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 $(\mathbf{nwl} - \mathbf{nwlinv})$, where level 0 is the original input dataset provided to nag_mldwt_3d (c09fcc).

Constraint: $1 \leq \mathbf{nwlinv} \leq \mathbf{nwl}$, 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: $\mathbf{lenc} \geq n_{\text{ct}}$, 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_coeff_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 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 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** $\geq$ ⟨*value*⟩, the number of coefficients in the third dimension at the required level of reconstruction.

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

On entry, **n** = ⟨*value*⟩.
Constraint: **n** $\geq$ ⟨*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** $\geq$ **m**.

On entry, **lenc** = ⟨*value*⟩.
Constraint: **lenc** $\geq$ ⟨*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** $\leq$ **nwl** as used in the call to nag_mldwt_3d (c09fcc).

On entry, **sdb** = ⟨*value*⟩ and **n** = ⟨*value*⟩.
Constraint: **sdb** $\geq$ **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.

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

Not applicable.

9 Further Comments

None.

10 Example

See Section 10 in nag_mldwt_3d (c09fcc).