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Information technology — Computer graphics and image processing — The Virtual Reality Modeling Language —

Part 1: Functional specification and UTF-8 encoding

Technologies de l'information — Infographie et traitement de l'image — Le langage de modélisation de réalité virtuelle —

Partie 1: Spécification fonctionnelle et codage UTF-8

Reference number
ISO/IEC 14772-1:1997(E)

Foreword

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ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form a 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. See http://www.iso.ch for information on ISO and http://www.iec.ch for information on IEC.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75% of the national bodies casting a vote. See http://www.iso.ch/meme/JTC1.html for information on JTC 1.

International Standard ISO/IEC 14772 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee 24, *Computer graphics and image processing*, in collaboration with The VRML Consortium, Inc. (http://www.vrml.org) and the VRML moderated email list (www-vrml@vrml.org).

ISO/IEC 14772 consists of the following part, under the general title *Information technology -- Computer graphics and image processing -- The Virtual Reality Modeling Language:*

Part 1: Functional specification and UTF-8 encoding.

Further parts will follow.

Annexes A to C form an integral part of this part of ISO/IEC 14772. Annexes D to F are for information only.

This part of ISO/IEC 14472 is distributed as both a hard copy edition and an HTML file which is on the attached CD-ROM. The paper and the electronic versions contain the same material. However, the structure and presentation are more relevant to the document as viewed on-screen. Please note that the electronic file must be viewed using a recent version of a web browser.

Introduction

Purpose

The Virtual Reality Modeling Language (VRML) is a file format for describing interactive 3D objects and worlds. VRML is designed to be used on the Internet, intranets, and local client systems. VRML is also intended to be a universal interchange format for integrated 3D graphics and multimedia. VRML may be used in a variety of application areas such as engineering and scientific visualization, multimedia presentations, entertainment and educational titles, web pages, and shared virtual worlds.

Design Criteria

VRML has been designed to fulfill the following requirements:

Authorability

Enable the development of computer programs capable of creating, editing, and maintaining VRML files, as well as automatic translation programs for converting other commonly used 3D file formats into VRML files.

Composability

Provide the ability to use and combine dynamic 3D objects within a VRML world and thus allow re-usability.

Extensibility

Provide the ability to add new object types not explicitly defined in VRML.

Be capable of implementation

Capable of implementation on a wide range of systems.

Performance

Emphasize scalable, interactive performance on a wide variety of computing platforms.

Scalability

Enable arbitrarily large dynamic 3D worlds.

Characteristics of VRML

VRML is capable of representing static and animated dynamic 3D and multimedia objects with hyperlinks to other media such as text, sounds, movies, and images. VRML browsers, as well as authoring tools for the creation of VRML files, are widely available for many different platforms.

VRML supports an extensibility model that allows new dynamic 3D objects to be defined

allowing application communities to develop interoperable extensions to the base standard. There are mappings between VRML objects and commonly used 3D application programmer interface (API) features.

Information technology -- Computer graphics and image processing -- The Virtual Reality Modeling Language -- Part 1: Functional specification and UTF-8 encoding

1 Scope

ISO/IEC 14772, the Virtual Reality Modeling Language (VRML), defines a file format that integrates 3D graphics and multimedia. Conceptually, each VRML file is a 3D time-based space that contains graphic and aural objects that can be dynamically modified through a variety of mechanisms. This part of ISO/IEC 14772 defines a primary set of objects and mechanisms that encourage composition, encapsulation, and extension.

The semantics of VRML describe an abstract functional behaviour of time-based, interactive 3D, multimedia information. ISO/IEC 14772 does not define physical devices or any other implementation-dependent concepts (e.g., screen resolution and input devices). ISO/IEC 14772 is intended for a wide variety of devices and applications, and provides wide latitude in interpretation and implementation of the functionality. For example, ISO/IEC 14772 does not assume the existence of a mouse or 2D display device.

Each VRML file:

a. implicitly establishes a world coordinate space for all objects defined in the file, as well as all objects included by the file;

b. explicitly defines and composes a set of 3D and multimedia objects;

c. can specify hyperlinks to other files and applications;

d. can define object behaviours.

An important characteristic of VRML files is the ability to compose files together through inclusion and to relate files together through hyperlinking. For example, consider the file *earth.wrl* which specifies a world that contains a sphere representing the earth. This file may also contain references to a variety of other VRML files representing cities on the earth (e.g., file *paris.wrl)*. The enclosing file, *earth.wrl*, defines the coordinate system that all the cities reside in. Each city file defines the world coordinate system that the city resides in but that becomes a local coordinate system when contained by the earth file.

