NAG Library Function Document

nag_wav_3d_coeff_ext (c09fyc)

1 Purpose

nag_wav_3d_coeff_ext (c09fyc) extracts a selected set of discrete wavelet transform (DWT) coefficients from the full set of coefficients stored in compact form, as computed by nag_dwt_3d (c09fac) (single level three-dimensional DWT) or nag_mldwt_3d (c09fcc) (multi-level three-dimensional DWT).

2 Specification

```
#include <nag.h>
#include <nagc09.h>
void nag_wav_3d_coeff_ext (Integer ilev, Integer cindex, Integer lenc,
     const double c[], double d[], Integer ldd, Integer sdd, Integer icomm[],
     NagError *fail)
```

3 Description

nag_wav_3d_coeff_ext (c09fyc) is intended to be used after a call to either nag_dwt_3d (c09fac) (single level three-dimensional DWT) or nag_mldwt_3d (c09fcc) (multi-level three-dimensional DWT), either of which must be preceded by a call to nag_wfilt_3d (c09acc) (three-dimensional wavelet filter initialization). Given an initial three-dimensional data set A, a prior call to nag_dwt_3d (c09fac) or nag_mldwt_3d (c09fcc) computes the approximation coefficients (at the highest requested level in the case of nag_mldwt_3d (c09fcc)) and seven sets of detail coefficients (at all levels in the case of nag_mldwt_3d (c09fcc)) and stores these in compact form in a one-dimensional array **c**. nag_wav_3d_coeff_ext (c09fyc) can then extract either the approximation coefficients or one of the sets of detail coefficients (at one of the levels following nag_mldwt_3d (c09fcc)) into a three-dimensional data set stored in **d**.

If a multi-level DWT was performed by a prior call to nag_mldwt_3d (c09fcc) then the dimensions of the three-dimensional data stored in **d** depend on the level extracted and are available from the arrays **dwtlvm**, **dwtlvn** and **dwtlvfr** as returned by nag_mldwt_3d (c09fcc) which contain the first, second and third dimensions respectively.

If a single level DWT was performed by a prior call to nag_dwt_3d (c09fac) then the dimensions of the three-dimensional data stored in **d** can be determined from **nwct**, **nwcn** and **nwcfr** as returned by the setup function nag_wfilt_3d (c09acc).

See Section 2.1 in the c09 Chapter Introduction for a discussion of the three-dimensional DWT.

4 References

None.

5 Arguments

Note: the following notation is used in this section:

n_{cm} is the number of wavelet coefficients in the first dimension. Following a call to nag_dwt_3d (c09fac) (i.e., when **ilev** $= 0$) this is equal to **nwct**$/(8 \times$ **nwcn** $\times$ **nwcfr**$)$ as returned by nag_wfilt_3d (c09acc). Following a call to nag_mldwt_3d (c09fcc) transforming **nwl** levels, and when extracting at level **ilev** > 0, this is equal to **dwtlvm**[**nwl** $-$ **ilev**].

n_{cn} is the number of wavelet coefficients in the second dimension. Following a call to nag_dwt_3d (c09fac) (i.e., when **ilev** $= 0$) this is equal to **nwcn** as returned by nag_wfilt_3d (c09acc).

Following a call to nag_mldwt_3d (c09fcc) transforming **nwl** levels, and when extracting at level **ilev** > 0, this is equal to **dwtlvn**[**nwl** $-$ **ilev**].

n_{cfr} is the number of wavelet coefficients in the third dimension. Following a call to nag_dwt_3d (c09fac) (i.e., when **ilev** $= 0$) this is equal to **nwcfr** as returned by nag_wfilt_3d (c09acc). Following a call to nag_mldwt_3d (c09fcc) transforming **nwl** levels, and when extracting at level **ilev** > 0, this is equal to **dwtlvfr**[**nwl** $-$ **ilev**].

1: **ilev** – Integer *Input*

On entry: the level at which coefficients are to be extracted.

If **ilev** $= 0$, it is assumed that the coefficient array **c** was produced by a preceding call to the single level function nag_dwt_3d (c09fac).

If **ilev** > 0, it is assumed that the coefficient array **c** was produced by a preceding call to the multi-level function nag_mldwt_3d (c09fcc).

