical bone connecting the centre point of the cross section of the *virtual elbow girth* (2.2.15) and the centre point of the cross section of the *virtual wrist girth* (2.2.16) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.4
virtual thigh bone
hypothetical bone connecting the centre point of the cross section of the *virtual knee girth* (2.2.25) and the *virtual hip girth* (2.2.22) with a perpendicular line in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.5
virtual leg bone
hypothetical bone connecting the centre point of the cross section of the *virtual knee girth* (2.2.25) and the centre point of the cross section of the *virtual minimum leg girth* (2.2.27) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.6
virtual neck joint
uppermost point of the *virtual neck bone* (2.3.1) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.7
virtual neck-base joint
lowest point of the *virtual neck bone* (2.3.1) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.8
virtual shoulder joint
uppermost point of the *virtual upper arm bone* (2.3.2) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.9
virtual elbow joint
point where the virtual arm bone and *virtual forearm bone* (2.3.3) meet in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.10
virtual wrist joint
lowest point where the *virtual forearm bone* (2.3.3) and virtual hand meet in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.11
virtual waist joint
centre point of the cross section of the *virtual waist girth* (see 2.2.20) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.12
virtual hip joint
uppermost point of the *virtual thigh bone* (2.3.4) in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.13
virtual knee joint
point where the *virtual thigh bone* (2.3.4) and virtual lower leg bone meet in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

2.3.14
virtual ankle joint
lowest point where the virtual lower leg bone and virtual foot meet in the virtual standing position

Note 1 to entry: See ISO 18825-1:2016, 2.2.5.

3 Expression of the virtual torso, arms and legs

3.1 Composition of the virtual torso, arms and legs

3.1.1 Virtual body region

The criteria dividing the human body in the apparel area is different from those in the anatomy area. In the apparel industry, visual appearance as the result of garment fitting is important, and basic construction lines of garment are used to divide the human body. This part of ISO 18825 follows the criteria from basic construction lines of a garment to refer to virtual body segments of the virtual human body.

The virtual torso is divided into the virtual neck region, virtual shoulder region, virtual chest (bust) region, virtual waist region, virtual abdomen region and virtual crotch region. Virtual arms consist of 2 virtual upper arm regions and 2 virtual forearm regions, and virtual legs also consist of 2 virtual thigh regions and 2 virtual calf regions (see Table 1 and Figure 1).

NOTE Virtual body landmarks and virtual body dimensions follow existing definitions.

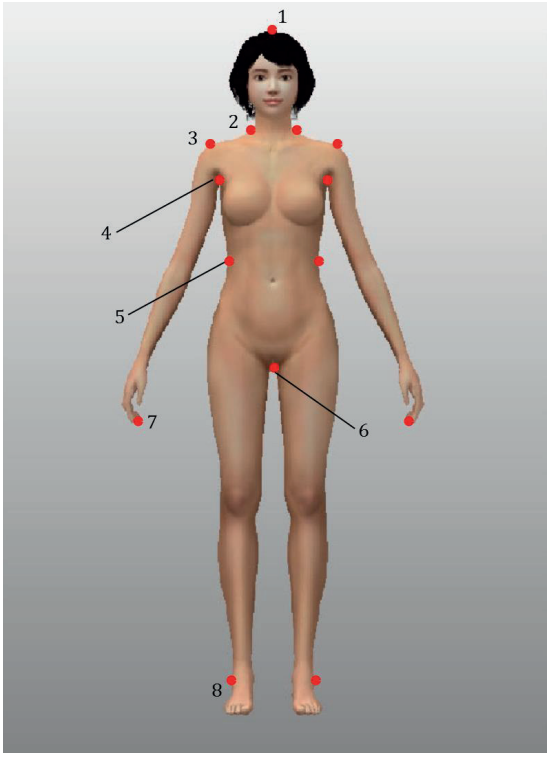
Table 1 — Virtual body regions of the virtual torso, arms and legs

Class	Virtual body region	Definitions
Virtual torso	Virtual neck region	From the girth line passing the virtual top neck point (see 4.1.2) and virtual back head-base point (see 4.1.2) and to the virtual neck-base girth (see 2.2.12) line.
	Virtual shoulder region	Upper and lower boundaries: From the virtual neck-base girth (see 2.2.12) line to the virtual chest girth (see 2.2.17) line. Right and left boundaries: The inner side of each virtual armscye girth (see 2.2.13) line.
	Virtual chest region (male)	From the virtual chest girth (see 2.2.17) line to the virtual waist girth (see 2.2.20) line.
	Virtual bust region (female)	
	Virtual waist region	From the virtual waist girth (see 2.2.20) line to the virtual abdomen girth (see 2.2.21) line.
	Virtual abdomen region	From the virtual abdomen girth (see 2.2.21) line to the virtual hip girth (see 2.2.22) line.
	Virtual crotch region	From the virtual hip girth (see 2.2.22) line to the virtual thigh girth (see 2.2.23) line.
Virtual arms	Virtual upper arm region	From the virtual armscye girth (see 2.2.13) line to the virtual elbow girth (see 2.2.15) line.
	Virtual forearm region	From the virtual elbow girth (see 2.2.15) line to the virtual wrist girth (see 2.2.16) line.
Virtual legs	Virtual thigh region	From the virtual thigh girth (see 2.2.23) line to the virtual knee girth (see 2.2.25) line.
	Virtual calf region	From the virtual knee girth (see 2.2.25) line to the virtual ankle girth (see 2.2.28) line.