Hierarchical file inclusion enables the creation of arbitrarily large, dynamic worlds. Therefore, VRML ensures that each file is completely described by the objects contained within it.

Another essential characteristic of VRML is that it is intended to be used in a distributed environment such as the World Wide Web. There are various objects and mechanisms built into the language that support multiple

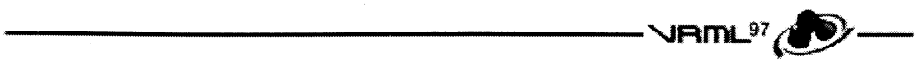
distributed files, including:

e. in-lining of other VRML files;

f. hyperlinking to other files;

g. using established Internet and ISO standards for other file formats;

h. defining a compact syntax.



2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 14772. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/IEC 14772 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

Annex E, Bibliography, contains a list of informative documents and technology.

Identifier	Reference
1766	IETF RFC 1766, Tags for the Identification of Languages, Internet standards track protocol. http://ds.internic.net/rfc/rfc1766.txt
CGM	ISO/IEC 8632:1992 (all parts) Information technology -- Computer graphics -- Metafile for the storage and transfer of picture description information. http://www.iso.ch/isob/switch-engine-cate.pl?searchtype=refnumber&KEYWORDS=8632
ESCR	ISO/IEC DIS 16262 Information technology -- ECMAScript: A general purpose, cross-platform programming language. http://www.ecma.ch http://www.iso.ch/isob/switch-engine-cate.pl?searchtype=refnumber&KEYWORDS=16262
HTML	HTML 3.2 Reference Specification. http://www.w3.org/TR/REC-html32.html
I639	ISO 639:1988 Code for the representation of names of languages. http://www.iso.ch/isob/switch-engine-cate.pl?KEYWORDS=10918&searchtype=refnumber, http://www.chemie.fu-berlin.de/diverse/doc/ISO_639.html
I3166	ISO 3166:1997 (all parts) Codes for the representation of names of countries and their subdivisions. http://www.iso.ch/isob/switch-engine-cate.pl?searchtype=refnumber&KEYWORDS=3166
I8859	ISO/IEC 8859-1:1987 Information technology -- 8-bit single-byte coded graphic character sets -- Part 1: Latin alphabet No. 1. http://www.iso.ch/isob/switch-engine-cate.pl?searchtype=refnumber&KEYWORDS=8859

ISOC	ISO/IEC 9899:1990 Programming languages -- C. http://www.iso.ch/isob/switch-engine-cate.pl?searchtype=refnumber&KEYWORDS=9899
ISOG	ISO/IEC 10641:1993 Information technology -- Computer graphics and image processing -- Conformance testing of implementations of graphics standards. http://www.iso.ch/isob/switch-engine-cate.pl?KEYWORDS=10641&searchtype=refnumber
JAVA	"The Java Language Specification" by James Gosling, Bill Joy and Guy Steele, Addison Wesley, Reading Massachusetts, 1996, ISBN 0-201-63451-1. http://java.sun.com/docs/books/jls/index.html "The Java Virtual Machine Specification" by Tim Lindhold and Frank Yellin, Addison Wesley, Reading Massachusetts, 1996, ISBN 0-201-63452-X. http://java.sun.com/docs/books/vmspec/index.html
JPEG	"JPEG File Interchange Format," JFIF, Version 1.02, 1992. http://www.w3.org/pub/WWW/Graphics/JPEG/jfif.txt ISO/IEC 10918-1:1994 Information technology -- Digital compression and coding of continuous-tone still images: Requirements and guidelines. http://www.iso.ch/isob/switch-engine-cate.pl?KEYWORDS=10918&searchtype=refnumber
MIDI	Complete MIDI 1.0 Detailed Specification, MIDI Manufacturers Association, P.O. Box 3173, La Habra, CA 90632 USA 1996. http://www.midi.org
MPEG	ISO/IEC 11172-1:1993 Information technology -- Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s -- Part 1: Systems. http://www.iso.ch/isob/switch-engine-cate.pl?searchtype=refnumber&KEYWORDS=11172
PNG	PNG (Portable Network Graphics), Specification Version 1.0, W3C Recommendation, 1 October 1996. http://www.w3.org/pub/WWW/TR/REC-png-multi.html
RURL	IETF RFC 1808 Relative Uniform Resource Locator, Internet standards track protocol. http://ds.internic.net/rfc/rfc1808.txt
URL	IETF RFC 1738 Uniform Resource Locator, Internet standards track protocol. http://ds.internic.net/rfc/rfc1738.txt

UTF8	ISO/IEC 10646-1:1993 Information technology -- Universal Multiple-Octet Coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane, Internet standards track protocol. http://www.iso.ch/isob/switch-engine-cate.pl?searchtype=refnumber&KEYWORDS=10646, http://ds.internic.net/rfc/rfc2044.txt

3 Definitions

For the purposes of this part of ISO/IEC 14722, the following definitions apply.