Constraints:

ilev $= 0$ (following a call to nag_dwt_3d (c09fac));
$0 \leq$ **ilev** $\leq$ **nwl**, where **nwl** is as used in a preceding call to nag_mldwt_3d (c09fcc);
if **cindex** $= 0$, **ilev** $=$ **nwl** (following a call to nag_mldwt_3d (c09fcc)).

2: **cindex** – Integer *Input*

On entry: identifies which coefficients to extract. The coefficients are identified as follows:

cindex $= 0$
The approximation coefficients, produced by application of the low pass filter over columns, rows and frames of A (LLL). After a call to the multi-level transform function nag_mldwt_3d (c09fcc) (which implies that **ilev** > 0) the approximation coefficients are available only for **ilev** $=$ **nwl**, where **nwl** is the value used in a preceding call to nag_mldwt_3d (c09fcc).

cindex $= 1$
The detail coefficients produced by applying the low pass filter over columns and rows of A and the high pass filter over frames (LLH).

cindex $= 2$
The detail coefficients produced by applying the low pass filter over columns, high pass filter over rows and low pass filter over frames of A (LHL).

cindex $= 3$
The detail coefficients produced by applying the low pass filter over columns of A and high pass filter over rows and frames (LHH).

cindex $= 4$
The detail coefficients produced by applying the high pass filter over columns of A and low pass filter over rows and frames (HLL).

cindex $= 5$
The detail coefficients produced by applying the high pass filter over columns, low pass filter over rows and high pass filter over frames of A (HLH).

cindex $= 6$
The detail coefficients produced by applying the high pass filter over columns and rows of A and the low pass filter over frames (HHL).

cindex $= 7$
The detail coefficients produced by applying the high pass filter over columns, rows and frames of A (HHH).

Constraints:

if **ilev** $= 0$, $0 \leq$ **cindex** ≤ 7;
if **ilev** $=$ **nwl**, following a call to nag_mldwt_3d (c09fcc) transforming **nwl** levels, $0 \leq$ **cindex** ≤ 7;
otherwise $1 \leq$ **cindex** ≤ 7.

3: **lenc** – Integer *Input*

On entry: the dimension of the array **c**.

Constraint: **lenc** must be unchanged from the value used in the preceding call to either nag_dwt_3d (c09fac) or nag_mldwt_3d (c09fcc)..

4: **c**[**lenc**] – const double *Input*

On entry: DWT coefficients, as computed by nag_dwt_3d (c09fac) or nag_mldwt_3d (c09fcc).

5: **d**[*dim*] – double *Output*

Note: the dimension, *dim*, of the array **d** must be at least **ldd** $\times$ **sdd** $\times n_{\text{cfr}}$.

On exit: the requested coefficients.

If the DWT coefficients were computed by nag_dwt_3d (c09fac) then

if **cindex** $= 0$, the approximation coefficients are stored in $\mathbf{d}[(k-1) \times \mathbf{ldd} \times \mathbf{sdd} + (j-1) \times \mathbf{ldd} + i - 1]$, for $i = 1, 2, \ldots, n_{\text{cm}}$, $j = 1, 2, \ldots, n_{\text{cn}}$ and $k = 1, 2, \ldots, n_{\text{cfr}}$;

if $1 \leq$ **cindex** ≤ 7, the detail coefficients, as indicated by **cindex**, are stored in $\mathbf{d}[(k-1) \times \mathbf{ldd} \times \mathbf{sdd} + (j-1) \times \mathbf{ldd} + i - 1]$, for $i = 1, 2, \ldots, n_{\text{cm}}$, $j = 1, 2, \ldots, n_{\text{cn}}$ and $k = 1, 2, \ldots, n_{\text{cfr}}$.

If the DWT coefficients were computed by nag_mldwt_3d (c09fcc) then

if **cindex** $= 0$ and **ilev** $=$ **nwl**, the approximation coefficients are stored in $\mathbf{d}[(k-1) \times \mathbf{ldd} \times \mathbf{sdd} + (j-1) \times \mathbf{ldd} + i - 1]$, for $i = 1, 2, \ldots, n_{\text{cm}}$, $j = 1, 2, \ldots, n_{\text{cn}}$ and $k = 1, 2, \ldots, n_{\text{cfr}}$;

if $1 \leq$ **cindex** ≤ 7, the detail coefficients, as indicated by **cindex**, for level **ilev** are stored in $\mathbf{d}[(k-1) \times \mathbf{ldd} \times \mathbf{sdd} + (j-1) \times \mathbf{ldd} + i - 1]$, for $i = 1, 2, \ldots, n_{\text{cm}}$, $j = 1, 2, \ldots, n_{\text{cn}}$ and $k = 1, 2, \ldots, n_{\text{cfr}}$.

