Operator `CALC_SPEC`

1 Goal

To build whole or part of a matrix inter spectral or transfer starting from functions or of a function table.

When the selected user to return a series of functions, those Ci are used completely. When the selected user to return one `table_fonction`, the stored functions can be cut out, realised and fenestrated, with a given covering.

To clear up the matter, it is supposed that the user has 2 functions A and B. If it chooses to use the operator starting from functions, the definition of the interspectre G_{AB} that it will calculate will necessarily be

$$G_{AB}=\frac{1}{N_A}FFT(A)*FFT(B)^{H.} .$$

Where N_A is the number of points contained in the vector A. If it chooses to build one `table_fonction` with the functions A and B, it will be able to extract N under vectors $A_{1,} \dots, A_N$ vector A (resp. $B_{1,} \dots, B_N$ vector B), and to calculate an realised interspectre G_{AB} such as

$$G_{AB}=\frac{1}{N_A}\left(\frac{1}{N}\sum_{k=1}^{N} FFT(A_k)*FFT(B_k)^{H.}\right) .$$

The functions read are of type `sd_fonction`.

The produced concept is of type `interspectre`.

It is possible to exploit this operator in a command file *Code_Aster,* but also in an interactive way by the means of the operator `CALC_ESSAI` (U4.90.01).

Contents

2 Syntax

```
int [ interspectre ] = CALC_SPEC
   (  ♦  /  TAB_ECHANT   =_F (
             ♦  NOM_TAB      =nom                         [table_fonction],

             ◊  /  LONGUEUR_DUREE      =                /  [R]
                /  LONGUEUR_POURCENT   =                /  [R]
                /  LONGUEUR_NB_PTS     =                /  [I]

             ◊  /  RECOUVREMENT_DUREE  =                /  [R]
                /  RECOUVREMENT_POURCENT  =             /  [R]
                /  RECOUVREMENT_NB_PTS    =             /  [I]
                                  ),

         /  ECHANT    =_F (
             ♦  FUNCTION     =  fonc                    /  [fonction_sdaster]

             ♦  NUME_ORDRE_I =                          /  [I]

             ♦  NUME_MES     =                          /  [I]
                       ),

      ♦  /  INTERSPE  =_F (
             ◊   WINDOW   =  /   'RECT'                    [DEFECT]
                             /   'HAMM'
                             /   'HANN'
                             /   'EXHIBITION'
                             /   'SHARE'

             ◊   DEFI_FENE   =                          /  [l_R]
                       ),

         /  TRANSFER  =_F (
             ◊   ESTIM    =  /   'H1'                      [DEFECT]
                             /   'H2'
                             /   'CO'

             ♦   REFER    =                                [l_I]

             ◊   WINDOW   =  /   'RECT'                    [DEFECT]
                             /   'HAMM'
                             /   'HANN'
                             /   'EXHIBITION'
                             /   'SHARE'

             ◊   DEFI_FENE=                             /  [l_R]
                       ),

      ◊ TITLE    =   name                                  /   [TXM]

   )
```

3 Keywords

3.1 Keyword TAB_ECHANT

Defines `table_fonction` temporal samples and associated parameters of treatment of the signal. Cannot be associated with the keyword `ECHANT`.

3.1.1 Keyword NOM_TAB

Name of `table_fonction` in which the samples are stored. One can specify one name of `table_fonction` as starter to carry out calculations.

Functions stored in `table_fonction` correspond to the results of measurement, true or simulated, who are used as a basis for calculation of the matrix of spectral concentration. All functions stored in `table_fonction` must be defined with the same sampling rate.

NB: `table_fonction` must associate a sequence number and a number of measurement with each function (see sections 3.2.2 and 3.2.3 for the significance of these parameters)

3.1.2 Keywords LONGUEUR_DUREE/LONGUEUR_POURCENT/LONGUEUR_NB_PTS

The length of the subsamples defines which will be retained for the treatment of the signal. If the keyword is not indicated, the length of the smallest sample available is affected by default. If the specified length is shorter than the length of the smallest sample, one cuts out the total sample in as much length than the specified length. This length can be specified in three different ways:

- `LONGUEUR_DUREE` : One defines the length of the sample by their duration, expressed in the same unit as that used for the vector defining the moments.
- `LONGUEUR_POURCENT` : One defines the length of the sample as a percentage overall length.
- `LONGUEUR_NB_PTS` : One defines the length of the sample starting from the number of point which one wishes to retain.

