

El Centro Earthquake Data Analysis

Introduction

This application analyzes the response of a SDOF to the 1940 El Centro earthquake. It uses acceleration data recorded from a seismograph located near the fault line

Import and Visualize Data from Seismograph

- > *restart* :
with(*SignalProcessing*) : with(*plots*) :
- > *NS* := *ImportMatrix*("elcentro_NS.csv", source = *csv*[*standard*], datatype = *float*[8]);

NS := $\left[\begin{array}{l} 2688 \times 2 \text{ Matrix} \\ \text{Data Type: float}_8 \\ \text{Storage: rectangular} \\ \text{Order: Fortran_order} \end{array} \right]$

(2.1)

Separate the data into time (in seconds) and acceleration (in g) components

- > *t_NS* := *NS*[.., 1] ;
acc_NS := *NS*[.., 2] ;

Sample rate of data

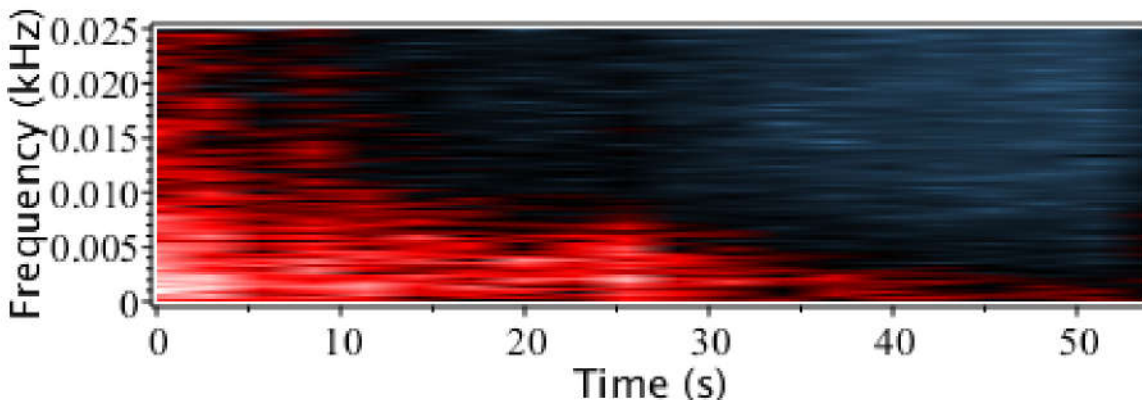
- > *sr* := $\frac{1}{t_NS[2] - t_NS[1]}$

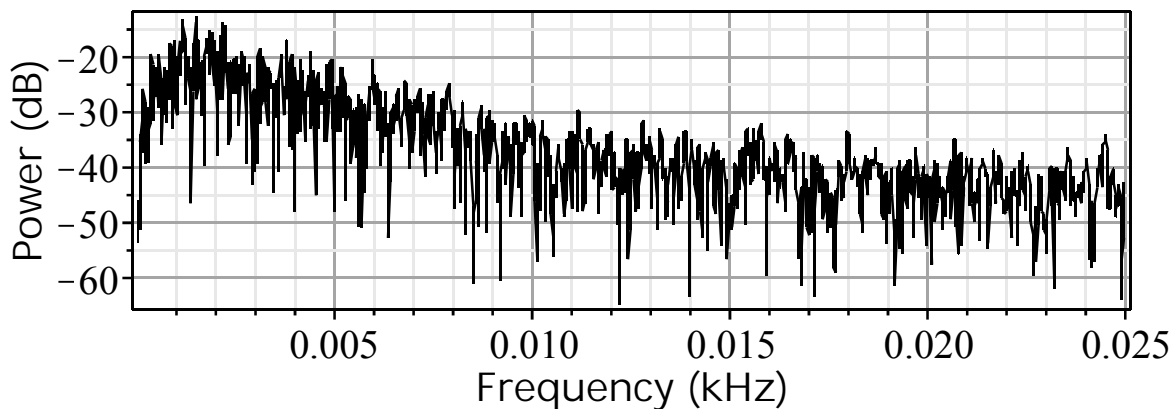
sr := 50.

(2.2)

