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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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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 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.

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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 ISO/IEC 13818-2 (MPEG-2 Video) and ISO/IEC 14496-2 (MPEG-4 Visual) based testbeds for testing drift of fixed-point IDCT implementations. These testbeds are located in subdirectories \MPEG2test and \MPEG4 effects 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 $Q = 1\,000\,000$

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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 $f_z''[y][x] = \text{clip3}(-2^B, (2^B)-1, f'_z[y][x])$.
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 $g_z''[y][x] = \text{clip3}(-2^B, (2^B)-1, g'_z[y][x])$.
7. For x = 0..7 and y = 0..7, set $w[y][x] = \max(w[y][x], \text{abs}(f''_z[y][x] - g''_z[y][x]))$.

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 $G''_z[y][x] = \text{clip3}(-2^{B+3}, (2^{B+3})-1, G'_z[y][x])$.

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 $p[y][x] = \max(p[y][x], \text{abs}(h''_z[y][x] - g''_z[y][x]))$.

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 $h''_z[y][x] = \text{clip3}(-2^B, (2^B)-1, h'_z[y][x])$.

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

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.

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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> — L value for pseudo-random test

-h <255> — H value for pseudo-random test

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

-i <10000> — # iterations

-b <8> — pixel depth

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

0-IDCT test,

1 - all-zero input test,

2 - near-DC inversion test,

3 - DCT test,

4 - PR test,

5 - all IDCT tests,

6 - all tests,

7 - linearity test,

8 - invertibility test

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

0 - none (only single test, defined by (l,h,s,i) parameters will be executed),

1 - default normative tests (± 5, 256, 300),

2 - additional MPEG tests (± 5...384),

3 - extended dynamic range tests (± 1,512,1085)

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

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