NAG Library Routine Document

C09FDF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

C09FDF computes the inverse three-dimensional multi-level discrete wavelet transform (IDWT). This routine reconstructs data from (possibly filtered or otherwise manipulated) wavelet transform coefficients calculated by C09FCF from an original input array. The initialization routine C09ACF must be called first to set up the IDWT options.

2 Specification

```
SUBROUTINE C09FDF (NWLINV, LENC, C, M, N, FR, B, LDB, SDB, ICOMM, IFAIL)
INTEGER            NWLINV, LENC, M, N, FR, LDB, SDB, ICOMM(260), IFAIL
REAL (KIND=nag_wp) C(LENC), B(LDB,SDB,FR)
```

3 Description

C09FDF performs the inverse operation of C09FCF. That is, given a set of wavelet coefficients, computed up to level n_{fwd} by C09FCF using a DWT as set up by the initialization routine C09ACF, on a real three-dimensional array, A, C09FDF 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 C09FCF. 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 Parameters

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 parameter NWL as used in the computation of the wavelet coefficients using C09FCF. The data will be reconstructed to level (NWL – NWLINV), where level 0 is the original input dataset provided to C09FCF.

Constraint: $1 \leq \mathrm{NWLINV} \leq \mathrm{NWL}$, where NWL is the value used in a preceding call to C09FCF.

2: LENC – INTEGER *Input*

On entry: the dimension of the array C as declared in the (sub)program from which C09FDF is called.

Constraint: $\mathrm{LENC} \geq n_{\mathrm{ct}}$, where n_{ct} is the total number of wavelet coefficients that correspond to a transform with NWLINV levels.

3: C(LENC) – REAL (KIND=nag_wp) array *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 routine C09FCF.

Note that the coefficients in C may be extracted according to level and type into three-dimensional arrays using C09FYF, and inserted using C09FZF.

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 C09FCF, this must be the same as parameter M used in a preceding call to C09FCF. For a partial reconstruction of NWLINV $<$ NWL levels, this must be equal to DWTLVM(NWLINV $+ 1$), as returned from C09FCF

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 C09FCF, this must be the same as parameter N used in a preceding call to C09FCF. For a partial reconstruction of NWLINV $<$ NWL levels, this must be equal to DWTLVN(NWLINV $+ 1$), as returned from C09FCF.

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 C09FCF, this must be the same as parameter FR used in a preceding call to C09FCF. For a partial reconstruction of NWLINV $<$ NWL levels, this must be equal to DWTLVFR(NWLINV $+ 1$), as returned from C09FCF.

7: B(LDB, SDB, FR) – REAL (KIND=nag_wp) array *Output*

On exit: 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 multi-level wavelet transform coefficients and the transform options supplied to the initialization routine C09ACF.

8: LDB – INTEGER *Input*

On entry: the first dimension of the array B as declared in the (sub)program from which C09FDF is called.

Constraint: LDB $\geq$ M.

9: SDB – INTEGER *Input*

On entry: the second dimension of the array B as declared in the (sub)program from which C09FDF is called.

Constraint: SDB $\geq$ N.

10: ICOMM(260) – INTEGER array *Communication Array*

On entry: contains details of the discrete wavelet transform and the problem dimension as setup in the call to the initialization routine C09ACF.

11: IFAIL – INTEGER *Input/Output*

On entry: IFAIL must be set to 0, -1 or 1. If you are unfamiliar with this parameter you should refer to Section 3.3 in the Essential Introduction for details.

For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, if you are not familiar with this parameter, the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

On exit: IFAIL $= 0$ unless the routine detects an error or a warning has been flagged (see Section 6).

6 Error Indicators and Warnings

If on entry IFAIL $= 0$ or -1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL $= 1$

On entry, NWLINV $= \langle value \rangle$.
Constraint: NWLINV ≥ 1.

On entry, NWLINV $= \langle value \rangle$ and NWL $= \langle value \rangle$ where NWL is as used in the computation of the wavelet coefficients by a call to C09FCF.
Constraint: NWLINV $\leq$ NWL as used in the call to C09FCF.

IFAIL $= 2$

On entry, LDB $= \langle value \rangle$ and M $= \langle value \rangle$.
Constraint: LDB $\geq$ M.

On entry, SDB $= \langle value \rangle$ and N $= \langle value \rangle$.
Constraint: SDB $\geq$ N.

IFAIL $= 3$

On entry, LENC $= \langle value \rangle$.
Constraint: LENC $\geq \langle value \rangle$, 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 C09ACF, then LENC must be at least n_{ct}, the value returned in NWCT by the same call to C09ACF.

IFAIL $= 4$

On entry, FR $= \langle value \rangle$.
Constraint: FR $\geq \langle value \rangle$, the number of coefficients in the third dimension at the required level of reconstruction.

On entry, M $= \langle value \rangle$.
Constraint: M $\geq \langle value \rangle$, the number of coefficients in the first dimension at the required level of reconstruction.

On entry, N $= \langle value \rangle$.
Constraint: N $\geq \langle value \rangle$, the number of coefficients in the second dimension at the required level of reconstruction.

IFAIL $= 6$

Either the communication array ICOMM has been corrupted or there has not been a prior call to the initialization routine C09ACF.

The initialization routine was called with WTRANS = 'S'.

IFAIL $= -99$

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

See Section 3.8 in the Essential Introduction for further information.

IFAIL $= -399$

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

See Section 3.7 in the Essential Introduction for further information.

IFAIL $= -999$

Dynamic memory allocation failed.

See Section 3.6 in the Essential Introduction 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

Not applicable.

9 Further Comments

None.

10 Example

See Section 10 in C09FCF.