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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 9234

Information technology — Information modelling for VR/AR/ MR based learning, education and training systems

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2024-10-07

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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 document 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) or www.iec.ch/members_experts/refdocs).

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1 *Information Technology, SC 24 Computer graphics, image processing and environmental data representation* in collaboration with subcommittees: SC 29 *Coding of audio, picture, multimedia and hypermedia information*, and SC 36 *Information technology for learning, education and training*.

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 and www.iec.ch/national-committees.

Introduction

Virtual, Augmented, and Mixed Reality (VR/AR/MR) systems that are used for learning, education and training require approaches that support systems integration with various industry areas. Because the integration aspects should include common functionalities, unique information modelling requirements are necessary. Use cases for learning, education and training have been reviewed and included in this document to determine learning, education and training technologies that are commonly used and to determine an information model that can be used to support these types of activities supported by VR/AR/MR technologies.

VR/AR/MR based learning, education, and training (LET) systems have requirements related to learning and teaching approaches, representation, exchange, data, and interaction, in the following ways. First, existing learning and teaching approaches can be integrated with the use of VR/AR/MR technology and form the basis for user interactions with the systems and its elements. Based on differences in learning and teaching methods when using VR/AR/MR, requirements for interaction and simulation should be added. For example, the use of haptics to support user interaction with the system. Second, visual and interactive representation should be provided to enhance the effectiveness of learning, education and training. Simulation is an important aspect in representing information and in understanding the education itself and the training content. Third, information for education and training should be exchangeable over heterogeneous computing environments so that users can access education and training information anytime and anywhere. Fourth, information data for education and training should be organized and be able to be transferred securely and with minimal delay. Fifth, interfaces for interacting with devices and sensors should be included and should meet the requirements of users.

This document provides guidelines for developing VR/AR/MR based LET systems to meet the requirements listed above. The guidelines include concepts, information modelling architecture, standards based functional components, and implementation components for VR/AR/MR based LET.

Information technology — Information modelling for VR/AR/MR based learning, education and training systems

1 Scope

This document describes guidelines for developing education and training systems using VR/AR/MR technology. It specifies how to organize the information and data necessary for the development of VR/AR/MR integrated systems for education and training. It includes a procedure for the development of VR/AR/MR integrated systems for education and training using ISO/IEC JTC 1 standards.

This document includes several topics for consideration when developing VR/AR/MR based LET systems, as follows. First, it defines concepts of VR/AR/MR based LET. Second, it defines an information modelling architecture for education and training systems. Third, standards based functional components for education and training systems are specified. Fourth, framework components for implementing education and training systems are specified. And, finally, use cases for VR/AR/MR based LET systems based on the information modelling architecture are included.

Device hardware technology for learning, education, and training systems is excluded from this document.

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 14496-1:2010, *Information technology — Coding of audio-visual objects — Part 1: Systems*

ISO/IEC 18023-1:2006, *Information technology — SEDRIS — Part 1: Functional specification*

ISO/IEC 18025:2014, *Information technology — Environmental Data Coding Specification (EDCS)*

ISO/IEC 18026:2009, *Information technology — Spatial Reference Model (SRM)*

ISO/IEC 18038:2020, *Information technology — Computer graphics, image processing and environmental representation — Sensor representation in mixed and augmented reality*

ISO/IEC 18039:2019, *Information technology — Computer graphics, image processing and environmental data representation — Mixed and augmented reality (MAR) reference model*

ISO/IEC 18040, *Information technology — Computer graphics, image processing and environmental data representation — Live actor and entity representation in mixed and augmented reality (MAR)*

ISO/IEC 19774-1, *Information technology — Computer graphics, image processing and environmental data representation — Part 1: Humanoid animation (HAnim) architecture*

ISO/IEC 19774-2, *Information technology — Computer graphics, image processing and environmental data representation — Part 2: Humanoid animation (HAnim) motion data animation*

ISO/IEC 19775-1:2013, *Information technology -- Computer graphics, image processing and environmental data representation -- Extensible 3D (X3D) -- Part 1: Architecture and base components*

ISO/IEC 19788-1:2011, *Information technology — Learning, education and training — Metadata for learning resources — Part 1: Framework*

ISO/IEC/TR 20748-1:2016, *Information technology for learning, education and training — Learning analytics interoperability — Part 1: Reference model*

ISO/IEC/TR 20821:2018, *Information technology — Learning, education and training — Learning environment components for automated contents adaptation*

ISO/IEC 22602:2019, *Information technology — Learning, education and training — Competency models expressed in MLR*

ISO/IEC 23000-13:2017, *Information technology - Multimedia application format (MPEG-A) — Part 13: Augmented reality application format*

3 Terms, definitions, acronyms, and abbreviations

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 <https://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

systems integration

process of bringing together the component sub-systems into one cohesive system to meet specified requirements

3.1.2

ICT integration systems

combination of interacting information and communication technology (ICT) elements organized to achieve one or more stated purposes

[SOURCE: ISO/IEC/IEEE 24765:2017]

3.1.3

virtual reality

VR

interactive and immersive technology generated experience taking place in an artificial and simulated environment

Note 1 to entry: Virtual reality has a high level of immersiveness, fidelity of information representation, and degree of active learner participation compared to other forms of mixed reality.

