CHAPTER 1

INTRODUCTION

1.1 General

The earth is quiet from far but it vibrates almost continuously at periods ranging from millisecond to days and amplitudes ranging from nanometers to meters. Majority of these vibrations are so weak that they cannot be felt or even detected without specialized measurement equipment. Micro seismic activity is more important to seismologist than engineers. Prime interest of earthquake engineers is strong ground motion.

The ground motions produced by earthquakes can be quite complicated. At a given point, they can be completely described by three components of translation and three components of rotation. Mostly three orthogonal components of translation motion are measured and rotational components are usually neglected in practice. Tremendous amount of information is stored in typical ground motion records, such as acceleration – time histories shown in figure 1. Every twist and turn in a time – history plot must be described to express all of this information precisely. The motions shown in figure 1 were determined from 1560 acceleration values measured at time increments of 0.02 sec. This large amount of information makes precise description of a ground motion rather cumbersome.

It is necessary to be able to describe the characteristics of ground motion that are of engineering significance and to indentify a number of ground motion parameters that reflect those characteristics. Three characteristics of earthquake motion are of primary significance for engineering purposes: (1) Amplitude, (2) Frequency content and (3) Duration of the motion.

A number of different ground motion parameters have been proposed, each of which provides information about one or more of these characteristics. In practice, it is usually necessary to use more than one of these parameters to characterize a particular ground motion adequately.

Tajimi(1960) proposed that the strong ground motion can be modeled as a simple linear oscillator (single degree of freedom), where y(t) the output acceleration measured on ground and x(t)- acceleration of the input(earthquake) function.

$$m\ddot{y} + c\dot{y} + ky(t) = kx(t) + c\dot{x}$$

Where, m = mass of the system, c = damping constant, k = spring constant

Now, the transfer function for the above equation becomes;

$$H(\omega) = \frac{k + cj\omega}{(j\omega)^2 + c(j\omega) + k}$$

Using,

$$\omega_g = \sqrt{\frac{k}{m}} \text{ and } 2\xi_g \omega_g = \frac{c}{m}$$

The transfer function becomes:

$$H(\omega) = \frac{\omega_g^2 + 2\xi_g \omega_g (j\omega)}{(j\omega)^2 + 2\xi_g \omega_g (j\omega) + \omega_g^2}$$

The basic input – output relationship of a linear dynamic system excited by stationary random excitation can be described by Vanmarcke [4]:

$$G_y(\omega) = G_x(\omega) \, |H(\omega)|^2$$

$G_y(\omega)$ – power spectral density of earthquake, $G_x(\omega)$ – Ideal white noise excitation and $H(\omega)$ is the transfer function.

The power spectral density of an earthquake on a firm ground as a function of soil overburden effective damping coefficient ξ_g and natural frequency ω_g and G_0 –the intensity of ideal white noise excitation at the bed rock – overburden interface, is then,

$$G_y(\omega) = G_0 \left[\frac{\omega_g^2 + 4\xi_g^2 \omega^2 \omega_g^2}{(\omega_g^2 - \omega^2)^2 + 4\xi_g^2 \omega^2 \omega_g^2} \right]$$

In this thesis a ground motion is predicted by filtering white noise using adaptive Normalized Least Mean Square filter. Also a method to compute Power Spectral Density Function is described. The K –T parameters i.e ξ_g and ω_g are estimated using a method of spectral moments.

1.2 Objectives Of The Present Work

The main objectives of the present work are as follows;

i. To calculate power spectral density of strong ground motion for different time window by using two Lowpass filters.
ii. To determine Kanai and Tajimi frequency and damping ratio parameter for different time window and to analyze the change of K – T parameter at different time of an earthquake.

1.3 OUTLINE OF THESIS

The chapter wise description of this dissertation is given as under:

Chapter-1 gives the introductory view of the overall work that has been presented in this thesis. This chapter also gives a brief introduction of strong ground motion and their characteristics.

Chapter-2 presents brief literature review of Kanai and Tajimi parameter.

Chapter-3 discusses Ground motion parameters.

Chapter-4 describes the Adaptive filters and design of Time-Varying Wiener Filter and Normalized Least Mean Square.

Chapter-5 presents the method of calculating Power Spectral Density Function of ground motion for different earthquake data.

Chapter-6 discusses Spectral Parameters and their behavior during earthquake duration.

Chapter-7 explains the variation of K-T parameter with time of different earthquake data.

Chapter-8 provides the main conclusion and further scope of work.

CHAPTER 2

LITERATURE REVIEW

2.1 General

In this research effort I have tried to filter the white noise with the help of Adaptive filter to produce artificial earthquake data and divided the data in 10 time window. The power spectral density function versus frequency relation for each window using Digital Signal Filter techniques by processing the filtered data is plotted. Kanai – Tajimi did calculated PSDF using conventional mathematical approach. The K – T parameters are for is evaluated from PSDF vs frequency curve using Vanmarcke and Lai (1980) [5] and Shih – Sheng Paul Lai, (1982) [7]methodology. Brief description of research work which I have referred to produce my thesis is as given below.

2.2 Erik H. Vanmarcke (1970)

In this paper many important statistical properties of stationary random motions depend on the spectral density function only through the spectral parameter ω_c and δ which depends on the few spectral moments has been shown. This has been used by Shih –Sheng Paul Lai,(1982) [7].

2.3 Erick H. Vanmarcke and S.P Lai (1980)

Estimation of the strong-motion duration of earthquakes is done by simple process. The suggested strong-motion duration is approximately proportional to the quantity I_o / a_{max}, where a_{max} is the maximum acceleration and I_o is the Arias intensity of integral over time of the squared accelerations. Further after study of the 140 strong ground motion duration of strong ground motion has been correlated and a relation has been suggested between strong motion duration and peak ground acceleration

$$\mathbf{S_O = 30 \exp(-3.254\, a_{max}^{0.35})}$$

Where, S_o is strong motion duration a_{max} is the peak ground acceleration.

In this thesis strong motion duration has not been studied but this parameter is important and can be evaluated negatively by the above relation.

2.3 Kanai, K. (1957)

In this paper Semi-empirical formula for the seismic characteristics of the ground has been given. The following formula for the seismic characteristics of the ground

$$\mathbf{U_s = c_1 U_o / \sqrt{[1- (T/T_o)]^2 + (\tau.\ T/ T_o)^2}}$$

Where, U_s = absolute amplitude of seismic waves reaching the bottom boundary of the surface layer, T_o = Predominant period of the ground , T = Period of seismic waves, τ = apparent damping coefficient of the surface vibration,c_1 = coefficient depending upon the impedance ratio of two media and is independent of T_o.

2.4 Shih- Sheng Paul Lai (1982)

The spectral content and duration of strong motion accelerograms have been studied to quantify the uncertainty of ground motion representation. Ground motion are characterised by the parameters of Kanai-Tajimi spectral density function and by strong motion duration. Parameters for each record are estimated by method of spectral moments. The statistics and dependencies of the parameters are evaluated and in particular, correlations between the Kanai-Tajimi parameters, maximum ground acceleration, epicentral distance and magnitude of earthquake are investigated. The estimated parameters by using correlation can be used for purposes during seismic consideration of design.

2.5 Tajimi H. (1960)

In his paper, Tajimi has explained about a statistical method of determining the maximum response of the building structure during the earthquake and semi empirical formula by Kanai (1957) has been extended to get power spectral density function, used in the thesis for determination of K-T parameters.

2.6 Tom Irvine (2000): An introduction to the filtering of digital

In the paper by Tom Irviane, explanation of filtering of digital signals is done. Sixth order Butterworth filter design is also explained which has been used in thesis for filtering of earthquakes. The phase correction refiltering is being done as suggested in this paper.

2.7 Tom Irvine (2000): Power Spectral density units

In this paper, the method of calculation of power spectral density function is explained and is included in this thesis. According to this, signals are filtered in a particular bandwidth and then power in that bandwidth corresponding to band centre frequency will be plotted to get Power spectral density function.

CHAPTER 3

GROUND MOTION PARAMETERS

3.1 General

Ground motion parameters describe important characteristics of strong ground motion in compact and quantitative form. To characterize the duration, amplitude and frequency content of strong ground motions many parameters have been proposed. It is impossible to identify a single parameter that accurately describes all important ground motion characteristics because of the complexity of earthquake ground motions.

3.2 Amplitude parameters

The most common way to describe ground motion is with time history. Parameters of motion may be acceleration, velocity, or displacement. Only one of these quantities is measured directly while others can be computed from it by integration of differentiation. The acceleration time history shows a significant portion of relatively high frequencies than velocity and displacement.

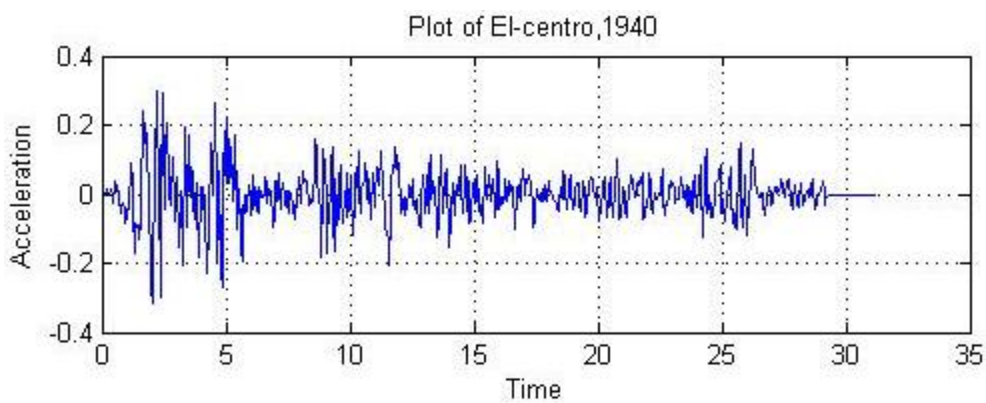

Fig. 3.1 Acceleration Time History of El – Centro Earthquake

3.2.1 Peak Acceleration

The peak horizontal acceleration (PHA) is the most commonly used measure of amplitude of a particular ground motion. PHA is the largest value of horizontal acceleration for a given component obtained from accelerogram of that component. Because of the natural relationship with inertial forces horizontal acceleration have commonly been used to describe ground motions. The large dynamic forces induced in certain types of structures are intimately related to the PHA.

Vertical accelerations have been received less attention in earthquake engineering than horizontal accelerations because of the margins of safety against gravity –induced static vertical forces in constructed works usually provide adequate resistance to dynamic forces induced by vertical accelerations during earthquakes.

3.3 Frequency content parameters

Only the simplest of analyses are required to show dynamic response of compliant objects, be they bridges, building, slopes or soil deposits is very sensitive to the frequency at which they are loaded. Earthquake produce complicated loading with components of motion that span a broad range of frequencies. The frequency content explains how the amplitude of ground motion is distributed among different frequencies. Characterization of the motion cannot be complete without consideration of its frequency content because the frequency content of an earthquake motion will strongly influence the effects of that motion.

3.3.1 Power spectra

The frequency content of ground motion can also explained by a *power spectrum* or *power spectral density function.* The power spectral density function can also be used to estimate the statistical properties of a ground motion and to compute stochastic response using random vibration techniques. In this thesis a technique for calculating power spectral density function proposed by Irvine Tom (2000) [2] is used which is explained in chapter 5.

3.4 Duration of motion

The duration of strong ground motion can have a strong influence on earthquake damage.

Many physical processes, such as the degradation of stiffness and strength of certain types of structures and the buildup of porewater pressures in loose, saturated sands, are sensitive to the number of load or stress reversals that occur during an earthquake. A motion of short duration may not produce enough load reversals for damping response to buildup in a structure, even if the amplitude of motion is high. On the other hand, a motion with moderate amplitude but long duration can produce enough load reversals to cause substantial damage. The duration of a strong ground motion is related to the time required for release of accumulated strain energy by rupture along the fault. As a result, or area, of the fault rupture increases, with increasing earthquake magnitude.

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CHAPTER 4

ADAPTIVE FILTER

4.1 General

Filters in which adjustable coefficients can be employed is called *adaptive filter*. Adaptive filters have been used widely in communication system, control system, seismic signal studies and various other system in which statistical characteristics of the signals to be filtered are either unknown a priori or, are slowly time –variant (non-stationary signals like earthquake signal).

4.2 Discrete Time Processing of Signals

4.2.1 Signal: Signal is defined as a function that conveys information, generally about the state or behavior of a physical system. Information is contained in a pattern of variations of some form. They can be represented mathematically as a function of one or more independent variables.

4.2.2 Deterministic and Random Signals:

Deterministic signal is a signal that can be uniquely explained by a distinct mathematical expression or a well defined rule.

In many practical applications, however, there are signals that are either cannot be described to any reasonable degree of accuracy by explicit mathematical formulas, or such description is too complicated to be of any practical use. The lack of such a relationship implies that such signals evolve in time in a unpredictable manner and these signals are refer as *random signals*. Seismic signal are example of random signals.

4.2.3 Convolution:

$$y(n) = \sum_{k=-\infty}^{\infty} x(k)h(n-k)$$

the above equation gives the response y(n) of the system as a function of the input signal x(n) and the unit sample (impulse) response h(n) is called a *convolution sum*. We say that the input signal x(n) convolved with the impulse response h(n) to yield the output y(n).

The process of computing the convolution between x(k) and h(k) involves the following four steps.

1. Folding: Fold h(k) about k = 0 to obtain h(-k).
2. Shifting: shift h(-k) by n_0 to the right if n_0 is positive, to obtain $h(n_0 - k)$.
3. Multiplication: Multiply x(k) by $h(n_0 - k)$ to obtain the product sequence $v_{n0}(k) = x(k)\, h(n_0 - k)$.
4. Summation: Sum all the values of the product sequences $v_{n0}(k)$ to obtain the value of the output at time $n = n_0$.

4.2.4 Cross-correlation and Auto-Correlation Sequences:

Suppose that we two real signal sequences x(n) and y(n) each of which has finite energy. The *cross-correlation* of x(n) and y(n) is a sequence of $r_{xy}(l)$, which is defined as

$$r_{xy}(l) = \sum_{n=-\infty}^{\infty} x(n)y(n-l)$$

in special case where y(n) = x(n), we have the auto-correlation of x(n), which is defined as the sequence

$$r_{xx}(l) = \sum_{n=-\infty}^{\infty} x(n)x(n-l)$$

4.2.5 Filter: Filtering is a process by which the frequency spectrum of a signal can be modified, reshaped, or manipulated according to some desired specification. It may entail amplifying or attenuating a range of frequency components, rejecting or isolating one specific frequency component, etc.

4.2.6 Digital Filter: The digital filter system that can be used to filter discrete –time signals. it can be represented by the block diagram. Input x(nT) and output y(nT) are related by some rule of correspondence known as transfer function.

we can indicate this fact

$$y(nT) = Rx(nT)$$

4.3 Types of adaptive filter

1. Time Variant Wiener Filter.
2. Least Mean Square Filter.
3. Normalized Least Mean Square Filter.
4. Kalman Filter.

In this study only Time Variant Wiener filter and Normalized Least Mean Square filter.

4.3.1Time-Variant Wiener Filter:

“The spectral distributions of signal are assumed stationary but in many applications stationary characteristics of signal are not satisfied completely. The time dependent power spectral density of input signal allows the wiener filter as time varying in nature. Most vibration data are in time varying in nature and its analytical solution is very difficult. The time varying application of wiener filter allows data processing in block by block. The .analysis and the simulation shows that the proposed algorithm provides better filtered signal than time invariant wiener filter. Time invariant wiener filter is for linear signals and time variant wiener filter is for nonlinear wiener filter.”

4.3.1.1 Design of Time – Variant Wiener Filter:

Time –Variant Wiener Filter is a type of adaptive filter. Time – variant wiener filter is considered within the context of non-stationary process.

Let w(n) denote the unit sample response of the Wiener filter that produces the minimum mean-square estimate of a desired process d(n),

$$\hat{\hat{d}}(n) = \sum_{k=0}^{p} w(k)x(n-k)$$

If x(n) and d(n) are jointly wide sense stationary processes, with $e(n) = d(n) - \hat{d}(n)$ then the filter coefficients that minimize the mean –square error $E\{|e(n)|^2\}$ are found by solving the Wiener – Hopf equations

$$\mathbf{R_x\, w = r_{dx}}$$

Where R_x is auto-correlation matrix of x(n) and r_{dx} is cross-correlation matrix of d(n) and x(n)

However, if d(n) and x(n) are non-stationary, then the filter coefficients that minimize $E\{|e(n)|^2\}$ will depend on n, and the filter will be shift –varying i.e.,

$$\hat{d}(n) = \sum_{k=0}^{p} w_n(k)x(n-k)$$

where $w_n(k)$ is the value of kth filter coefficient at time n. Using vector notation, this estimate may be expressed as

$$\hat{d}(n) = \boldsymbol{w}_n^T \mathbf{x}(n)$$

where $w_n = [w_n(0), w_n(1), \ldots\ldots, w_n(p)]^T$ is the vector filter coefficients at time n, and

$x(n) = [x(n), x(n-1), \ldots\ldots, x(n-p)]^T$

In the design of adaptive wiener filter, for each value of n, it is necessary to find the set of optimum filter coefficients, $w_n(k)$, for k = 0,1,…,p.

$$\mathbf{w_n} = \boldsymbol{R}_x^{-1}\mathbf{r_{dx}}$$

In many respects, the design of Time Variant Wiener Filter is much more difficult than the design of Time – Invariant Wiener Filter of a , since for each value of ‘n’, it is necessary to find the set of optimum filter coefficients, $w_n(k)$; for k = 0, 1,….,p .Instead of solving for each value of ‘n’, which would be impractical in most real time implementations. So to overcome this problem there is an iterative approach that is called the steepest descent method.

4.3.2 Normalized Least Mean square Filter

4.3.2.1 Steepest Descent Method

In designing an FIR adaptive filter, the goal is to find the vector w_n at time n that minimizes the quadratic function

$\xi(n) = E\{|e(n)^2|\}$

Although the vector that minimizes $\xi(n)$ may be fund by setting the derivations of $\xi(n)$ with respect to $w^*(k)$ equal to zero, another approach is to search for the solution using the method of steepest descent.

The method of steepest descent is an iterative procedure that has been used to find extrema of non – linear functions.

The basic idea of this is as follows:

1. Let w_n be an estimate of the vector that minimizes the mean – square error $\xi(n)$ at time n.
2. At the n+1 a new estimate is formed by adding a correction to w_n , that is designed to bring w_n closer to the desired solution. The correction involves taking a step of size μ in the direction of maximum descent down the quadratic error surface.
3. $w_{n+1} = w_n - \mu \Delta \xi(n)$,where w_{n+1} is update in equation of w_n.
4. $w_{n+1} = w_n + \mu E\{e(n)\mathbf{x}^*(n)\}$

Least Mean Square and Normalized Least Mean Square Filters are based on steepest descent approach.

In Least Mean Square, $w_{n+1} = w_n + \mu.e(n)\, \mathbf{x}^*(n)$

In the design and implementation of above algorithm, it is difficult to select the step size μ.

Therefore, in this study **Normalized Least Mean Square Filter** is used for predicting earthquake.

In NLMS time varying step size of the form is used.

$$\mu(n) = \frac{\beta}{X^H(n)X(n)} = \frac{\beta}{||X(n||^2}$$

4.3.2.2 Algorithm of Normalized Least Mean Square

p = filter order,

μ(n) = Time varying step size.

$w_0 = 0$

$\beta = 0 < \beta < 2$

Computation :

For n = 0, 1, 2…

a) $y(n) = w_n^T x(n)$

b) $e(n) = d(n) – y(n)$

c) $w_{n+1} = w_{n} + \mu(n)\, e(n)\, x^*(n)$

4.3.2.3 OUTPUT OF NORMALIZED LEAST MEAN SQUARE

a. EL-CENTRO EARTHQUAKE

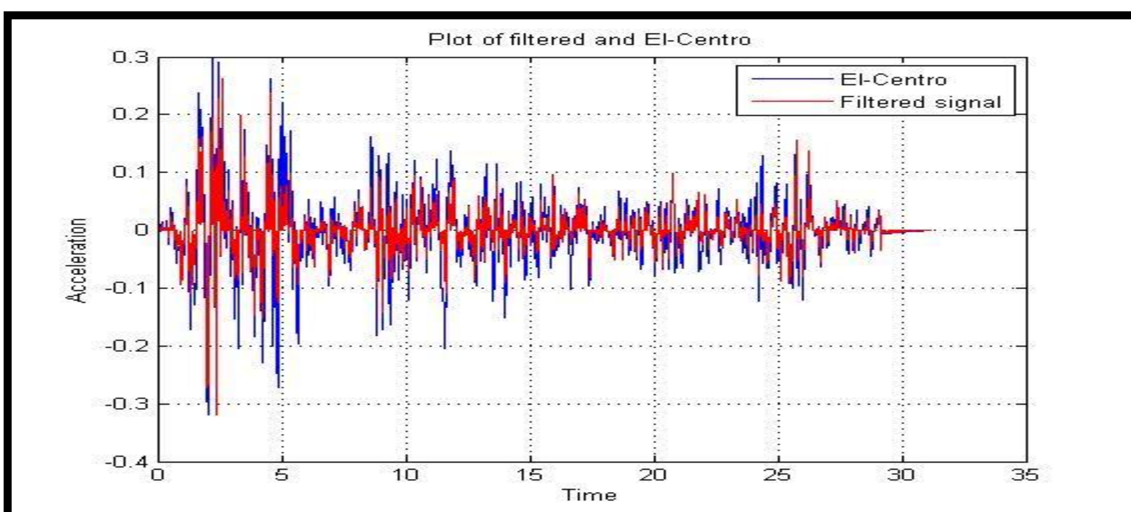

Figure 4.1 Plot of El-Centro,1940 and filtered WGN.

b. CHAMOLI, 1999 EARTHQUAKE

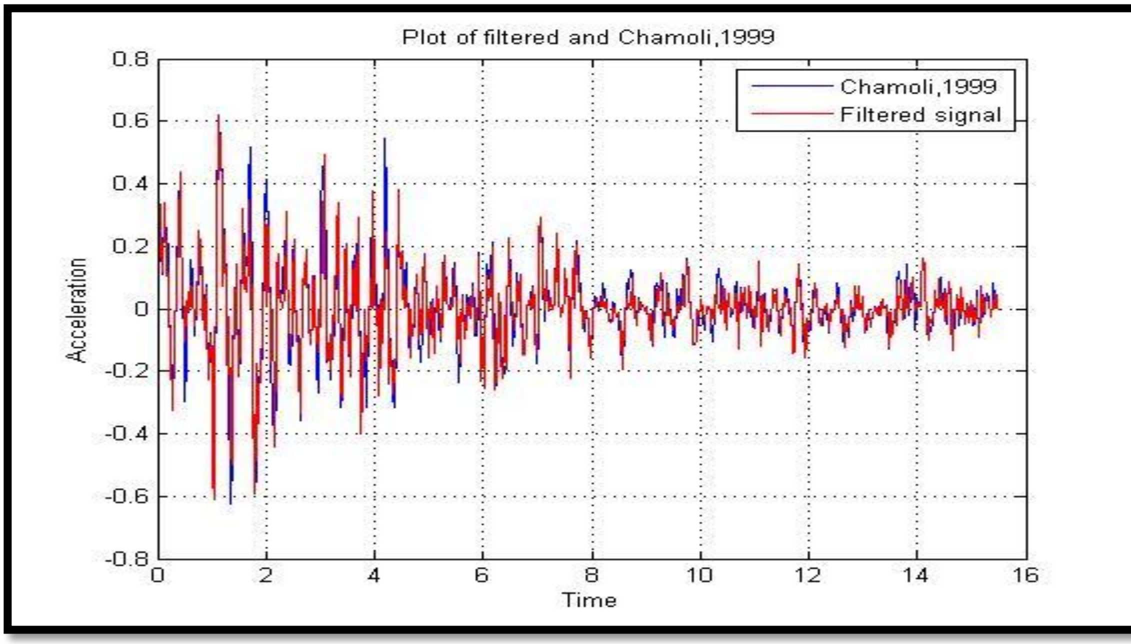

Figure 4.2 Plot of Chamoli, 1999 and filtered WGN.

c. NONGSTAIN, NORTH-EAST, INDIA

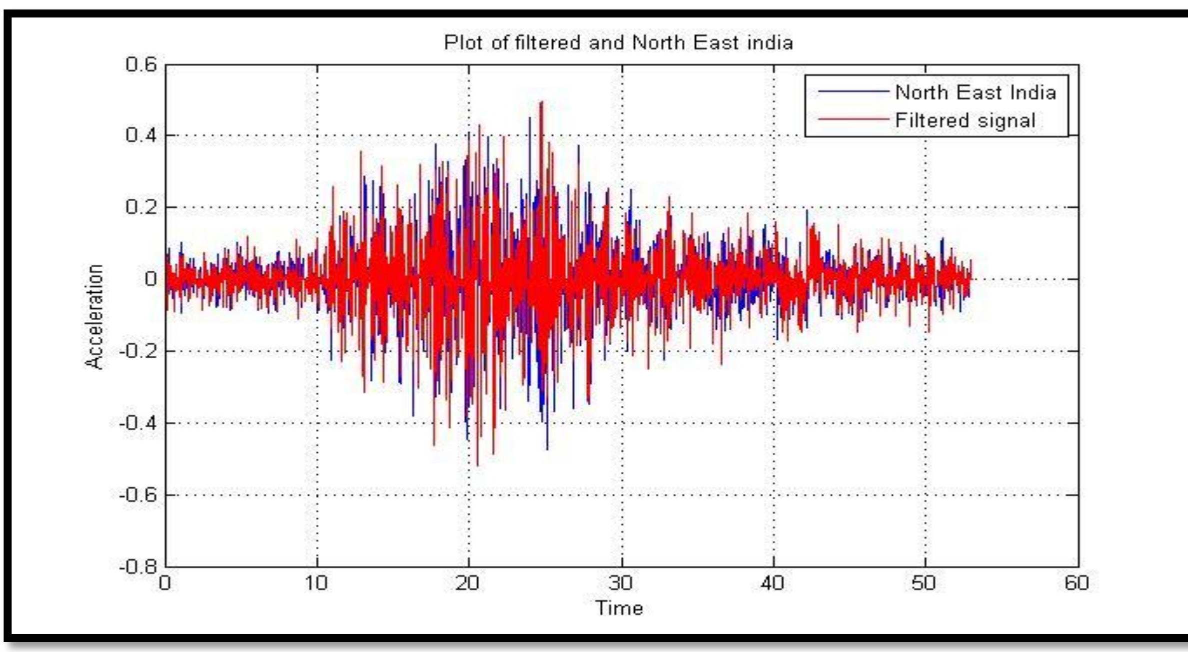

Figure 4.3 Plot of Nongstain, N-E, India and filtered WGN.