Plot a spectrogram and power spectrum

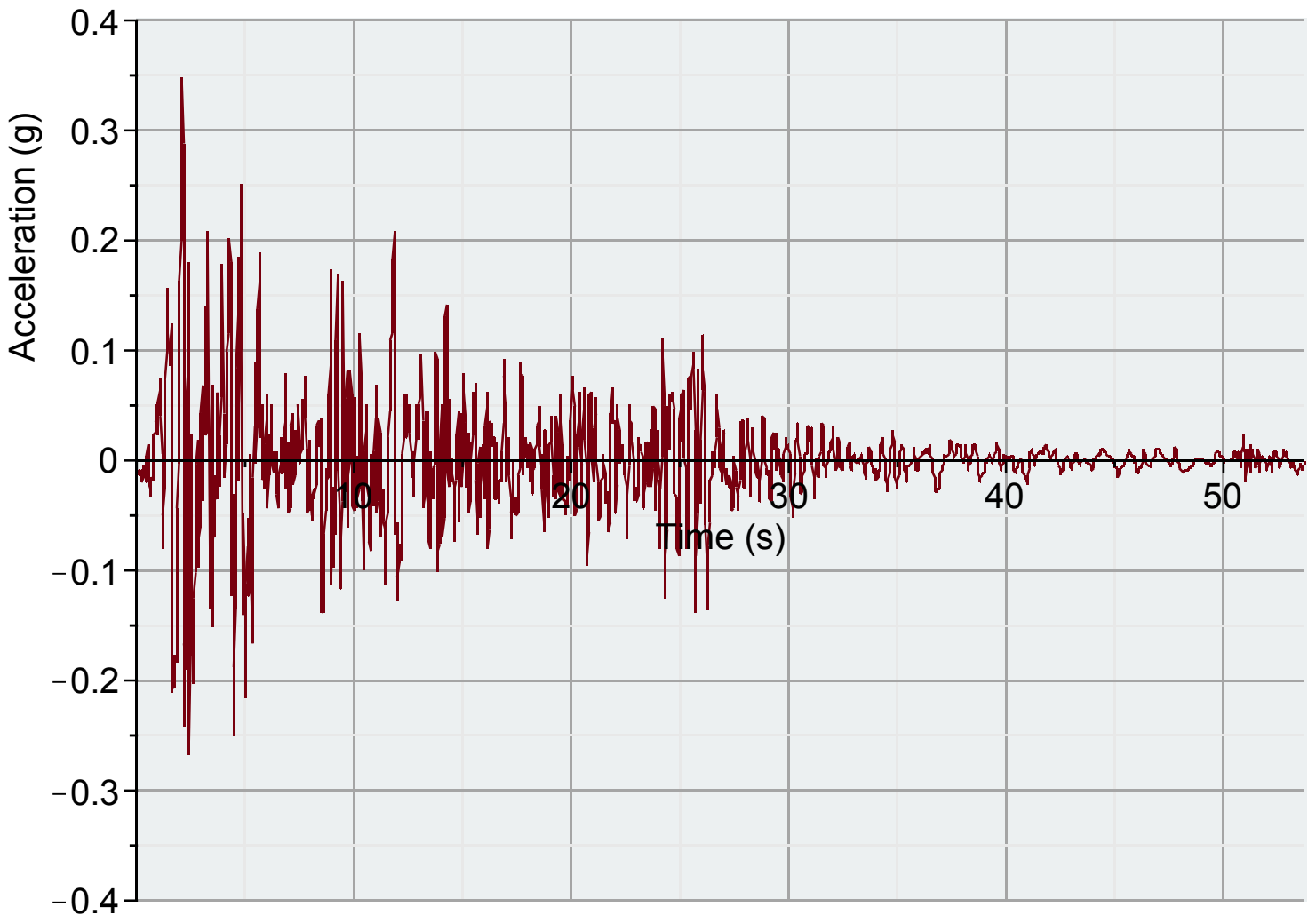
- > *Spectrogram*(*acc_NS*, samplerate = 50, fftsize = 256, includepowerspectrum, colorscheme = ["zgradient", "SteelBlue", "black", red, white], markers = [0, 0.7, 0.85, 1])





Plot the time history

```
> plot(t_NS, acc_NS, view = [default, -0.4 .. 0.4], labels = ["Time (s)", "Acceleration (g)"], labeldirections = [horizontal,
vertical], labelfont = [Arial], axesfont = [Arial], gridlines, size = [1200, 400], background = ColorTools:
Color("RGB", [ 236 240 241 / 255 255 255 ]), style = patchnogrid, thickness = 0)
```



Set the eigenperiod of an ideally zero-stiffness SDOF oscillator, in order to calculate the maximum velocity of the earthquake

▼ Displacement Response of a SDOF

```
> eq := ü + 2ξ·ωn·ū + ωn2·u = -9.81 acc(t) :
```

$$> \omega_n := \frac{2 \cdot \pi}{T_n} :$$

where ω_n is the natural frequency, and T_n is the natural period of vibration.

$$> \xi := 0.02 :$$

$$T_n := 5 :$$

$$> acc := unapply\left(\text{CurveFitting:-Spline}\left(t_NS, \frac{acc_NS}{9.81}, t, degree = 1\right), t\right) :$$

$$> res := dsolve(\{eq, u(0) = 0, D(u)(0) = 0\}, numeric, maxfun = 0) :$$

$$> odeplot\left(res, [t, u(t)], t = 0..50, labels = ["Time (s)", "Displacement (m)"], labeldirections = [horizontal, vertical],$$

$$labelfont = [Arial], axesfont = [Arial], size = [800, 500], background = \text{ColorTools:-Color}\left("RGB", \left[\frac{236}{255}, \frac{240}{255}, \frac{241}{255}\right]\right), style = \text{patchnogrid}, thickness = 0, size = [800, 500]\right)$$