Key

1 virtual neck region
2 virtual shoulder region
3 virtual chest region
4 virtual waist region
5 virtual abdomen region
6 virtual crotch region
7 virtual upper arm region
8 virtual forearm region
9 virtual thigh region
10 virtual calf region

Figure 1 — Virtual body regions of the virtual torso, arms and legs



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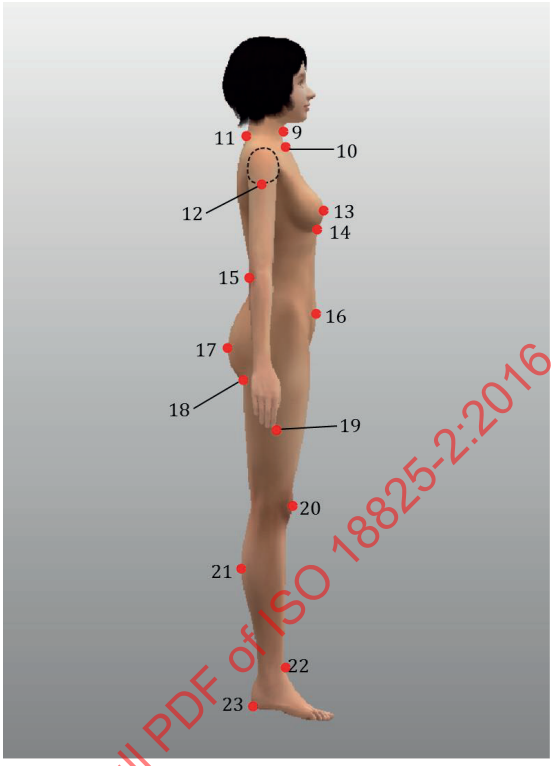

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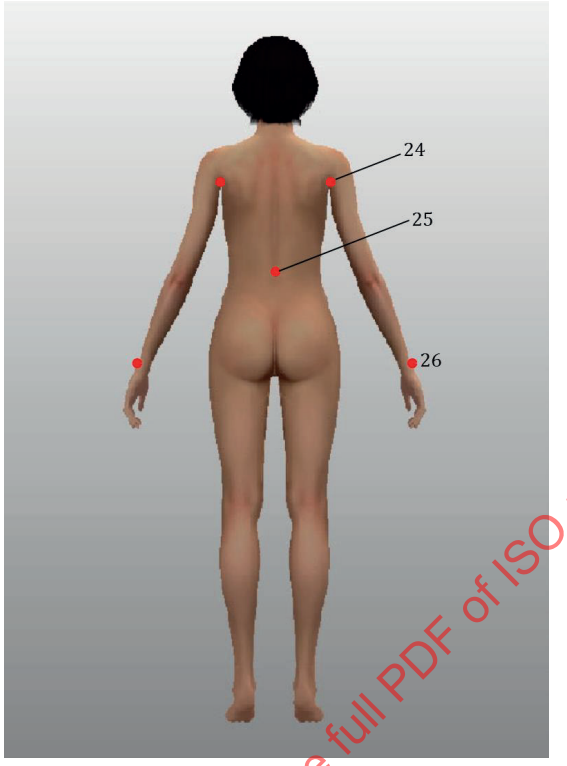
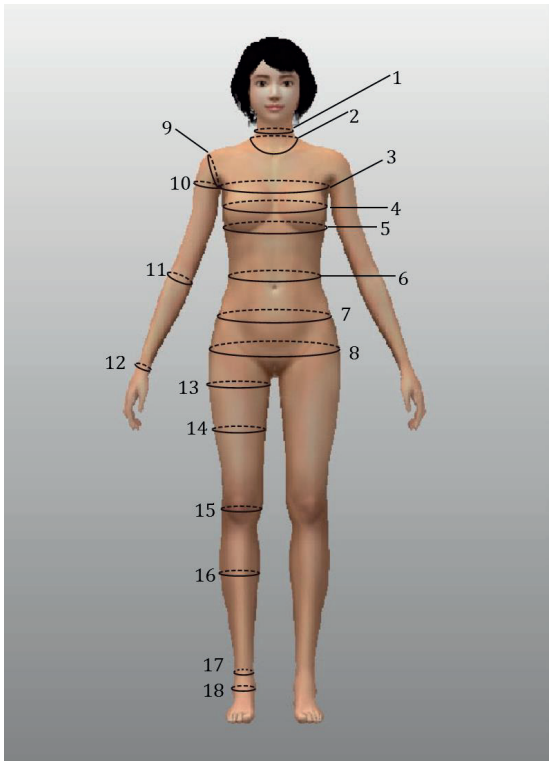


c)

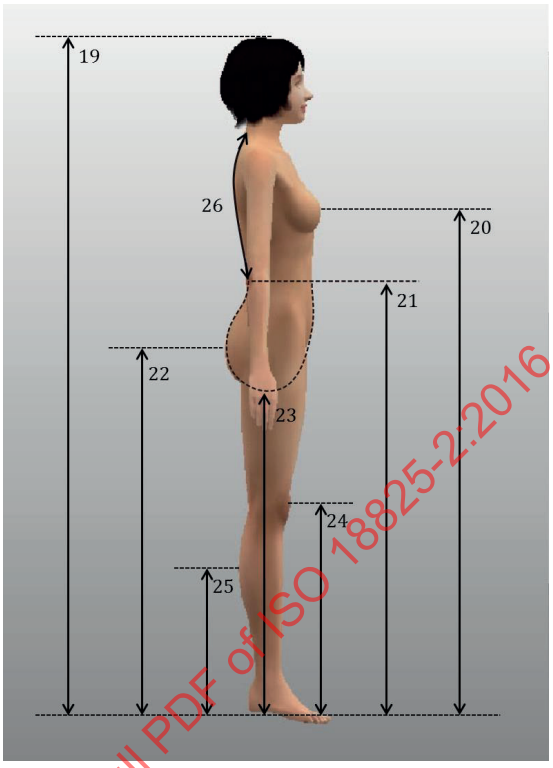
Key

1	virtual top head point	14	virtual underbust point
2	virtual side neck-base point	15	virtual elbow point
3	virtual shoulder point	16	virtual abdomen point
4	virtual front axillia point	17	virtual hip point
5	virtual side waist point	18	virtual gluteal fold point
6	virtual crotch point	19	virtual mid-thigh point
7	virtual middle finger tip point	20	virtual knee point
8	virtual outside ankle point	21	virtual calf point
9	virtual neck point	22	virtual lower leg point
10	virtual front neck-base point	23	virtual landing heel point
11	virtual back neck-base point	24	virtual back axillia point
12	virtual axillia point	25	virtual back waist point
13	virtual bust point	26	virtual wrist point