CHAPTER 5

POWER SPECTRAL DENSITY

Power Spectral Density (PSD) is the frequency response of a random or periodic signal. It represents where the average power is distributed as a function of frequency. The units of PSD are $[(m/sec^2)^2/Hz]$. A power spectrum method is suited for analysis of random processes as it breaks the signal into sinusoids of different frequencies. Mathematically it can be expressed as $G(\omega) = (RMS^2)/(\text{frequency bandwidth})$.A PSD can be plotted using various methods like FFT. This thesis Band-pass filtering method is used as explained in Irvine Tom (2000) [2]. The PSD is plotted by filtering the signal through a two low-pass filter, which will act like band-pass filter, for all consequent frequencies. The RMS from each band of frequencies is used to plot the Power Spectral Density. A power spectral density plotted using the filtering process has a similar power content and distribution of power as the original signal, over the frequency range.

In this thesis the predicted earthquake signal is divided into 10 time window each having 3 second width and various PSD graph is plotted for each 10 time-window as shown in figure 2 to 12. These values of PSD are utilized for calculation of spectral moments as explained in next chapter.

5.1 PSDF of Filtered data using El-Centro:

PSDF vs frequency graph for 10 windows each of 3 second time width. Filtered El-Centro signal has total 1559 data of acceleration which is divided into 156 data for each window.

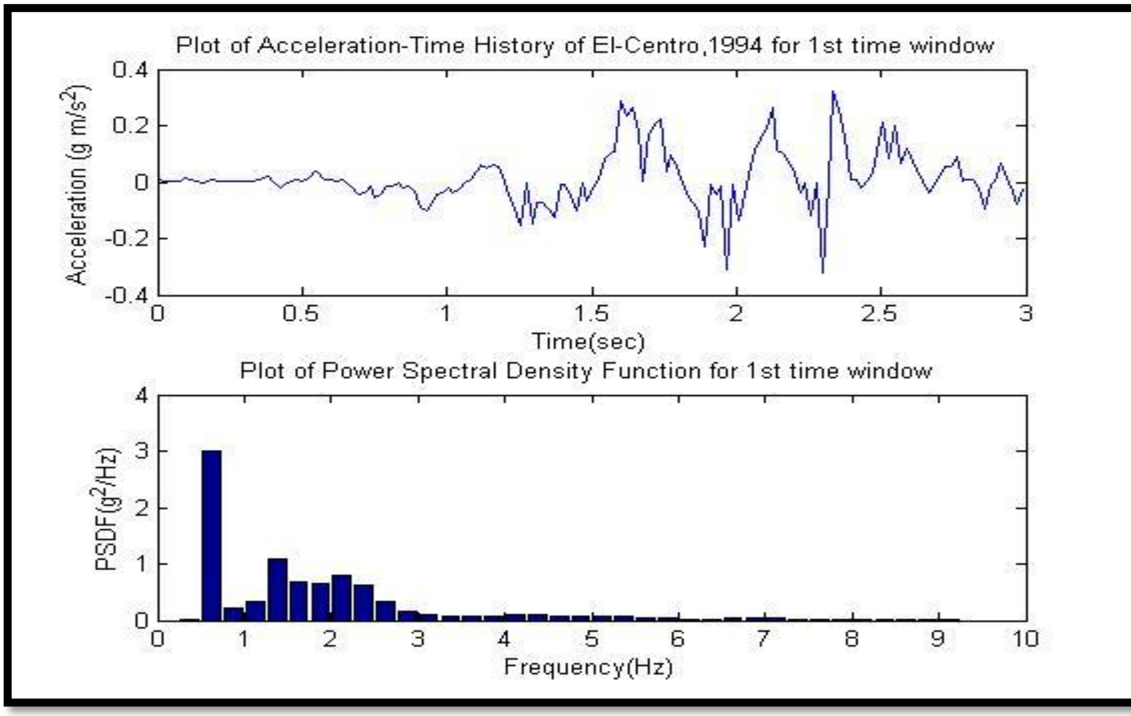

Figure 5.1 Acceleration – time history and PSDF plot for time window 1(i.e. 0 – 3 sec)

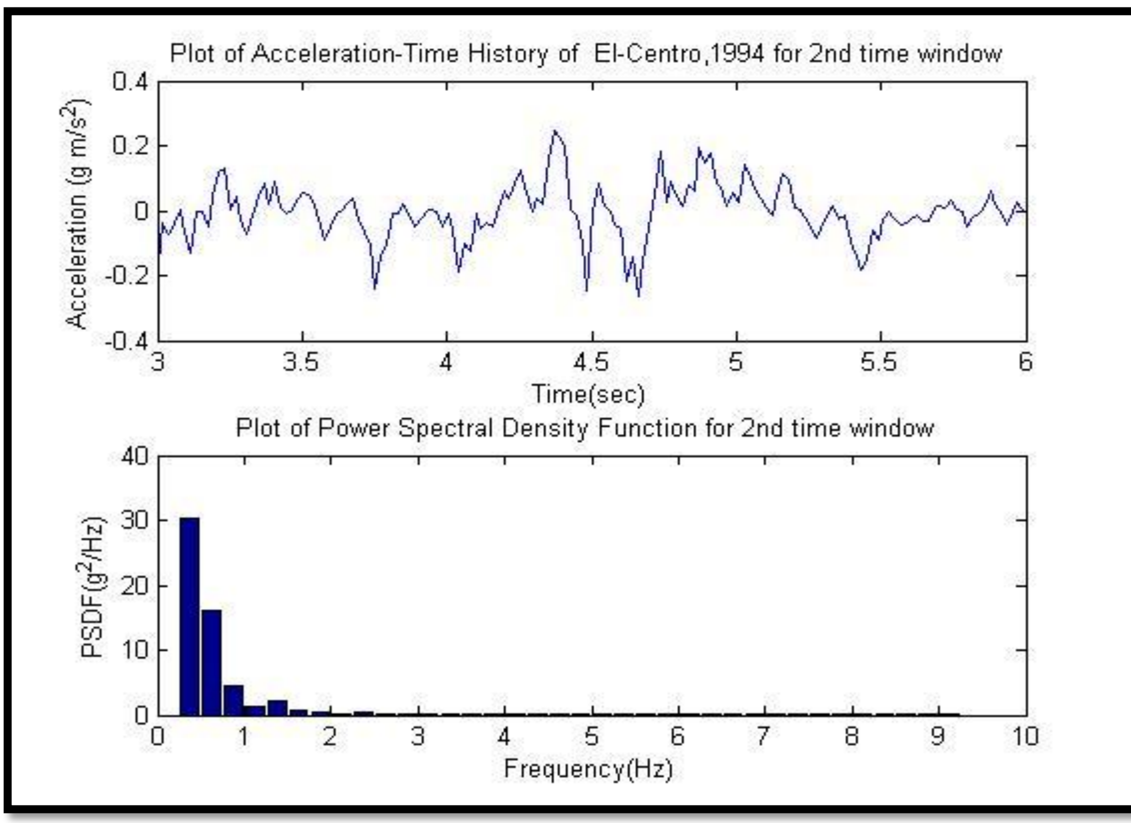

Figure 5.2 Acceleration – time history and PSDF plot for time window 2 (i.e. 4 – 6 sec)

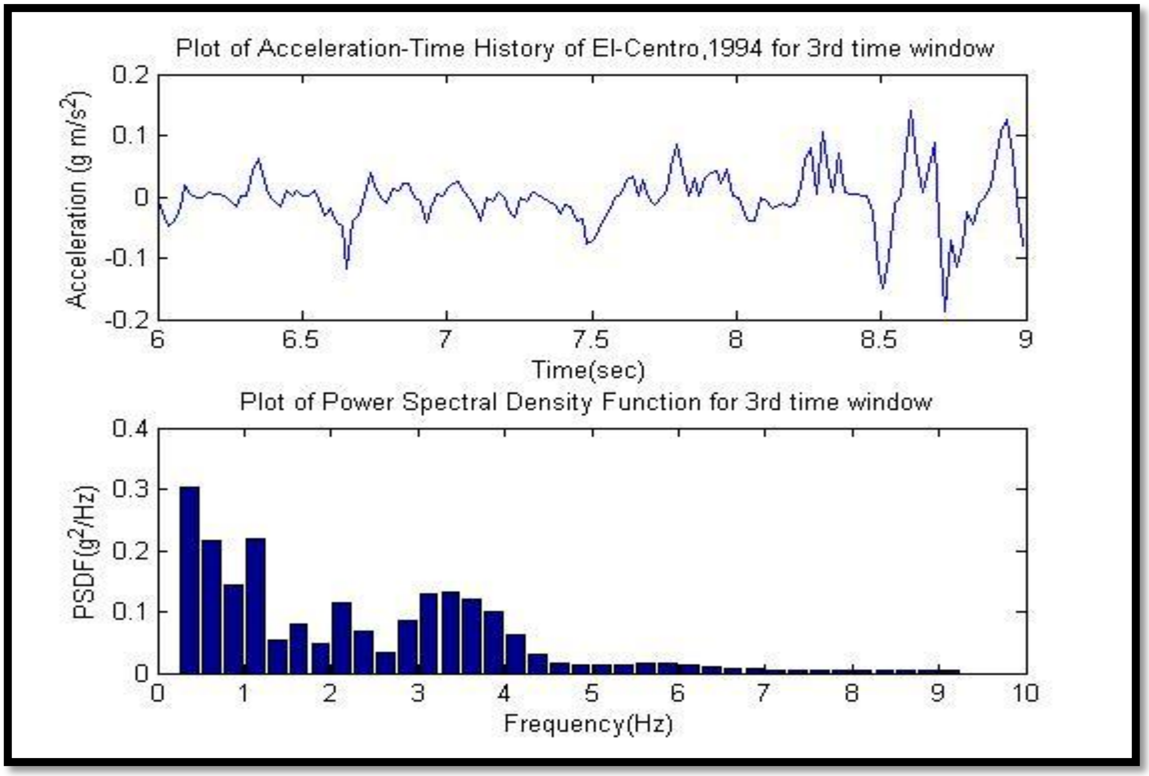

Figure 5.3 Acceleration–time history and PSDF plot for time window 3rd (i.e. 7–9 sec)

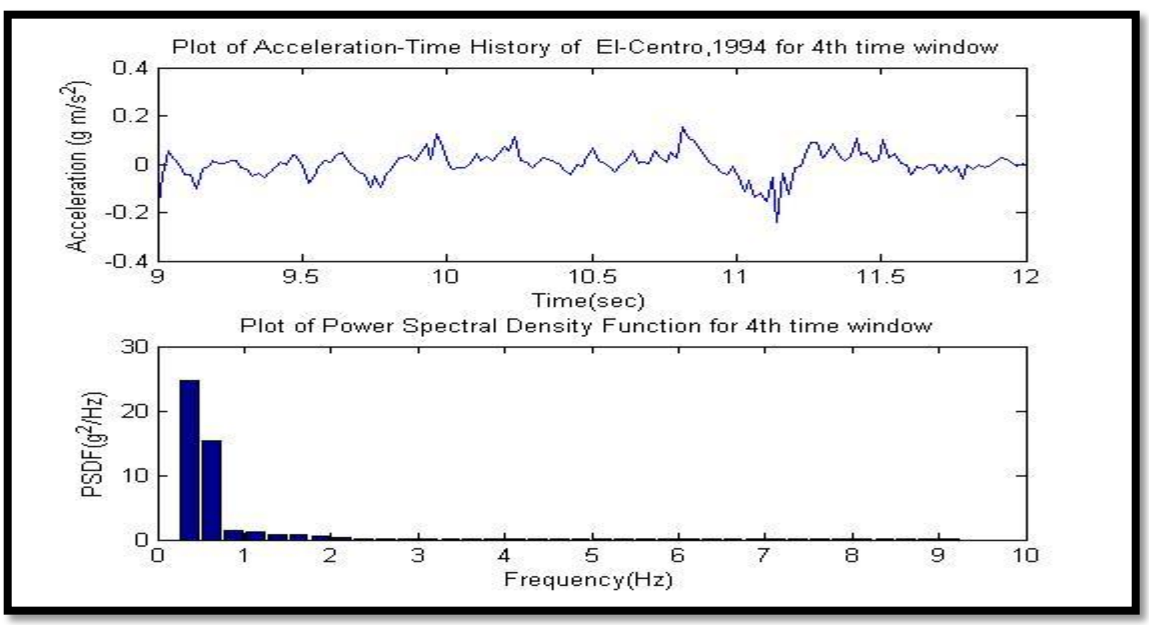

Figure 5. 4 Acceleration–time history and PSDF plot for time window 4 (i.e. 10–13 sec)

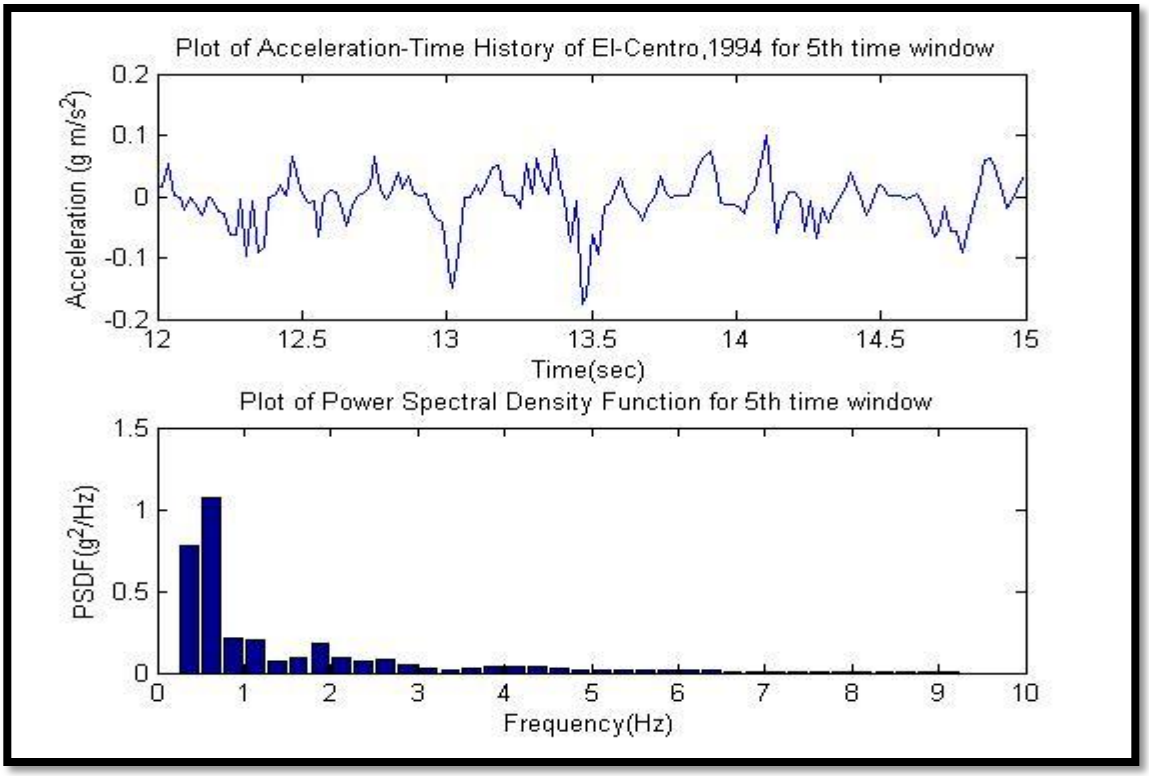

Figure 5.5 Acceleration–time history and PSDF plot for time window 5 (i.e. 14–16 sec)

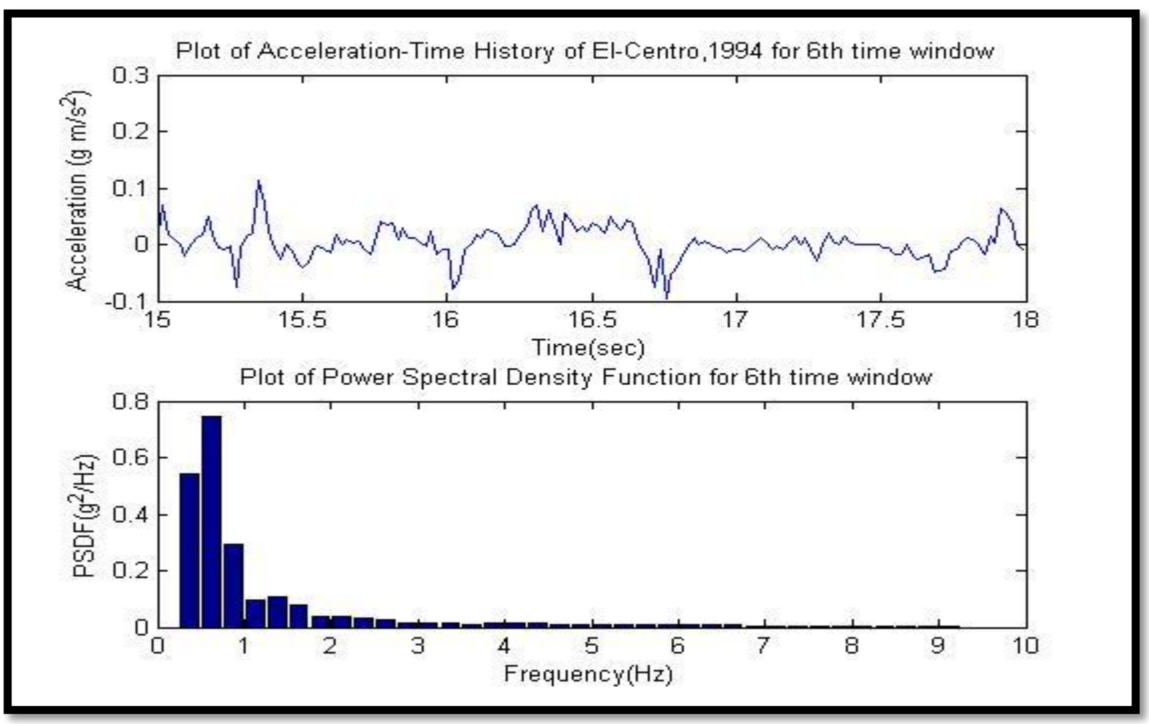

Figure 5.6 Acceleration–time history and PSDF plot for time window 6 (i.e. 17– 19 sec)

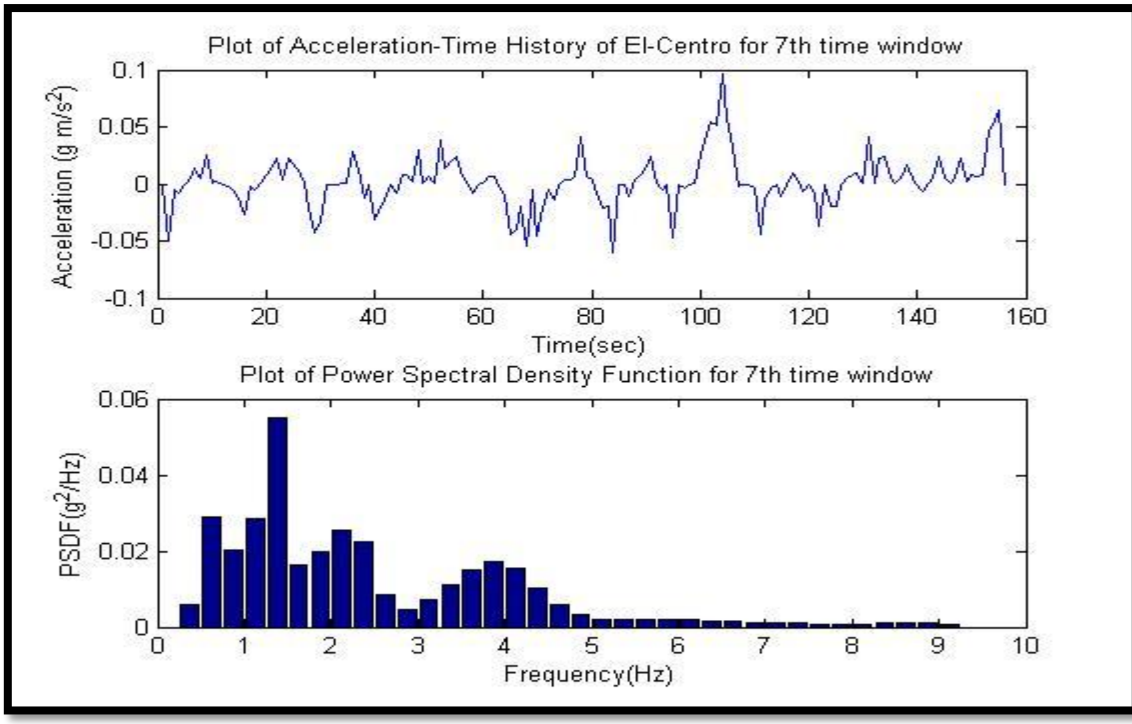

Figure 8.Acceleration–time history and PSDF plot for time window 7th (i.e. 20–21 sec)

