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Information technology — Multimedia content description interface —

Part 14: Reference software, conformance and usage guidelines for compact descriptors for visual search

Technologies de l'information — Interface de description du contenu multimédia —

Partie 14: Logiciels de référence, conformité et lignes directrices pour l'utilisation des descripteurs compacts pour recherche visuelle

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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

A list of all parts in the ISO/IEC 15938 series can be found on the ISO website.

Introduction

ISO/IEC 15938 (all parts) also known as "Multimedia Content Description Interface," provides a standardized set of technologies for describing multimedia content. It addresses a broad spectrum of multimedia applications and requirements by providing a metadata system for describing the features of multimedia content.

The following are specified in ISO/IEC 15938 (all parts).

— **Description schemes (DS)** describe entities or relationships pertaining to multimedia content. Description schemes specify the structure and semantics of their components, which may be Description Schemes, descriptors, or datatypes.

— **Descriptors (D)** describe features, attributes, or groups of attributes of multimedia content.

— **Datatypes** are the basic reusable datatypes employed by description schemes and descriptors

— **Systems tools** support delivery of descriptions, multiplexing of descriptions with multimedia content, synchronization, file format, and so forth.

ISO/IEC 15938 consists of 14 parts.

— **Part 1 – Systems**: specifies the tools for preparing descriptions for efficient transport and storage, compressing descriptions, and allowing synchronization between content and descriptions.

— **Part 2 – Description definition language**: specifies the language for defining the International Standard set of description tools (DSs, Ds, and datatypes) and for defining new description tools.

— **Part 3 – Visual**: specifies the description tools pertaining to visual content.

— **Part 4 – Audio**: specifies the description tools pertaining to audio content.

— **Part 5 – Multimedia description schemes**: specifies the generic description tools pertaining to multimedia including audio and visual content.

— **Part 6 – Reference software**: provides a software implementation of ISO/IEC 15938.

— **Part 7 – Conformance testing**: specifies the guidelines and procedures for testing conformance of implementations of ISO/IEC 15938.

— **Part 8 – Extraction and use of MPEG-7 descriptions**: provides guidelines and examples of the extraction and use of descriptions.

— **Part 9 – Profiles and levels**: provides guidelines and standard profiles.

— **Part 10 – Schema definition**: specifies the schema using description definition language.

— **Part 11 – Profile Schemas**: listing of profile schemas using description definition language.

— **Part 12 – Query format**: contains the tools of the MPEG Query Format (MPQF).

— **Part 13 – Compact descriptors for visual search**: specifies an image description tool for visual search applications.

— **Part 14 – Reference software, conformance and usage guidelines for compact descriptors for visual search**: provides the reference software, specifies the conformance testing, and gives usage guidelines for compact descriptors for visual search.

The compact descriptors for visual search (CDVS) tool specified in ISO/IEC 15938-13 is designed to enable efficient and interoperable visual search applications, allowing visual content matching in images. Visual content matching includes matching of views of objects, landmarks, and printed

documents, while being robust to partial occlusions as well as changes in viewpoint, camera parameters, and lighting conditions.

ISO/IEC 15938-14:

— specifies the reference software for CDVS (Clause 5);

— specifies the conformance testing dataset, reference descriptors and conditions for CDVS (Clause 6);

— provides guidelines for the usage of CDVS (Clause 7).

The CDVS reference software is provided at http://standards.iso.org/iso-iec/15938/-14/ed-1/en.

Information technology — Multimedia content description interface —

Part 14: Reference software, conformance and usage guidelines for compact descriptors for visual search

1 Scope

This document provides the reference software, specifies the conformance testing, and gives usage guidelines for ISO/IEC 15938-13.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
image descriptor
descriptor extracted from one image

3.2
image descriptor length
size of an image descriptor in bytes

Note 1 to entry: ISO/IEC 15938-13 specifies six average (i.e. over a large number of images) image descriptor lengths, i.e. 512 bytes, 1024 bytes, 2048 bytes, 4096 bytes, 8192 bytes and 16384 bytes.

3.3
interest point
point in an image showing detection stability under local and global perturbations in the image domain, including perspective transformations, changes in image scale, and illumination variations

3.4
local region
area in an image in the neighbourhood of an interest point, used to generate local feature descriptors

3.5
local feature descriptor
descriptor of a local region

3.6
global descriptor
aggregation of local feature descriptors into a compact representation of the image

3.7
compressed local feature descriptor
compressed representation of a local feature descriptor

4 Symbols and abbreviated terms

4.1 General

NOTE The mathematical operators used in this part of ISO/IEC 15938 are similar to those used in the C programming language. Unless otherwise indicated, all the arithmetic operations are performed with real values. Numbering and counting conventions generally begin from 0.