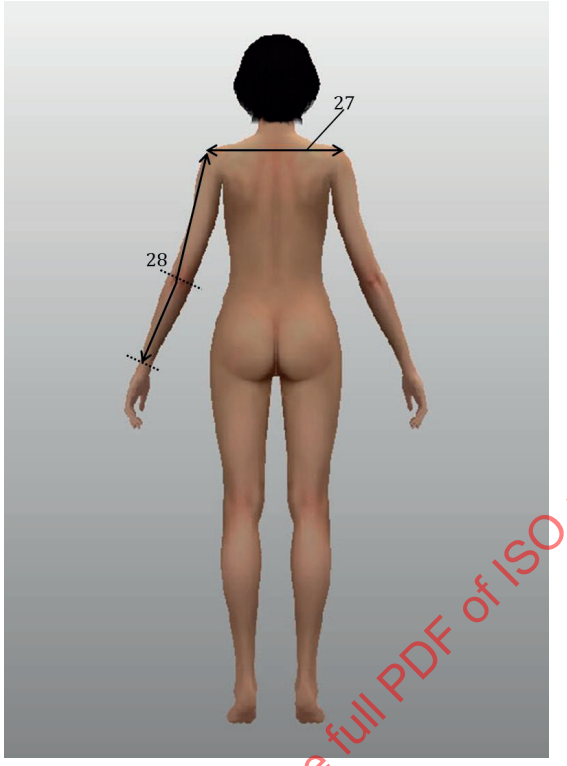
Figure 2 — Virtual body landmarks of the virtual torso, arms and legs



a)



b)



c)

Key

1	virtual neck girth	15	virtual knee girth
2	virtual neck-base girth	16	virtual calf girth
3	virtual chest girth	17	virtual lower leg girth
4	virtual bust girth	18	virtual ankle girth
5	virtual underbust girth	19	virtual height
6	virtual waist girth	20	virtual bust height
7	virtual abdomen girth	21	virtual waist height
8	virtual hip girth	22	virtual hip height
9	virtual armscye girth	23	virtual crotch height; virtual inside leg length
10	virtual upper arm girth	24	virtual knee height
11	virtual elbow girth	25	virtual calf height
12	virtual wrist girth	26	virtual back waist length
13	virtual thigh girth	27	virtual shoulder width
14	virtual mid-thigh girth	28	virtual arm length

Figure 3 — Virtual body dimensions of the virtual torso, arms and legs

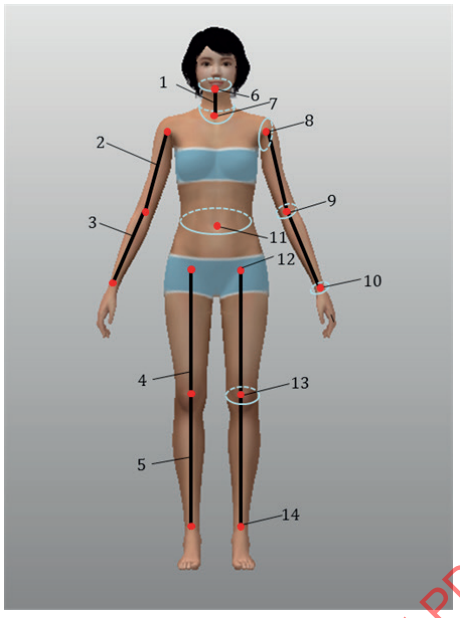
3.1.2 Virtual skeletal structure

Virtual joints of the virtual human body for clothing simulation are not the same as articulations of the actual human body. Virtual bones and virtual joints in the virtual human body are simplified (see Figure 4 and Table 3).

There is a difference between the actual human body and the virtual human body such as the number and position of joints. For example, the actual human body has three shoulder joints, but there is only

one virtual shoulder joint. The virtual joint is a hypothetical spherical joint. The virtual bone is a hypothetical bone shaped like a one-dimensional bar.

NOTE Virtual bones and virtual joints follow existing definitions (see ISO/IEC 19774).



Key

1	virtual neck bone	8	virtual shoulder joint
2	virtual upper arm bone	9	virtual elbow joint
3	virtual forearm bone	10	virtual wrist joint
4	virtual thigh bone	11	virtual waist joint
5	virtual lower leg bone	12	virtual hip joint
6	virtual neck joint	13	virtual knee joint
7	virtual neck-base joint	14	virtual ankle joint

Figure 4 — Virtual bones and virtual joints of virtual torso, arms and legs

3.1.3 Virtual joint

The number of axes of rotation of virtual joints is as follows (see Table 2). The DOF of each virtual joint that has a different the number of axes of rotation. There is no limit of the ROM for virtual joints

NOTE 1 The DOF refers to the degree of freedom.

NOTE 2 The ROM refers to the range of motion.

Table 2 — The number of axes of rotation of the virtual joints

Virtual joint	Number of axes of rotation
Virtual neck joint	3
Virtual neck-base joint	2
Virtual shoulder joint	3
Virtual elbow joint	2
Virtual wrist joint	3
Virtual waist joint	3

Table 2 *(continued)*

Virtual joint	Number of axes of rotation
Virtual hip joint	3
Virtual knee joint	1
Virtual ankle joint	2

Table 3 — Spot where virtual bones and virtual joints meet

Virtual joint	Virtual bone				
	Virtual neck bone	Virtual upper arm bone	Virtual forearm bone	Virtual thigh bone	Virtual lower leg bone
Virtual neck joint	X				
Virtual neck-base joint	X				
Virtual shoulder joint		X			
Virtual elbow joint			X		
Virtual wrist joint[b]			X		
Virtual waist joint					
Virtual hip joint				X	
Virtual knee joint				X	X
Virtual ankle joint[b]					X

[a] Shaded: Points where virtual bones and virtual joints meet.

[b] The virtual wrist joint and virtual ankle joint also meet with the virtual hand and virtual foot, respectively.

