NAG Toolbox

nag_wav_3d_sngl_inv (c09fb)

1 Purpose

nag_wav_3d_sngl_inv (c09fb) computes the three-dimensional inverse discrete wavelet transform (IDWT) at a single level. The initialization function nag_wav_3d_init (c09ac) must be called first to set up the DWT options.

2 Syntax

```
[b, ifail] = nag_wav_3d_sngl_inv(m, n, fr, c, icomm, 'lenc', lenc)
[b, ifail] = c09fb(m, n, fr, c, icomm, 'lenc', lenc)
```

3 Description

nag_wav_3d_sngl_inv (c09fb) performs the inverse operation of function nag_wav_3d_sngl_fwd (c09fa). That is, given sets of wavelet coefficients computed by function nag_wav_3d_sngl_fwd (c09fa) using a DWT as set up by the initialization function nag_wav_3d_init (c09ac), on a real data array, B, nag_wav_3d_sngl_inv (c09fb) will reconstruct B.

4 References

None.

5 Parameters

5.1 Compulsory Input Parameters

1: **m** – INTEGER

The number of rows of each two-dimensional frame.

Constraint: this must be the same as the value **m** passed to the initialization function nag_wav_3d_init (c09ac).

2: **n** – INTEGER

The number of columns of each two-dimensional frame.

Constraint: this must be the same as the value **n** passed to the initialization function nag_wav_3d_init (c09ac).

3: **fr** – INTEGER

The number two-dimensional frames.

Constraint: this must be the same as the value **fr** passed to the initialization function nag_wav_3d_init (c09ac).

4: **c**(**lenc**) – REAL (KIND=nag_wp) array

The coefficients of the discrete wavelet transform. This will normally be the result of some transformation on the coefficients computed by function nag_wav_3d_sngl_fwd (c09fa).

Note that the coefficients in **c** may be extracted according to type into three-dimensional arrays using nag_wav_3d_coeff_ext (c09fy), and inserted using nag_wav_3d_coeff_ins (c09fz).

5: **icomm**(**260**) – INTEGER array

Contains details of the discrete wavelet transform and the problem dimension as setup in the call to the initialization function nag_wav_3d_init (c09ac).

5.2 Optional Input Parameters

1: **lenc** – INTEGER

Default: the dimension of the array **c**.

The dimension of the array **c**.

Constraint: **lenc** $\geq n_{\mathrm{ct}}$, where n_{ct} is the total number of wavelet coefficients, as returned by nag_wav_3d_init (c09ac).

5.3 Output Parameters

1: **b**($ldb, sdb,$ **fr**) – REAL (KIND=nag_wp) array

$sdb =$ **n**.

The m by n by fr reconstructed array, B, with B_{ijk} stored in **b**(i, j, k). The reconstruction is based on the input wavelet coefficients and the transform options supplied to the initialization function nag_wav_3d_init (c09ac).

2: **ifail** – INTEGER

ifail $= 0$ unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

Constraint: **fr** $= \langle value \rangle$, the value of **fr** on initialization (see nag_wav_3d_init (c09ac)).

Constraint: **m** $= \langle value \rangle$, the value of **m** on initialization (see nag_wav_3d_init (c09ac)).

Constraint: **n** $= \langle value \rangle$, the value of **n** on initialization (see nag_wav_3d_init (c09ac)).

ifail $= 2$

Constraint: $ldb \geq$ **m**.

Constraint: $sdb \geq$ **n**.

ifail $= 3$

Constraint: **lenc** $\geq n_{\mathrm{ct}}$, where n_{ct} is the number of DWT coefficients returned by nag_wav_3d_init (c09ac) in argument **nwct**.

ifail $= 6$

Either the communication array **icomm** has been corrupted or there has not been a prior call to the initialization function nag_wav_3d_init (c09ac).

The initialization function was called with **wtrans** = 'M'.

ifail $= -99$

An unexpected error has been triggered by this routine. Please contact NAG.

ifail $= -399$

Your licence key may have expired or may not have been installed correctly.

ifail $= -999$

Dynamic memory allocation failed.

7 Accuracy

The accuracy of the wavelet transform depends only on the floating-point operations used in the convolution and downsampling and should thus be close to ***machine precision***.

8 Further Comments

None.

9 Example

See Section 10 in nag_wav_3d_sngl_fwd (c09fa).