3.1.3 Keyword RECOUVREMENT_DUREE/RECOUVREMENT_POURCENT/RECOUVREMENT_NB_PTS

The length of covering between two subsample defines which will be retained for the treatment of the signal. If the keyword is not indicated, there is no covering, the initial sample corresponds to the juxtaposition of the subsamples. This length can be specified in three different ways:

- `RECOUVREMENT_DUREE`: One defines the length of the sample by their duration, expressed in the same unit as that used for the vector defining the moments.
- `RECOUVREMENT_POURCENT` : One defines the length of the sample as a percentage overall length.
- `RECOUVREMENT_NB_PTS` : One defines the length of the sample starting from the number of points which one wishes to retain.

The figure 3.1.3-1 illustrate the cutting and the fenestration of an initial sample under fenestrated samples.

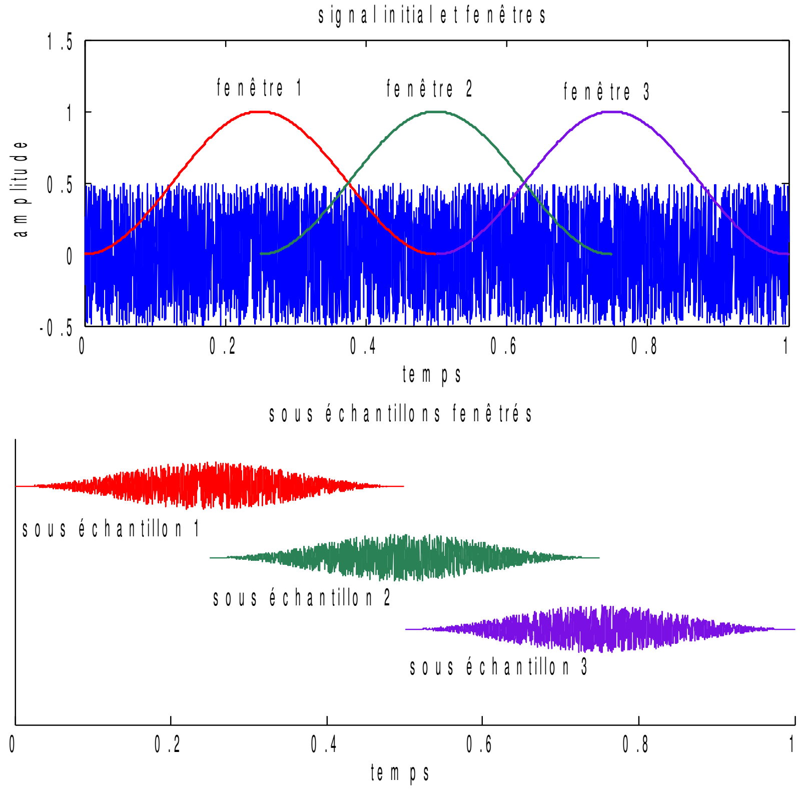

Figure 3.1.3-1: illustration of the cutting and the fenestration of an initial sample. The window applied is of Hanning type, with a covering of 50% between under samples.

3.2 Keyword ECHANT

Keyword factor where the functions used for the treatment of the signal are defined. Cannot be used jointly with the keyword TAB_ECH

3.2.1 Keyword FUNCTION

Name of the function containing the temporal sample.

3.2.2 Keyword NUME_ORDRE_I

The sequence number of the temporal sample defines (for example, a number of sensor, way of measurement, or point on a grid). This obligatory keyword is used to locate the interspectres or the transfers in the concept interspectre result

3.2.3 Keyword NUME_MES

The number of measurement of the sample defines. This obligatory keyword is used to locate measurements which would be carried out simultaneously, or with the same reference of phase, so that the average of the spectra is licit. If two samples have the same number of measurement, that means that they were acquired simultaneously. It is then possible to fulfill interspectres and transfer functions transfer of the one compared to the other. In another case, it is impossible, because of absence of reference of phase between the two signals.

