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誠,樸,精,勤

Matlab HW3: Exercise from Chap 3

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Matlab HW3

1. Type 1 Signal and Spectrum
2. Type 2 Signal and the Least Squares Estimator

Type 1 Signal and Spectrum

Example 1 (Type 1: Linear FM)

- Linear FM: the phase is $\beta[n] = 2\pi(f_0 n + \frac{1}{2} m n^2)$

$$s[n] = A\cos[2\pi(f_0 n + \frac{1}{2} m n^2) + \phi] \qquad n = 0, \ldots, N-1$$

  - The phase is quadratic in $n \rightarrow$ the first difference is linear with n
  - It is called a linear FM (LFM) or a chirp

- Plot the following signals samples and the spectrum as the parameters indicated in the figure

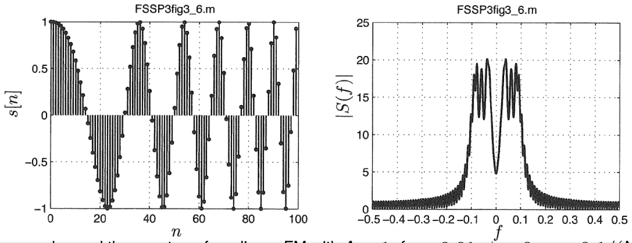

Figure 1: Signals samples and the spectrum for a linear FM with $A = 1$, $f_0 = 0.01$, $\phi = 0$, $m = 0.1/(N-1)$ and $N = 100$

Ref: Exercise 2.3

%FSSP3exer2_3.m
%This program computes the magnitude of the discrete-time Fourier transform for a time truncated sinusoid having various frequencies. It illustrates the distinguishability of a sinusoid at $f_d = 0$ from a sinusoid at another frequency.
close all
clear all
$N = 20$; % number of data samples
$n = [0 : N - 1]'$; % time samples
$fd = 0.2$; % change to 0.01 to see a peak at $fd = 0$
$s1 = cos(2 * pi * (0) * n)$; % signal freq at zero
$s2 = cos(2 * pi * fd * n)$; % signal freq at fd
$f = ([0 : 1023]'/1024) - 0.5$; % frequencies from -0.5 to 0.5
for $i = 1 : 1024$
    $e = exp(j * 2 * pi * f(i) * n)$;
    $S1mag(i, 1) = abs(sum(e' * s1))$; % complex magnitude of Fourier transform
    $S2mag(i, 1) = abs(sum(e' * s2))$;
end
figure(1)
subplot(2,1,1)
plot(n,s1)
xlabel($'n'$); ylabel($'s_1[n]'$); grid; title($'f_d = 0'$);
subplot$(2, 1, 2)$;
plot$(n, s2)$;
xlabel($'n'$); ylabel($'s_2[n]'$); grid
figure(2)
subplot(2,1,1)
plot(f,S1mag)
xlabel($'f'$); ylabel($'|S_1(f)|'$); grid; title($'f\_d = 0'$)
subplot$(2, 1, 2)$ plot$(f, S2mag)$
xlabel($'f'$); ylabel($'|S\_2(f)|'$); grid; title($['f\_d =' \ num2str(fd)]$)

Type 2 Signal and the Least Squares Estimator

Example 2 (Type 2: Line Signal)

Given the observed data model $x[n] = 1 + 0.2n + w[n]$ where $w[n]$ is a WGN with unit variance. Find the least squares estimate of parameters $[A\ B]^T$ from the line model $s[n] = A + Bn$.

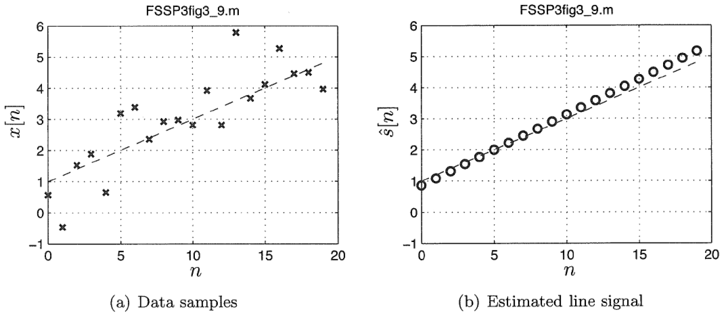

Figure 2: Least squares estimate of a noisy line signal. The true line signal $s[n] = 1 + 0.2n$ is shown as the dashed line, its points having been connected for easier viewing. The estimated line signal is $\hat{s}[n] = 0.8648 + 0.2265n$ and is shown by o's.

Ref: Figure 2.2

- Use the function inv(.)
- Recall from the last exercise: How to generate Figure 2.2 (the clot signal with random noise)

```
close all
clear all
A=1*sqrt(15);phi=0;sig2=15;N=20; % set parameter values
n = [0 : N − 1]′; % set time samples
fd = 0.2; s0=A*cos(2*pi*fd*n+phi)+randn(N,1); % signal when no clot is present
s1=A*cos(phi)+randn(N,1); % signal when clot is present
subplot(2,1,1)
stem(n,s0)
xlabel(′n′)
ylabel(′s1[n]′)
grid
title(′fd = 0′)
subplot(2,1,2)
stem(n,s1)
xlabel(′n′)
ylabel(′s2[n]′)
grid
```

Question & Answer