4.2 Abbreviations

CDVS Compact Descriptors for Visual Search

MPEG Moving Picture Experts Group

MPEG-7 ISO/IEC 15938

4.3 Arithmetic operations

+ addition

− subtraction (as a binary operator) or negation (as a unary operator)

++ increment by 1, i.e. x++ is equivalent to x=x+1

-- decrement by 1, i.e. x-- is equivalent to x=x-1

+= increment by value, i.e. x+=y is equivalent to x=x+y

-= decrement by value, i.e. x-=y is equivalent to x=x-y

***** multiplication (in binary representation syntax and pseudo-code) or convolution (elsewhere)

× multiplication

· multiplication

/ division

÷ division

% modulo operator

4.4 Logical operators

|| logical OR

∨ logical OR

&& logical AND

∧ logical AND

! logical NOT

4.5 Relational operators

> greater than

>= greater than or equal to

≥ greater than or equal to

< less than

<= less than or equal to

≤ less than or equal to

== equal to

!= not equal to

≠ not equal to

4.6 Bitwise operators

| OR

& AND

4.7 Assignment

= assignment operator

← assignment operator

→ assignment operator, except in $Q \rightarrow R$ and $R \rightarrow Q$, where it denotes matching direction between image descriptors Q and R

4.8 Set operators

∪ set union

∩ set intersection

⊆ subset

cardinality

4.9 Constants

π 3.141 592 653 58…

e 2.718 281 828 45…

4.10 Functions

ln() base-e logarithm

max() maximum value in argument list

min() minimum value in argument list

cos() cosine function

$|\ |$ absolute value of scalar or a vector norm

$\lfloor\ \rfloor$ floor function which returns the maximum integer number less than or equal to the given real number

5 Reference software

5.1 Reference software location

The CDVS reference software is provided at http://standards.iso.org/iso-iec/15938/-14/ed-1/en.

5.2 Reference software license

Licensing information is provided in "CDVS_evaluation_framework/COPYING" and "CDVS_applications/COPYING". Each source code file also contains its own detailed licensing information in the header.

5.3 Reference software documentation

The CDVS reference software is documented by means of Doxygen. The documentation is provided in "CDVS_evaluation_framework/docs" of the CDVS reference software.

5.4 Reference software compilation

Instructions on how to compile the CDVS reference software is provided in "CDVS_evaluation_framework/docs/CDVS-build-run-instructions.pdf" of the CDVS reference software.

The CDVS reference software is entirely written in C and C++. On Windows, it has been compiled and tested on Windows 7 Enterprise 64-bit using Visual C++ 2010 (64-bit). On Linux, it has been compiled and tested on Ubuntu 14.04 LTS (64-bit).

5.5 Reference software architecture

The CDVS reference software comprises a library and several 64-bit applications using the library, which are functionally split into two groups:

a) CDVS evaluation framework, as used during the development of ISO/IEC 15938-13:

   1) "extract": extracts CDVS descriptor from a set of images;

   2) "match": examines pairs of CDVS descriptors and determines if the corresponding images are matching or not;

   3) "mkIndex": concatenates CDVS descriptors in a file structure that may be used as a reference database for the "retrieve" application;

4) “joinIndices”: concatenates reference databases previously produced by “mkIndex” to produce a larger reference database for the “retrieve” application;

5) “retrieve”: compares a query CDVS descriptor against a reference database and identifies the most similar entries in the database.

b) CDVS example applications:

1) “simpleextract”: extracts a CDVS descriptor from a single image;

2) “simplematch”: examines two CDVS descriptors and determines if the corresponding images are matching or not;

3) “simpleretrieve”: compares a set of query images with a set of reference images and identifies the most similar entries;

4) “conformance”: an application implementing the CDVS conformance testing procedure of Clause 6;

5) “HTTPServer”: a web service able to perform retrieval on a database of images, and to update its own database (this code has an additional dependency on libmicrohttpd);

6) “batchextract”: parallel extraction from an input directory of images to an output directory of CDVS descriptors;

7) “example1”, “example2”, “example3”: very simple examples using the CDVS library.

Information on how to build, install and run the CDVS reference software is provided in “CDVS_evaluation_framework/docs/CDVS-build-run-instructions.pdf” of the CDVS reference software.

6 Conformance testing

6.1 Conformance image data set and reference CDVS bitstreams

The conformance image dataset comprises a set of 1000 images. These images are named cvds000.jpg, cdvs001.jpg, …, cdvs999.jpg and are provided in “CDVSConformanceDaset.zip” available at http://standards.iso.org/iso-iec/15938/-14/ed-1/en.

Reference CDVS bitstreams for the conformance image dataset are also provided. For each image cdvsxxx.jpg in the conformance image dataset, six reference CDVS bitstreams are provided corresponding to the six image descriptor lengths specified in the ISO/IEC 15938-13, i.e. 512 bytes, 1024 bytes, 2048 bytes, 4096 bytes, 8192 bytes and 16384 bytes. The reference CDVS bitstreams are provided in “CDVSReferenceBitstreams.zip”.

6.2 Conformance test conditions

6.2.1 General

To verify conformance of a CDVS encoder, test CDVS bitstreams shall be extracted from all the images in the conformance image dataset and for all six image descriptor lengths, and the test CDVS bitstreams shall be compared to the corresponding reference CDVS bitstreams.

A CDVS encoder shall be deemed conformant if all 6000 of the test CDVS bitstreams are decoded correctly by the CDVS reference software conformance application and no less than 5940 of the test CDVS bitstreams pass all of the conformance tests specified in 6.2.2 to 6.2.4.