3.2 Alteration of the virtual torso, arms and legs

3.2.1 Virtual body size alteration

Users want to take their real size or similar virtual human body to evaluate garment fit on online. Therefore, it is essential for the user to alter the size fit for them easily and correctly. The virtual body size alteration method of virtual human body is divided into body type selection and body dimension change. For body type selection, users get a virtual human body similar to their own body from a 3D model library of the virtual human body, through manual or automatic measurement input and statistical searching method. And for alteration to the details of virtual body dimensions, users can use parameter input from the operator list. For instance, a user can choose the virtual body regions that need to be changed and adjust virtual body dimensions of the virtual body regions by entering the target size from the operator list. If a measurement is increased, the size grows bigger. Moreover, virtual body dimensions such as virtual height and virtual shoulder width can be changed in real time, and users can get changed size data from the operator's list (see Figure 5).

a) Normal body b) Shorten legs c) Shorten height

d) Expand bust e) Expand waist and abdomen f) Expand overall figure and hips

Figure 5 — Examples of virtual body size alterations

3.2.2 Virtual skin colour alteration

Virtual skin colour is an important element whether it matches the garment colour or not. And changing the virtual skin colour can also express a person's skin tone. Through loading the replaceable body texture map and controlling the colour, opacity and shine, not only the skin colour of the virtual human body, but also details such as wrinkles and hair, can be changed to make the virtual body texture similar to the appearance of the real body (see Figure 6).

NOTE General virtual body texture follows existing definitions (see ISO 18825-1:2016, 2.2.6).

a) Brighter

b) Darker

Figure 6 — Examples of virtual skin colour alteration

3.2.3 Virtual body pose and motion alteration

Because people make pose and motion wearing clothes in everyday life, changing body pose and motion is also necessary for fit evaluation. By loading the existing body pose and motion library or making a new body pose and motion, users can alter virtual body poses and motions. Users can choose the virtual bone to be changed, and then adjust the angle of the virtual joint and virtual bone directly from the operator list. Or, functions such as “move”, “tilt”, “fold”, and “turn” can be used to adjust the angle of a virtual joint or bone(see Figure 7).

NOTE Virtual bones and virtual joints follow existing definitions (see ISO 18825-1:2016, 2.2.5).

Figure 7 — Examples of virtual body poses and motion alterations

4 Expression of the virtual head and face

4.1 Composition of the virtual head and face

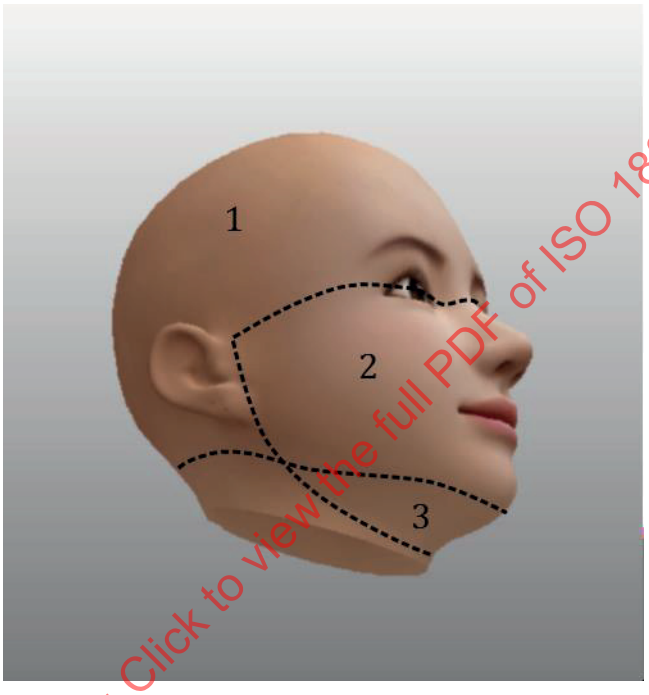
4.1.1 Virtual head and face region

Boundary line between the head and neck of the virtual human body is the curve connecting the concave points of upper neck which meets the lower jaw part and lower back head area.

The head of the virtual human body is divided into the virtual forehead region, virtual face region, virtual lower jaw region, and virtual head region, and there are eyes, nose, mouth, jaw, ears and cheeks on the head of the virtual human body (see Table 4 and Figure 8).

Table 4 — Virtual head and face regions

Class	Virtual body region	Definitions
Virtual head	Virtual head region	From the horizontal line passing virtual sellion point (see 4.1.2), including the ears and back head part, to the girth line passing the virtual back head-base point (see 4.1.2).
	Virtual face region	From the horizontal line passing virtual sellion point (see 4.1.2), inside the line where the ear starts, to the line connecting the lowest points, virtual jaw point (see 4.1.2) of the face.
	Virtual lower jaw region	From the line connecting the lowest points, virtual jaw point (see 4.1.2) of the face, to the girth line passing the virtual top neck point (see 4.1.2).