3.1 activate

To cause a *sensor node* to generate an "isActive" *event*. The various types of sensor nodes are "activated" by *user* interactions, the passage of *time*, or other events. Only active sensor nodes affect the *user's* experience. A Script *node* is activated when it receives an event. A pointing device such as a *mouse* is activated when one of its buttons is depressed by a user. See 4.12.2, Script execution, for details.

3.2 ancestor

A *node* which is an antecedent of another node in the *transformation hierarchy*.

3.3 author

A person or agent that creates *VRML files*. Authors typically use *generators* to assist them.

3.4 authoring tool

See *generator*.

3.5 avatar

The abstract representation of the *user* in a VRML *world*. The physical dimensions of the avatar are used for collision detection and terrain following. See 6.29, NavigationInfo, for details.

3.6 bearing

A straight line passing through the *pointer* location in the direction of the pointer. If multiple sensors' geometry intersect this line, only the sensor nearest the viewer will be eligible to generate *events* regardless of material and texture properties (e.g., transparency).

3.7 bindable node

A *node* that may have many *instances* in a *scene graph*, but only one instance may be active at any instant of *time*. A node of type Background, Fog, NavigationInfo, or Viewpoint. See 4.6.10, Bindable children nodes, for details.

3.8 browser

A computer program that interprets *VRML files*, presents their content to a *user* on a *display device*, and allows the user to interact with *worlds* defined by VRML files by means of a user interface.

3.9 browser extension

Nodes defined using the prototyping mechanism that are understood only by certain *browsers*. See 4.9.3, Browser extensions, for details.

3.10 built-in node

A *node* of a *type* explicitly defined in this part of ISO/IEC 14772.

3.11 callback

A function defined in a *scripting language* to which *events* are passed. See 4.12.8, EventIn handling, for details.

3.12 candidate

One of potentially several choices. The *user* or the *browser* will select none or one of the choices when all candidates are identified. See 4.6.10, Bindable children nodes, and 6.2, Anchor, for details.

3.13 child

An instance of a *children node*.

3.14 children node

One of a set of *node types*, instances of which can be collected in a group to share specific properties dependent on the type of the *grouping node*. See 4.6.5, Grouping and children nodes, for a list of allowable children nodes.

3.15 client system

A computer system, attached to a *network*, that relies on another computer (the server) for essential processing functions. Many client systems also function as stand-alone computers.

3.16 collision proxy

A *node* used as a substitute for all of a Collision node's children during collision detection. See 6.8, Collision, for details.

3.17 colour model

Characterization of a colour space in terms of explicit parameters. ISO/IEC 14772 allows colours to be defined only with the RGB colour model. However, colour interpolation is performed in the HSV colour space.

3.18 culling

The process of identifying *objects* or parts of objects which do not need to be processed further by the *browser* in order to produce the desired view of a *world*.

3.19 descendant

A *node* which descends from another node in the *transformation hierarchy*. A *children node*.

3.20 display device

A graphics device on which VRML *worlds* may be rendered.

3.21 drag sensor

A *pointing device sensor* that causes *events* to be generated in response to sensor-dependent pointer motions. For example, the SphereSensor generates spherical rotation events. A *node* of type CylinderSensor, PlaneSensor, or SphereSensor. See 4.6.7, Sensor nodes, and 4.6.7.4, Drag sensors, for details.

3.22 environmental sensor

A sensor *node* that generates *events* based on the location of the viewpoint in the *world* or in relation to *objects* in the world. The TimeSensor node generates events at regular intervals in *time*. A node of type Collision, ProximitySensor, TimeSensor, or VisibilitySensor. See 4.6.7.2, Environmental sensors, for details.

3.23 event

A *message* sent from one *node* to another as defined by a *route*. *Events* signal external stimuli, changes to *field* values, and interactions between nodes. An event consists of a *timestamp* and a field value.

3.24 event cascade

A sequence of *events* initiated by a script or sensor event and propagated from *node* to node along one or more *routes*. All events in an event cascade are considered to have occurred simultaneously. See 4.10.3, Execution model, for details.

3.25 eventIn

A logical receptor attached to a *node* which receives *events*.

3.26 eventOut

A logical output terminal attached to a *node* from which *events* are sent. The eventOut also stores the event most recently sent.

3.27 execution model

The rules governing how *events* are processed by *browsers* and scripts.

