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Information technology — MPEG video technologies —

Part 1: Accuracy requirements for implementation of integer-output 8x8 inverse discrete cosine transform

AMENDMENT 1: Software for integer IDCT accuracy testing

Technologies de l'information — Technologies vidéo MPEG —

Partie 1: Exigences d'exactitude pour l'implémentation de la transformation cosinus inverse discrète de sortie du nombre entier 8x8

AMENDEMENT 1: Logiciel pour essai de précision IDCT entier

Reference number
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Foreword

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Amendment 1 to ISO/IEC 23002-1:2006 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This corrected version incorporates the following corrections:

— reference to ISO 23002 now reads ISO/IEC 23002;

— reference to ISO/IEC 13818-2 now reads ITU-T Rec. H.262 | ISO/IEC 13818-2;

— the last paragraph of C.2 clarifies that the reference software package testbeds are for testing "drift effects", as opposed to "drift";

— changes to the presentation of C.3.3 to C.3.5, to improve legibility;

— changes to C.4 that

  — provide additonal information about default test values,

  — specify to which clauses/subclauses of ISO/IEC 23002-1 the test modes relate, and

  — remove the invertibilty test mode.

Information technology — MPEG video technologies —

Part 1:
Accuracy requirements for implementation of integer-output 8x8 inverse discrete cosine transform

AMENDMENT 1: Software for integer IDCT accuracy testing

Add the following annex:

Annex C
(normative)

Reference software

C.1 Introduction

This annex specifies reference software that implements 8x8 IDCT precision tests as defined in this part of ISO/IEC 23002. Several additional tests (precision, dynamic range, linearity, and drift), implemented by the reference software are also specified.

C.2 Reference software overview

The reference software is implemented using the C programming language. It contains the following modules:

1. **testbed.h** – header file to contain prototypes and lists of fixed-point IDCTs available for testing
2. **testbed.c** – module implementing all tests specified in this part of ISO/IEC 23002 and containing main program
3. **example_idct.c** – example fixed-point IDCT used for testing.

The mapping between the precision tests and functions in module testbed.c is provided in Table C.1.

Table C.1 — ISO/IEC 23002-1 testing procedures and corresponding functions in reference software

Subclauses of ISO/IEC 23002-1	Procedure	Corresponding function(s) in reference software
5.1	Ideal real-valued 8x8 forward DCT	ref_double_fdct()
5.2	Ideal integer-valued 8x8 forward DCT	ref_fdct()
5.3	Ideal real-valued 8x8 inverse DCT	ref_double_idct()
5.4	Ideal integer-valued 8x8 inverse DCT	ref_idct()
5.5.1.2	Process for pseudo-random number generation	rand_gen() rand_gen_reset()
5.5.1.1 5.5.1.3	IDCT test procedure using pseudo-random input data	idct_test()
5.5.2	Test of all-zero input behaviour	zeroinput_test()
A.2	Test of near-DC inversion behaviour	neardc_test()
5.5.1 B.2 C.3.2	Pseudo-random data IDCT tests Additional pseudo-random input data tests Extended dynamic range pseudo-random input data tests	run_tests(), idct_test()
C.3.3	IDCT linearity test	linearity_test()
C.3.4	DCT pseudo-random input data test	dct_test()
C.3.5	DCT- IDCT pair pseudo-random input data test	pr_test()

In addition, the reference software package includes ITU-T Rec.H.262 | ISO/IEC 13818-2 (MPEG-2 Video) and ISO/IEC 14496-2 (MPEG-4 Visual) based testbeds for testing the drift effects of fixed-point IDCT implementations. These testbeds are located in subdirectories \MPEG2test and \MPEG4 test, respectively.

C.3 Additional IDCT and DCT tests

C.3.1 Introduction

Subclauses C.3.2 to C.3.5 specify additional (informative) accuracy tests that are useful for testing of IDCT and DCT designs.

C.3.2 Extended dynamic range pseudo-random input data tests

For the sets of values of the variables *L*, *H*, and *Q* specified below in this subclause, the tests using pseudo-random input data specified in 5.5.1.1 are performed using the pseudo-random number generator specified in 5.5.1.2. The desired accuracy for these additional tests using pseudo-random input data should be as specified in 5.5.1.3.

The sets of values of the variables *L*, *H*, and *Q* are specified as follows.

— $L = 1$ and $H = 1$ and $Q = 1\,000\,000$

— $L = 512*2^{B-8}$ and $H = 512*2^{B-8}$ and $Q = 1\,000\,000$

— $L = 1805*2^{B-8}$ and $H = (1805*2^{B-8})-1$ and $Q = 1\,000\,000$

C.3.3 IDCT linearity test

For s = 0..7, t = 0..7 and z = 1, 3, 5 …, 528*2^{B-8}-1, the following test is performed.