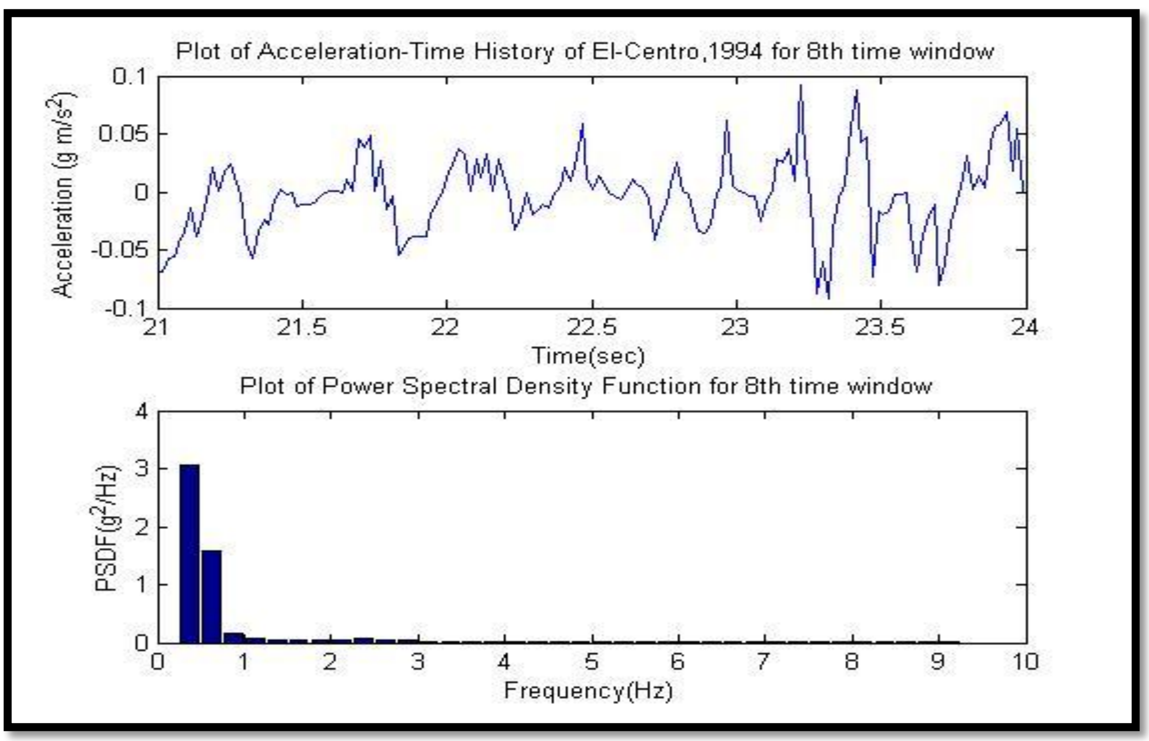

Figure 5.8. Acceleration–time history and PSDF plot for time window 8(i.e. 22–24 sec)

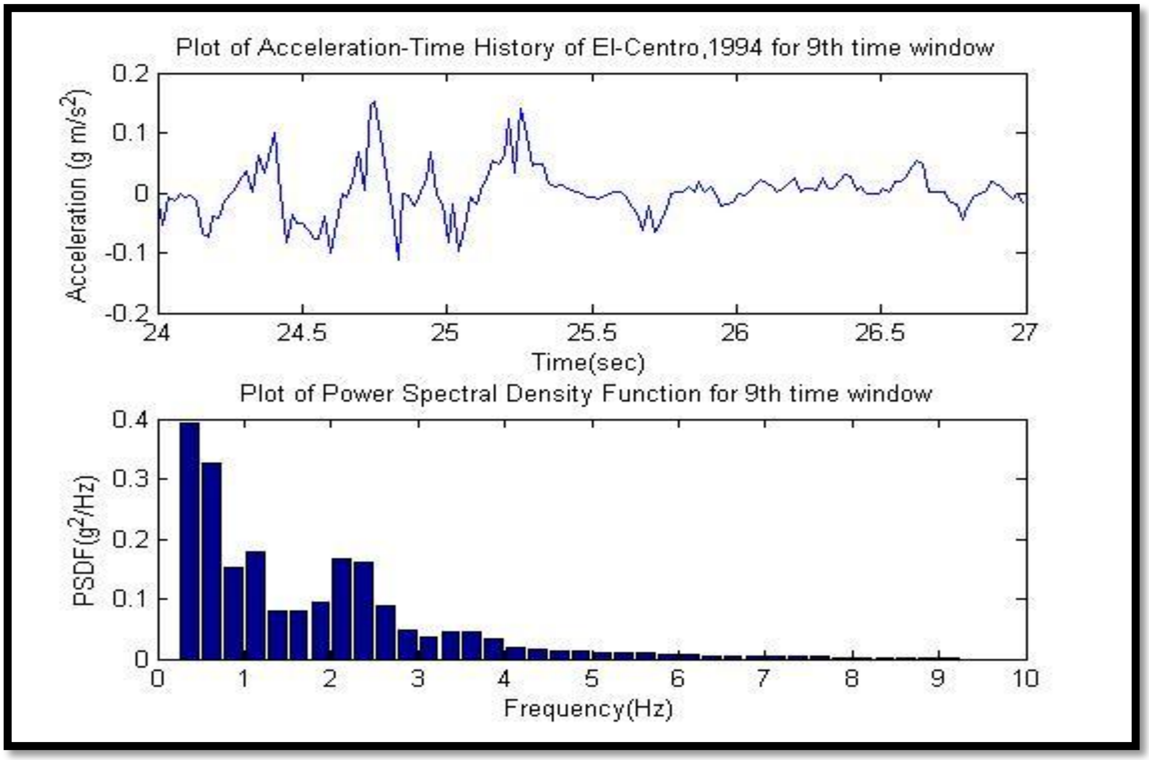

Figure 5.9 Acceleration–time history and PSDF plot for time window 9 (i.e. 25 – 27 sec)

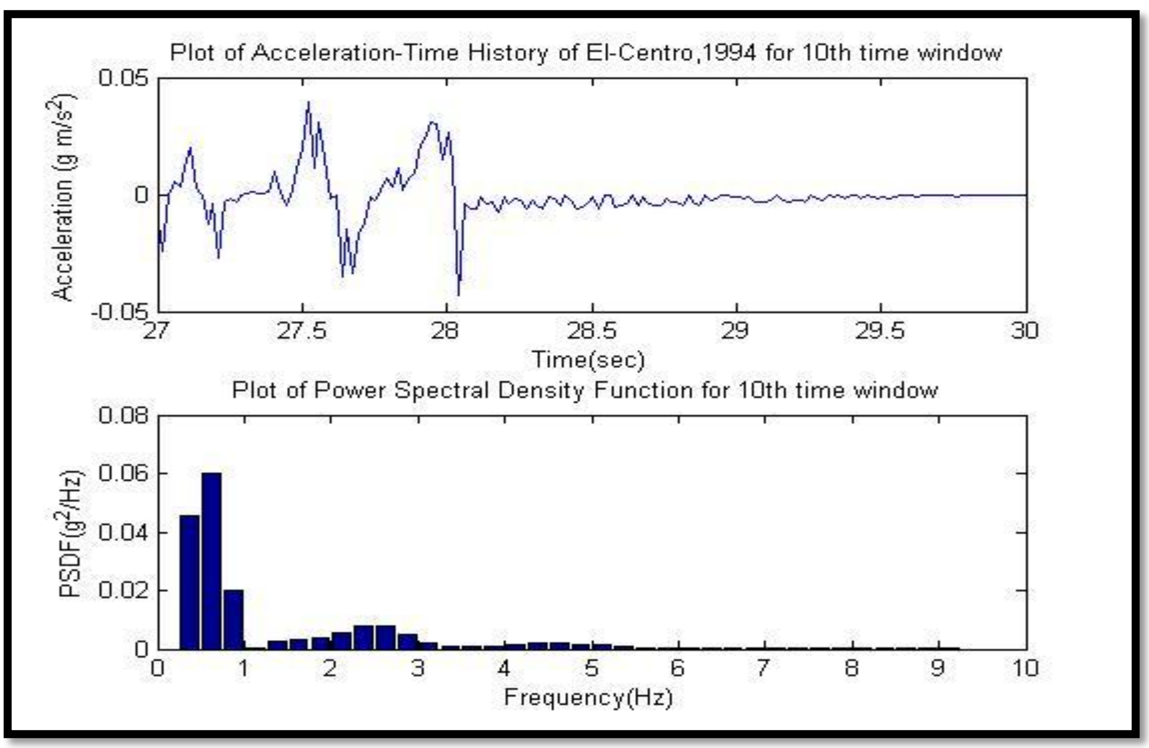

Figure 5.10Acceleration–time history and PSDF plot for time window 10 (i.e28–30 sec)

5.2 PSDF of Filtered data using Chamoli, 1999: total 776 data is divided into 8 windows of 1.94 sec width containing 97 data in each window.

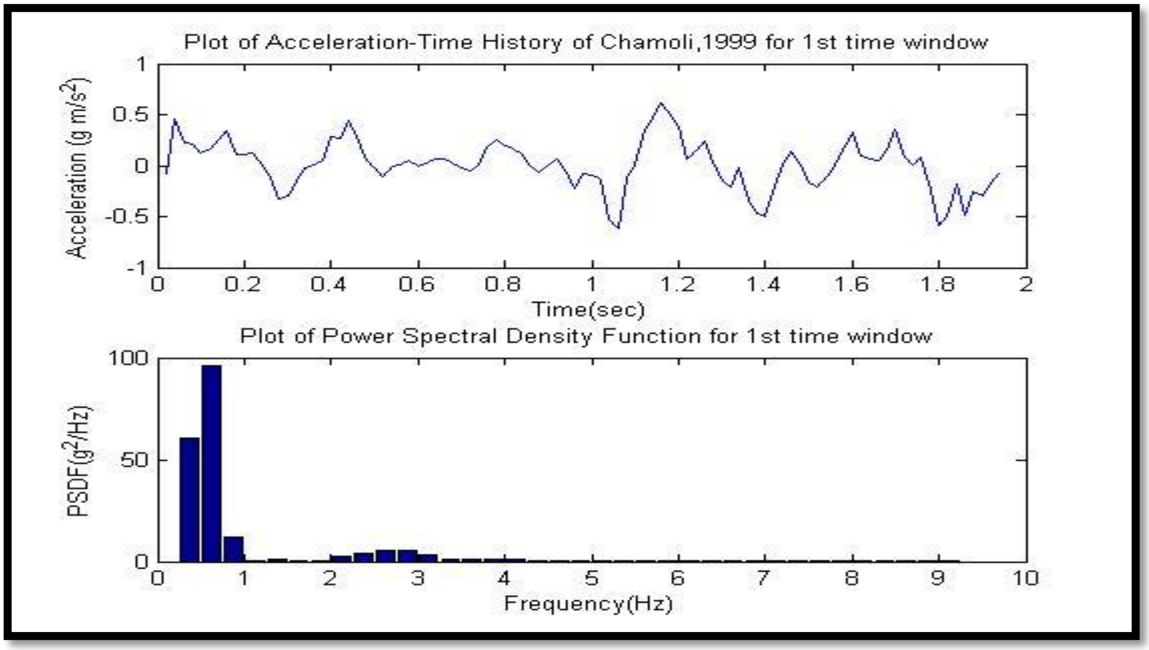

Figure 5.11 Acceleration-time history and PSDF plot for time window 1 of Chamoli, 1999 (i.e. 0-1.94 sec).

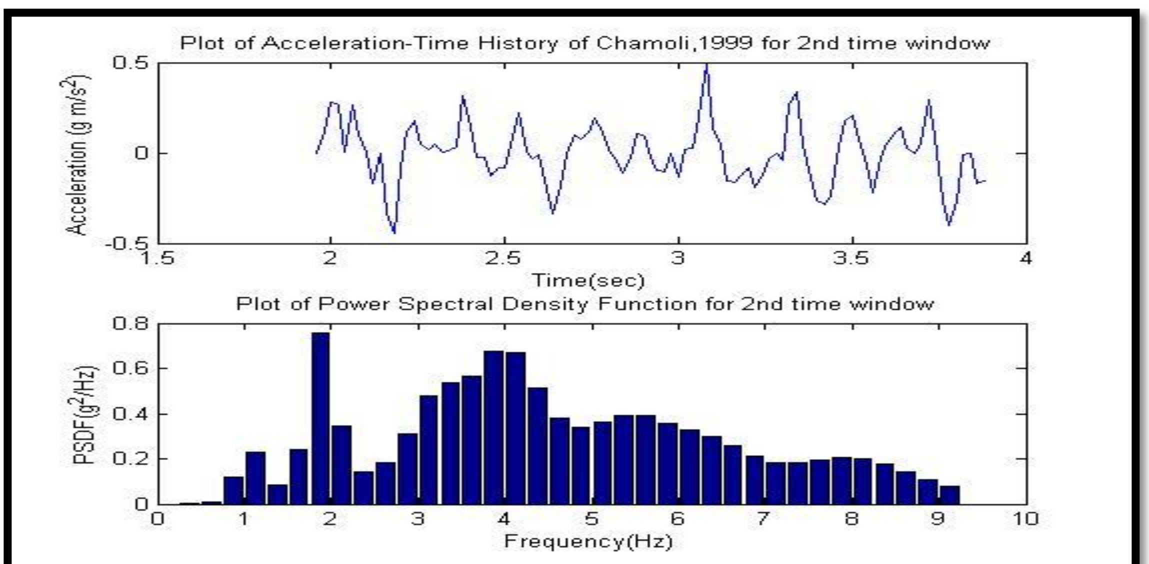

Figure 5.12 Acceleration-time history and PSDF plot for time window 2 of Chamoli, 1999 (i.e. 1.94 - 3.88 sec).

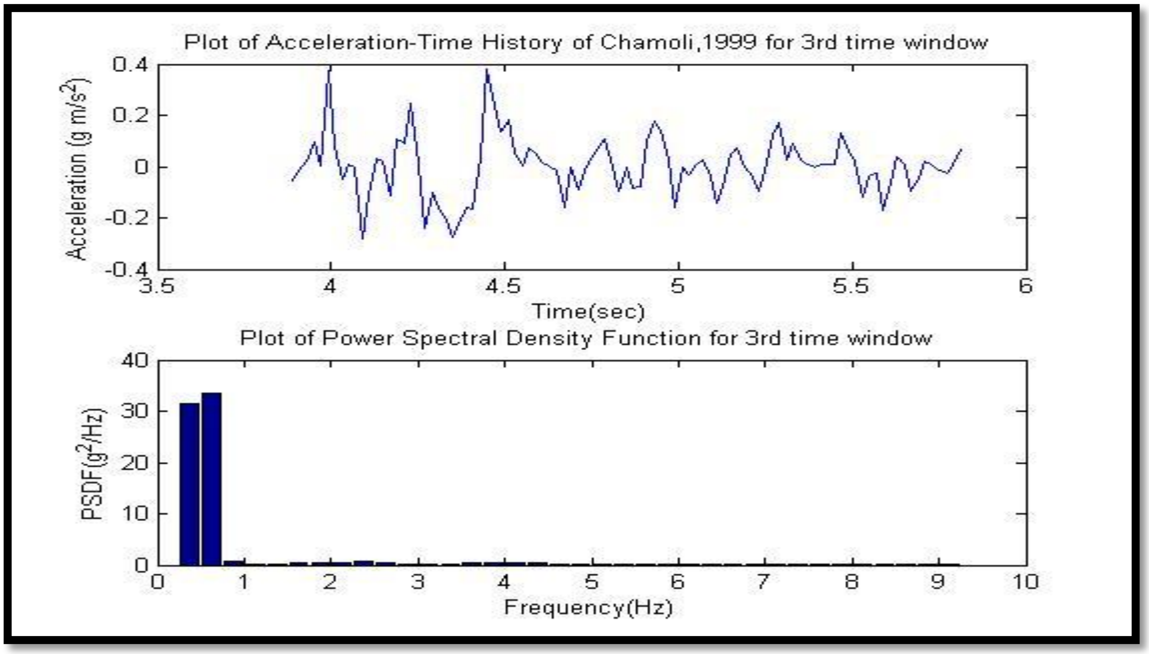

Figure 5.13 Acceleration-time history and PSDF plot for time window 3 of Chamoli, 1999 (i.e. 3.88 – 5.82 sec).

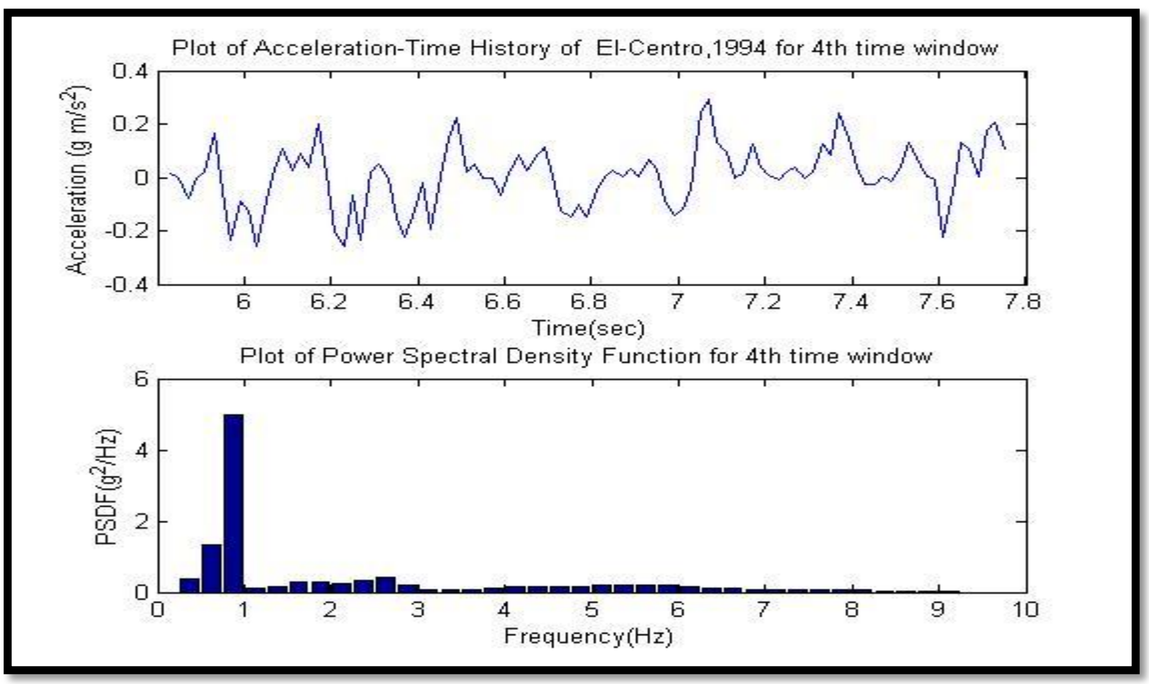

Figure 5.14 Acceleration-time history and PSDF plot for time window 4 of Chamoli, 1999 (i.e. 5.82 – 7.76 sec).

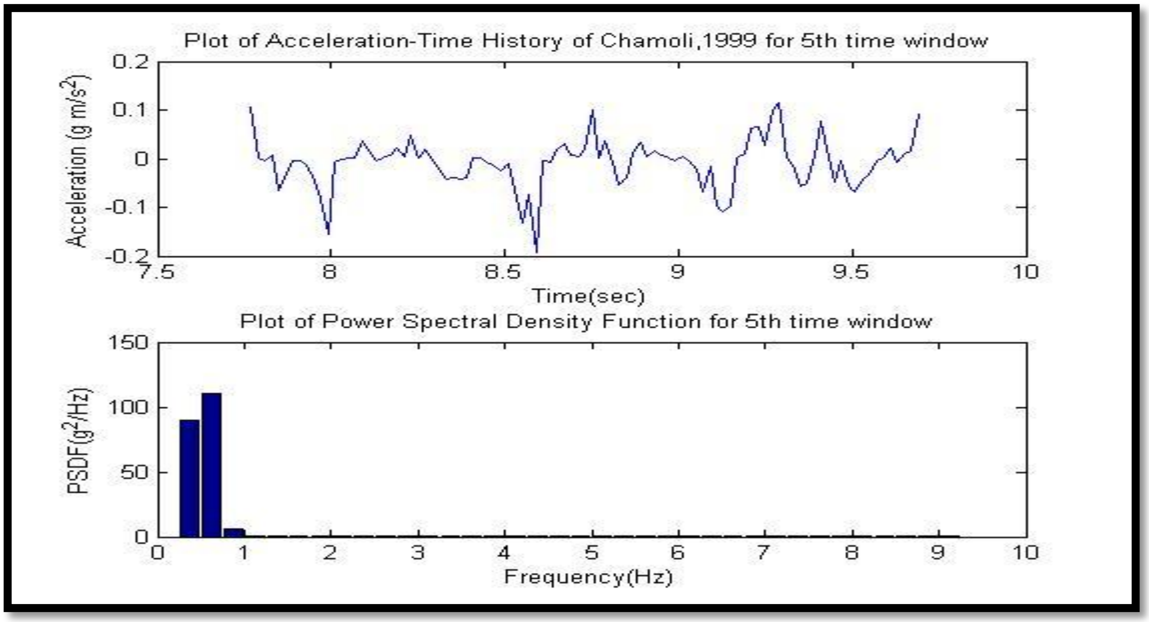

Figure 5.15 Acceleration-time history and PSDF plot for time window 5 of Chamoli, 1999 (i.e. 7.76 – 9.7 sec).

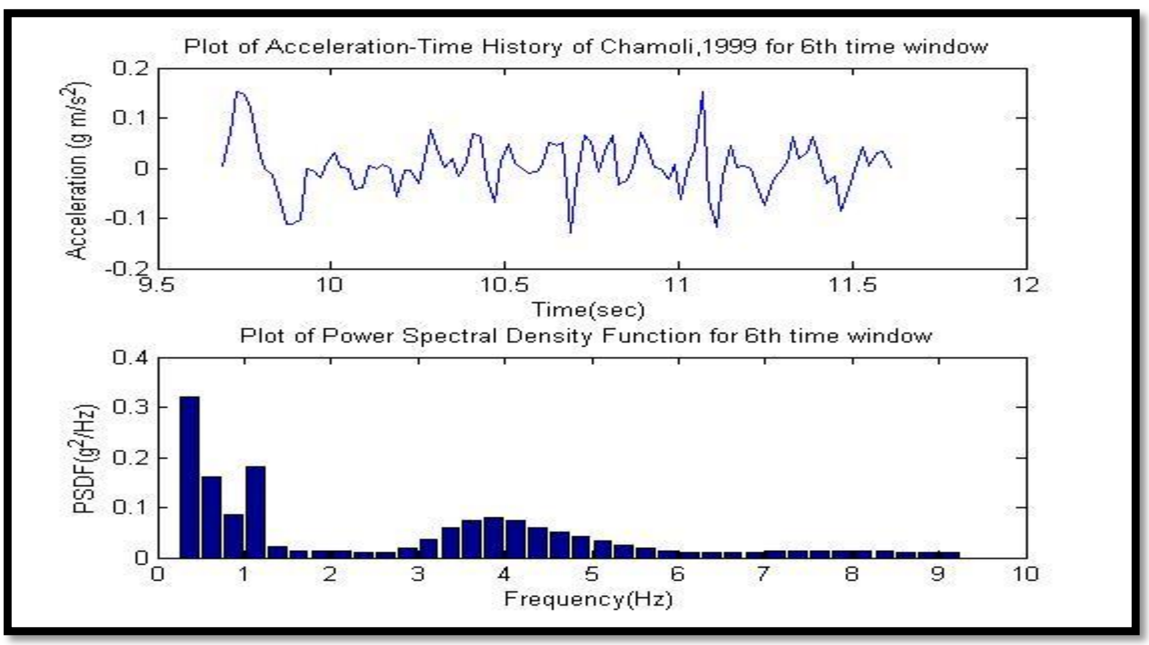

Figure 5.16 Acceleration-time history and PSDF plot for time window 6 of Chamoli, 1999 (i.e. 9.7 – 11.64 sec).

