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Introduction

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/IEC DIS 16466

Information Technology — 3D Printing and scanning — Assessment methods of 3D scanned data for 3D printing model

ICS: 35.020

ISO/IEC JTC 1

Secretariat: **ANSI**

Voting begins on:
2024-06-10

Voting terminates on:
2024-09-02

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Foreword

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The committee responsible for this document is ISO/IEC JTC 1.

Introduction

This standard was developed in response to the needs of quality management of 3D printing and scanning technology by taking full advantage of information and communication technology (ICT).

3D scanning is the process of scanning a real-world object or environment to collect data on its shape and possibly its style attributes. The main purpose of 3D scanning is for generating high-precision digital 3D models.

A 3D scanner can be based on many different technologies, each with its own purposes and targets, limitations, and advantages. There could be many limitations in each type of target object that will be digitized. For example, optical technology may encounter many difficulties with dark, shiny, reflective, or transparent objects. Another example, as using computed tomography scanning, structured-light 3D scanners, and LiDAR technology, there is a need to use non-destructive internal scanning technology for generating digital 3D models.

Despite the rapid growth of 3D scanning applications, the accuracy, precision, and reproducibility of generated 3D models from 3D scanned data have not been thoroughly investigated. Especially if 3D scanned data are used for 3D printing its accuracy and precision are critical. Inaccuracies are due to errors that occur during the imaging, segmentation, postprocessing, and 3D printing steps. The total accuracy, precision, and reproducibility of 3D printed models are affected by the sum of errors introduced in each step involved in the creation of the 3D models.

For the spreading of 3D printing applications, it is necessary to review and evaluate the various factors in each step of the 3D model printing process that contribute to 3D model inaccuracy, including the intrinsic limitations of each printing technology.

- In this context evaluation of the overall process of data processing will be critical.
- For minimization of cumulative errors of 3D printing life cycles using 3D scanned data the initial error should be assessed and corrected.
- The assessment methods of 3D scanned data for 3D printing are essential.

There are many algorithms for 3D scanned data such as semi-automatic segmentation, deformable model-based segmentation, and Convolutional Neural Network based segmentation. There are several well-known errors during image-based modelling of Region of Interest (ROI), which are over segmentation, under segmentation, outlier, inaccurate contour, and malalignment. Even though there are more than twenty metrics for evaluating 3D image segmentation there is no consistent definition of metrics and suitable combination of assessment metrics for 3D printing.

Segmentation assessment is the task of comparing two segmentations by measuring the distance or similarity between them, where one is the segmentation to be assessed and the other is the corresponding ground truth segmentation.

There are three major requirements (accuracy, precision, and efficiency) of assessment for 3D scanned data. The accuracy is the degree to which the segmentation results agree with the ground truth segmentation. The precision is a measure of repeatability, and the efficiency which is mostly related with time.

Here we are going to propose the assessment methods of 3D scanned data on how to assess quality-enhancing and error minimizing of 3D printing model.

Information Technology — 3D Printing and scanning — Assessment methods of 3D scanned data for 3D printing model

1 Scope

This document specifies the assessment methods for 3D scanned data for 3D printing model for the accuracy and precision in the total 3D printing life cycle.

This document focusses mainly on 3D scanned data from computed tomography. Computed tomography can acquire the information of internal structures, regional density, orientation and/or alignment of scanning objects as well as shape and appearance.

This document is not intended to assess the 3D printed product itself.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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/IEC 2382:2015, *Information technology — Vocabulary*

ISO 12052:2017, *Health informatics — Digital imaging and communication in medicine (DICOM) including workflow and data management*

3 Terms, definitions and abbreviated terms

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

assessment

act of judging or deciding the amount, value, quality, or importance of something, or the judgment or decision that is made

3.1.2

contour

shape of an anatomical structure or part of body, especially its surface or the shape formed by its outer edge

3.1.3

enhancement

process of improving the quality, amount, or strength of something

3.1.4

Euclidean distance

length of a line segment between the two points in Euclidean space

3.1.5

normalization

changing of the values of numeric columns in the dataset to use a common scale, without distorting differences in the ranges of values.

3.1.6

reference image

image that is assumed to have perfect quality

3.1.7

reference volume

3D stack of reference images

3.1.8

region of interest

ROI

boundary of a specific object defined in the image

[SOURCE: ISO/IEC 3532-2]

3.1.9

segmentation

process of separating the objects of interest from their surroundings

Note 1 to entry: segmentation can be applicable to 2D, 3D, raster or vector data.

Note 2 to entry: segmentation method: terms and definition standardized by ISO [ISO 13322-1:2014(en)].

3.1.10

segmented image

separated image extracted from original image with ROI

3.1.11

segmented volume

3D stack of segmented images

3.1.12

ground truth

ground truth label

correct answer of the training set for segmentation based on supervised learning

[SOURCE: ISO/IEC 3532-2]

3.2 Abbreviated terms

ARI	Adjusted Rand Index
AUC	Area Under ROC Curve
AVD	Average Hausdorff Distance
CT	Computed Tomography
DICOM	Digital Imaging and Communications in Medicine
DSC	Dice Similarity Coefficient
FMS	F-Measure
FN	False Negative