9.1 Program Text

```
function c09fb_example

fprintf('c09fb example results\n\n');

m  = nag_int(5);
n  = nag_int(4);
fr = nag_int(3);
wavnam = 'Haar';
mode = 'half';
wtrans = 'Single Level';
a = zeros(m, n, fr);
a(:, :, 1) = [3, 2, 2, 2;
              2, 9, 1, 2;
              2, 5, 1, 2;
              1, 6, 2, 2;
              5, 3, 2, 2];
a(:, :, 2) = [2, 1, 5, 1;
              2, 9, 5, 2;
              2, 3, 2, 7;
              2, 1, 1, 2;
              2, 1, 2, 8];
a(:, :, 3) = [3, 1, 4, 1;
              1, 1, 2, 1;
              4, 1, 7, 2;
              3, 2, 1, 5;
              1, 1, 2, 2];

% Query wavelet filter dimensions
[lmax, nf, nwct, nwcn, nwcfr, icomm, ifail] = ...
      c09ac(wavnam, wtrans, mode, m, n, fr);

nwcm = nwct/(8*nwcn*nwcfr);

% 3D DWT decomposition
[c, icomm, ifail] = c09fa(n, fr, a, nwct, icomm);

d = zeros(nwcm, nwcn, nwcfr);

for cindex = 0:7

  % Decide which coefficient type we are considering and advance the
  % pointer locc to the first element of that 3D array in C.
  switch (cindex)
    case {0}
      fprintf('Approximation coefficients (LLL)\n');
      locc = 1;
    case {1}
      fprintf('Detail coefficients (LLH)\n');
```

```
      % Advance pointer past approximation coefficients
      locc = nwcm*nwcn*nwcfr + 1;
    case {2}
      fprintf('Detail coefficients (LHL)\n');
      % Advance pointer past approximation coefficients and 1 set of
      % detail coefficients
      locc = 2*nwcm*nwcn*nwcfr + 1;
    case {3}
      fprintf('Detail coefficients (LHH)\n');
      % Advance pointer past approximation coefficients and 2 sets of
      % detail coefficients
      locc = 3*nwcm*nwcn*nwcfr + 1;
    case {4}
      fprintf('Detail coefficients (HLL)\n');
      % Advance pointer past approximation coefficients and 3 sets of
      % detail coefficients
      locc = 4*nwcm*nwcn*nwcfr + 1;
    case {5}
      fprintf('Detail coefficients (HLH)\n');
      % Advance pointer past approximation coefficients and 4 sets of
      % detail coefficients
      locc = 5*nwcm*nwcn*nwcfr + 1;
    case {6}
      fprintf('Detail coefficients (HHL)\n');
      % Advance pointer past approximation coefficients and 5 sets of
      % detail coefficients
      locc = 6*nwcm*nwcn*nwcfr + 1;
    case {7}
      fprintf('Detail coefficients (HHH)\n');
      % Advance pointer past approximation coefficients and 6 sets of
      % detail coefficients
      locc = 7*nwcm*nwcn*nwcfr + 1;
  end

  for k = 1:nwcfr
    for j = 1:nwcn
      for i = 1:nwcm
        i1 = locc - 1 + (j-1)*nwcfr*nwcm + (i-1)*nwcfr + k;
        d(i,j,k) = c(i1);
      end
    end
  end

  for j = 1:nwcfr
    if (j==1)
      fprintf('Coefficients        Frame 1');
    else
      fprintf('          Frame %d', j);
    end
  end
  fprintf('\n');
  d2 = reshape(d, nwcm, nwcn*nwcfr);
  for i = 1:nwcm
    if i == 1
      fprintf('    %d         ', cindex);
    else
      fprintf('              ');
    end
    for j=1:nwcn*nwcfr
      fprintf('%8.4f ', d2(i,j));
    end
    fprintf('\n');
  end
end

% 3D DWT reconstruction
[b, ifail] = c09fb(m, n, fr, c, icomm);

fprintf('\nOutput Data          b : \n');
```

```
% Convert to int16 to get more compact output
for i=1:nwcm
  fprintf('Frame %d :\n', i);
  disp(b(:, :, i));
end
```

9.2 Program Results

```
     c09fb example results

Approximation coefficients (LLL)
Coefficients        Frame 1          Frame 2
    0          10.6066   7.0711   4.2426   5.6569
                7.7782   6.7175   7.0711  10.6066
                7.7782   9.8995   2.8284   5.6569
Detail coefficients (LLH)
Coefficients        Frame 1          Frame 2
    1           0.7071  -2.1213   0.0000   0.0000
                2.1213  -1.7678   0.0000   0.0000
                3.5355  -4.2426   0.0000   0.0000
Detail coefficients (LHL)
Coefficients        Frame 1          Frame 2
    2          -4.2426   2.1213   1.4142   2.8284
               -2.8284  -2.4749   2.8284   0.7071
                2.1213  -4.2426   0.0000   0.0000
Detail coefficients (LHH)
Coefficients        Frame 1          Frame 2
    3           0.0000  -2.8284   0.0000   0.0000
               -2.8284   1.7678   0.0000   0.0000
                0.7071   4.2426   0.0000   0.0000
Detail coefficients (HLL)
Coefficients        Frame 1          Frame 2
    4          -4.9497   0.0000   1.4142   1.4142
                0.7071   1.7678  -0.0000   2.1213
                0.0000   0.0000   0.0000   0.0000
Detail coefficients (HLH)
Coefficients        Frame 1          Frame 2
    5           0.7071   0.7071   0.0000   0.0000
               -0.7071  -2.4749   0.0000   0.0000
                0.0000   0.0000   0.0000   0.0000
Detail coefficients (HHL)
Coefficients        Frame 1          Frame 2
    6           5.6569   0.7071   1.4142   1.4142
                0.0000  -1.7678   1.4142   6.3640
                0.0000   0.0000   0.0000   0.0000
Detail coefficients (HHH)
Coefficients        Frame 1          Frame 2
    7           0.0000   0.0000   0.0000   0.0000
                1.4142   1.0607   0.0000   0.0000
                0.0000   0.0000   0.0000   0.0000

Output Data          b :
Frame 1 :
    3.0000    2.0000    2.0000    2.0000
    2.0000    9.0000    1.0000    2.0000
    2.0000    5.0000    1.0000    2.0000
    1.0000    6.0000    2.0000    2.0000
    5.0000    3.0000    2.0000    2.0000

Frame 2 :
    2.0000    1.0000    5.0000    1.0000
    2.0000    9.0000    5.0000    2.0000
    2.0000    3.0000    2.0000    7.0000
    2.0000    1.0000    1.0000    2.0000
    2.0000    1.0000    2.0000    8.0000

Frame 3 :
```

```
    3.0000    1.0000    4.0000    1.0000
    1.0000    1.0000    2.0000    1.0000
    4.0000    1.0000    7.0000    2.0000
    3.0000    2.0000    1.0000    5.0000
    1.0000    1.0000    2.0000    2.0000
```