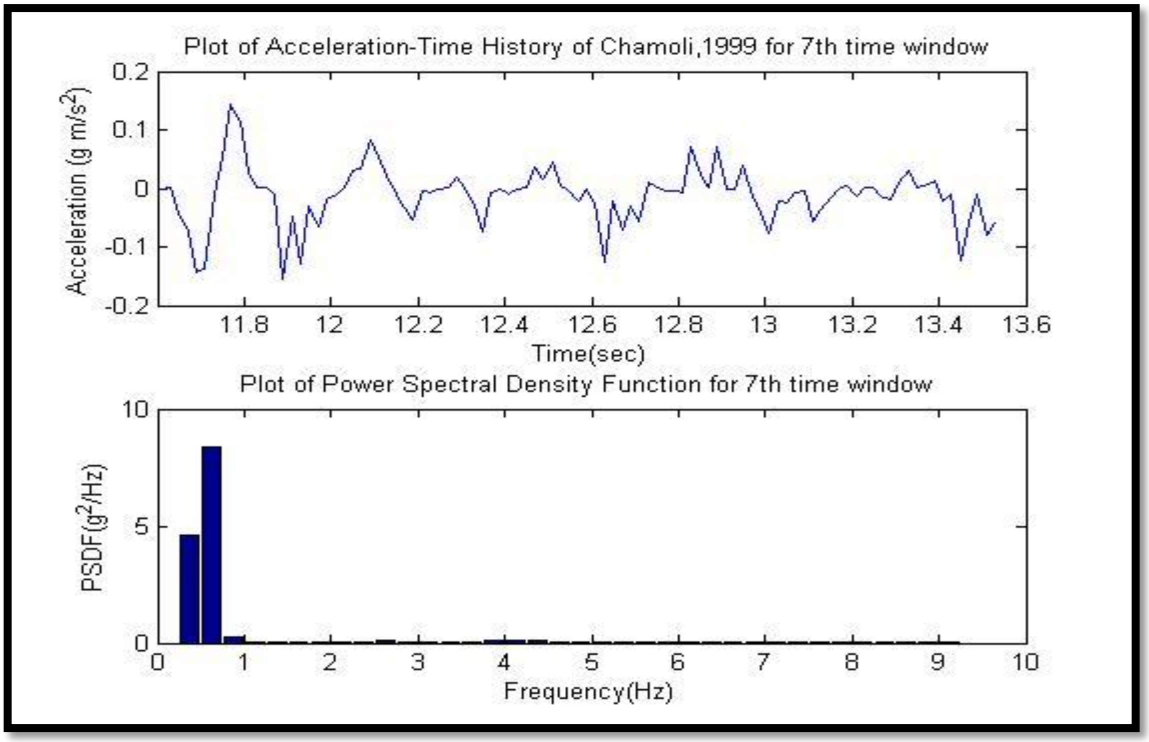

Figure 5.17 Acceleration-time history and PSDF plot for time window 7 of Chamoli, 1999 (i.e. 11.64 – 13.58 sec).

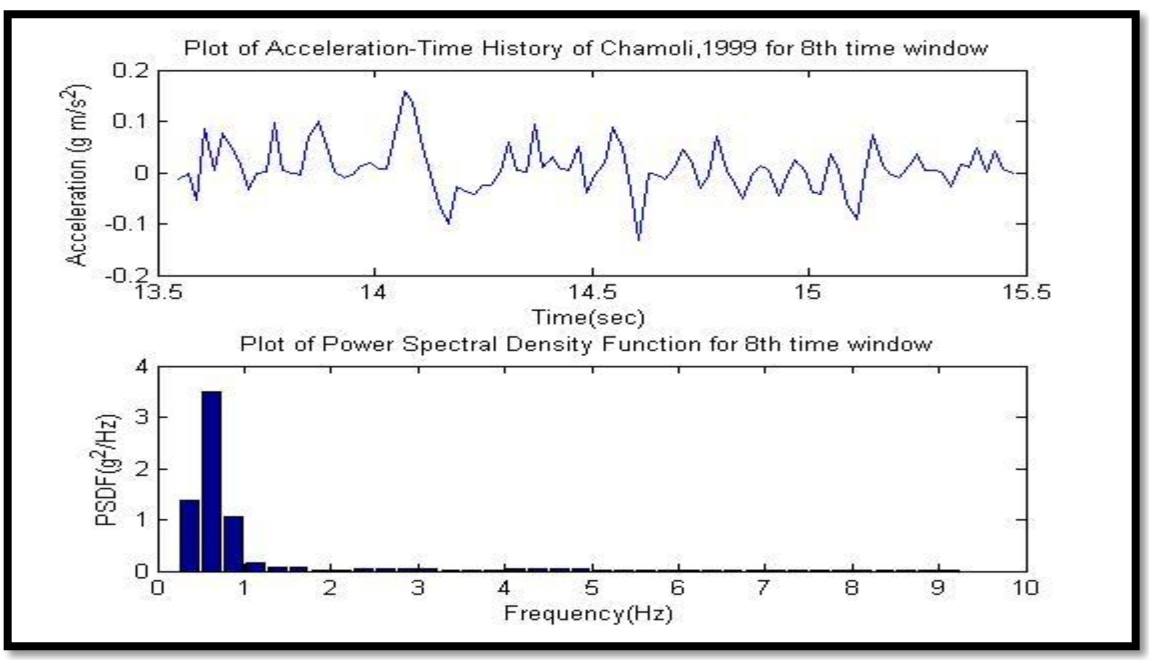

Figure 5.18 Acceleration-time history and PSDF plot for time window 8 of Chamoli, 1999 (i.e. 13.58 – 15.52 sec).

5.3 PSDF of Filtered data using Nongstoin, North-East, India: total 2656 data is divided into 16 windows of 3.318 sec width having 97 data in each window.

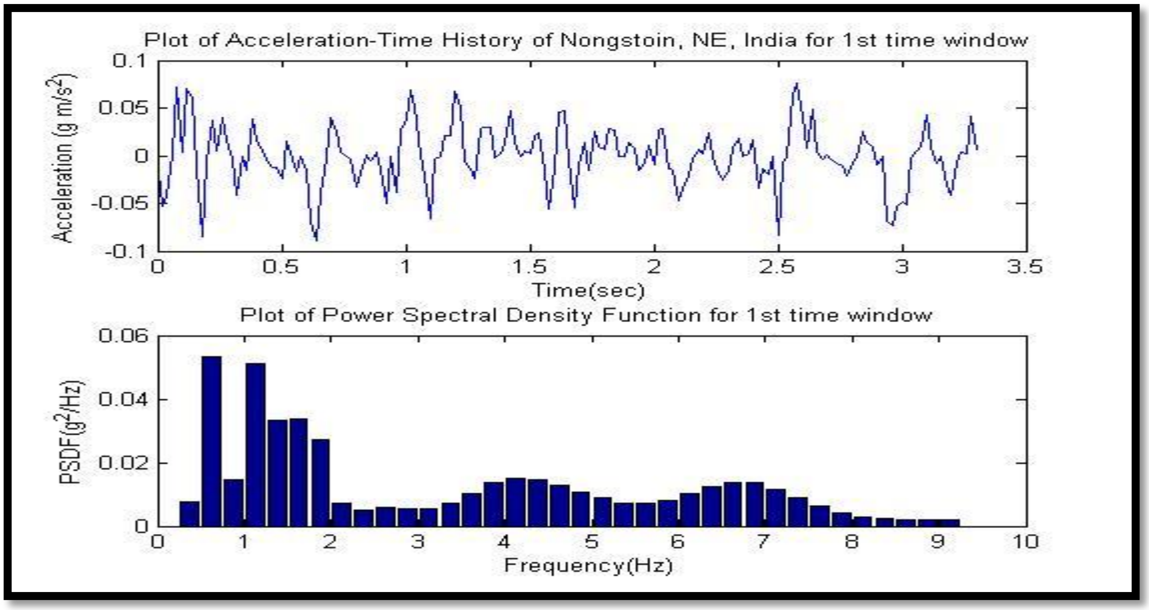

Figure 5.19 Acceleration-time history and PSDF plot for time window 1 of N-E, India (i.e. 0-3.3188 sec).

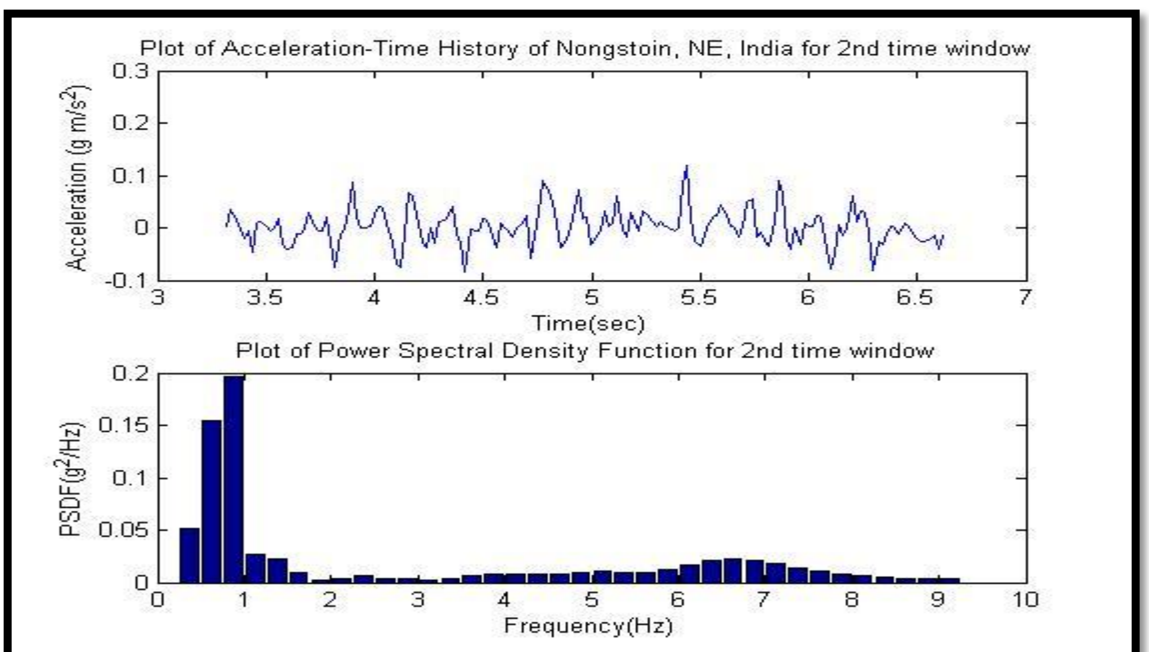

Figure 5.20 Acceleration-time history and PSDF plot for time window 2 of N-E, India (i.e. 3.3188-6.6376 sec).

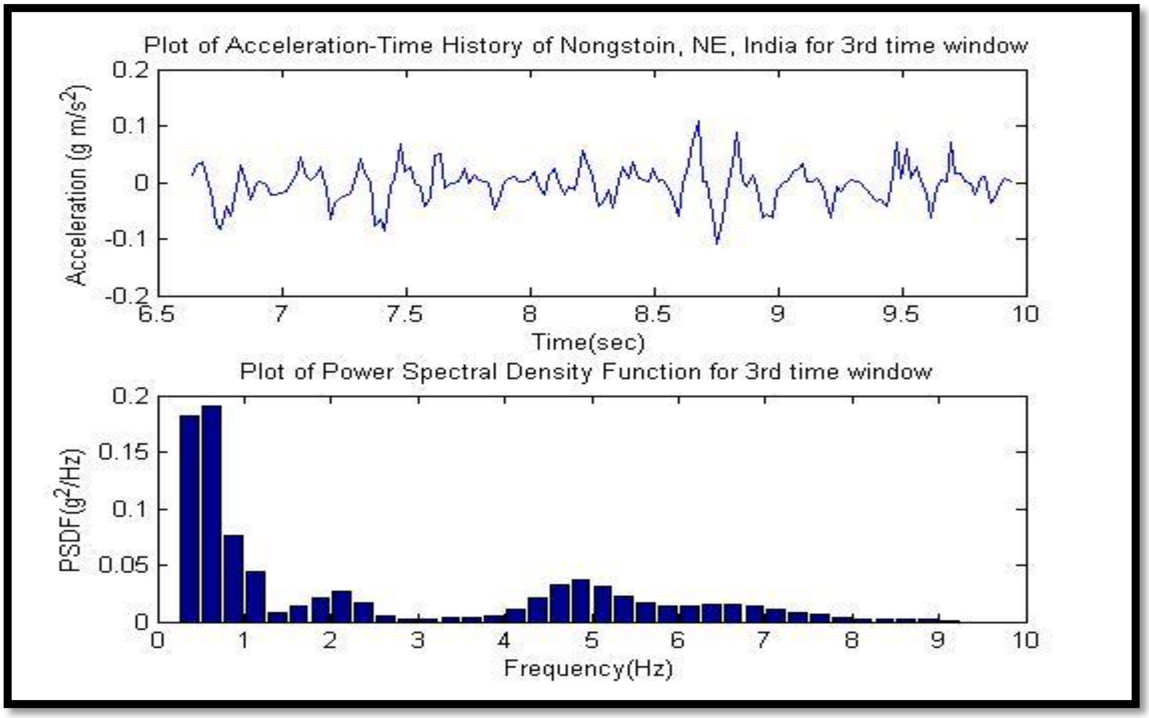

Figure 5.21 Acceleration-time history and PSDF plot for time window 3 of N-E, India (i.e. 6.6376- 9.9564).

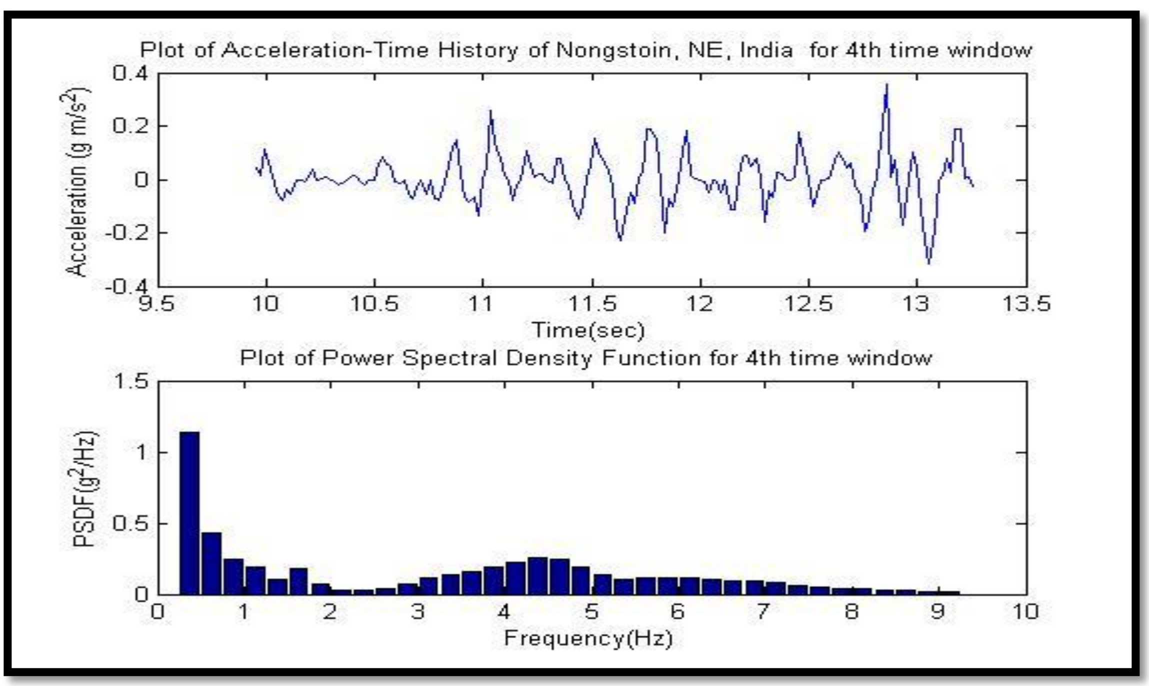

Figure 5.22 Acceleration-time history and PSDF plot for time window 4 of N-E, India (i.e. 9.9564-13.2752 sec).

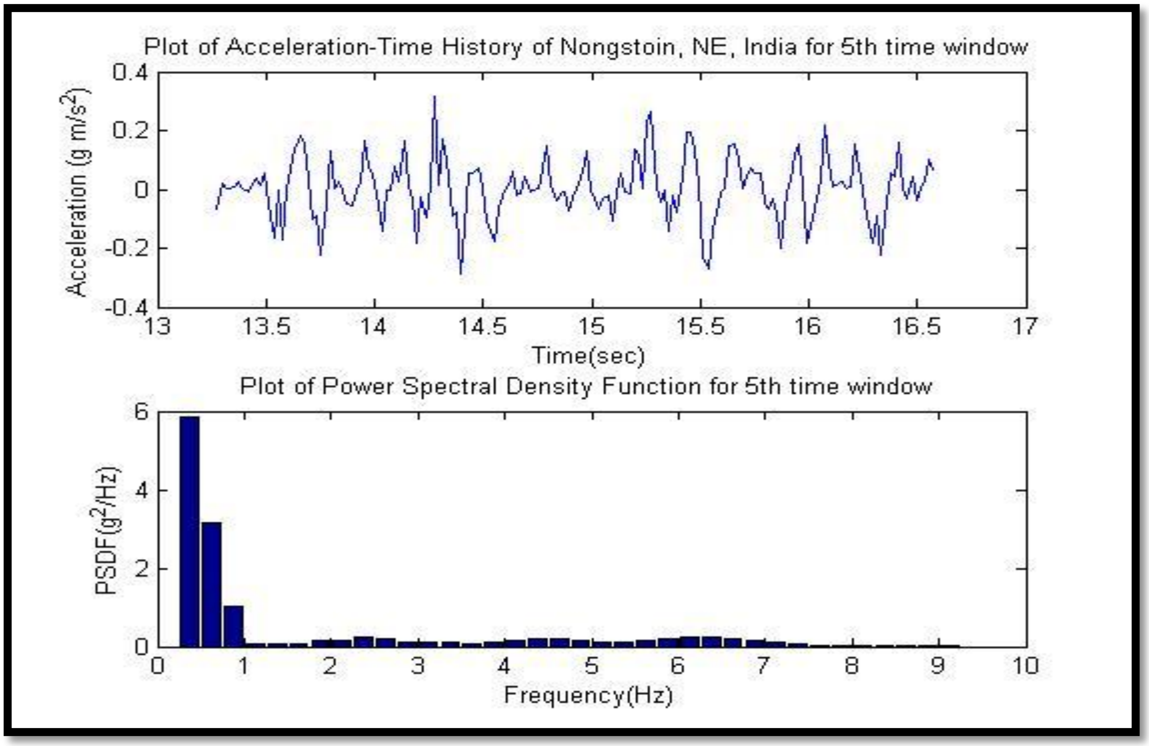

Figure 5.23 Acceleration-time history and PSDF plot for time window 5 of N-E, India (i.e. 13.2752-16.592).

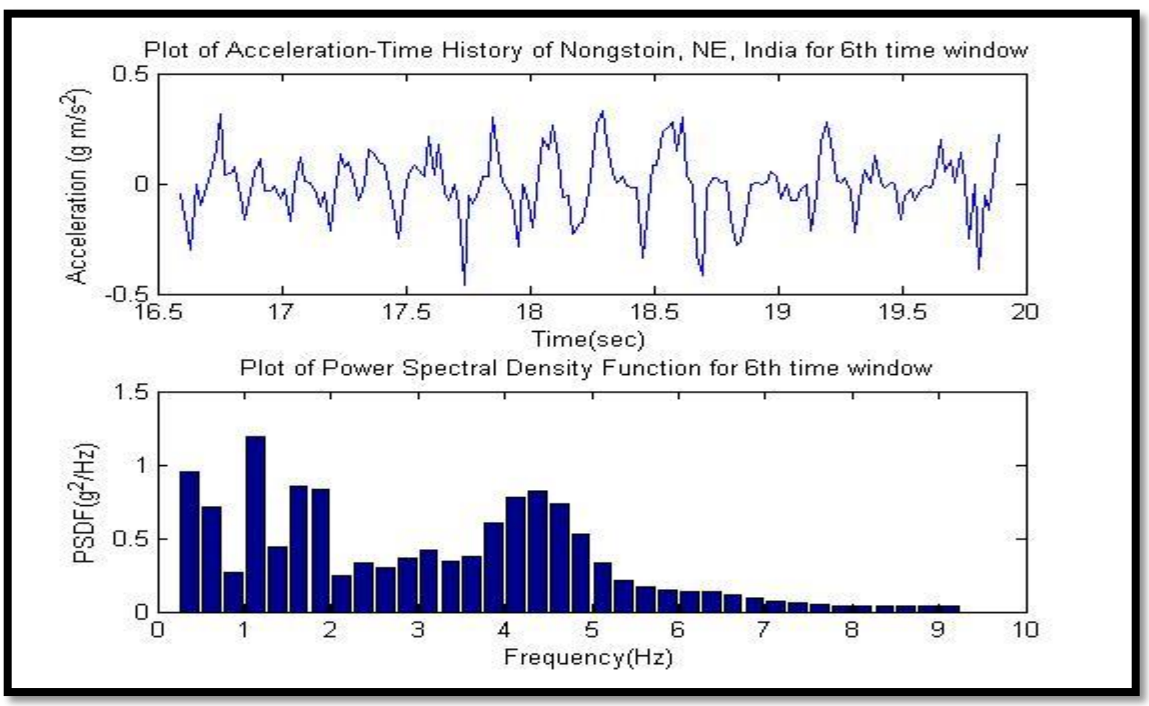

Figure 5.24 Acceleration-time history and PSDF plot for time window 6 of N-E, India (i.e. 16.594-19.912 sec).

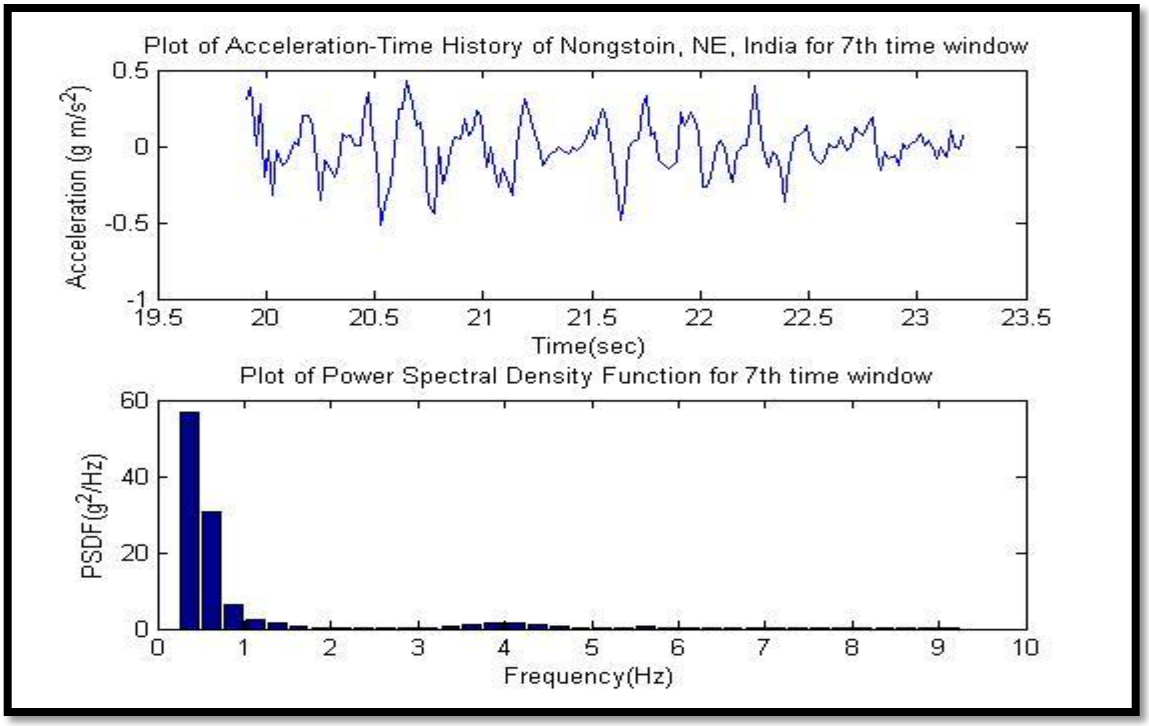

Figure 5.25 Acceleration-time history and PSDF plot for time window 7 of N-E, India (i.e. 19.912-23.2316 sec).