Key

1 virtual head region
2 virtual face region
3 virtual lower jaw region

Figure 8 — Virtual head and face regions

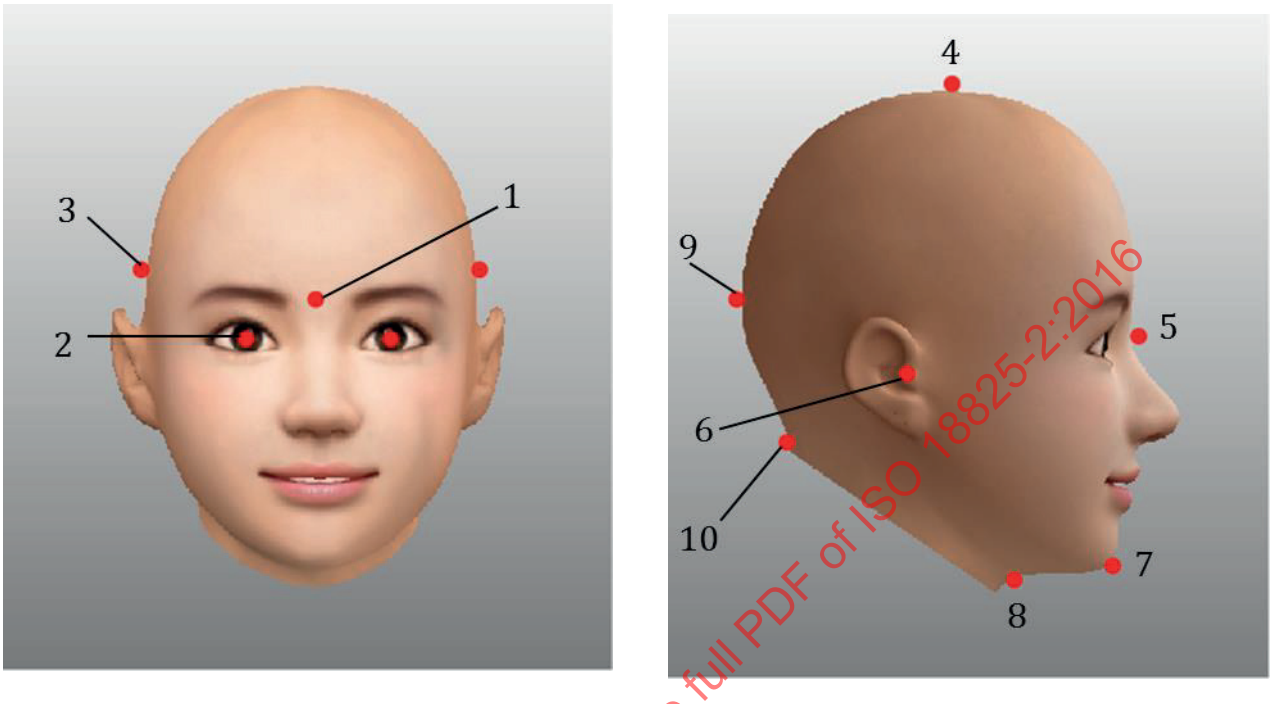
4.1.2 Virtual body landmark

Virtual body dimensions on the head and face of the virtual human body are established based on landmarks. Virtual body landmarks on the head and face of the virtual human body are as follows (see Table 5 and Figure 9).

NOTE Other virtual body landmarks such as the virtual nose tip, virtual lateral mouth point and virtual medial eye point can be added to express appearance of the head and face more elaborately, depending on the user's purpose.

Table 5 — Virtual body landmarks on the virtual head and face

Class	Virtual body landmark	Definition
Virtual head and face	Virtual top head point	The highest point of the head on the midsagittal plane with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual sellion point	The point of greatest indentation of the nasal root depression on the midsagittal plane with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual centre eyebrow point	The centre point between the eyebrows at which the face and forehead meet on the midsagittal plane with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual eyeball point	The centre point of the front eyeball with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual side head point	The most lateral point above the ears with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual tragion point	The point just above the the small flap in front of the ear hole with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual jaw point	The most curved point of the jaw on the midsagittal plane with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual top neck point	The most concave point of the front lower jaw and the highest point of the front neck on the midsagittal plane with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual back head point	The most posterior point of the back head on the midsagittal plane with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).
	Virtual back head-base point	The point of the line at which the back neck and hair of the back head meet and the highest point of the back neck on the midsagittal plane with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.4).



Key

1	virtual centre eyebrow point	6	virtual tragion point
2	virtual eyeball point	7	virtual jaw point
3	virtual side head point	8	virtual top neck point
4	virtual top head point	9	virtual back head point
5	virtual sellion point	10	virtual back head-base point

Figure 9 — Virtual body landmarks on the virtual head and face

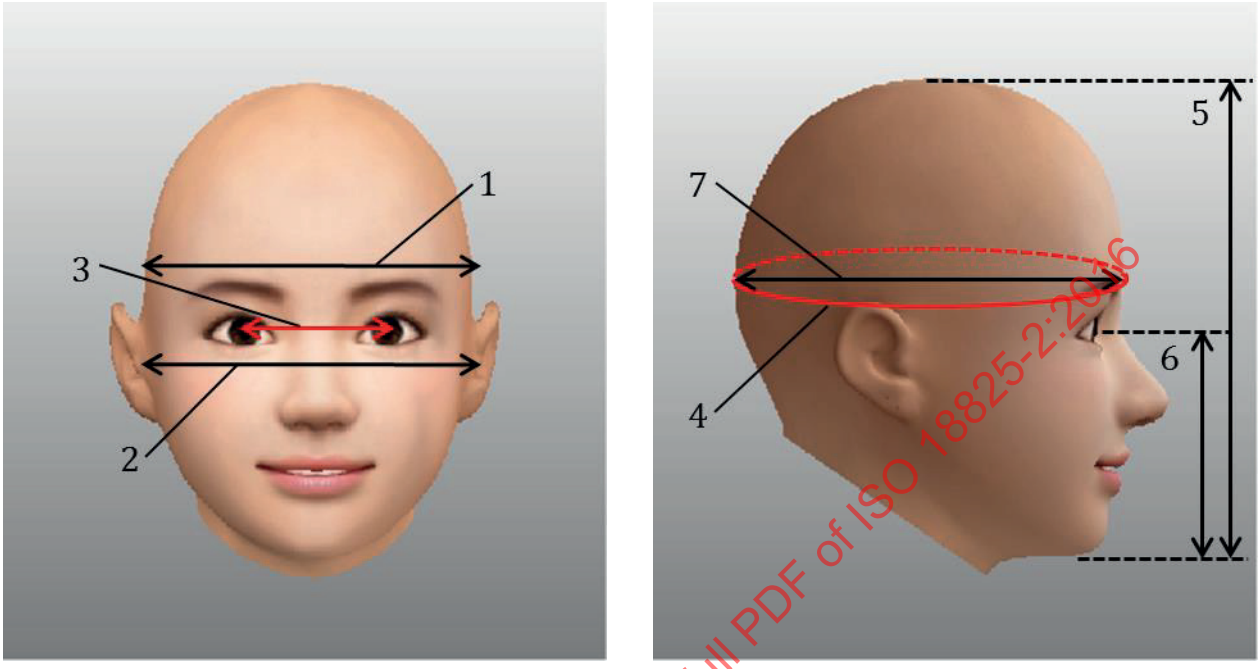
4.1.3 Virtual body dimension

Virtual body dimensions on the head and face of the virtual human body are as follows (see Table 6 and Figure 10).

Other virtual body landmarks such as the virtual nose tip, virtual lateral mouth point and virtual medial eye point can be added to express appearance of the head and face more elaborately, depending on the user's purpose.