[SOURCE: ISO/IEC 18038:2020; ISO/IEC TR 23843:2020; ISO/IEC 29140:2021]

3.1.4

augmented reality

AR

interactive experience whereby virtual objects are superimposed upon or embedded within the physical world

[SOURCE: ISO/IEC 18038:2020; ISO/IEC TR 23842-1:2020; ISO/IEC TR 23842-2:2020]

3.1.5

mixed reality

MR

merging of real and virtual worlds to generate new environments where physical and synthetic objects co-exist and interact

[SOURCE: ISO/IEC 18038:2020]

Note 1 to entry: Augmented reality (AR) and virtual reality (VR) are considered to be on the mixed reality continuum.

3.1.6

education

process of receiving or giving systematic instruction, especially at a school or university

[SOURCE: ISO/IEC 19896-1:2018]

3.1.7

training

development of skills and/or understanding through procedurally defined learning activities focused on a specific application

[SOURCE: ISO/IEC 2382-36:2019; ISO/IEC 19896-1:2018]

3.1.8

learning

acquisition of knowledge, skills or attitudes

[SOURCE: ISO/IEC 2382-36:2019]

3.1.9

VR/AR/MR based education

education using virtual, augmented and mixed environments where real and synthetic objects generated by VR, AR, and MR technologies co-exist and interact

3.1.10

VR/AR/MR based learning

learning using virtual, augmented and mixed environments where real and synthetic objects generated by VR, AR, and MR technologies co-exist and interact

3.1.11

VR/AR/MR based training

training using virtual, augmented and mixed environments where real and synthetic objects generated by VR, AR and MR technologies co-exist and interact

3.2 Acronyms and abbreviations

[Table 3.1](#) lists the abbreviated terms used in this document.

Table 3.1 — Abbreviated terms

Abbreviation	Abbreviated term
3D	3-Dimensional
AFX	Animation Framework eXtension
AR	Augmented Reality
ARAF	Augmented Reality Application Format
BIFS	BIFS: Binary Format for Scenes
DRM	Data Representation Model
EDCS	Environmental Data Coding Specification
EVC	Essential Video Coding
G-PCC	Geometry-based Cloud Compression
GUI	Graphical User Interface
HDR	High Dynamic Range
HEVC	High Efficiency Video Coding
HNSS	Hybrid Natural/Synthetic Scene
HAnim	Humanoid Animation
ICT	Information and Communications Technology
IT	Information Technology
ITLET	IT-enhanced Learning, Education, and Training
JPEG	Joint Photographic Experts Group
LET	Learning, Education, and Training
LOA	Level of Articulation
MAR	Mixed and Augmented Reality
MLR	Metadata for Learning Resources
MPEG	Moving Picture Experts Group
MPEG-A	MPEG Augmented Reality Application Format
MR	Mixed Reality
OMAF	Omnidirectional Media Format
SAI	Scene Access Interface
SRM	Spatial Reference Model
STF	SEDRIS Transmittal Format
UI	User Interface
UX	User Experience
VR	Virtual Reality
VCC	Versatile Video Coding
V-PCC	Video-based Point Cloud Coding
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
VRML	Virtual Reality Modelling Language
X3D	Extensible 3D
XML	Extensible Markup Language

4 Concepts

4.1 Overview

This document specifies an information modelling method for organizing a VR/AR/MR based system that is used for learning, education and training. Such a system includes computer simulated learning, education and training processes and provides for repetitive and empirical learning in an immersive virtual environment using VR/AR/MR technologies. It includes 3D virtual environments for education locales or scenes, 3D avatars for educators and learners, interfaces for interaction with other users and also device sensors, and knowledge data generated or created by systems or educators.

Use cases for learning, education and training systems can be classified as one of two types based on general education or training using devices with sensors. The first type facilitates education via digital information

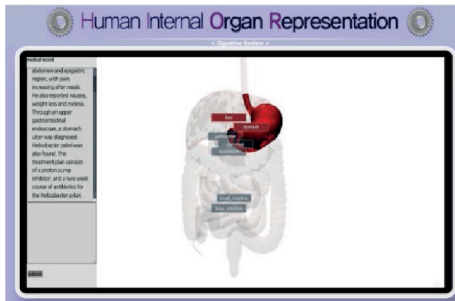
and devices based on ICT including VR. Education systems include online and offline learning and teaching (Figure 4.1). Online virtual learning and teaching are wholly accomplished using computing devices in virtual environments, while offline virtual learning and teaching only partially uses digital information and virtual environments. The latter corresponds to an environment where both educators and learners are present in a virtual room and where digital information within the virtual environments is sometimes used.



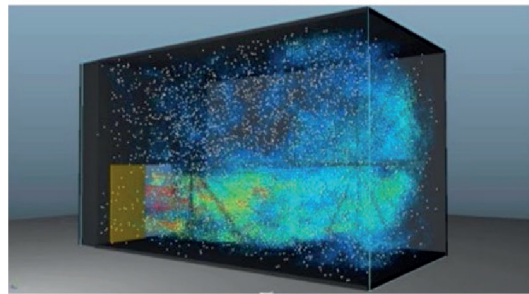
(a) Education classes



(b) Virtual road map education



(c) Medical education



(d) Gas flow visualization

Figure 4.1 — VR/AR/MR based education systems

The second type refers to VR/AR/MR based training systems that make use of real-world sensor devices along with virtual environments. It is based on MAR virtual environments with training devices, sensor information, and interactions with sensors (Figure 4.2). Implementation complexities can differ depending on whether human information as avatars will also be included in the virtual environments. Training systems that include sensors and avatars in virtual environments will be the most complex. This document describes an information modelling architecture that can generate and manage information necessary for these various types of learning, education and training systems.