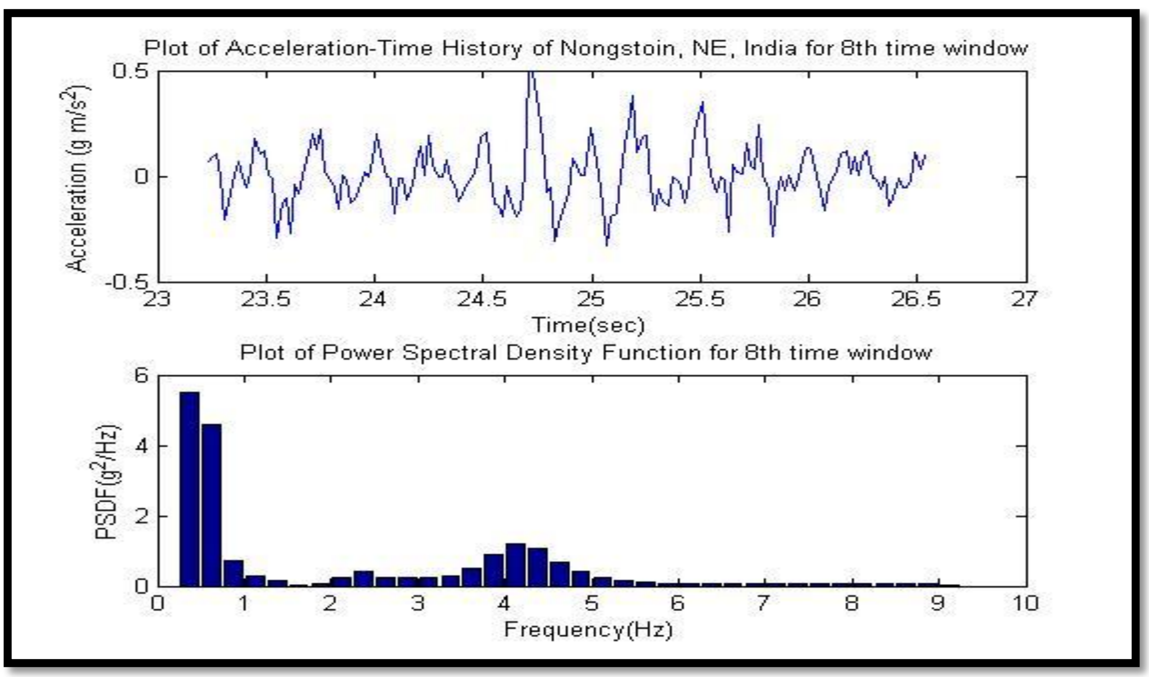

Figure 5.27 Acceleration-time history and PSDF plot for time window 8 of N-E, India (i.e. 23.2316-26.5504 sec).

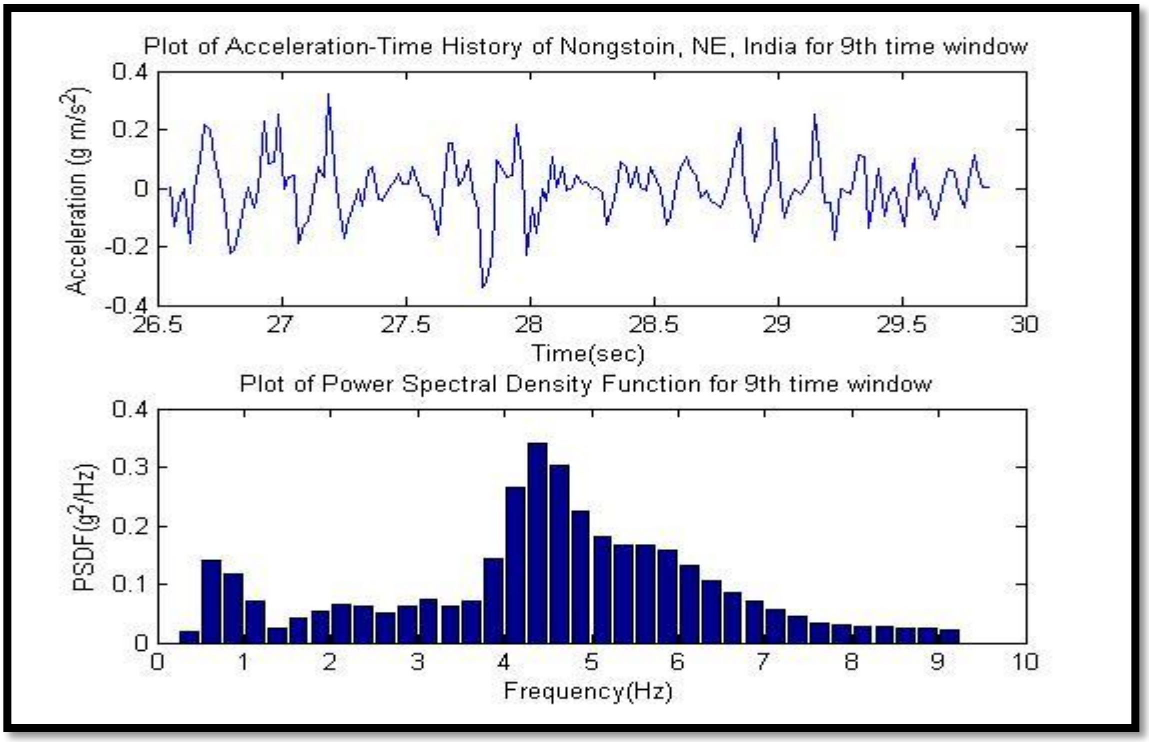

Figure 5.28 Acceleration-time history and PSDF plot for time window 9 of N-E, India (i.e. 26.5504-29.5504 sec).

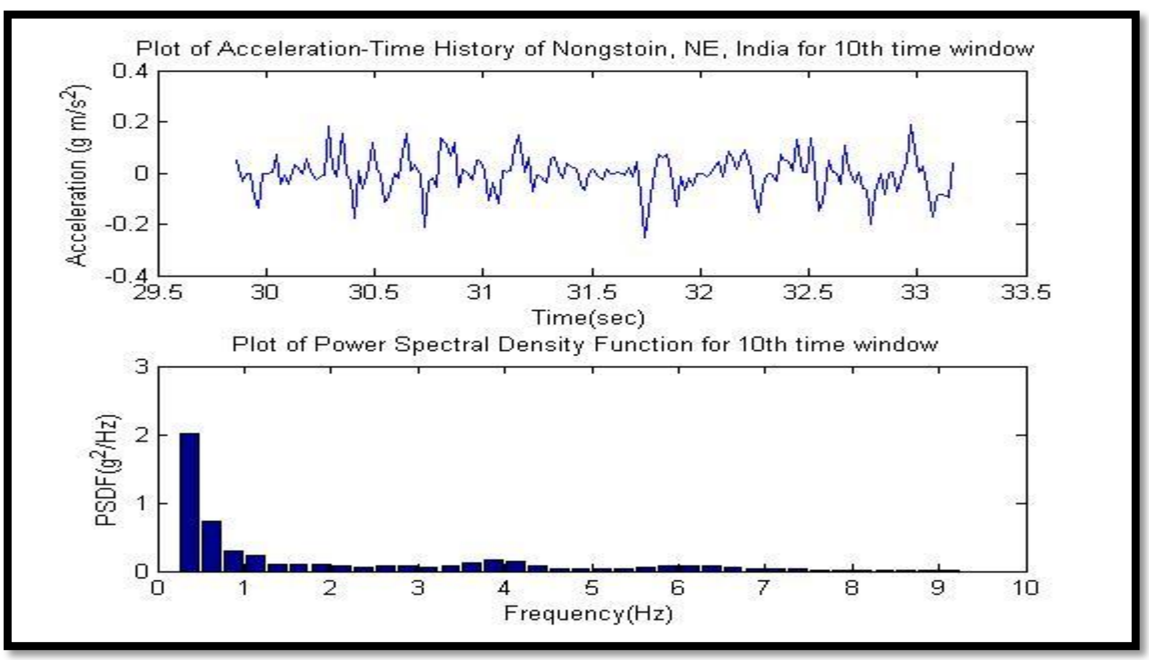

Figure 5.29 Acceleration-time history and PSDF plot for time window 10 of N-E, India (i.e. 29.8682-33.188 sec).

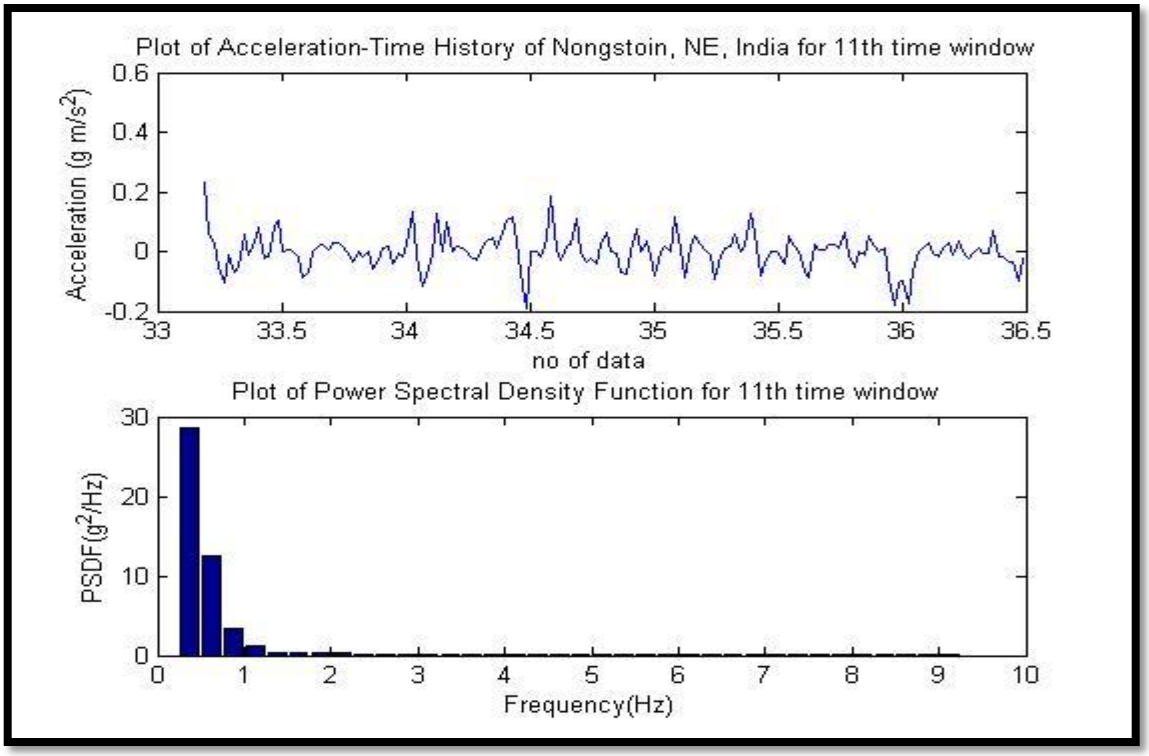

Figure 5.30 Acceleration-time history and PSDF plot for time window 11 of N-E, India (i.e. 33.188-36.5068 sec).

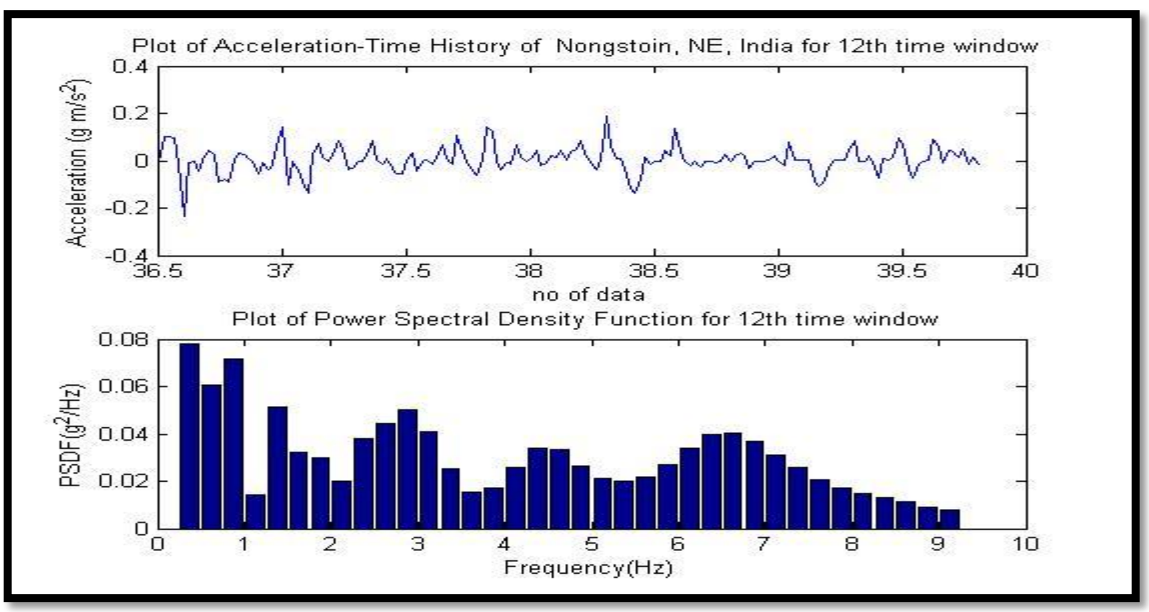

Figure 5.31 Acceleration-time history and PSDF plot for time window 12 of N-E, India (i.e. 36.5068-39.8256 sec).

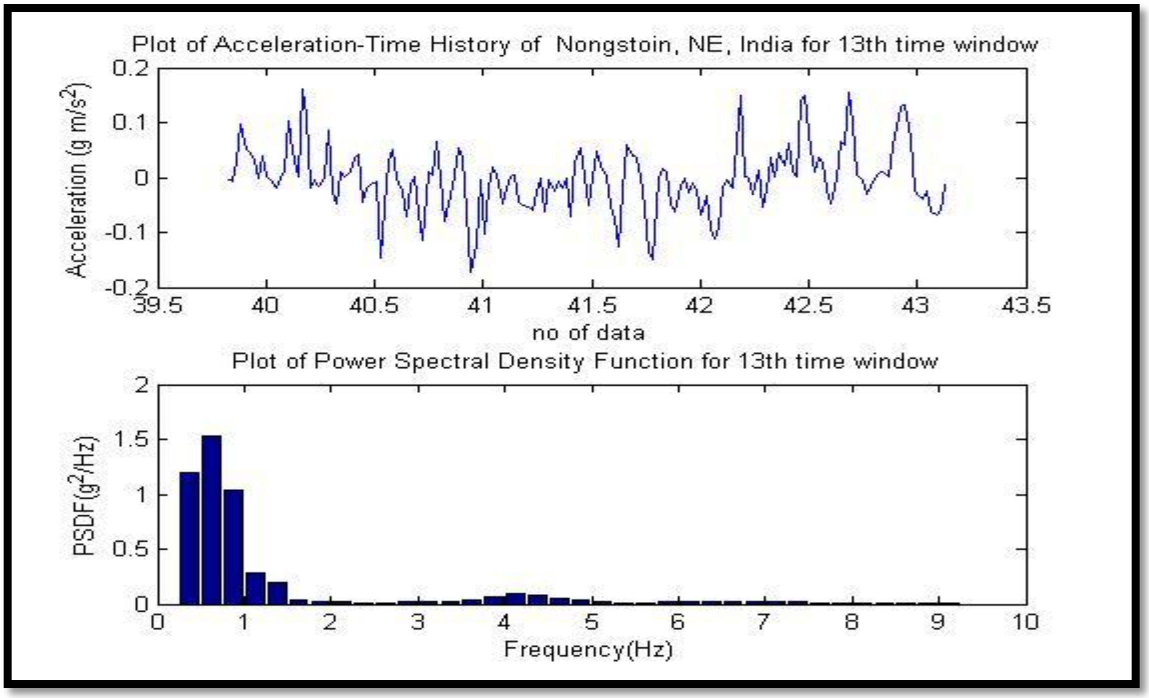

Figure 5.32 Acceleration-time history and PSDF plot for time window 13 of N-E, India (i.e. 39.8256-43.1444 sec).

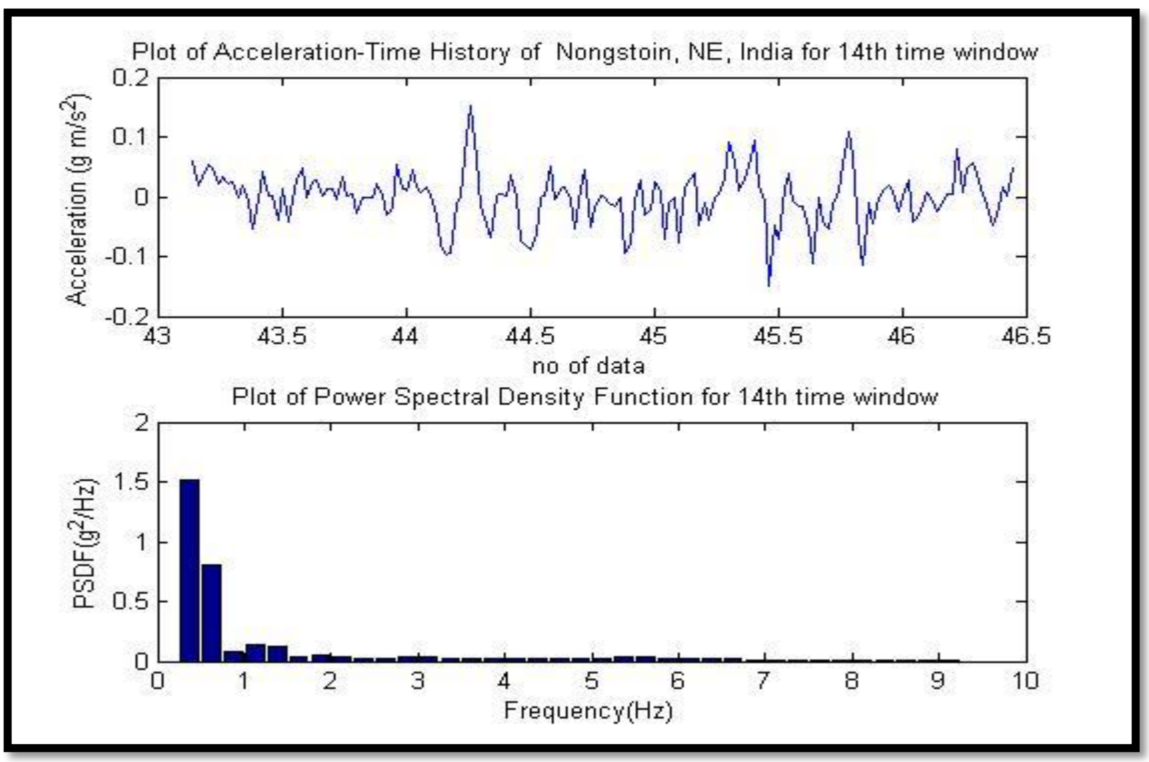

Figure 5.33 Acceleration-time history and PSDF plot for time window 14 of N-E, India (i.e. 43.1444-46.4632 sec).

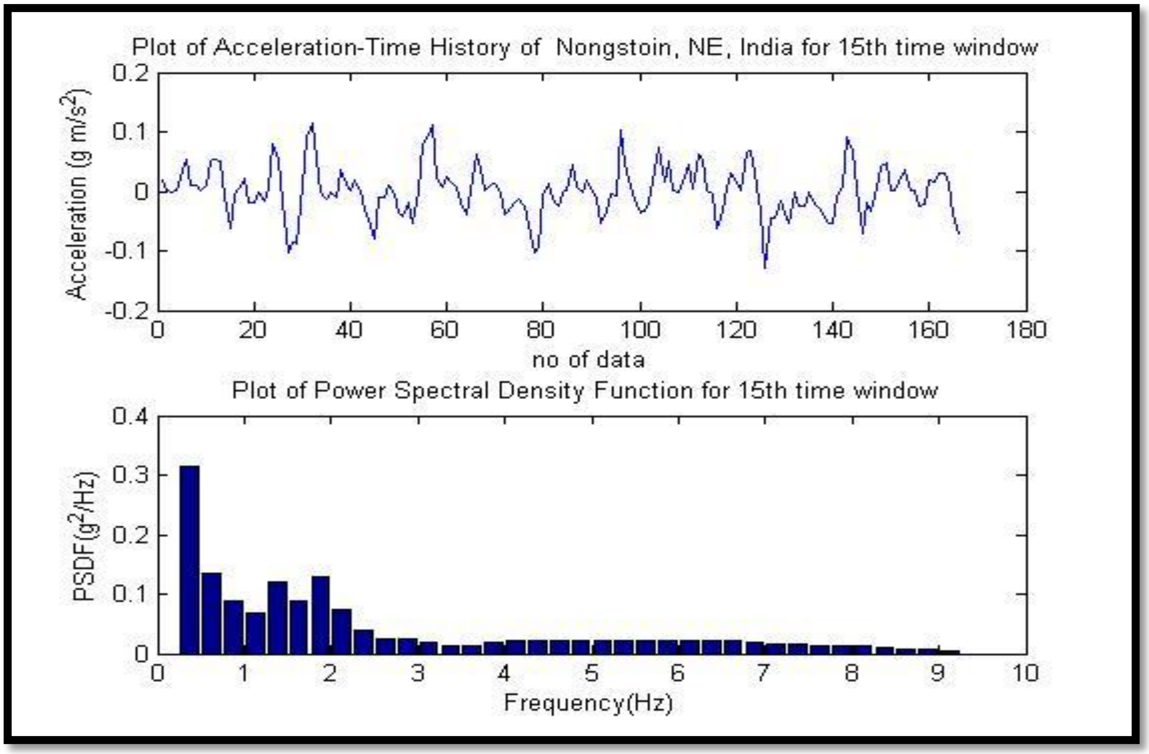

Figure 5.34 Acceleration-time history and PSDF plot for time window 15 of N-E, India (i.e. 46.4632-49.782 sec).

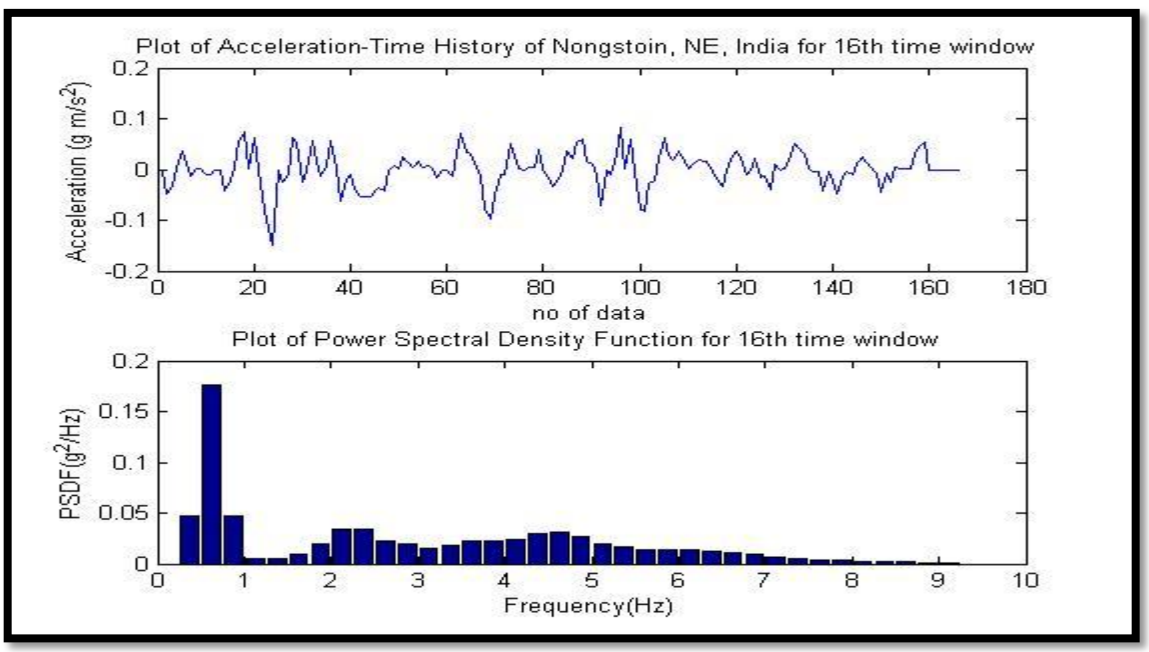

Figure 5.35 Acceleration-time history and PSDF plot for time window 16 of N-E, India (i.e. 49.782-53.1 sec).

CHAPTER 6

SPECTRAL PARAMETERS

6.1 General

There are three types of spectra that can be used to characterize strong ground motion. The Fourier amplitude spectrum and the closely related power spectral density, combined with the phase spectrum, can describe a ground motion completely. The response spectrum does not describe the actual ground motion, but it does provide valuable additional information on its potential effects on structures. Each of these spectra is a complicated function and, as with time histories, a great many data required to describe them completely. A number of spectral parameters have been proposed to extract important pieces of information from each spectrum.