1. For u = 0..7 and v = 0..7, set $F''_z[v][u]$ = 0 and $G''_z[v][u]$ = 0.
2. Set $F''_z[s][t]$ = z, and $G''_z[s][t]$ = -z.
3. Apply the IDCT under test to the 8x8 transform coefficient matrix F''_z to produce a corresponding integer-valued 8x8 sample matrix f'_z for testing.
4. For x = 0..7 and y = 0..7, set $f''_z[y][x]$ = clip3(-2^B, $(2^B)-1$, $f'_z[y][x]$).
5. Apply the IDCT under test to the 8x8 transform coefficient matrix G''_z to produce a corresponding integer-valued 8x8 sample matrix g'_z for testing.
6. For x = 0..7 and y = 0..7, set $g''_z[y][x]$ = clip3(-2^B, $(2^B)-1$, $g'_z[y][x]$).
7. For x = 0..7 and y = 0..7, set $w[y][x]$ = max($w[y][x]$, abs($f''_z[y][x]$ - $g''_z[y][x]$)).

For x = 0..7 and y = 0..7, the resulting value of $w[y][x]$, which may be referred to as the peak absolute error (PAE) for location [y][x] for the linearity test, should be 0.

C.3.4 DCT pseudo-random input data test

For the purpose of testing precision of FDCT implementations, the process of 5.5.1.1 is employed with the following alteration. Instead of steps 3.c to 3.h specified in 5.5.1.1, the following steps are performed:

c. For x = 0..7 and y = 0..7, set $g''_z[y][x]$ = $F''_z[y][x]$.

d. Apply the FDCT under test to the integer-valued 8x8 sample matrix f_z to produce a corresponding integer-valued 8x8 transform coefficient matrix G'_z for testing.

e. For u = 0..7 and v = 0..7, set $G''_z[y][x]$ = clip3(-2^{B+3}, $(2^{B+3})-1$, $G'_z[y][x]$).

f. For x = 0..7 and y = 0..7, set $h''_z[y][x]$ = $G''_z[y][x]$.

g. For x = 0..7 and y = 0..7, set $p[y][x]$ = max($p[y][x]$, abs($h''_z[y][x]$ - $g''_z[y][x]$)).

This process is executed using the pseudo-random number generator specified in 5.5.1.2 for the following set of variables:

— L = 2^B and H = $(2^B)-1$ and Q = 1 000 000.

C.3.5 Joint DCT-IDCT pair pseudo-random input data test

For the purpose of testing precision of FDCT implementations, the process of 5.5.1.1 is employed with the following alteration. Instead of steps 3.b to 3.h specified in 5.5.1.1, the following steps are performed:

b. For x = 0..7 and y = 0..7, set $g''_z[y][x]$ = $f_z[y][x]$.

c. Apply the FDCT under test to the integer-valued 8x8 sample matrix f_z to produce a corresponding integer-valued 8x8 transform coefficient matrix G'_z for testing.

d. Apply the IDCT under test to the integer-valued 8x8 transform coefficient matrix G''_z to produce a corresponding integer-valued 8x8 sample matrix h'_z for testing.

e. For x = 0..7 and y = 0..7, set $h''_z[y][x]$ = clip3(-2^B, $(2^B)-1$, $h'_z[y][x]$).

f. For x = 0..7 and y = 0..7, set $p[y][x]$ = max($p[y][x]$, abs($h''_z[y][x]$ - $g''_z[y][x]$)).

This process is executed using the pseudo-random number generator specified in 5.5.1.2 for the sets of variables L, H, and Q specified in 5.5.1.

C.4 Reference software usage

The fixed-point IDCT implementation under test needs to be declared and included in a list of algorithms located in the header file (testbed.h). Then the package needs to be recompiled and executed.

The executable module (testbed.exe) has the following command-line options/modes.

Options: default value inside <...>

-l <-256> value of-L (lower bound for pseudo-random input test)

-h <255> value of H (upper bound for pseudo-random input test)

-s <1> sign = +1 for normal, –1 to run negated test

-i <10000> value of Q

-b <8> value of B (sample bit depth)

-t <0> specifies one of the following test modes:

0 - pseudo-random input IDCT test,

1 - Subclause 5.5.2 all-zero input test,

2 - Annex A near-DC inversion IDCT test,

3 - Subclause C.3.4 pseudo-random input DCT test,

4 - Subclause C.3.5 pseudo-random input joint DCT-IDCT test,

5 - all IDCT tests,

6 - all DCT, IDCT and joint DCT-IDCT tests,

7 - Subclause C.3.3 linearity IDCT test,

-m <0> defines which pseudo-random input tests to use:

0 - single test defined by (l, h, s, i) parameters,

1 - Subclause 5.5.1 tests (± 5, 256, 300),

2 - Annex B tests (± 5, 256, 300, 384),

3 - Subclause C.3.2 tests (± 1, 512, 1805),

-f outputfilename specifies name of a file to contain test results.