3.28 exposed field

A *field* that is capable of receiving *events* via an *eventIn* to change its value(s), and generating events via an

eventOut when its value(s) change.

3.29 external prototype

A *prototype* defined in an external file and referenced by a *URL*.

3.30 field

A property or attribute of a *node*. Each *node type* has a fixed set of fields. Fields may contain various kinds of data and one or many values. Each field has a default value.

3.31 field name

The identifier of a *field*. Field names are unique within the scope of the *node*.

3.32 file

A collection of related data. A file may be stored on physical media or may exist as a data stream or as data within a computer program.

3.33 frame

A single rendering of a *world* on a *display device* or a single time-step in a simulation.

3.34 generator

A computer program which creates *VRML files*. A generator may be used by a person or operate automatically. Synonymous with *authoring tool*.

3.35 geometric property node

A *node* defining the properties of a specific geometry node. A node of type Color, Coordinate, Normal, or TextureCoordinate. See 4.6.3.2, Geometric property nodes, for details.

3.36 geometric sensor node

A *node* that generates *events* based on *user* actions, such as a *mouse* click or navigating close to a particular *object*. A node of type CylinderSensor, PlaneSensor, ProximitySensor, SphereSensor, TouchSensor, VisibilitySensor, or Collision. See 4.6.7.1, Introduction to sensors, for details.

3.37 geometry node

A *node* containing mathematical descriptions of three-dimensional (3D) points, lines, surfaces, text strings and solids. A node of type Box, Cone, Cylinder, ElevationGrid, Extrusion, IndexedFaceSet, IndexedLineSet, PointSet, Sphere, or Text. See 4.6.3, Shapes and geometry, for details.

3.38 grab

To receive *events* from activated pointing devices (e.g., *mouse* or *wand*). A *pointing device sensor* becomes the exclusive recipient of pointing device events when one or more pointing devices are activated simultaneously.

3.39 gravity

In the context of ISO/IEC 14772, gravity may be simulated by constraining the motion of the viewpoint to the lowest possible path (smallest Y-coordinate in the local coordinate system of the viewpoint) consistent with following the surface of encountered *objects*. See 6.29, NavigationInfo, for details.

3.40 grouping node

One of a set of *node types* which include a list of nodes, referred to as its *children nodes*. These children nodes are collected together to share specific properties dependent on the type of the grouping node. Each grouping node defines a coordinate space for its children relative to its own coordinate space. The children may themselves be instances of grouping nodes, thus forming a *transformation hierarchy*. See 4.6.5, Grouping and children nodes, for details.

3.41 HSV

Hue, Saturation, and Value colour model. See E.[FOLE].

3.42 HTML

HyperText Markup Language. See 2.[HTML].

3.43 hyperlink

A reference to a *URL* that is associated with an Anchor *node*. See 6.2, Anchor, for details.

3.44 ideal VRML implementation

An implementation of VRML that presents all *objects* and simulates movement without approximation. Not realizable in practice.

3.45 IEC

International Electrotechnical Commission. See `http://www.iec.ch`.

3.46 IETF

Internet Engineering Task Force. The organization which develops *Internet* standards. See `http://www.ietf.org/overview.html`.

3.47 image

A two-dimensional (2D) rectangular array of pixel values. Pixel values may have from one to four components. See 5.5, SFImage, for details.

3.48 in-lining

The mechanism by which one *VRML file* is hierarchically included in another.

3.49 Internet

The world-wide named *network* of computers which communicate with each other using a common set of communication protocols known as TCP/IP. See *IETF*. The *World Wide Web* is implemented on the Internet.

3.50 instance

A reference to a previously defined and named *node*. Nodes are named by means of the DEF syntax and reference by USE syntax (see 4.6.2, DEF/USE semantics). Instances of nodes may be used in any context in which the defining node may be used.

3.51 interpolator node

A *node* that defines a piece-wise linear interpolation. A node of type ColorInterpolator, CoordinateInterpolator, NormalInterpolator, OrientationInterpolator, PositionInterpolator, or ScalarInterpolator. See 4.6.8, Interpolator nodes, for details.

3.52 intranet

A private *network* that uses the same protocols and standards as the *Internet*.

3.53 ISO

International Organization for Standardization. See `http://www.iso.ch/infoc/intro.html`.

3.54 JPEG

Joint Photographic Experts Group. See 2.[JPEG].

3.55 JTC 1

ISO/IEC Joint Technical Committee 1. See `http://www.iso.ch/meme/JTC1.html`.

3.56 level of detail

The amount of detail or complexity which is displayed at any particular *time* for any particular *object*. The level of detail for an object is controllable as a function of the distance of the object from the viewer. See 6.26, LOD, for details. (Abbreviated LOD)