6.2 Bandwidth: The predominant period can be used to locate the peak of the Fourier amplitudes about the predominant period. The bandwidth of the Fourier amplitude spectrum is the range of the frequency over which some level of Fourier amplitude is exceeded.

Bandwidth is usually measured at level where the power of the spectrum is half its maximum value; this corresponds to a level of $1/\sqrt{2}$ times the maximum Fourier amplitude.

6.3 Central Frequency: the central frequency is a measure where the power spectral density is concentrated. It can also be used, along with the average intensity and duration, to calculate the theoretical median peak acceleration

6.4 Shape Factor: The shape factor indicates the dispersion of the power spectral density function about the central frequency. The shape factor is always between o0 and 1, with higher values corresponding to larger bandwidths.

6.5 Kanai – Tajimi Parameters: These parameters are natural frequency and damping ratio of soil which is proposed by two scientists Kanai and Tajimi. Most of the estimated PSD functions are very erratic in shape which makes it difficult to calculate Kanai and Tajimi parameters directly through the graph. Binder (1978) [1] tried two different methods, namely, the "least square method" and "method of moments" to compute the K – T parameters by fitting the PSD functions. Based on the study he concluded that method of moments would yield satisfactory results. In this study, method of moments as proposed by Binder was used to calculate the K – T parameters for 10 small time window of 3 seconds for artificial earthquake data.

6.5.1 Method of moments for fitting the PSD spectrum:

The ith spectral moment λ_j, of a power spectral density function is defined as:

$$\lambda_j = \int_0^{\infty} \omega^j G(\omega) d\omega$$

Hence, zero Spectral moment λ_0 can define variance of excitation:

$$\lambda_0 = \sigma_0^2 = \int_0^{\infty} \omega^0 G(\omega) d\omega$$

$$= \int_0^{\infty} G_0 \frac{1+[2\xi_g(\omega/\omega_g)]^\wedge 2}{\left[1-\left(\frac{\omega}{\omega_g}\right)^2\right]^2 +[2\xi_g(\omega/\omega_g)]^\wedge 2} d\omega$$

For generalization consider $J_1(\Omega^*)$:

$$J_i(\Omega^*) = \frac{4\xi_g}{\pi} \int_0^{\Omega^*} \frac{\Omega^i}{(1-\Omega^2)^2 + 4*\xi_g^2\Omega^2}$$

Ω^* is the upper bond limit of the integration, in this study $\Omega^* = 25*\pi/\omega_g$.

Furthermore, the central frequency, ω_c , and bandwidth measure, δ can be directly calculated from spectral moments Vanmarcke (1973) [4]

$$\omega_c = \sqrt{\frac{\lambda_2}{\lambda_0}}$$

$$\delta = \sqrt{1 - \frac{\lambda_1^2}{\lambda_0\lambda_2}}$$

This method evaluates the Kanai – Tajimi's parameters in such a way that spectral moments λ_0, λ_1 and λ_2 of estimated ergodic PSD function and the fitted Kanai – Tajimi PSD function are the same.

CHAPTER 7

KANAI – TAJIMI PARAMETER FOR DIFFERENT EARTHQUAKE

The method of spectral moments has been applied to each time window of predicted earthquake from time varying Wiener Filter. Change in Kanai Tajimi frequency and damping ratio with time is identified based on windowed data of earthquake using a moving time window of 0.3845 sec. A graph is plotted showing the variation of natural frequency and damping ratio with respect to time, where horizontal axis indicates window start time.

It is seen that shaking of earthquake significantly reduces the soil layer stiffness, causing the corresponding decrease of natural frequency and damping ratio increases.

7.1 Kanai-Tajimi parameter of El-Centro earthquake

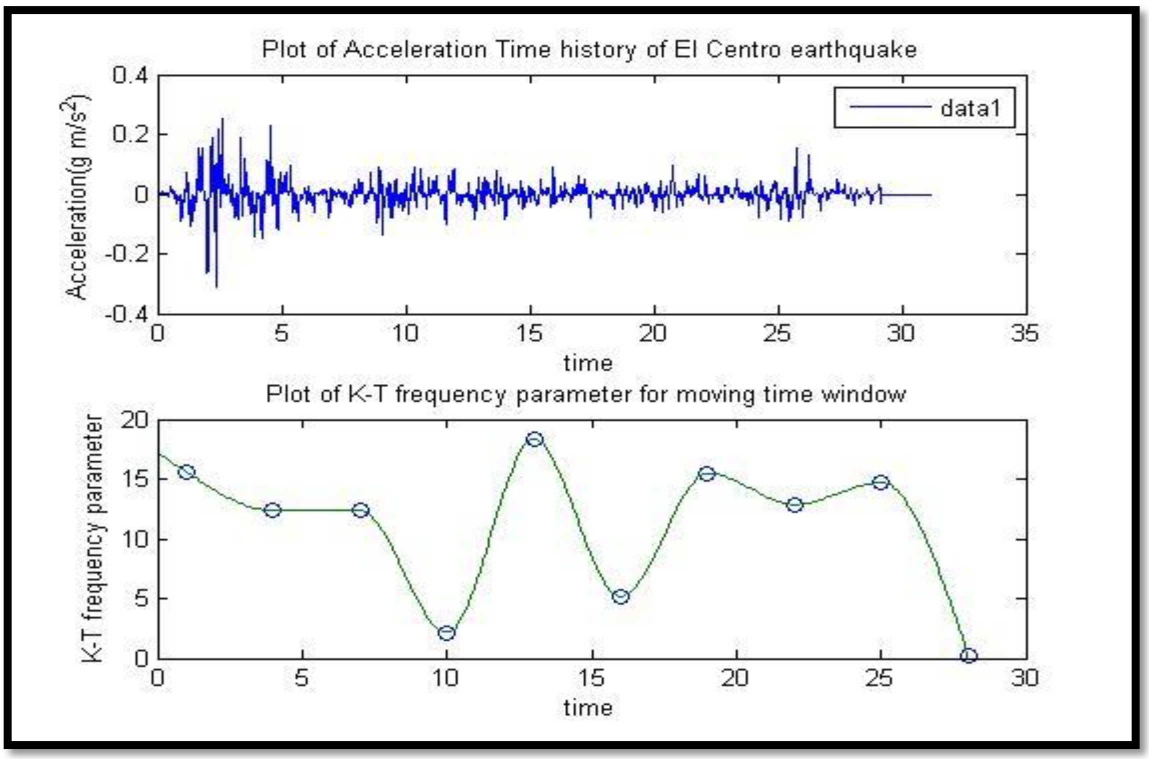

Figure7.1 Plot of Acceleration time history El- Centro and Kanai –Tajimi frequency parameter.

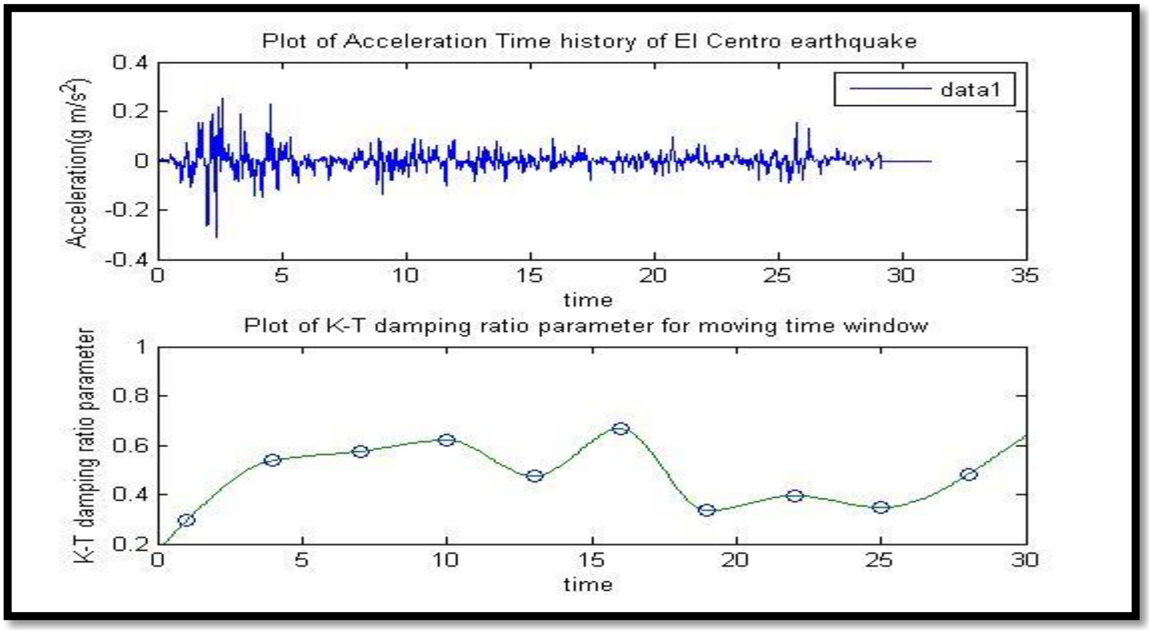

Figure 7.2 Plot of Acceleration time history El- Centro and Kanai –Tajimi damping ratio parameter.

7.2 Kanai-Tajimi parameter of Chamoli , 1999 Earthquake

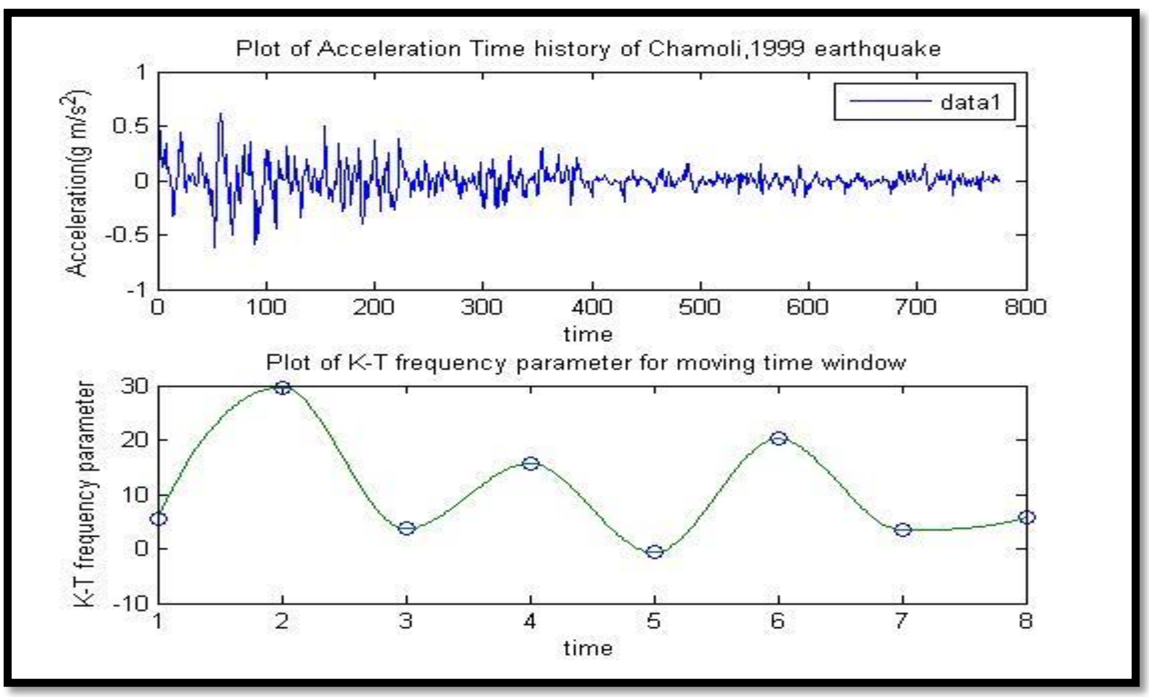

Figure 7.3 Plot of Acceleration time history Chamoli,1999 and Kanai –Tajimi frequency parameter.

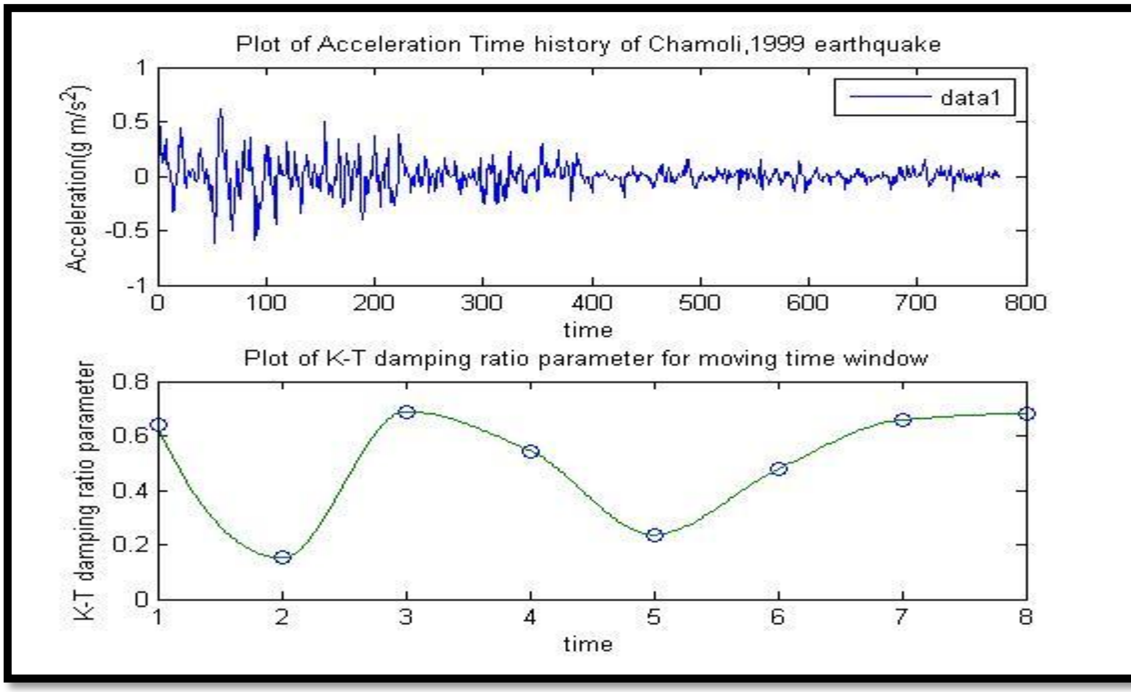

Figure 7.4 Plot of Acceleration time history Chamoli, 1999 and Kanai –Tajimi damping ratio parameter.

7.3 Kanai-Tajimi Parameter of North-East, India Earthquake

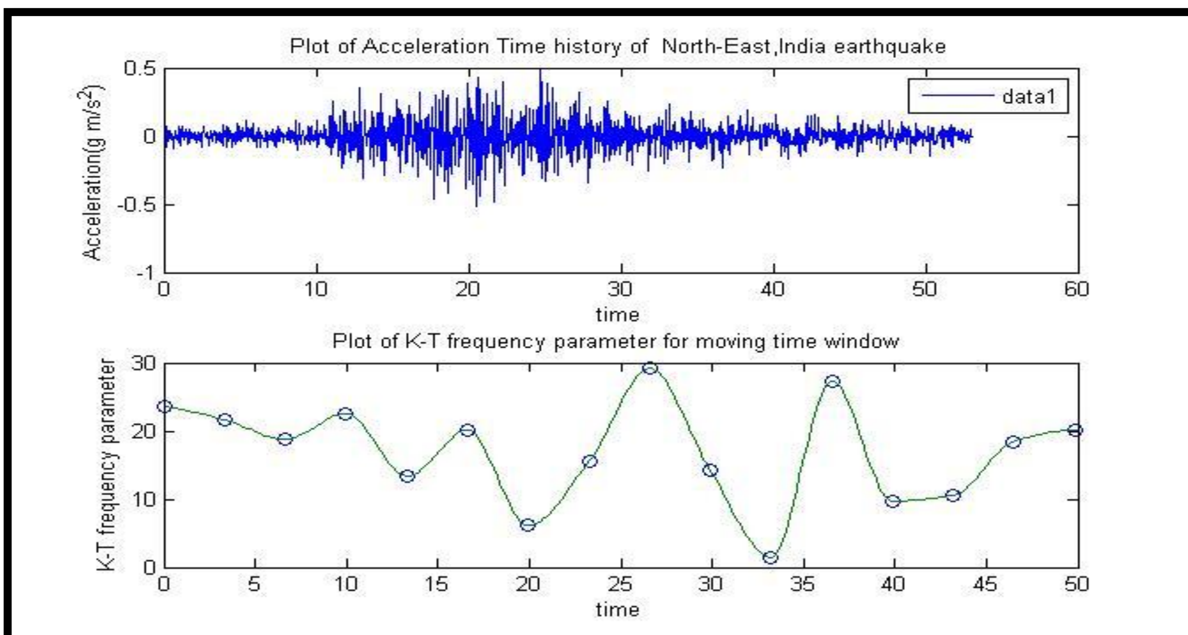

Figure 7.5 Plot of Acceleration time history North-East, India and Kanai –Tajimi frequency parameter.

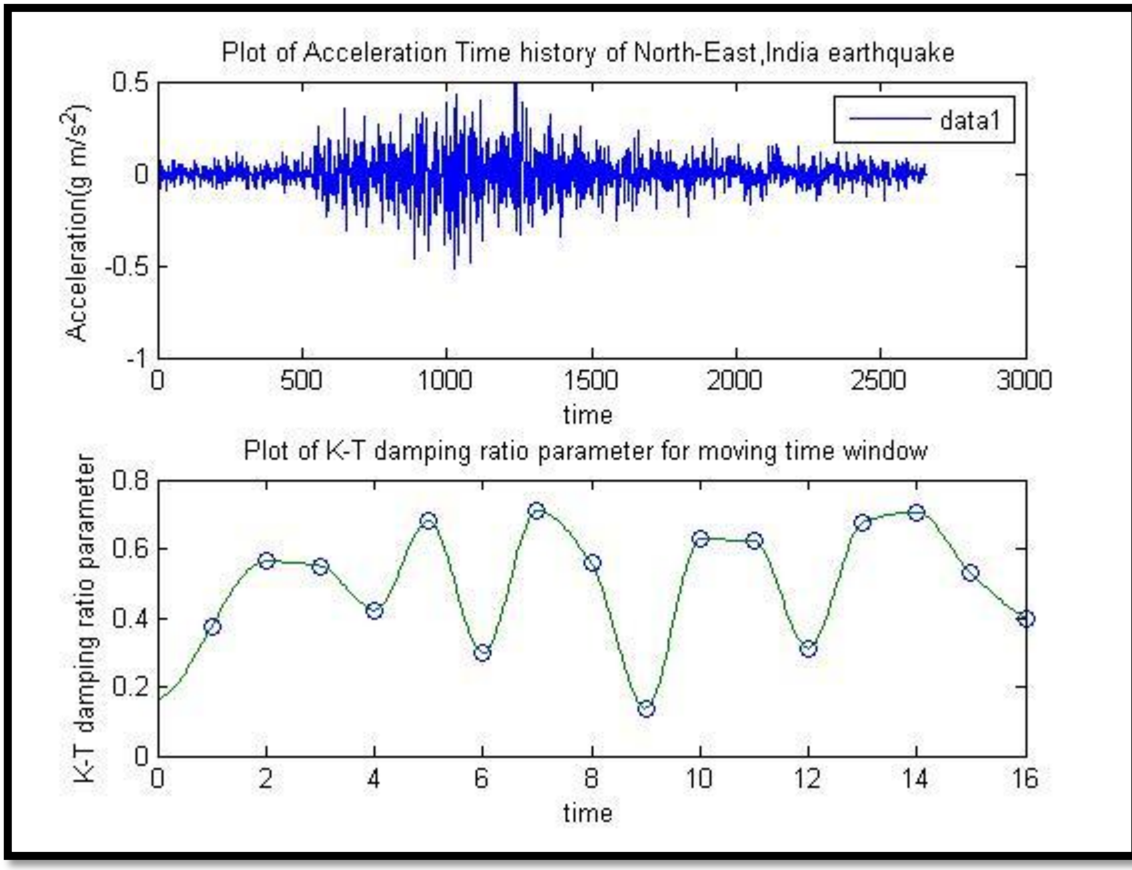

Figure 7.6 Plot of Acceleration time history North-East, India and Kanai –Tajimi damping ratio parameter.

CHAPTER 8

MAIN CONCLUSIONS AND FURTHER SCOPE OF WORK

In this thesis I have used two types of adaptive filter i.e Time – Variant Wiener Filter and Normalized least mean square filter to get artificial earthquake from the white noise. White noise is assumed to be signal generated at the fault zone and filter is assumed to be soil layer. This study shows normalized least mean square filter gives less error than Time Varying Wiener Filter.

Also Kanai and Tajimi frequency and damping ratio parameter for different earthquake is calculated in this study. It is observed that K-T parameters are very closely related to nonlinear response of ground and there is reduction in soil natural frequency and increase in soil damping ratio which was found to time varying characteristics.

REFERENCES

Journals:

[1] Binder, R. (1978), “Strong motion Duration and Spectral Density Functons for a set of 39 Earthquake Ground Motions” Internal Study Report No. 16 Seismic Safety of Buildings, M.I.T. Department of Civil Engineering, April 1978.

[2] Irvine Tom (2000), “An introduction to the filtering of digital signals”, Revision A.

[3] Irvine Tom (2000), “Power Spectral Density Function”, Revision A.

[4] Erik H. Vanmarke (1973), “Parameters of the spectral density function : Their significance in time and frequency domain” M.I.T. Dept. of Civil Engineeering, Research Report.

[5] Erik H. Vanmarke and S.P. Lai (1980), “Strong – motion duration of earthquakes, M.I.T., Dept. Civil Engineering, Research Report.

[6] Kanai, K. (1957), “Semi – empirical formula for the seismic characteristics of the ground, Bull. Earthquake Res. Inst., Univ. Tokyoo,35” .

[7] Shih – Sheng Paul Lai, (1982). Statistical Characterization of Strong Ground Motions Using Power Spectral Density Function, Bull. Of the seismological society of America, Vol. 72, No. 1, pp. 259- 274, February 1982.

[8] Tajimi, H. (1960), A statistical method of determining the maximum response of the building structure during the earthquake.

Books

[1] Anil Chopra, “Dynamics of Structures”, Pearson Education, Inc.

[2] John G. Proakis and Dimitris G.Manolakis, “Digital Signal Processing, Principles, Algorithms, and Applications”, PHI learning.

[3] Kramer, S.L.(1996), "Geotechnical earthquake engineering", Prentice hall, Pearson Education Inc., India.

[4] Monson H. Hayes.(1996), "Statistical Digital Signal Processing and Modeling", John Willey and Sons, Inc.

[5] Simon Haykin, "Adaptive Filter Theory", Pearson Education, Inc.

