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** $\times n_{\mathrm{cfr}}$.

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 **d**$[(k-1) \times$ **ldd** $\times$ **sdd** $+ (j-1) \times$ **ldd** $+ i - 1]$, for $i = 1, 2, \ldots, n_{\mathrm{cm}}$, $j = 1, 2, \ldots, n_{\mathrm{cn}}$ and $k = 1, 2, \ldots, n_{\mathrm{cfr}}$;

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

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

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

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

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** $\geq n_{\mathrm{cm}}$.

7: **sdd** – Integer *Input*

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

Constraint: **sdd** $\geq n_{\mathrm{cn}}$.

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 2.7 in How to Use the NAG Library and its Documentation).

6 Error Indicators and Warnings

NE_ALLOC_FAIL

Dynamic memory allocation failed.
See Section 3.2.1.2 in How to Use the NAG Library and its Documentation for further information.

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.

An unexpected error has been triggered by this function. Please contact NAG.
See Section 3.6.6 in How to Use the NAG Library and its Documentation for further information.

NE_NO_LICENCE

Your licence key may have expired or may not have been installed correctly.
See Section 3.6.5 in How to Use the NAG Library and its Documentation for further information.

7 Accuracy

Not applicable.

8 Parallelism and Performance

nag_wav_3d_coeff_ext (c09fyc) is not threaded in any implementation.

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).