Project S6 – Data base of the Italian strong-motion data relative to the period 1972-2004

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TASK 2 - Deliverable 4

Software for strong-motion data display and processing

Authors

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1. INTRODUCTION

The deliverable 4 is composed by a set of routines created to read and process the time series stored in the data base format, that is an ASCII file with a 43 row header, with the name codified as specified in the Deliverable 1. The files can also be read in SAC format.

In order to run the routines, one should copy all the files contained in the .zip file in a local directory and add the directory path in Matlab (use command *addpath*or or *File …Set Path…*). Once the path has been set, in order to run the routines the user should write *itaca* at the Matlab prompt.

The input mask of figure 1 will appear, asking for the files and file format.

There are two possibilities

- add the files one by one (the three components)
- read form an ASCII file containing the list of the files that have to be processed (the files are listed with groups of three components).

As en example, the ASCII file containing the list can have the following format:

```
19980405_155221ITDPC_ANNI_NSC.DAT
19980405_155221ITDPC_ANNI_UPC.DAT
19980405_155221ITDPC_ANNI_WEC.DAT
19980405_155221ITDPC_ASS__NSC.DAT
19980405_155221ITDPC_ASS__UPC.DAT
19980405_155221ITDPC_ASS__WEC.DAT
19980405_155221ITDPC_BVG__NSC.DAT
19980405_155221ITDPC_BVG__UPC.DAT
19980405_155221ITDPC_BVG__WEC.DAT
19980405_155221ITDPC_CAG__NSC.DAT
19980405_155221ITDPC_CAG__UPC.DAT
19980405_155221ITDPC_CAG__WEC.DAT
19980405_155221ITDPC_CESV_NSC.DAT
19980405_155221ITDPC_CESV_UPC.DAT
19980405_155221ITDPC_CESV_WEC.DAT
```
…………………..

Advice: before starting the itaca routine change the directory to the one containing the files to be processed. Then run itaca. It will be easier to retrieve the single files or the list.
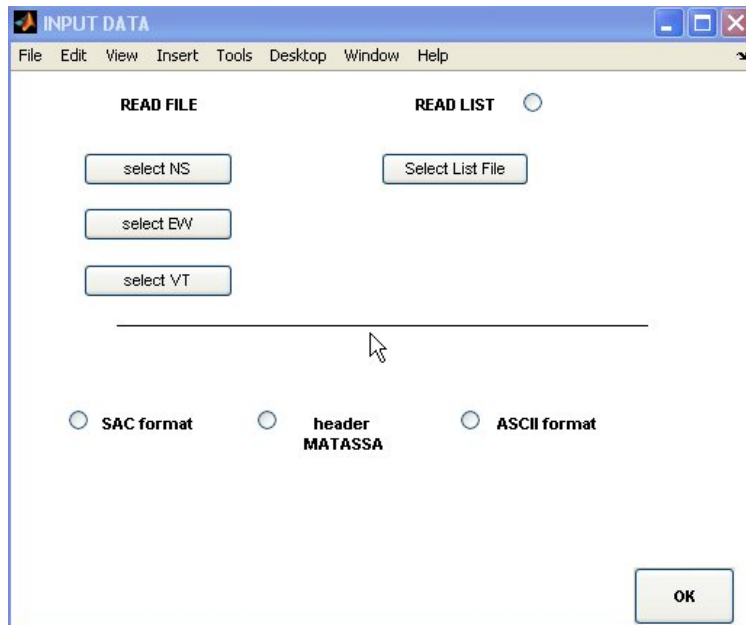
Figure 1: data input mask

Step one, the files:

- to read a list: check the radiobutton *READ LIST* and press the button *Select List File* (then select the ASCII file containg the list of the acceleration files)

- to read the three components separately: one by one press *Select NS*, *Select WE*, *Select UP*

Step 2, file format:

SAC format reads files in a SAC format

ITACA reads ASCII files with 43 row header

ASCII format (inactive), should read any ASCII format

2. PROCESSING OPTIONS

The main program window displays the three components, the display options and the processing options (Figure 2).
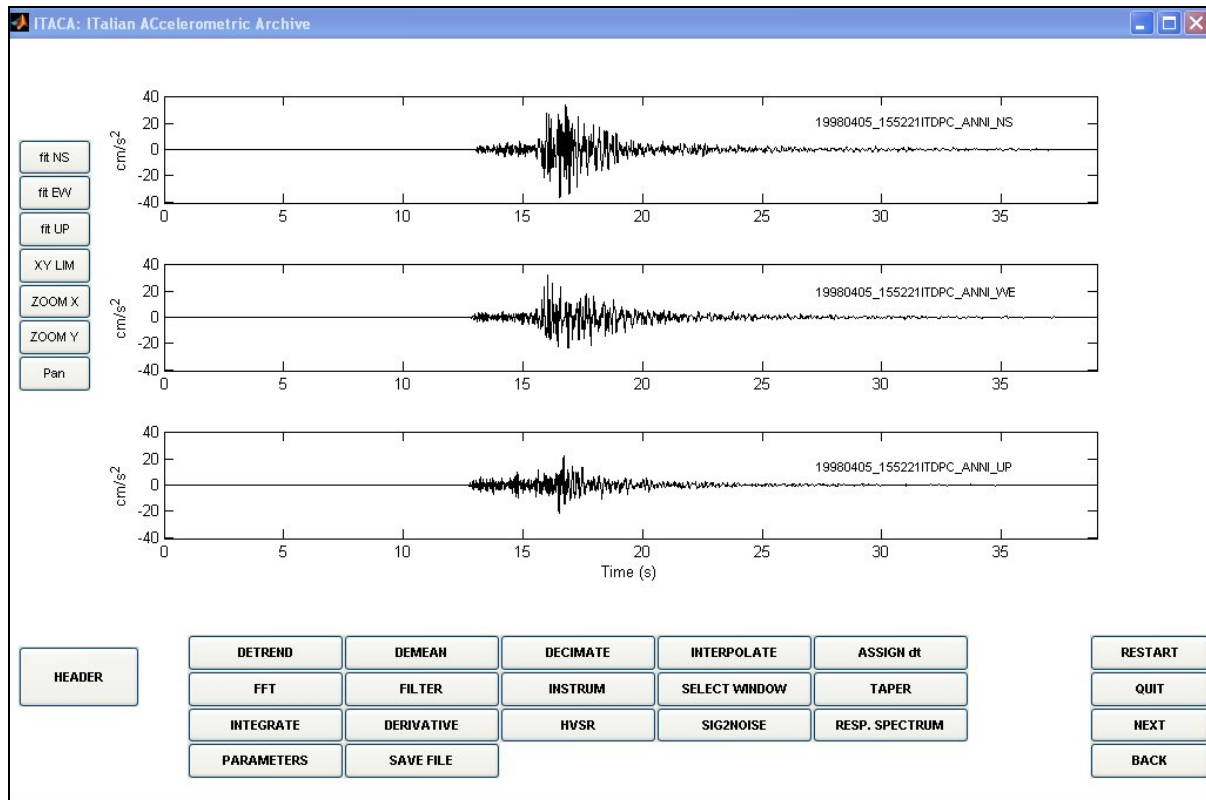

Figure 2: Main window

Several operations can be performed:

- modify the display (upper left corner)
- process data (bottom)
- scroll the file list, restart program or go back (lower right corner)
- see header (lower left corner)

2.1 MODIFY THE DISPLAY

To modify the display:

Zoom X executes zoom on X axis (to go back press the left mouse button)
Zoom Y executes zoom on Y axis (to go back press the left mouse button)

fit NS (WE or UP) fits accelerogram to another component
XYlim assigns the x-y limits for the three components
Pan pans the view of a graph interactively

2.2 DATA PROCESSING

At the bottom of the main program mask there are several buttons which allow to perform simple operations on the time series.