Table 6 — Virtual body dimension on the virtual head and face

Class	Virtual body dimensions	Definition
Virtual head and face	Virtual head height	The vertical distance between the virtual jaw point and virtual top head point with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.3).
	Virtual face length	The vertical distance between the virtual sellion point with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.3).
	Virtual head girth	The girth of the contour line passing through the virtual centre eyebrow point and virtual back head point with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.3).
	Virtual head width	The horizontal distance between the virtual side head point extremities with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.3).
	Virtual tragion width	The horizontal distance between the virtual tragion point extremities with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.3).
	Virtual eyeball width	The horizontal distance between virtual eyeball points with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.3).
	Virtual head depth	The straight distance between the virtual centre eyebrow point and virtual back head point with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.3).



Key

1 virtual head width
2 virtual tragion width
3 virtual eyeball width
4 virtual head girth
5 virtual head height
6 virtual face length
7 virtual head depth

Figure 10 — Virtual body dimensions of the virtual head and face

4.1.4 Virtual skeletal structure

4.1.4.1 Virtual bone

Virtual bones of the virtual head connect to the virtual neck joint (see 2.3.6 and 4.1.4.2) which is located between the virtual head and virtual neck (see Table 7 and Figure 11).

Unlike bones of the head and face of the real human body divided into 4 sections consisting of several bones, virtual bones of the virtual head and face of virtual human body consists of 2 bones, or virtual head bone, and virtual jaw bone.

Table 7 — Virtual bones of the virtual head

Class	Virtual bone
Virtual head	Virtual head bone
	Virtual jaw bone

4.1.4.2 Virtual joint

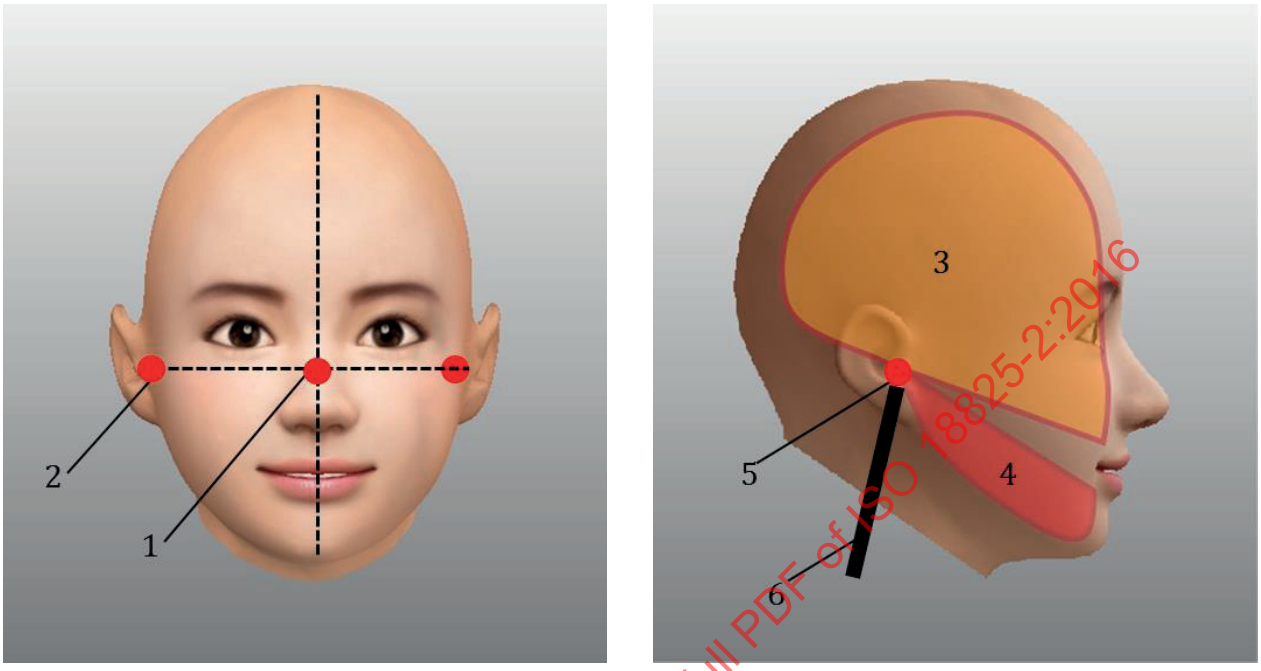
As suggested in ISO/IEC 19774, there is just one kind of joint, 2 virtual jaw joints on the virtual head and face of the virtual human body, which are different from the joints of real human. This is why the virtual jaw joint can move the mouth and make virtual facial expressions (see Table 8 and Figure 11).

The virtual jaw joint has the same definition as the virtual tragion point (see 4.1.2) which refers to the point just above the small flap in front of the ear hole.

NOTE The virtual neck joint is located at the centre between the virtual jaw joint extremities with the virtual human body in the virtual standing position (see ISO 18825-1:2016, 2.2.5).

Table 8 — Virtual joints of the virtual head

Class	Virtual joint
Virtual head	Virtual neck joint
	Virtual jaw joint



Key

1 virtual neck joint
2 virtual jaw joint
3 virtual head bone
4 virtual jaw bone
5 virtual jaw joint
6 virtual neck bone

Figure 11 — Virtual bones and joints of the virtual head

4.1.5 Virtual head pose and motion

Virtual head poses and motions of the virtual human body follow the vocabulary and terminology used for virtual bones, virtual joints, virtual body poses and virtual motions of the virtual human body. This is why it is necessary to use the virtual head joint in virtual head poses and motions of the virtual human body.

The virtual human body can strike head poses such as tilting the head, or averting the head using head joints. Furthermore, head motions can be created by interpolating individual head poses.

4.1.6 Virtual facial expression

Virtual poses and motions related to the face of virtual human body make virtual facial expressions. As suggested in ISO/IEC 19774, virtual facial expression simulation of the virtual human body can be controlled with a muscle group, meaning a mesh structure instead of joints. As an exception the virtual jaw joint is the only virtual joint to make a facial expression. Mouth poses and motions can be created using the virtual jaw joint and mesh structure.