[6] Stevan and Kay, "Statistical Signal Processing"

Websites:

[1] http://www.cosmos-eq-org

[2] http://www.nicee.org

[3] http://nisee2.berkeley.edu

[4] http://peer.berkeley.edu

[5] http://strongmotioncentre.org

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APPENDICES

Appendix 1

MATLAB PROGRAM FOR NORMALIZED LEAST MEAN SQUARE FILTER

1st Step:

```
function [e,w,f]=nlmsFunc(mu,M,u,D,a);
% Normalized LMS
% Input arguments:
% mu = step size, dim 1x1
% M = filter length, dim 1x1
% u = input signal, dim Nx1
% d = desired signal, dim Nx1
% a = constant, dim 1x1
%
% Output arguments:
% e = estimation error, dim Nx1
% w = final filter coefficients, dim Mx1
%intial value 0
M=1;
w=zeros(1560,1); %This is a vertical column

%input signal length
N=length(u);
%make sure that u and d are colon vectors
u=u(:);
D=D(:);
%NLMS
for n=M:N %Start at M (Filter Length) and Loop to N (Length of Sample)
uvec=u(n:-1:n-M+1); %Array, start at n, decrement to n-m+1
e(n)=D(n)-w(n)'*uvec;
w(n)=w(n)+mu/(a+uvec'*uvec)*uvec*conj(e(n));
f(n) = w(n)'*uvec; %In ALE, this will be the narrowband noise.
end
w=w(:);
e=e(:);
```

2nd Step:

```
clear all;clc;
mu=1.3;
M = 1560;
a=1;

s = load('dat.dat');
[x y] = size(s);
for i = 1:x
    for j = 1:y
```

```
        d(7*(i - 1) + i + j - 1) = s(i,j);
    end
end
[x1 y1] = size(d);
D=transpose(d);
for k=1:1:y1
    t(k)=.02*(k-1);
end
figure
subplot(211)
plot(t,d);
grid;
xlabel('Time')
ylabel('Acceleration')
title('Plot of El-centro,1940')

u=load('WGN.dat');

[e,w,f]=nlmsFunc(mu,M,u,D,a); %nlms
%[e,w,f]=lms2(mu,M,u,D); %lms2

subplot(212)
plot(t,f);
grid;
xlabel('Time')
ylabel('Acceleration')
title('Plot of Filtered data')
% plot(t,d);
% grid;
% hold on
% plot(t,f,'r')
% xlabel('Time')
% ylabel('Acceleration')
% legend('El-Centro','Filtered signal')
% title('Plot of filtered and El-Centro')
for i = 1:10
   El_pre(i,:) = f(156*(i-1)+1:156*i);
end
```

3rd Step

```
%PSDF of time varying wiener filter Output
clear;clc;
load nlms_out;
for ind = 1 : 10
     s = El_pre(ind,:);
%lowpass- lowpass
n=length(s);
%lowpass filter 1
[b1,a1] = butter(6,2*0.25/50,'low');
lpd1 = filtfilt(b1,a1,s);

GRMS1= rms(lpd1);
GRMSS1= rms(lpd1).^2;
PSDF1= GRMSS1/.25;
```

```
 figure(4)
 plot(lpd1);
%lowpass filter 2
cnt=1;
j = 1;
t=0:0.02:(n-1)*0.02;
for i= .25:.25:9
[b2,a2] = butter(6,2*i/50,'low');
lpd2(cnt,:) = filtfilt(b2,a2,s);
BCF(cnt,:)=(2*i+0.25)/2;
cnt=cnt+1;
end

for n = 1:35
    net(n,:) = lpd2((n+1),:) - lpd2(n,:);
     figure(4+n);
     plot(net(n,:));
     legend('Filtered ACC.');
end

for k=1:size(net,1)
X=net(k,:);
GRMS(k,:) = rms(X);
GRMSS(k,:) = rms(X).^2;
PSDF(:,k)=GRMSS(k,:)/0.25;
end
     psd1(ind,:) = [PSDF1 PSDF];
     figure;
     %subplot(5,2,)
     bar(BCF,psd1(ind,:));
     xlabel('Frequency(Hz)');
     ylabel('PSDF(g^2/Hz)');
     title(['Plot of Power Spectral Density Function for time window '
num2str(ind)]);
%
end
%%
figure(1)
subplot(211)
plot(El_pre(1,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 1st time window
');
subplot(212)
bar(BCF,1000*psd1(1,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 1st time window ');
%%
figure(2)
subplot(211)
plot(El_pre(2,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
```

```
title('Plot of Acceleration-Time History of El-Centro for 2nd time window
');
subplot(212)
bar(BCF,1000*psd1(2,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 2nd time window ');
%%
figure(3)
subplot(211)
plot(El_pre(3,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 3rd time window
');
subplot(212)
bar(BCF,1000*psd1(3,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 3rd time window ');
%%
figure(4)
subplot(211)
plot(El_pre(4,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 4th time window
');
subplot(212)
bar(BCF,1000*psd1(4,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 4th time window ');
%%
figure(5)
subplot(211)
plot(El_pre(5,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 5th time window
');
subplot(212)
bar(BCF,1000*psd1(5,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 5th time window ');
%%
figure(6)
subplot(211)
plot(El_pre(6,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 6th time window
');
subplot(212)
bar(BCF,1000*psd1(6,:));
xlabel('Frequency(Hz)');
```

```
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 6th time window ');
%%
figure(7)
subplot(211)
plot(El_pre(7,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 7th time window
');
subplot(212)
bar(BCF,1000*psd1(7,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 7th time window ');
%%
figure(8)
subplot(211)
plot(El_pre(8,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 8th time window
');
subplot(212)
bar(BCF,1000*psd1(8,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 8th time window ');
%%
figure(9)
subplot(211)
plot(El_pre(9,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 9th time window
');
subplot(212)
bar(BCF,1000*psd1(9,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 9th time window ');
%%
figure(10)
subplot(211)
plot(El_pre(10,:))
xlabel('Time(sec)');
ylabel('Acceleration (g m/s^2)');
title('Plot of Acceleration-Time History of El-Centro for 10th time
window ');
subplot(212)
bar(BCF,1000*psd1(10,:));
xlabel('Frequency(Hz)');
ylabel('PSDF(g^2/Hz)');
title('Plot of Power Spectral Density Function for 10th time window ');
```

4th Step :

```
close all;
clear;clc;
load psd_TV;
load central_freq;
BCF=BCF'
for i = 1:10
    temp1 = psd1(i,:);
    lambda0(i) = sum(temp1);
    lambda1(i) = sum(BCF.*(2*pi).*temp1);
    lambda2(i) = sum((BCF.*(2*pi).*BCF.*(2*pi)).*temp1);
    omegaC(i) = sqrt(lambda2(i)/lambda0(i));
    delta1(i) = sqrt(1-((lambda1(i)^2)/(lambda0(i)*lambda2(i))));
    omegaG(i) = 1.12 * omegaC(i) - 5.15;
end
load nlms_filt
t1=0:.02:31.18;
figure
subplot(211)
plot(t1,f)
xlabel('time')
ylabel('Acceleration(g m/s^2)')
title('Plot of Acceleration Time history of El Centro earthquake')
t2=1:3:30;
subplot(212)
plot(t2,omegaG,'o')
xlabel('time');
ylabel('K-T frequency parameter');
title('Plot of K-T frequency parameter for moving time window ');
```

5th Step:

```
clear all;
close all;
clc;
load delta_TV;
for i = 1 :10
   z(i) = fzero(@(x)(4/pi)*x^3-(4.4/pi)*x^2+(4/pi)*x-(delta1(i)^2),0.1);
end

load nlms_filt
t1=0:.02:31.18;
figure
subplot(211)
plot(t1,f)
xlabel('time')
ylabel('Acceleration(g m/s^2)')
title('Plot of Acceleration Time history of El Centro earthquake')
t2=1:3:30;
subplot(212)
plot(t2,z,'o')
xlabel('time');
ylabel('K-T damping ratio parameter');
title('Plot of K-T damping ratio parameter for moving time window ');
```

APPENDIX 2

Data is taken from website ftp://strongmotioncenter.org/vdc/india/199903281905/uttach.t

Desired Signal: El-Centro, 1940 ground acceleration data (1559 points)

0.00630	0.00364	0.00099	0.00428	0.00758	0.01087	0.00682	0.00277
-0.00128	0.00368	0.00864	0.01360	0.00727	0.00094	0.00420	0.00221
0.00021	0.00444	0.00867	0.01290	0.01713	-0.00343	-0.02400	-0.00992
0.00416	0.00528	0.01653	0.02779	0.03904	0.02449	0.00995	0.00961
0.00926	0.00892	-0.00486	-0.01864	-0.03242	-0.03365	-0.05723	-0.04534
-0.03346	-0.03201	-0.03056	-0.02911	-0.02766	-0.04116	-0.05466	-0.06816
-0.08166	-0.06846	-0.05527	-0.04208	-0.04259	-0.04311	-0.02428	-0.00545
0.01338	0.03221	0.05104	0.06987	0.08870	0.04524	0.00179	-0.04167
-0.08513	-0.12858	-0.17204	-0.12908	-0.08613	-0.08902	-0.09192	-0.09482
-0.09324	-0.09166	-0.09478	-0.09789	-0.12902	-0.07652	-0.02401	0.02849
0.08099	0.13350	0.18600	0.23850	0.21993	0.20135	0.18277	0.16420
0.14562	0.16143	0.17725	0.13215	0.08705	0.04196	-0.00314	-0.04824
-0.09334	-0.13843	-0.18353	-0.22863	-0.27372	-0.31882	-0.25024	-0.18166
-0.11309	-0.04451	0.02407	0.09265	0.16123	0.22981	0.29839	0.23197
0.16554	0.09912	0.03270	-0.03372	-0.10014	-0.16656	-0.23299	-0.29941
-0.00421	0.29099	0.22380	0.15662	0.08943	0.02224	-0.04495	0.01834
0.08163	0.14491	0.20820	0.18973	0.17125	0.13759	0.10393	0.07027
0.03661	0.00295	-0.03071	-0.00561	0.01948	0.04458	0.06468	0.08478
0.10487	0.05895	0.01303	-0.03289	-0.07882	-0.03556	0.00771	0.05097
0.01013	-0.03071	-0.07156	-0.11240	-0.15324	-0.11314	-0.07304	-0.03294
0.00715	-0.06350	-0.13415	-0.20480	-0.12482	-0.04485	0.03513	0.11510
0.19508	0.12301	0.05094	-0.02113	-0.09320	-0.02663	0.03995	0.10653
0.17311	0.11283	0.05255	-0.00772	0.01064	0.02900	0.04737	0.06573
0.02021	-0.02530	-0.07081	-0.04107	-0.01133	0.00288	0.01709	0.03131
-0.02278	-0.07686	-0.13095	-0.18504	-0.14347	-0.10190	-0.06034	-0.01877
0.02280	-0.00996	-0.04272	-0.02147	-0.00021	0.02104	-0.01459	-0.05022
-0.08585	-0.12148	-0.15711	-0.19274	-0.22837	-0.18145	-0.13453	-0.08761
-0.04069	0.00623	0.05316	0.10008	0.14700	0.09754	0.04808	-0.00138
0.05141	0.10420	0.15699	0.20979	0.26258	0.16996	0.07734	-0.01527
-0.10789	-0.20051	-0.06786	0.06479	0.01671	-0.03137	-0.07945	-0.12753
-0.17561	-0.22369	-0.27177	-0.15851	-0.04525	0.06802	0.18128	0.14464
0.10800	0.07137	0.03473	0.09666	0.15860	0.22053	0.18296	0.14538
0.10780	0.07023	0.03265	0.06649	0.10033	0.13417	0.10337	0.07257
0.04177	0.01097	-0.01983	0.04438	0.10860	0.17281	0.10416	0.03551
-0.03315	-0.10180	-0.07262	-0.04344	-0.01426	0.01492	-0.02025	-0.05543
-0.09060	-0.12578	-0.16095	-0.19613	-0.14784	-0.09955	-0.05127	-0.00298
-0.01952	-0.03605	-0.05259	-0.04182	-0.03106	-0.02903	-0.02699	0.02515
0.01770	0.02213	0.02656	0.00419	-0.01819	-0.04057	-0.06294	-0.02417
0.01460	0.05337	0.02428	-0.00480	-0.03389	-0.00557	0.02274	0.00679
-0.00915	-0.02509	-0.04103	-0.05698	-0.01826	0.02046	0.00454	-0.01138
-0.00215	0.00708	0.00496	0.00285	0.00074	-0.00534	-0.01141	0.00361
0.01863	0.03365	0.04867	0.03040	0.01213	-0.00614	-0.02441	0.01375
0.01099	0.00823	0.00547	0.00812	0.01077	-0.00692	-0.02461	-0.04230
-0.05999	-0.07768	-0.09538	-0.06209	-0.02880	0.00448	0.03777	0.01773
-0.00231	-0.02235	0.01791	0.05816	0.03738	0.01660	-0.00418	-0.02496
-0.04574	-0.02071	0.00432	0.02935	0.01526	0.01806	0.02086	0.00793
-0.00501	-0.01795	-0.03089	-0.01841	-0.00593	0.00655	-0.02519	-0.05693

-0.04045	-0.02398	-0.00750	0.00897	0.00384	-0.00129	-0.00642	-0.01156
-0.02619	-0.04082	-0.05545	-0.04366	-0.03188	-0.06964	-0.05634	-0.04303
-0.02972	-0.01642	-0.00311	0.01020	0.02350	0.03681	0.05011	0.02436
-0.00139	-0.02714	-0.00309	0.02096	0.04501	0.06906	0.05773	0.04640
0.03507	0.03357	0.03207	0.03057	0.03250	0.03444	0.03637	0.01348
-0.00942	-0.03231	-0.02997	-0.03095	-0.03192	-0.02588	-0.01984	-0.01379
-0.00775	-0.01449	-0.02123	0.01523	0.05170	0.08816	0.12463	0.16109
0.12987	0.09864	0.06741	0.03618	0.00495	0.00420	0.00345	0.00269
-0.05922	-0.12112	-0.18303	-0.12043	-0.05782	0.00479	0.06740	0.13001
0.08373	0.03745	0.06979	0.10213	-0.03517	-0.17247	-0.13763	-0.10278
-0.06794	-0.03310	-0.03647	-0.03984	-0.00517	0.02950	0.06417	0.09883
0.13350	0.05924	-0.01503	-0.08929	-0.16355	-0.06096	0.04164	0.01551
-0.01061	-0.03674	-0.06287	-0.08899	-0.05430	-0.01961	0.01508	0.04977
0.08446	0.05023	0.01600	-0.01823	-0.05246	-0.08669	-0.06769	-0.04870
-0.02970	-0.01071	0.00829	-0.00314	0.02966	0.06246	-0.00234	-0.06714
-0.04051	-0.01388	0.01274	0.00805	0.03024	0.05243	0.02351	-0.00541
-0.03432	-0.06324	-0.09215	-0.12107	-0.08450	-0.04794	-0.01137	0.02520
0.06177	0.04028	0.01880	0.04456	0.07032	0.09608	0.12184	0.06350
0.00517	-0.05317	-0.03124	-0.00930	0.01263	0.03457	0.03283	0.03109
0.02935	0.04511	0.06087	0.07663	0.09239	0.05742	0.02245	-0.01252
0.00680	0.02611	0.04543	0.01571	-0.01402	-0.04374	-0.07347	-0.03990
-0.00633	0.02724	0.06080	0.03669	0.01258	-0.01153	-0.03564	-0.00677
0.02210	0.05098	0.07985	0.06915	0.05845	0.04775	0.03706	0.02636
0.05822	0.09009	0.12196	0.10069	0.07943	0.05816	0.03689	0.01563
-0.00564	-0.02690	-0.04817	-0.06944	-0.09070	-0.11197	-0.11521	-0.11846
-0.12170	-0.12494	-0.16500	-0.20505	-0.15713	-0.10921	-0.06129	-0.01337
0.03455	0.08247	0.07576	0.06906	0.06236	0.08735	0.11235	0.13734
0.12175	0.10616	0.09057	0.07498	0.08011	0.08524	0.09037	0.06208
0.03378	0.00549	-0.02281	-0.05444	-0.04030	-0.02615	-0.01201	-0.02028
-0.02855	-0.06243	-0.03524	-0.00805	-0.04948	-0.03643	-0.02337	-0.03368
-0.01879	-0.00389	0.01100	0.02589	0.01446	0.00303	-0.00840	0.00463
0.01766	0.03069	0.04372	0.02165	-0.00042	-0.02249	-0.04456	-0.03638
-0.02819	-0.02001	-0.01182	-0.02445	-0.03707	-0.04969	-0.05882	-0.06795
-0.07707	-0.08620	-0.09533	-0.06276	-0.03018	0.00239	0.03496	0.04399
0.05301	0.03176	0.01051	-0.01073	-0.03198	-0.05323	0.00186	0.05696
0.01985	-0.01726	-0.05438	-0.01204	0.03031	0.07265	0.11499	0.07237
0.02975	-0.01288	0.01212	0.03711	0.03517	0.03323	0.01853	0.00383
0.00342	-0.02181	-0.04704	-0.07227	-0.09750	-0.12273	-0.08317	-0.04362
-0.00407	0.03549	0.07504	0.11460	0.07769	0.04078	0.00387	0.00284
0.00182	-0.05513	0.04732	0.05223	0.05715	0.06206	0.06698	0.07189
0.02705	-0.01779	-0.06263	-0.10747	-0.15232	-0.12591	-0.09950	-0.07309
-0.04668	-0.02027	0.00614	0.03255	0.00859	-0.01537	-0.03932	-0.06328
-0.03322	-0.00315	0.02691	0.01196	-0.00300	0.00335	0.00970	0.01605
0.02239	0.04215	0.06191	0.08167	0.03477	-0.01212	-0.01309	-0.01407
-0.05274	-0.02544	0.00186	0.02916	0.05646	0.08376	0.01754	-0.04869
-0.02074	0.00722	0.03517	-0.00528	-0.04572	-0.08617	-0.06960	-0.05303
-0.03646	-0.01989	-0.00332	0.01325	0.02982	0.01101	-0.00781	-0.02662
-0.00563	0.01536	0.03635	0.05734	0.03159	0.00584	-0.01992	-0.00201
0.01589	-0.01024	-0.03636	-0.06249	-0.04780	-0.03311	-0.04941	-0.06570
-0.08200	-0.04980	-0.01760	0.01460	0.04680	0.07900	0.04750	0.01600
-0.01550	-0.00102	0.01347	0.02795	0.04244	0.05692	0.03781	0.01870
-0.00041	-0.01952	-0.00427	0.01098	0.02623	0.04148	0.01821	-0.00506
-0.00874	-0.03726	-0.06579	-0.02600	0.01380	0.05359	0.09338	0.05883
0.02429	-0.01026	-0.04480	-0.01083	-0.01869	-0.02655	-0.03441	-0.02503

-0.01564	-0.00626	-0.01009	-0.01392	0.01490	0.04372	0.03463	0.02098
0.00733	-0.00632	-0.01997	0.00767	0.03532	0.03409	0.03287	0.03164
0.02403	0.01642	0.00982	0.00322	-0.00339	0.02202	-0.01941	-0.06085
-0.10228	-0.07847	-0.05466	-0.03084	-0.00703	0.01678	0.01946	0.02214
0.02483	0.01809	-0.00202	-0.02213	-0.00278	0.01656	0.03590	0.05525
0.07459	0.06203	0.04948	0.03692	-0.00145	0.04599	0.04079	0.03558
0.03037	0.03626	0.04215	0.04803	0.05392	0.04947	0.04502	0.04056
0.03611	0.03166	0.00614	-0.01937	-0.04489	-0.07040	-0.09592	-0.07745
-0.05899	-0.04052	-0.02206	-0.00359	0.01487	0.01005	0.00523	0.00041
-0.00441	-0.00923	-0.01189	-0.01523	-0.01856	-0.02190	-0.00983	0.00224
0.01431	0.00335	-0.00760	-0.01856	-0.00737	0.00383	0.01502	0.02622
0.01016	-0.00590	-0.02196	-0.00121	0.01953	0.04027	0.02826	0.01625
0.00424	0.00196	-0.00031	-0.00258	-0.00486	-0.00713	-0.00941	-0.01168
-0.01396	-0.01750	-0.02104	-0.02458	-0.02813	-0.03167	-0.03521	-0.04205
-0.04889	-0.03559	-0.02229	-0.00899	0.00431	0.01762	0.00714	-0.00334
-0.01383	0.01314	0.04011	0.06708	0.04820	0.02932	0.01043	-0.00845
-0.02733	-0.04621	-0.03155	-0.01688	-0.00222	0.01244	0.02683	0.04121
0.05559	0.03253	0.00946	-0.01360	-0.01432	-0.01504	-0.01576	-0.04209
-0.02685	-0.01161	0.00363	0.01887	0.03411	0.03115	0.02819	0.02917
0.03015	0.03113	0.00388	-0.02337	-0.05062	-0.03820	-0.02579	-0.01337
-0.00095	0.01146	0.02388	0.03629	0.01047	-0.01535	-0.04117	-0.06699
-0.05207	-0.03715	-0.02222	-0.00730	0.00762	0.02254	0.03747	0.04001
0.04256	0.04507	0.04759	0.05010	0.04545	0.04080	0.02876	0.01671
0.00467	-0.00738	-0.00116	0.00506	0.01128	0.01750	-0.00211	-0.02173
-0.04135	-0.06096	-0.08058	-0.06995	-0.05931	-0.04868	-0.03805	-0.02557
-0.01310	-0.00063	0.01185	0.02432	0.03680	0.04927	0.02974	0.01021
-0.00932	-0.02884	-0.04837	-0.06790	-0.04862	-0.02934	-0.01006	0.00922
0.02851	0.04779	0.02456	0.00133	-0.02190	-0.04513	-0.06836	-0.04978
-0.03120	-0.01262	0.00596	0.02453	0.04311	0.06169	0.08027	0.09885
0.06452	0.03019	-0.00414	-0.03848	-0.07281	-0.05999	-0.04717	-0.03435
-0.03231	-0.03028	-0.02824	-0.00396	0.02032	0.00313	-0.01406	-0.03124
-0.04843	-0.06562	-0.05132	-0.03702	-0.02272	-0.00843	0.00587	0.02017
0.02698	0.03379	0.04061	0.04742	0.05423	0.03535	0.01647	0.01622
0.01598	0.01574	0.00747	-0.00080	-0.00907	0.00072	0.01051	0.02030
0.03009	0.03989	0.03478	0.02967	0.02457	0.03075	0.03694	0.04313
0.04931	0.05550	0.06168	-0.00526	-0.07220	-0.06336	-0.05451	-0.04566
-0.03681	-0.03678	-0.03675	-0.03672	-0.01765	0.00143	0.02051	0.03958
0.05866	0.03556	0.01245	-0.01066	-0.03376	-0.05687	-0.04502	-0.03317
-0.02131	-0.00946	0.00239	-0.00208	-0.00654	-0.01101	-0.01548	-0.01200
-0.00851	-0.00503	-0.00154	0.00195	0.00051	-0.00092	0.01135	0.02363
0.03590	0.04818	0.06045	0.07273	0.02847	-0.01579	-0.06004	-0.05069
-0.04134	-0.03199	-0.03135	-0.03071	-0.03007	-0.01863	-0.00719	0.00425
0.01570	0.02714	0.03858	0.02975	0.02092	0.02334	0.02576	0.02819
0.03061	0.03304	0.01371	-0.00561	-0.02494	-0.02208	-0.01923	-0.01638
-0.01353	-0.01261	-0.01170	-0.00169	0.00833	0.01834	0.02835	0.03836
0.04838	0.03749	0.02660	0.01571	0.00482	-0.00607	-0.01696	-0.00780
0.00136	0.01052	0.01968	0.02884	-0.00504	-0.03893	-0.02342	-0.00791
0.00759	0.02310	0.00707	-0.00895	-0.02498	-0.04100	-0.05703	-0.02920
-0.00137	0.02645	0.05428	0.03587	0.01746	-0.00096	-0.01937	-0.03778
-0.02281	-0.00784	0.00713	0.02210	0.03707	0.05204	0.06701	0.08198
0.03085	-0.02027	-0.07140	-0.12253	-0.08644	-0.05035	-0.01426	0.02183
0.05792	0.09400	0.13009	0.03611	-0.05787	-0.04802	-0.03817	-0.02832
-0.01846	-0.00861	-0.03652	-0.06444	-0.06169	-0.05894	-0.05618	-0.06073
-0.06528	-0.04628	-0.02728	-0.00829	0.01071	0.02970	0.03138	0.03306