DETREND

Removes the linear trend which best fits the signal (routine Matlab *detrend* with *linear* option).
Message of correct execution: BASELINE REMOVED

DEMEAN

Removes the mean of the signal from the signal itself (routine Matlab *detrend* with *constant* option).
Message of correct execution: MEAN REMOVED with the mean values

DECIMATE

The program asks for the decimation factor (integer). The decimation is executed with the Matlab routine *decimate*

y = decimate(x, r)

which reduces the sampling step of the vector *x* of a factor *r*

Example: decimation factor = 2

If the original dt is 0.005s, then the new dt will be 0.01s

INTERPOLATE

The program asks for the interpolation factor (integer). The interpolation is executed with the Matlab routine *interp*

y = interp(x, r)

which increases the sampling step of the vector *x* of a factor *r*

ASSIGN dt

Assigns a new sampling interval (any value assigned by the user)
The program asks for a new time step. The interpolation is executed with the Matlab
routine *interp1*.

yi = interp1(x,Y,xi)

which changes the sampling step, by creating a new vector *yi* with *Y* the time step
vector, from vector *xi* with initial time step vector *x*.

FFT

Executes the fast Fourier transform of the signal and the logarithmic or linear plot on
a separate window (figure 3). It is possible to zoom or assign X-Y limits to the plots
and save the Fourier spectra, which can be smoothed. The program uses the Matlab
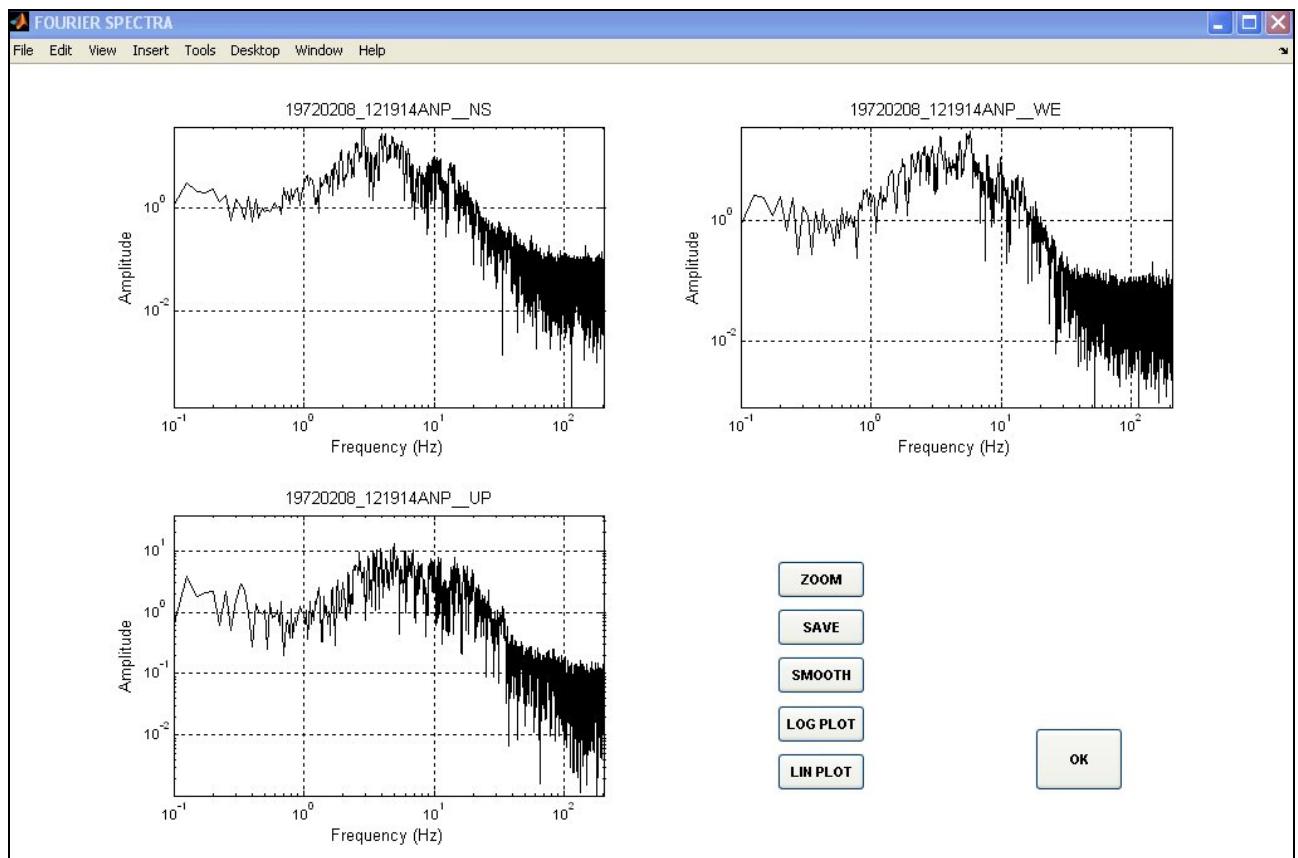routine *fft*