3.3 Keyword INTERSPEC

Calculate the matrix of spectral concentration (or inter spectral) starting from the provided temporal samples.

3.3.1 Keyword WINDOW

Defines the type of window to apply to the temporal sample. The size of the window is adapted to the length of the sample or the subsamples, according to the treated case. Keyword to be chosen among:

- RECT: Defines a rectangular window on the sample.
- HAMM: A window of Hamming defines.
- HANN: A window of Hanning defines.
- EXHIBITION: Defines a decreasing exponential window. The keyword should then be informed DEFI_FENE.
- SHARE: Allows the user to define his window starting from a list of real data in the keyword DEFI_FENE. The list must be of the same length than the samples or subsamples considered.

3.3.2 Keyword DEFI_FENE

Allows the user to provide the necessary information when the keyword WINDOW takes the values 'EXPOSITION' or 'PART'.

- 'EXPOSITION': The list draws up of exactly two values. The first corresponds to the number of point for which the window takes value 1. The second corresponds to the slope of exponential in the beginning. These two sizes are illustrated on the figure 3.3.2-1.
- 'PART': The window is defined by a list of real re-entry by the user.

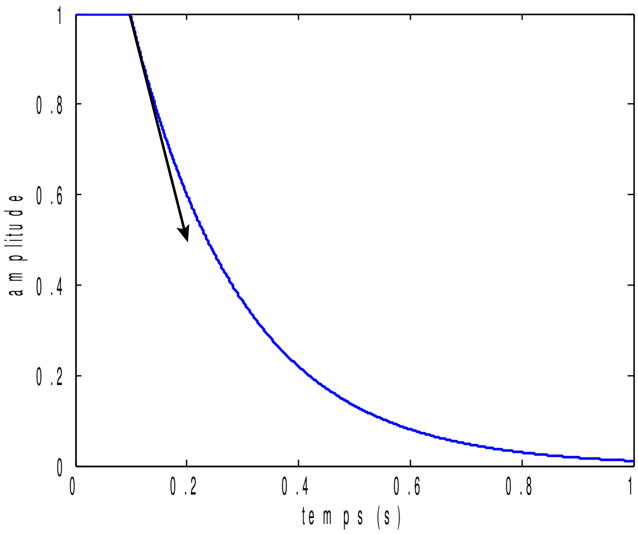

Figure 3.3.2-1: Definition of the parameters of DEFI_FENE: width (of number of point) of the initial plate, and slope at the origin of the exponential one.

3.4 Keyword **TRANSFER**

Calculate the transfer transfer functions starting from the provided temporal samples.

3.4.1 Keyword **ESTIM**

Defines the estimator to use for the calculation of the transfer transfer functions. To choose among:

- `H1`: Use the estimator $H1$
- `H2`: Use the estimator $H2$.
- `CO`: Calculate coherence between the estimators $H1$ and $H2$.

For memory, if one has two signals A and B , the estimator $H1$ transfer transfer function A/B east defines by:

$$H1(A/B)=G_{AB}/G_{BB} ,$$

And the estimator $H2$ by:

$$H2(A/B)=G_{AA}/G_{AB} ,$$

Where G_{AB} is the interspectre between the signals A and B . Coherence is defined by:

$$CO(A/B)=|H1/H2| .$$

The estimator $H1$ minimize the influence of noises on the measured exits, and $H2$ minimize the influence of the noises likely to appear to the measures of the entries.

3.4.2 Keyword **REFER**

List of entireties which define measurements of references for the calculation of the transfers. The entireties used correspond to the sequence number of the temporal samples.

3.4.3 Keyword **WINDOW**

Defines the type of window to apply to the temporal sample. See section 3.3.1.

3.4.4 Keyword **DEFI_FENE**

Allows the user to provide the necessary information when the keyword `WINDOW` takes the values '`EXPOSITION`' or '`PART`'. See section 3.3.2.