NOTE Rotation of eyes, eyelids and eyebrows are also possible.

4.2 Alteration of the virtual head and face

4.2.1 Virtual size alteration

4.2.1.1 Virtual head size alteration

The virtual head size of the virtual human body can be altered, controlling approximate visual size, or setting specific parameters of length, width, and depth (see Figure 12).

Figure 12 — Examples of head size alterations

4.2.1.2 Virtual face shape alteration

Virtual face fatness of virtual human body can be altered. The first way is to choose a model from the model library in which there are already created models, and the second way is to control the level of shape. The second way means increasing or decreasing the amount of the flesh on the cheek and jaw (see Figure 13).

a) Choosing a body model from the library

b) Controlling level of shape

Figure 13 — Examples of virtual face shape alterations

4.2.2 Virtual body texture alteration

4.2.2.1 Virtual facial skin colour alteration

If the virtual garment system has the function to control virtual facial skin colour of the virtual human body, users can choose the virtual facial skin colour, or level of skin tone they want to change into (see Figure 14).

Figure 14 — Examples of virtual facial colour alterations

4.2.2.2 Virtual hairstyle alteration

If the virtual garment system has the function to change the virtual hairstyle of the virtual human body, users can choose a virtual hairstyle from the hairstyle options library (see Figure 15). In addition, the virtual hairstyle of the virtual human body can be altered, choosing a virtual hairstyle from the head model library in which there are head models with different virtual hairstyles (see Figure 16).

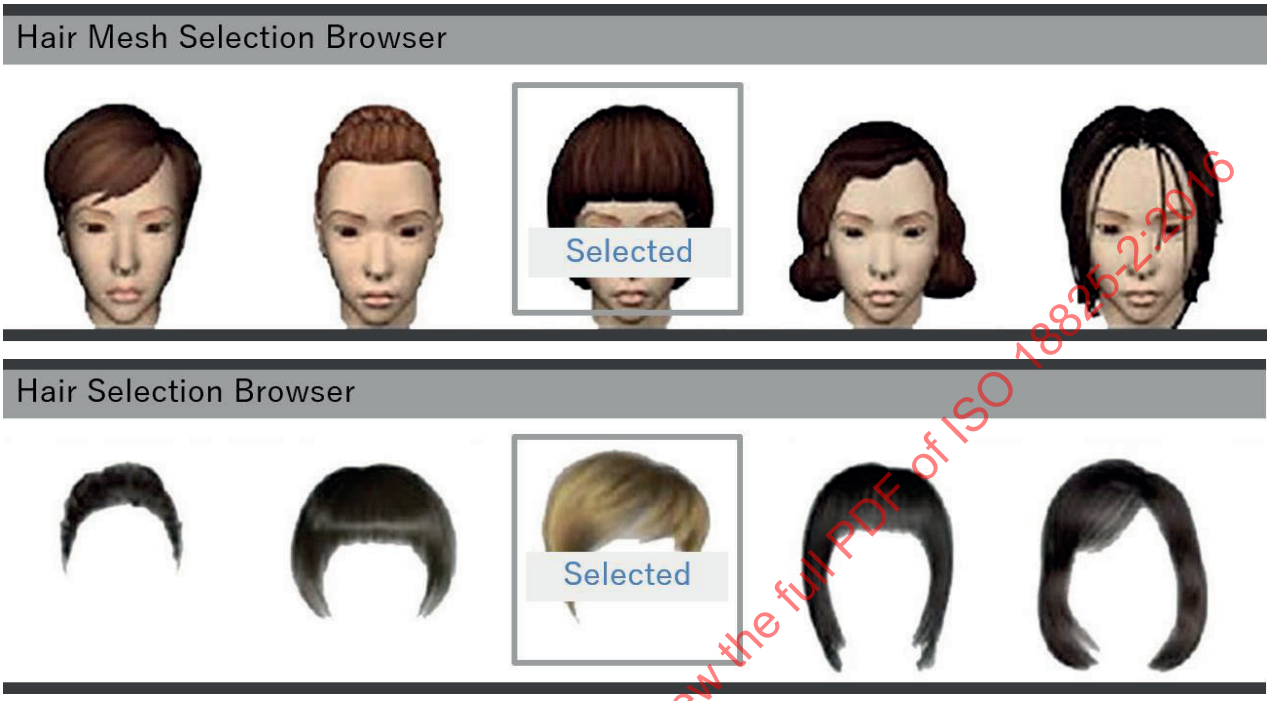


Figure 15 — Example of a hairstyles option library

a) Choosing virtual hairstyles from a hairstyles option library

b) Choosing virtual hairstyles from a head model library

Figure 16 — Examples of virtual hairstyle alterations

4.2.3 Virtual head pose and motion alteration

A virtual garment system may have a function that allows the user to change the position of the virtual head of the virtual human body. Specifically, the angle of the virtual neck joint (see 4.1.4.2) can be altered to hold the head up or look down. Also, the location of the neck joint can be altered to extend or reduce the length of the neck, and the virtual neck joint can move forward and back to change the horizontal location of the virtual head. Furthermore, the individual virtual head poses created with different angles and locations can be connected to create virtual head motions (see Figure 17).

a) Virtual head angle alterations

b) Virtual horizontal head position alterations

c) Virtual vertical head position alterations

Figure 17 — Examples of virtual head pose and motion alterations

4.2.4 Virtual facial expression alteration

The virtual facial expression of a virtual human body can be altered by changing virtual flesh structure, or mesh structure. If the virtual garment system has the function to change the facial expression of the virtual human body, the user can choose a virtual facial expression from the facial expressions option library. Virtual face motions can be created by connecting each virtual facial expression (see Figures 18 and 19).