6: **ldd** – Integer *Input*

On entry: the stride separating row elements of each of the sets of frame coefficients in the three-dimensional data stored in **d**.

Constraint: **ldd** $> n_{\text{cm}}$.

7: **sdd** – Integer *Input*

On entry: the stride separating corresponding coefficients of consecutive frames in the three-dimensional data stored in **d**.

Constraint: **sdd** $> n_{\text{cn}}$.

8: **icomm**[**260**] – Integer *Communication Array*

On entry: contains details of the discrete wavelet transform and the problem dimension as setup in the call to the initialization function nag_wfilt_3d (c09acc).

9: **fail** – NagError * *Input/Output*

The NAG error argument (see Section 3.6 in the Essential Introduction).

6 Error Indicators and Warnings

NE_ALLOC_FAIL

Dynamic memory allocation failed.

NE_BAD_PARAM

On entry, argument ⟨*value*⟩ had an illegal value.

NE_INITIALIZATION

Either the initialization function has not been called first or **icomm** has been corrupted.

NE_INT

On entry, **cindex** = ⟨*value*⟩.
Constraint: **cindex** ≤ 7.

On entry, **cindex** = ⟨*value*⟩.
Constraint: **cindex** ≥ 0.

On entry, **ilev** = ⟨*value*⟩.
Constraint: **ilev** $= 0$ following a call to the single level function nag_dwt_3d (c09fac).

On entry, **ilev** = ⟨*value*⟩.
Constraint: **ilev** > 0 following a call to the multi-level function nag_mldwt_3d (c09fcc).

NE_INT_2

On entry, **ilev** = ⟨*value*⟩ and **nwl** = ⟨*value*⟩.
Constraint: **ilev** $\leq$ **nwl**, where **nwl** is the number of levels used in the call to nag_mldwt_3d (c09fcc).

On entry, **ldd** = ⟨*value*⟩ and n_{cm} = ⟨*value*⟩.
Constraint: **ldd** $\geq n_{\mathrm{cm}}$, where n_{cm} is the number of DWT coefficients in the first dimension following the single level transform.

On entry, **lenc** = ⟨*value*⟩ and n_{ct} = ⟨*value*⟩.
Constraint: **lenc** $\geq n_{\mathrm{ct}}$, where n_{ct} is the number of DWT coefficients computed in the preceding call to nag_dwt_3d (c09fac).

On entry, **lenc** = ⟨*value*⟩ and n_{ct} = ⟨*value*⟩.
Constraint: **lenc** $\geq n_{\mathrm{ct}}$, where n_{ct} is the number of DWT coefficients computed in the preceding call to nag_mldwt_3d (c09fcc).

On entry, **sdd** = ⟨*value*⟩ and n_{cn} = ⟨*value*⟩.
Constraint: **sdd** $\geq n_{\mathrm{cn}}$, where n_{cn} is the number of DWT coefficients in the second dimension following the single level transform.

NE_INT_3

On entry, **ilev** = ⟨*value*⟩ and **nwl** = ⟨*value*⟩, but **cindex** $= 0$.
Constraint: **cindex** > 0 when **ilev** $<$ **nwl** in the preceding call to nag_mldwt_3d (c09fcc).

On entry, **ldd** = ⟨*value*⟩ and n_{cm} = ⟨*value*⟩.
Constraint: **ldd** $\geq n_{\mathrm{cm}}$, where n_{cm} is the number of DWT coefficients in the first dimension at the selected level **ilev**.

On entry, **sdd** = ⟨*value*⟩ and n_{cn} = ⟨*value*⟩.
Constraint: **sdd** $\geq n_{\mathrm{cn}}$, where n_{cn} is the number of DWT coefficients in the second dimension at the selected level **ilev**.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

7 Accuracy

Not applicable.

8 Parallelism and Performance

Not applicable.

9 Further Comments

None.

10 Example

See Section 10 in nag_wfilt_3d (c09acc), nag_dwt_3d (c09fac), nag_mldwt_3d (c09fcc) and nag_wav_3d_coeff_ins (c09fzc).