3.5 Keyword **TITLE**

The title associated with the structure of data defines `interspectre` where the results are stored.

4 Examples

These examples are drawn from the case test zzzz241a.

4.1 Calculation of matrix inter spectral from one table_fonction

The temporal answers can be stored in the form of lists in a separated file, or built on the basis of calculation. One supposes here to have four answers, of respective names REP_1, REP_2, REP_3 and REP_4. It is supposed that all these measurements were carried out simultaneously. In the contrary case, it would be necessary to define a number of measurement per batch of simultaneous acquisitions.

```
# These four answers are initially stored in one table_fonction :
tab_rep=CRÉA_TABLE (LISTE= (_F (PARA=' NOM_CHAM', LISTE_K=' Rep_Temp',),


# One defines the various numbers of measurements,
# associated with particular sensors, or DDL
                            _F (PARA=' NUMÉRIQUE_ORDRE_I', LISTE_I= (1,2,3,4),),


# One defines the numbers of measurements. Here, 4 measurements are simultaneous,
# they thus have the same number:
                            _F (PARA=' NUMÉRIQUE_MES', LISTE_I= (1,1,1,1),),


# One defines the functions starting from the temporal samples.
                            _F (PARA=' FONCTION',
                               LISTE_K= ('REP_1', 'REP_2', 'REP_3', 'REP_4'),),
                               ),
                            TITRE=”,
                        TYPE_TABLE='table_fonction',
                    )
# One then selected to calculate the matrix interspectrale in
# cutting out each sample in subsamples of 1201 points
# the long ones, with a 6 seconds covering, and balanced each one by
# a window of Hanning

SPEC=CALC_SPEC (TAB_ECHANT=_F (NOM_TAB=tab_rep,
                              LONGUEUR_NB_PTS=1201,
                              RECOUVREMENT_DUREE=6,),
                              INTERSPE= (_F (FENETRE=' HANN',),),
                                )
```

4.2 Calculation of transfer transfer function starting from functions

The temporal answers can be stored in the form of lists in a separated file, or built on the basis of calculation. One supposes here to have two measurements carried out at different moments. On the one hand, a signal of excitation `EXC_1`, and an answer `REP_1` are acquired simultaneously. That can be the response to a shock, or an excitation per vibrating pot. In addition, a signal of excitation `EXC_2`, and the associated answer `REP_2` are also acquired simultaneously. In both cases, the signal of excitation was applied to the same point. The answers are measured at two different places. The point of excitation to the sequence number 1, the point associated with the first measures number 2, and the point associated with the second measures number 3. The calculation of the transfer transfer functions 2/1 and 3/1 is carried out as follows:

Calculation of the transfer from the impulse response:

```
FRF1_IMP=CALC_SPEC (ECHANT= (
```

Definition of the various temporal samples

```
                                    _F (NUME_ORDRE_I = 1,
                                        NUME_MES=1,
                                        FONCTION=REP_1,),
                                    _F (NUME_ORDRE_I = 2,
                                        NUME_MES=1,
                                        FONCTION=REP_1,),
                                    _F (NUME_ORDRE_I = 1,
                                        NUME_MES=2,
                                        FONCTION=EXC_2,),
                                    _F (NUME_ORDRE_I = 3,
                                        NUME_MES=2,
                                        FONCTION=REP_2,),
                                        ),
```

Definition of the parameters for the calculation of the transfers:

Choice of the estimator:

```
                                        TRANSFERT= (_F (ESTIM=' H1',
```

Choice of the window to be applied:

```
                                                        FENETRE=' EXPOSITION',
```

Definition complementary to the window:

```
                                                        DEFI_FENE= (10, - 0.02),
```

Definition of the sequence numbers associated with the points of reference:

```
                                        REFER=1,),
                                    ),
                            )
```

By using the functions directly, rather than the passage by the setting in data in one `table_fonction`, the user does not reach the possibilities of average over the length of the signal. With this intention, either it defines itself the sub-functions, by preserving this same formalism of entry, or it fills one `table_fonction`, and uses the formalism presented in section 4.1.