An efficient approach to calculate the power of discrete power spectrum

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Abstract- The objective of this work is to estimation of power of discrete power spectrum using the DFT & FFT. There exist a number of methods for spectrum estimation and these are discussed in various statistical literatures, present here only the one method that has found the widest application in engineering and experimental physics. There exists various approaches like Nonparametric as periodogram, Multitaper, Welch in Parametric methods as and Subspace methods available to calculate the power of power spectrum. The proposed work is related to calculation of power of discrete power spectrum using an improved method. This work is proposed to be done using improved version of the periodogram i.e. Welch's method. In this paper presented a basic simulink model for speech processing.

Keyword: Welch, DFT, PSD.

I. INTRODUCTION

Spectral estimation is to describe the distribution (over frequency) of the power contained in a signal, based on a finite set of data. Estimation of power spectra is useful in a variety of applications, including the detection of signals buried in wide-band noise.

The power spectral density (PSD) of a stationary random process \( x_n \) is mathematically related to the correlation sequence by the discrete-time Fourier transform. In terms of normalized frequency, this is given by

\[
P_{xx}(\omega) = \frac{1}{2\pi} \sum_{m=-\infty}^{\infty} R_{xx}(m)e^{-j\omega m}
\]

II. METHODS AND MATERIALS

Nonparametric methods are those in which the PSD is estimated directly from the signal itself. The simplest such method is the periodogram. An improved version of the periodogram is Welch's method. A more modern nonparametric technique is the multitaper method (MTM). Make no assumptions about the data in the sample and work directly with the DFT. In periodogram we divide the set of \( N \) samples into \( L \) sets of \( M \) samples, compute the DFT of each set, square it to get the power spectral density and compute the average of all of them.
The modified periodogram windows the time-domain signal prior to computing the FFT in order to smooth the edges of the signal. This has the effect of reducing the height of the sidelobes or spectral leakage.

Welch's method is based on the concept of using periodogram spectrum estimates, which converts a signal from the time domain to the frequency domain. Welch's method is an improvement on the standard periodogram spectrum estimating method and Bartlett's method in that it reduces noise in the estimated power spectra in exchange for reducing the frequency resolution. Due to the noise caused by imperfect and finite data, the noise reduction from Welch's method is often desired.

Parametric methods are those in which the PSD is estimated from a signal that is assumed to be output of a linear system driven by white noise. Examples are the Yule-Walker autoregressive (AR) method and the Burg method.

The Welch method is based on Bartlett's method and differs in two ways:

1. The signal is split up into overlapping segments: The original data segment is split up into L data segments of length M, overlapping by D points.

   If D = M / 2, the overlap is said to be 50%

   If D = 0, the overlap is said to be 0%. This is the same situation as in the Bartlett's method.

2. The overlapping segments are then windowed: After the data is split up into overlapping segments, the individual L data segments have a window applied to them (in the time domain).

Most window functions afford more influence to the data at the center of the set than to data at the edges, which represents a loss of information. To mitigate that loss, the individual data sets are commonly overlapped in time (as in the above step).

The windowing of the segments is what makes the Welch method a "modified" periodogram.

The power spectrum of a signal represents the contribution of every frequency of the spectrum to the power of the overall signal. It is useful because many signal processing applications, such as noise cancellation and system identification, are based on frequency-specific modifications of signals. First, assemble and connect the blocks needed to calculate the power spectrum of speech signal

Stop time = 0.5

Type = Fixed-step

Solver = discrete (no continuous states)

h = spectrum.periodogram

h = spectrum.welch('kaiser',66,50)

h.WindowName = 'Chebyshev'
h = spectrum.welch; hopts
= psdopts(h)
Fs = 1000; t = 0:1/Fs:.3;
randn('state',0);
x = cos(2*pi*t*200)+randn(size(t));
h = pectrum.periodogram('rectangular');
hopts = psdopts(h,x);
set(hopts,'Fs',Fs,'SpectrumType','twosided','Cen
terDC',true);
psd(h,x,hopts) set(hopts,'NFFT',2^14);
hp = psd(h,x,hopts)
avgpower(hpsd)

III. RESULTS
Calcualted power of dicrete power spectrum and also processed speech signal and calculated PSD.

IV. REFERENCES