Figure 3: window displaying the Fourier spectra
Two smoothing options are provided:

1) Konno-Ohmachi: executes a smoothing according to the scheme proposed by Konno and Ohmachi (1998). The parameters that can be modified are the smoothing half-window, the *b* exponent (default = 20) and the *sm* parameter (default = 1) which assigns the relative weights
2) Logarithmic smoothing: the smoothing frequencies are sampled on a logarithmic scale.

FILTER

Executes the band-pass, the high-pass or low-pass filtering. Two types of filters are implemented: acausal Butterworth and raised Cosine. In the filter input mask input one should select the *filter order* (in case of Butterworth) or the *roll-off factor* (in case of cosine filter) and the high-pass, low-pass or band-pass frequencies. Figure 4 shows the filter input data. Different frequencies can be input for the different components. There is also a facility for the roll-off factor selection (button *See fre..*): the user can add the roll-off factor and the low, high or band pass frequency, so that the stop and pass frequences are shown.

Figure 4. filter input data

INSTRUM

Executes the convolution for the instrument response. The input data are the instrument frequency and damping (in case of *itaca* format, the program reads automatically these values from the header). The convolution is done by executing the FFT of the signal, and making a convolution with the instrument response (amplitude and phase).
Then an inverse FFT is performed.

SELECT WINDOW

Allows to select part of the signal specifying the x limits by: i) keyboard input, ii) selecting the energy content (%) or iii) picking two points ineractively.

TAPER

Performs a cosine taper of the signal. The user should enter the percentage of the points of the signal at the beginning and at the end of the record.

INTEGRATE

Integrates the time series in the time domain (using the trapezoidal integration).

DERIVATIVE

Performs the derivative of the signal in the time domain

HVSR

Performs the horizontal to vertical spectral ratio. The spectra smoothing options are the same as in the Fourier spectrum

SIG2NOISE

Performs a signal to noise ratio. The user should select interactively a signal and a noise window.

RESP. SPECTRUM

Calculates the elastic response spectrum. One should specify the damping value, the type of spectrum (pseudoabsoulte acceleration, absolute acceleration, relative velocity, pseudo relative velocity, relatve displacement). The periods can be equally spaced, or they can be stored in an external file, if they are oddly spaced, as shown in Figure 5.

The user can select the processing of all the files in the ASCII file list, specified at the beginning. The program will automatically save the spectra, which will have the following extension: .SA, .PSA, .SV, .PSV, .RD,   for absolute acceleration, pseudoabsoulte acceleration, relative velocity, pseudo relative velocity, relative displacement

If the periods are not equally spaced, the external file conaining the periods should be named *per_std.txt* and should contain the list of the periods of interest as:

0.03
0.04
0.07
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.60

0.70
0.80
....

