NAG Library Function Document

nag_imldwt_3d (c09fdc)

1 Purpose

nag_imldwt_3d (c09fdc) computes the inverse three-dimensional multi-level discrete wavelet transform (IDWT). This function reconstructs data from (possibly filtered or otherwise manipulated) wavelet transform coefficients calculated by nag_mldwt_3d (c09fcc) from an original input array. The initialization function nag_wfilt_3d (c09acc) must be called first to set up the IDWT options.

2 Specification

```
#include <nag.h>
#include <nagc09.h>
void nag_imldwt_3d (Integer nwlinv, Integer lenc, const double c[],
     Integer m, Integer n, Integer fr, double b[], Integer ldb, Integer sdb,
     const Integer icomm[], NagError *fail)
```

3 Description

nag_imldwt_3d (c09fdc) performs the inverse operation of nag_mldwt_3d (c09fcc). That is, given a set of wavelet coefficients, computed up to level n_{fwd} by nag_mldwt_3d (c09fcc) using a DWT as set up by the initialization function nag_wfilt_3d (c09acc), on a real three-dimensional array, A, nag_imldwt_3d (c09fdc) will reconstruct A. The reconstructed array is referred to as B in the following since it will not be identical to A when the DWT coefficients have been filtered or otherwise manipulated prior to reconstruction. If the original input array is level 0, then it is possible to terminate reconstruction at a higher level by specifying fewer than the number of levels used in the call to nag_mldwt_3d (c09fcc). This results in a partial reconstruction.

4 References

Wang Y, Che X and Ma S (2012) Nonlinear filtering based on 3D wavelet transform for MRI denoising *URASIP Journal on Advances in Signal Processing* **2012:40**

5 Arguments

1: **nwlinv** – Integer *Input*

On entry: the number of levels to be used in the inverse multi-level transform. The number of levels must be less than or equal to n_{fwd}, which has the value of argument **nwl** as used in the computation of the wavelet coefficients using nag_mldwt_3d (c09fcc). The data will be reconstructed to level (**nwl** – **nwlinv**), where level 0 is the original input dataset provided to nag_mldwt_3d (c09fcc).

Constraint: $1 \leq$ **nwlinv** $\leq$ **nwl**, where **nwl** is the value used in a preceding call to nag_mldwt_3d (c09fcc).

2: **lenc** – Integer *Input*

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

Constraint: **lenc** $\geq n_{\text{ct}}$, where n_{ct} is the total number of wavelet coefficients that correspond to a transform with **nwlinv** levels.

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

On entry: the coefficients of the multi-level discrete wavelet transform. This will normally be the result of some transformation on the coefficients computed by function nag_mldwt_3d (c09fcc).

Note that the coefficients in **c** may be extracted according to level and type into three-dimensional arrays using nag_wav_3d_coeff_ext (c09fyc), and inserted using nag_wav_3d_coef f_ins (c09fzc).

4: **m** – Integer *Input*

On entry: the number of elements, m, in the first dimension of the reconstructed array B. For a full reconstruction of **nwl** levels, where **nwl** is as supplied to nag_mldwt_3d (c09fcc), this must be the same as argument **m** used in a preceding call to nag_mldwt_3d (c09fcc). For a partial reconstruction of **nwlinv** $<$ **nwl** levels, this must be equal to **dwtlvm**[**nwlinv**], as returned from nag_mldwt_3d (c09fcc)

5: **n** – Integer *Input*

On entry: the number of elements, n, in the second dimension of the reconstructed array B. For a full reconstruction of **nwl**, levels, where **nwl** is as supplied to nag_mldwt_3d (c09fcc), this must be the same as argument **n** used in a preceding call to nag_mldwt_3d (c09fcc). For a partial reconstruction of **nwlinv** $<$ **nwl** levels, this must be equal to **dwtlvn**[**nwlinv**], as returned from nag_mldwt_3d (c09fcc).

6: **fr** – Integer *Input*

On entry: the number of elements, fr, in the third dimension of the reconstructed array B. For a full reconstruction of **nwl** levels, where **nwl** is as supplied to nag_mldwt_3d (c09fcc), this must be the same as argument **fr** used in a preceding call to nag_mldwt_3d (c09fcc). For a partial reconstruction of **nwlinv** $<$ **nwl** levels, this must be equal to **dwtlvfr**[**nwlinv**], as returned from nag_mldwt_3d (c09fcc).

7: **b**[dim] – double *Output*

Note: the dimension, *dim*, of the array **b** must be at least **ldb** $\times$ **sdb** $\times$ **fr**.

On exit: the m by n by fr reconstructed array, B, with B_{ijk} stored in **b**$[(k-1) \times$ **ldb** $\times$ **sdb** $+ (j-1) \times$ **ldb** $+ i - 1]$. The reconstruction is based on the input multi-level wavelet transform coefficients and the transform options supplied to the initialization function nag_wfilt_3d (c09acc).

8: **ldb** – Integer *Input*

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

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

9: **sdb** – Integer *Input*

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

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

10: **icomm**[**260**] – const 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).

11: **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 communication array **icomm** has been corrupted or there has not been a prior call to the initialization function nag_wfilt_3d (c09acc).

The initialization function was called with **wtrans** = Nag_SingleLevel.

NE_INT

On entry, **fr** = ⟨*value*⟩.
Constraint: **fr** ≥ ⟨*value*⟩, the number of coefficients in the third dimension at the required level of reconstruction.

On entry, **m** = ⟨*value*⟩.
Constraint: **m** ≥ ⟨*value*⟩, the number of coefficients in the first dimension at the required level of reconstruction.

On entry, **n** = ⟨*value*⟩.
Constraint: **n** ≥ ⟨*value*⟩, the number of coefficients in the second dimension at the required level of reconstruction.

On entry, **nwlinv** = ⟨*value*⟩.
Constraint: **nwlinv** ≥ 1.

NE_INT_2

On entry, **ldb** = ⟨*value*⟩ and **m** = ⟨*value*⟩.
Constraint: **ldb** ≥ **m**.

On entry, **lenc** = ⟨*value*⟩.
Constraint: **lenc** ≥ ⟨*value*⟩, the number of wavelet coefficients required for a transform operating on **nwlinv** levels. If **nwlinv** = **nwlmax**, the maximum number of levels as returned by the initial call to nag_wfilt_3d (c09acc), then **lenc** must be at least n_{ct}, the value returned in **nwct** by the same call to nag_wfilt_3d (c09acc).

On entry, **nwlinv** = ⟨*value*⟩ and **nwl** = ⟨*value*⟩ where **nwl** is as used in the computation of the wavelet coefficients by a call to nag_mldwt_3d (c09fcc).
Constraint: **nwlinv** ≤ **nwl** as used in the call to nag_mldwt_3d (c09fcc).

On entry, **sdb** = ⟨*value*⟩ and **n** = ⟨*value*⟩.
Constraint: **sdb** ≥ **n**.

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

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 Parallelism and Performance

nag_imldwt_3d (c09fdc) is not threaded in any implementation.

9 Further Comments

None.

10 Example

See Section 10 in nag_mldwt_3d (c09fcc).