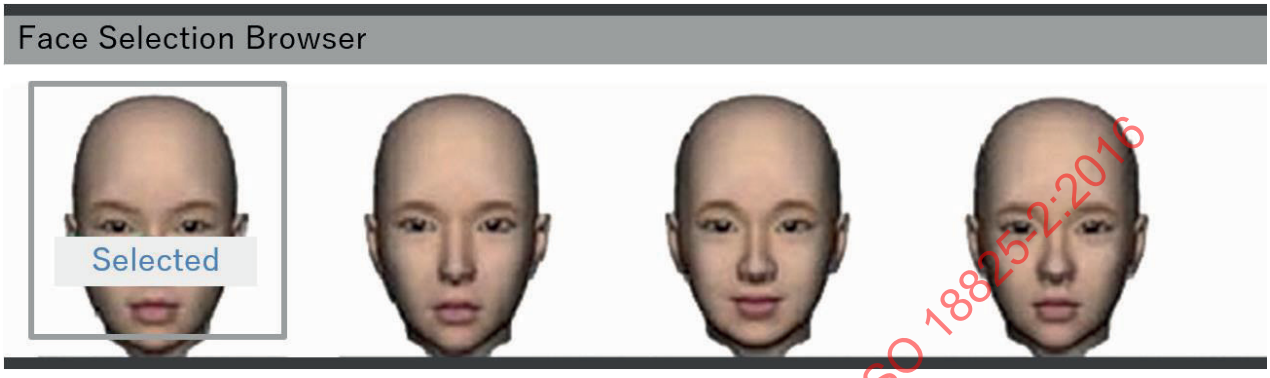


Figure 18 — Example of a facial expressions option library

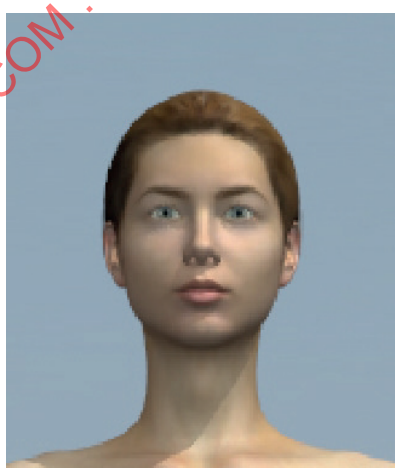
Figure 19 — Examples of virtual facial expression alterations

4.2.5 Overall virtual head and face alteration

The overall virtual head and face alterations of the virtual human body refers to the expression of composition elements such as the shape, size, wrinkles, skin colour, hairstyle and hair colour, which are changed synthetically(see Figure 20).

The virtual head and face can be altered by choosing a head model or whole body model from the library which has models already created to express individual characteristics.

a) Choosing head models from the library



b) Choosing a whole body model from the library

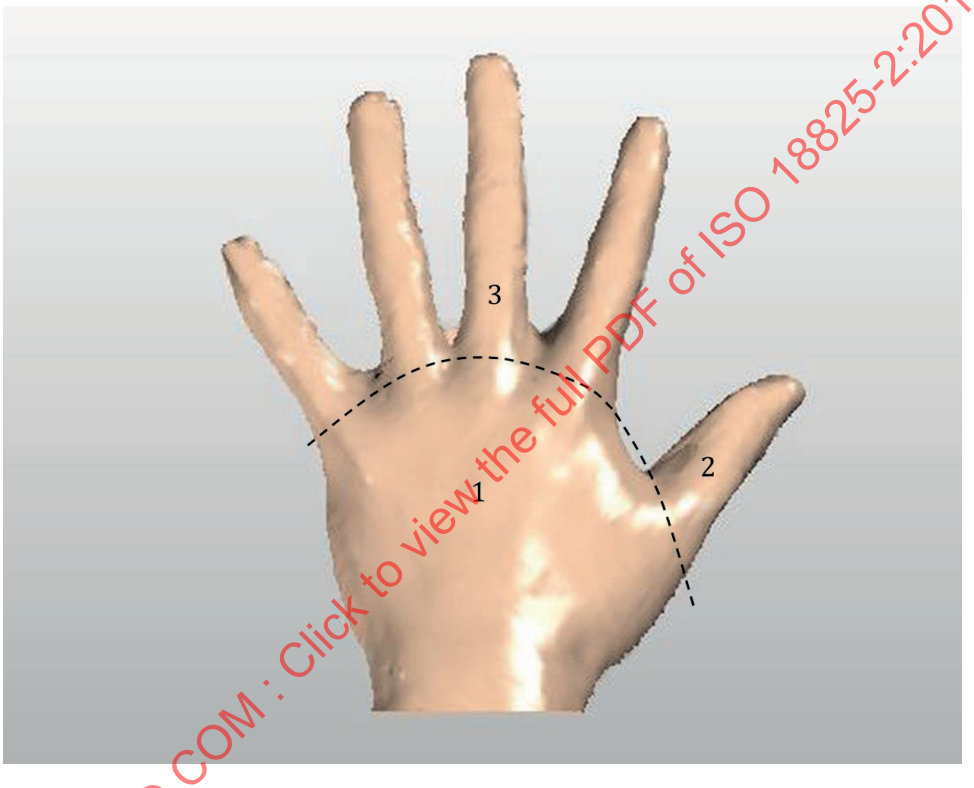
Figure 20 — Examples of overall virtual head and face alterations

5 Expression of the virtual hand

5.1 Composition of the virtual hand

5.1.1 Virtual hand region

The boundary of the hand for the virtual human body is from wrist to end of finger. The virtual hand is divided into three regions, virtual body of hand, virtual fingers and virtual thumb by the curve connecting virtual thumb root point, virtual index finger-thumb crease point, virtual hand inside point, virtual index finger root point, virtual middle finger root point, virtual ring finger root point, virtual pinky root point and virtual hand outside point (see 5.1.2. and Figure 21).



Key

1 virtual body of hand
2 virtual thumb
3 virtual fingers

Figure 21 — Virtual hand regions of the virtual hand

5.1.2 Virtual body landmark

Virtual dimensions on the hand of the virtual human body are established by landmarks. Virtual body landmarks on the hand of the virtual human body are as follows (see Table 9 and Figure 22).

Table 9 — Virtual body landmarks on the virtual hand

Class	Landmark	Definition
	Virtual wrist centre point	The intersection point where extension line from the root of the middle finger and virtual wrist girth (see 2.2.16) meet.
	Virtual hand inside point	The innermost point of the root joint of the index finger.
	Virtual hand outside point	The most protruding point of the root joint of the little finger.