0.03474	0.03642	0.04574	0.05506	0.06439	0.07371	0.08303	0.03605
-0.01092	-0.05790	-0.04696	-0.03602	-0.02508	-0.01414	-0.03561	-0.05708
-0.07855	-0.06304	-0.04753	-0.03203	-0.01652	-0.00102	0.00922	0.01946
0.02970	0.03993	0.05017	0.06041	0.07065	0.08089	-0.00192	-0.08473
-0.07032	-0.05590	-0.04148	-0.05296	-0.06443	-0.07590	-0.08738	-0.09885
-0.06798	-0.03710	-0.00623	0.02465	0.05553	0.08640	0.11728	0.14815
0.08715	0.02615	-0.03485	-0.09584	-0.07100	-0.04616	-0.02132	0.00353
0.02837	0.05321	-0.00469	-0.06258	-0.12048	-0.09960	-0.07872	-0.05784
-0.03696	-0.01608	0.00480	0.02568	0.04656	0.06744	0.08832	0.10920
0.13008	0.10995	0.08982	0.06969	0.04955	0.04006	0.03056	0.02107
0.01158	0.00780	0.00402	0.00024	-0.00354	-0.00732	-0.01110	-0.00780
-0.00450	-0.00120	0.00210	0.00540	-0.00831	-0.02203	-0.03575	-0.04947
-0.06319	-0.05046	-0.03773	-0.02500	-0.01227	0.00046	0.00482	0.00919
0.01355	0.01791	0.02228	0.00883	-0.00462	-0.01807	-0.03152	-0.02276
-0.01401	-0.00526	0.00350	0.01225	0.02101	0.01437	0.00773	0.00110
0.00823	0.01537	0.02251	0.01713	0.01175	0.00637	0.01376	0.02114
0.02852	0.03591	0.04329	0.03458	0.02587	0.01715	0.00844	-0.00027
-0.00898	-0.00126	0.00645	0.01417	0.02039	0.02661	0.03283	0.03905
0.04527	0.03639	0.02750	0.01862	0.00974	0.00086	-0.01333	-0.02752
-0.04171	-0.02812	-0.01453	-0.00094	0.01264	0.02623	0.01690	0.00756
-0.00177	-0.01111	-0.02044	-0.02977	-0.03911	-0.02442	-0.00973	0.00496
0.01965	0.03434	0.02054	0.00674	-0.00706	-0.02086	-0.03466	-0.02663
-0.01860	-0.01057	-0.00254	-0.00063	0.00128	0.00319	0.00510	0.00999
0.01488	0.00791	0.00093	-0.00605	0.00342	0.01288	0.02235	0.03181
0.04128	0.02707	0.01287	-0.00134	-0.01554	-0.02975	-0.04395	-0.03612
-0.02828	-0.02044	-0.01260	-0.00476	0.00307	0.01091	0.00984	0.00876
0.00768	0.00661	0.01234	0.01807	0.02380	0.02953	0.03526	0.02784
0.02042	0.01300	-0.03415	-0.00628	-0.00621	-0.00615	-0.00609	-0.00602
-0.00596	-0.00590	-0.00583	-0.00577	-0.00571	-0.00564	-0.00558	-0.00552
-0.00545	-0.00539	-0.00532	-0.00526	-0.00520	-0.00513	-0.00507	-0.00501
-0.00494	-0.00488	-0.00482	-0.00475	-0.00469	-0.00463	-0.00456	-0.00450
-0.00444	-0.00437	-0.00431	-0.00425	-0.00418	-0.00412	-0.00406	-0.00399
-0.00393	-0.00387	-0.00380	-0.00374	-0.00368	-0.00361	-0.00355	-0.00349
-0.00342	-0.00336	-0.00330	-0.00323	-0.00317	-0.00311	-0.00304	-0.00298
-0.00292	-0.00285	-0.00279	-0.00273	-0.00266	-0.00260	-0.00254	-0.00247
-0.00241	-0.00235	-0.00228	-0.00222	-0.00216	-0.00209	-0.00203	-0.00197
-0.00190	-0.00184	-0.00178	-0.00171	-0.00165	-0.00158	-0.00152	-0.00146
-0.00139	-0.00133	-0.00127	-0.00120	-0.00114	-0.00108	-0.00101	-0.00095
-0.00089	-0.00082	-0.00076	-0.00070	-0.00063	-0.00057	-0.00051	-0.00044
-0.00038	-0.00032	-0.00025	-0.00019	-0.00013	-0.00006	0.00000	0.00000

WHITE GAUSSIAN NOISE DATA FOR EL- CENTRO SIMULAION:

-2.41587	6.0041	-3.80921	2.141445	-0.48881	1.464011	-0.23909	-2.28594
0.309371	1.623048	-3.14158	-2.59161	-2.97013	0.693625	-1.40005	-0.44695
-2.69343	1.629466	-2.39657	-0.65247	-0.71236	1.456174	-3.15403	-2.83282
-2.79786	-0.31979	-2.57879	-1.5586	0.709047	1.142319	0.575168	-0.5246
0.283756	-0.62541	-0.17505	-1.54643	3.669826	-3.55515	0.480404	0.456057
3.812065	1.629564	-0.82521	-0.56737	1.795385	0.206758	1.24489	0.672239
-1.73532	2.359936	3.210121	0.286656	0.504605	3.869695	1.937038	1.366902
-3.19269	2.918564	1.476207	0.47207	1.968056	1.861346	-1.74906	1.96145

-4.64037	2.750519	-0.05211	-1.6889	-1.02912	-0.30167	0.524571	-0.43106
-1.77135	2.185184	-2.47751	0.681583	-2.62131	-0.9364	0.290033	1.922443
1.082305	-0.04957	0.314	1.029985	-1.37463	-0.73057	2.3951	2.069919
-0.3462	-0.05226	0.692659	-0.28048	-2.37093	0.516269	1.849479	-0.31382
0.043454	-1.7583	0.889175	-0.45449	1.964777	0.37072	-1.56769	0.22155
1.356174	-0.26888	-0.73524	-2.41843	-0.27069	-1.78913	-3.63014	1.818845
2.92845	0.785124	-2.0033	0.620678	-2.38008	-0.90885	-1.6237	-0.13213
-3.85528	-2.7825	3.135939	3.292312	-0.41462	-0.56603	1.97786	-1.45351
-0.86178	-0.81678	-1.09916	1.498286	-1.69123	2.193003	-0.01477	-1.01676
-1.461	-0.8152	0.086873	-0.23	-0.62859	2.035594	-0.40744	-1.28691
-1.35971	0.187499	1.387046	1.152971	2.848561	0.60511	-1.39349	-2.16819
-5.14744	-0.65386	0.052721	0.370191	2.982954	-2.52186	-1.25005	2.465803
-2.61193	-0.6462	-1.53509	1.145759	-1.4881	0.480302	0.926408	-4.17003
2.402312	-2.61762	3.271291	0.246533	-0.74875	1.566876	1.51626	-0.18432
1.374047	-2.31751	-5.57309	0.019122	0.848214	-0.38604	1.0128	0.259251
0.182248	-2.589	0.940811	3.179661	0.228231	-2.61402	0.360035	0.412585
1.426832	0.616736	3.011698	0.246343	-1.0222	-1.5312	2.33804	-0.42696
-2.74507	0.864751	-0.26781	1.276833	2.044674	1.565107	-0.3608	-3.05397
-0.3119	-3.74605	-0.22622	1.55605	-2.83837	-0.13733	-0.03257	-1.08844
-0.74519	-2.247	-1.23499	2.653915	5.093359	0.766433	-1.95904	-2.05562
1.498719	-0.73859	4.863839	-0.31129	-0.71591	0.622858	0.401217	1.375113
2.962829	1.086415	3.244546	1.25695	0.802637	1.504115	-0.29495	-0.78656
-1.74789	0.418209	-0.06677	0.131189	-1.41239	1.914384	-2.03975	0.951317
2.170857	1.721074	-0.50835	-0.96591	-2.04133	0.883008	1.110497	-0.12691
0.112773	-2.70539	-1.63725	-0.20449	2.267922	1.106292	0.539992	-1.11809
2.55831	-1.31217	3.074931	1.208663	0.077091	0.734376	4.122961	-1.47079
1.970751	-2.70209	-3.21297	-1.49429	0.461825	-2.28939	1.033455	-2.77324
-1.86544	0.179207	-1.73243	3.166547	0.251467	1.854968	1.035641	-1.59835
3.830121	-1.62942	-0.87673	3.767616	1.392571	2.09547	-0.35281	-1.22244
-2.87833	1.524539	-2.17917	-1.45807	3.478947	0.658191	-2.18484	-0.22045
0.42975	-3.3788	-2.44155	-0.6938	1.330755	-0.47935	-2.37263	0.828517
3.163779	0.161365	1.414868	0.92324	1.375064	-1.13567	0.676735	0.460191
-3.00992	-4.32462	-0.13973	0.805757	2.477937	-3.12922	3.067516	1.714062
-0.66842	-1.81831	-0.97262	2.769973	1.797326	0.059436	0.755596	0.096417
-0.77433	-0.15736	-0.51325	-0.1428	-2.3002	1.214356	1.90646	2.046697
0.319859	0.796293	-0.21397	3.188461	-0.52836	1.92058	-0.98029	-0.36399
1.166501	0.664267	-1.89774	-1.67001	-3.25036	-0.25107	0.627124	-0.58026
-0.56927	-3.51574	-0.42256	0.160695	1.163285	-0.96513	-0.52761	1.630408
0.877111	0.945116	-1.72062	0.646979	3.804985	3.44082	-1.58436	0.644665
4.350094	1.598969	1.617464	-1.93379	3.160189	3.423246	1.488191	0.276749
3.108958	-1.59678	0.978492	0.118377	1.842058	4.783905	-0.56111	-0.90202
3.461144	2.032124	-0.69438	-0.53035	-1.8758	-1.87448	-6.43388	-0.30608
1.094238	-1.12469	0.662325	1.715385	-1.47437	-2.56768	3.869538	-1.758

-1.37986	-1.69559	-1.70344	1.091372	0.359562	0.325193	-0.59752	-0.38541
0.742134	0.37399	-1.2213	3.707504	-0.26366	0.778061	0.765962	0.389771
1.358167	1.313642	-1.24235	1.992193	1.735854	1.369986	-0.90877	3.189756
2.067698	0.924707	0.414096	0.205783	2.628784	-0.98364	0.312918	-0.88389
1.515758	0.595519	0.106868	-3.83676	-0.50224	-0.3976	-0.52253	-0.84394
-1.20246	1.183119	-4.05596	-0.26214	-0.14352	-0.61661	-0.1229	0.451618
-2.58287	-0.62099	-1.96057	-1.53726	2.190417	-3.942	-0.86979	0.292811
-2.72194	1.372648	-0.97598	4.779904	0.978561	-1.64425	-2.20733	0.01938
-1.09558	1.244516	-0.43051	0.154491	-3.36031	0.134647	-0.91756	0.215197
1.013432	-3.1203	-1.02689	0.751215	-1.62305	-0.83126	0.588346	-4.09906
3.095252	-1.15815	1.308788	0.791128	-1.50445	1.683599	-0.38955	2.62806
-0.18921	1.888147	2.591737	-0.225	-2.65184	1.187014	3.195345	1.236081
1.846782	-0.72315	2.014283	-3.65807	-0.36296	0.598018	6.190884	-0.83853
-2.45019	-1.23194	0.773893	4.182904	0.262831	1.240652	-1.51159	-1.30924
2.677212	-0.51383	2.165066	0.718186	2.78766	4.109499	-1.74471	-1.38029
0.153925	1.856597	2.365237	-1.58869	1.412427	-0.50361	-2.10598	-3.35854
2.485943	-2.51287	1.109656	-0.45462	2.325694	5.327176	-1.9512	-0.49634
1.274171	1.561703	3.991158	3.187643	-1.50738	3.715649	-0.22422	2.38671
-1.29181	1.599941	-0.50573	0.310411	0.643849	2.529423	0.690845	-3.12715
-1.94732	1.019808	0.696041	0.357191	3.271408	-3.93768	0.309757	-3.49038
-4.61602	-1.30223	-0.91023	-0.67546	-1.29559	-1.12983	-2.61368	-0.04819
-0.22961	-2.25809	-1.27141	-3.04998	1.346527	-2.63443	3.051423	-2.69638
-0.29839	1.820939	-1.95971	-1.41881	2.547111	0.404223	1.917266	-0.57441
-0.79036	0.820383	-1.52298	-1.73323	-2.07962	-2.1168	-1.97234	-1.50253
1.829223	0.244326	-2.56709	0.142962	0.9759	-0.87994	-0.47438	0.86345
-0.02435	0.361824	-0.6025	0.311241	-1.81351	2.955773	-0.97158	-0.86248
1.377985	0.815733	-1.41446	-0.36438	-0.94941	-2.45652	-0.12233	0.24371
1.521871	0.731624	3.114052	1.462032	-1.33217	-3.69337	-1.27983	0.841134
0.541984	2.394185	1.055867	-0.69514	-1.00404	-1.49521	-1.43065	0.809701
-1.77146	1.325371	-3.86852	0.468848	-0.61777	-0.51262	0.362828	0.96746
1.14799	0.174946	2.337383	-1.73546	-1.6738	1.367852	-0.60519	-0.58665
-0.85169	1.95826	-1.06836	-1.96508	-1.25665	0.236425	-0.00435	-4.93896
-2.89997	3.793319	-3.15585	-0.58714	1.001807	-0.70469	-0.70304	0.504418
1.947961	0.504361	1.062343	1.648939	3.340507	0.469214	-0.28974	-1.85835
4.89223	1.977246	2.45023	0.388266	-3.08346	-2.27644	0.428143	1.063691
-1.59774	-2.18219	0.583372	0.595383	-0.54402	0.602064	-1.30828	-2.65262
0.032269	2.298285	0.807851	-1.42025	0.683293	2.073396	2.771163	2.04805
2.464699	-1.13513	-1.59663	-1.37535	0.968734	-0.04051	1.210256	-1.80253
-4.26314	-0.67389	-0.29898	1.145676	1.905368	2.371263	-5.51079	-1.31163
-3.84799	1.368255	-0.19662	0.890435	0.2627	-0.66524	-1.32541	0.796343
-0.49322	-0.81434	-0.46208	-2.65192	-3.48383	2.039786	1.287851	4.690623
2.095351	-4.35921	1.466382	-2.99975	1.335523	-2.69197	1.871466	-1.89059
6.775304	-3.97041	-1.54596	2.031936	1.796312	0.0905	-2.85295	3.579005

6.424783	-2.77034	-0.64461	-0.05503	-1.09863	1.139571	3.532725	0.980872
2.033143	1.092427	-0.89504	-0.32089	-0.635	-2.09608	-0.0795	-1.78587
1.282157	-0.9962	0.830012	0.75767	-1.16539	-2.9531	-3.00525	1.528412
-1.14452	-0.66449	2.518174	-0.21432	-0.32842	-1.18235	-0.84993	0.443634
-3.56483	-2.15092	3.552816	0.42567	-1.87027	-0.51802	-1.29858	-0.93988
-0.19538	3.75648	4.183215	0.936128	2.376215	2.713674	3.140907	-0.87421
0.356542	-0.48362	-2.00913	-3.23215	-2.42558	-2.0113	-4.3821	-4.10279
0.195689	-1.61315	-1.46225	0.029476	-0.76236	2.088445	-1.61419	-0.32159
3.314163	0.516949	3.884202	-0.07553	2.645307	-0.51864	0.773697	1.0615
0.222757	-3.14358	0.75072	0.807618	0.770693	-1.2384	1.48585	0.529048
3.203551	-1.0444	-1.10558	0.610509	-0.72364	-0.70203	-3.24963	-0.66387
1.540172	0.197965	2.802351	-2.48622	-0.85275	4.272397	2.736049	2.130148
1.615285	4.179424	-3.10744	0.263718	0.774276	-1.23199	-2.81768	-0.7928
-2.81026	0.597456	-0.92795	-1.99895	1.805554	3.027873	-1.76433	1.231693
1.588258	0.626861	-1.87545	-0.70843	1.435551	0.171108	-0.69312	-2.31553
1.313924	1.55717	2.237874	0.211177	3.472161	-1.0052	1.685679	-0.38608
-1.39793	2.079258	3.913613	1.910853	-2.01767	1.41165	1.101461	0.572593
0.765435	-1.07087	1.483769	0.929598	-0.36008	0.239387	0.010177	1.442438
0.907799	0.71382	2.994197	0.533413	-4.0531	-0.17139	1.754641	0.077381
1.102882	-3.38958	3.127001	-2.84645	0.817876	0.964103	-1.08708	0.68629
1.445529	0.949192	1.393209	0.222115	1.46865	-0.95194	3.144432	2.512196
2.339675	-2.26441	-1.01701	2.345711	0.163935	4.234081	0.183892	2.488372
0.161283	-0.32406	1.815808	-4.23117	-3.37303	0.198054	-3.68312	-1.12625
1.085729	0.412228	0.66012	0.924322	-4.12342	1.613342	-1.80813	0.469235
0.021443	-1.69117	-2.23995	-4.91981	3.641874	2.033838	-1.9713	3.094682
1.971954	2.553275	-1.11703	-0.60971	-2.49826	-1.8668	-2.25966	0.333963
-1.19446	-1.03103	2.991697	0.796467	1.872632	2.94501	1.321572	0.063001
2.106072	-1.26386	-2.30505	-3.41157	-0.34312	1.96992	-2.41563	2.83768
-2.43075	1.356358	0.647597	1.51882	-0.15674	-1.49337	-0.0004	1.784072
1.768796	2.637224	-1.5227	0.406475	-1.22074	0.630818	-0.24308	-1.31413
-0.27697	0.354895	1.119995	1.917366	1.137751	-1.82866	-1.54724	0.007596
0.617113	-2.10526	-1.96848	0.973659	-0.31439	2.460737	0.21758	-2.24815
-0.68498	2.083693	-2.51327	-0.89181	-2.13701	-0.05317	-1.40533	-0.49739
-0.25365	-1.50851	0.443467	0.651346	-0.62504	1.819434	3.69594	1.79734
0.632952	-4.05072	-1.77221	-0.0402	-0.03425	0.118513	-3.02006	-2.57619
1.736046	-1.98763	2.618469	-3.77695	-0.26466	0.536057	0.530209	2.043227
1.771081	3.083481	1.04228	0.676723	0.889371	-0.98843	-0.99943	-0.7685
0.703944	4.119266	-0.68244	0.675611	0.803477	-0.91827	-0.41901	-1.39485
2.508759	0.431189	-0.69312	0.848662	-5.02838	-0.37602	-3.46076	-1.46884
0.748174	0.184905	-3.99647	0.225742	-1.57699	4.851298	1.68329	-4.25948
2.4402	-3.5603	-0.02102	-0.23654	-0.22803	1.74109	0.43218	-0.1885
3.795068	-3.59311	4.367644	-5.37257	0.948274	1.123527	2.191191	-2.30409
-2.3579	1.499956	0.615501	3.096712	1.369832	1.09942	1.24221	-3.35834

-2.25597	-0.49941	-2.04872	-1.84876	1.079541	4.796683	-1.59098	-0.00998
2.498488	-1.56097	0.669449	-1.44081	-0.7609	0.914642	-2.44368	-1.17499
-0.3031	-1.04446	1.457509	1.667011	2.886113	1.310148	-1.02167	-0.79854
0.954345	-0.94555	-2.64569	-1.13298	-1.6186	-1.22696	1.039076	0.248418
3.129983	-0.24816	1.053571	-1.9983	-2.94246	-0.03738	-2.20987	0.328756
-1.27728	-2.18572	2.856321	1.282534	0.850844	-2.07609	-0.48977	-0.70017
-1.94529	0.418076	0.456302	-0.5079	1.928385	1.091724	-4.37146	-0.57057
0.180892	0.556637	-0.60106	-2.2434	1.940833	-1.3388	-1.96883	-0.79565
0.37683	1.650501	-2.02862	3.295854	1.044627	2.729592	0.946899	-0.51276
1.045712	-1.00461	0.140255	-0.61336	1.749558	1.957702	1.632932	-1.87095
1.009369	3.177717	-2.02182	-1.54808	0.316133	-0.13254	2.781841	-2.61494
-2.85084	-0.66289	-0.66412	-2.70848	3.131377	-0.71576	0.839782	-2.25058
-0.40681	1.073641	-0.833	-0.65185	2.705516	-2.74887	0.722506	1.055725
-0.4813	-0.9148	-0.09461	3.106433	0.185056	1.70133	-1.95657	0.010885
-4.68579	3.414676	0.931022	1.256262	1.565047	1.71631	-3.95765	1.799727
-2.63015	-0.95347	-0.84259	-2.05509	2.220049	-0.19911	1.989036	2.359972
1.543925	1.856258	0.139261	-0.40388	2.999893	4.208066	1.076052	-1.52741
-2.20124	-0.71281	-3.42757	1.722132	-0.26476	1.188371	0.891041	-2.11335
0.485475	1.889803	2.004672	3.116315	2.515599	1.203972	1.308443	-3.72128
-3.51805	2.18232	-1.98277	-0.25936	2.186586	0.046242	-0.87597	-0.42222
0.589375	-0.31951	-0.56143	-1.63554	1.950443	1.537284	2.245302	1.382596
1.763066	-0.66799	0.339736	0.577013	2.400572	-1.48563	1.919721	2.996409
2.28365	-1.12412	1.789796	-2.26276	-0.21457	-0.19261	-0.57719	0.152146
-0.87055	-0.3816	-1.60204	1.762634	1.238998	-1.99046	-1.23189	-0.92958
-1.96039	-0.86513	0.053645	-1.88843	2.181937	-2.46252	-0.10123	0.440587
1.568508	-3.76055	-1.17552	-1.24318	-0.88407	-3.67531	1.338369	-1.64358
-0.0896	-0.54275	-2.17408	-3.9821	-2.56159	3.179505	2.29975	0.181191
0.114992	0.582765	-0.07267	-1.90391	1.317567	-4.0637	1.978903	-0.1617
2.457834	-1.50551	-0.34112	0.515898	0.402059	4.710457	-3.78577	-2.47692
3.652559	-1.28805	-0.08143	2.396394	0.900039	1.528089	0.589194	-0.67285
-1.75026	-1.21368	-2.06095	2.217934	-0.02614	-4.22931	-6.13775	0.925084
-0.97866	-0.07988	-1.02894	-3.22533	-1.69296	-0.18071	-3.19756	2.849334
0.169778	-1.63688	0.666291	-0.71326	0.965437	1.769638	-1.69264	1.100565
1.342424	-2.48979	1.389039	-0.01723	1.866242	-1.37675	0.088404	3.885036
2.684392	3.08646	-0.54086	-0.02923	0.583401	1.591439	-0.11537	-1.38724
1.135407	-1.1148	3.980224	0.434175	-0.42679	-2.07549	-0.24524	0.370177
-0.8571	1.083269	-2.03278	0.360381	-0.08141	0.196399	2.074303	-0.33374
2.004745	-2.34383	-2.68129	-1.04103	-0.45606	3.047453	0.234482	0.295032
1.163023	3.952758	3.269536	-0.47916	-2.76221	0.748465	1.763343	-2.15261
-0.32406	0.018521	-1.85485	-1.38603	0.530128	2.478014	-0.15228	-0.20682
1.18748	2.329835	-0.37818	-1.36982	2.124146	0.13106	-1.82886	-0.63072
0.403439	1.542537	-1.98294	1.865206	0.117096	-1.36062	-2.37263	-0.74652
3.64703	-0.01664	-2.3469	-2.4171	-1.1292	1.027113	2.399509	-0.7285

-0.50165	0.629553	-1.54694	-0.72157	1.325302	0.107381	-0.83192	-0.51655
2.533981	-1.24413	-0.32577	-2.36474	2.418148	4.260234	0.967887	0.017682
2.372676	0.226055	-0.89548	1.289315	0.909643	-1.6392	-0.01302	2.591774
-1.06613	1.711657	1.734416	-2.17767	0.987143	0.197977	-1.04753	-0.75815
1.360602	-1.07103	-0.83701	-3.39695	0.443241	-2.92346	0.921034	-0.01067
1.796894	-1.1397	2.538247	-2.58072	-1.14929	3.253996	-1.68482	-3.29388
3.274583	-0.40969	-1.64477	1.091253	0.26454	1.320875	1.840586	0.372143
-2.5932	1.520874	-3.11906	4.270699	2.25728	2.834209	2.556831	0.161503
-1.61239	-1.97021	0.589784	-1.15372	-0.11201	-0.50646	3.640743	-1.29401
0.32177	-2.10209	2.640588	1.650378	1.412532	0.900847	1.35181	0.740394
-4.73244	-0.58177	-0.46553	3.226208	-0.1211	2.602731	1.870969	-0.57334
-3.05301	-0.52968	2.470739	2.431844	1.180497	-0.58663	1.576522	-0.54293
-3.61664	1.38026	-0.4869	3.227823	-1.23921	1.138432	-2.01639	-2.25853
1.399579	2.154784	-1.26539	-1.19988	-2.38056	-2.81137	-0.23066	1.754595
-1.26051	-2.13306	-2.47682	2.08016	-4.87071	-0.58627	0.838287	-1.84456