PARAMETERS

Calculates some of the engineering parameters, such as peak ground acceleration
peak ground velocity, peak ground displacement, Arias intensity, effective duration,
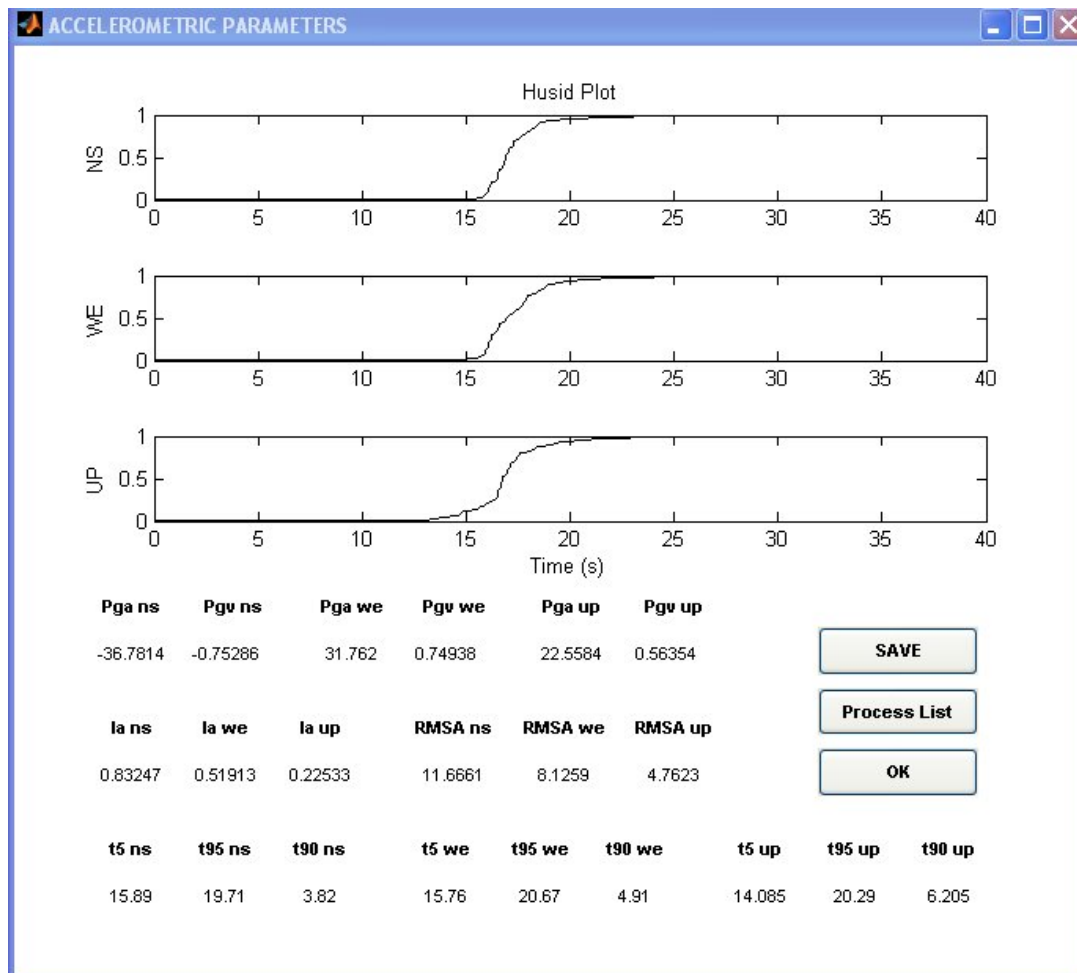together with the Husid plot of the time series, as shown in figure 6.

Figure 6: strong motion parameters calculated with the routine *itaca*

The user can select to process the entire list and the parameters will be stored in en
external ASCII files. The strong motion parameters relative to a single record can be
saved pressing the *SAVE* button.

3. REFERENCES

Konno K., Ohmachi T. (1998). Ground motion characteristics estimated from spectral ratio between horizontal and vertical components of microtremors. Bull. Seism. Soc. Am. Vol. 88, n. 1, 228-241.