**BEE 442 Digital Signal Processing**

**Nima Naimi**

**Lab 1: Generation and Detection of Sinusoidal Signals**

**Objective**: This lab introduces the generation and detection of sinusoids and their application in the transmission of information in push button telephones.

Main

dialedNumbers = ['7'];

duration = 0.5;

sampleRate = 8000;

N = 1024;

y = DTMFGenerate(dialedNumbers, sampleRate, duration);

yy = fftshift(fft(y, 1024));

Wd = -sampleRate / 2 : sampleRate / N : (sampleRate / 2 - sampleRate / N);

stem(Wd, abs(yy));

xlabel('Frequency (Hz)');

dialedNumbers = ['1' '2' '3' '5' '6' '7' '8'];

sampleRate = 8000;

duration = 0.1;

x = DTMFGenerate(dialedNumbers, sampleRate, duration);

sound(x, 8000);

dialedNumbers = ['1' '5' '4' '8'];

N = 1024;

duration = 0.1;

sampleRate = 8000;

x = DTMFGenerate(dialedNumbers, sampleRate, duration);

z = DTMFDetector(x, N, sampleRate, duration);



**Task 1: Generation of the DTMF signals**

GenerateSignal Function:

function [x] = GenerateSignal(frequency, sampleRate, duration)

N = duration\*sampleRate;

n = 0:N-1;

x = cos(2\*pi\*frequency\*n/sampleRate);

end

DTMFGenerate Function:

function [x] = DTMFGenerate(dialedNumbers, sampleRate, duration)

row = [697 697 697 770 770 770 852 852 852 941 941 941];

column = [1209 1336 1477 1209 1336 1477 1209 1336 1477 1209 1336 1477 ];

number = ['1', '2', '3', '4', '5', '6', '7', '8', '9', '\*', '0', '#'];

x = [];

for i = 1:length(dialedNumbers)

index = find(number == dialedNumbers(i));

x = [x GenerateSignal(row(index), sampleRate, duration)+ ...

GenerateSignal(column(index), sampleRate, duration)];

end

end

**Task 2: Detection of DTMF signals.**

DTMFDetector Function

function [number] = DTMFDetector(x, N, sampleRate, duration)

numDigit = length(x) / (sampleRate\*duration);

fa = [697 770 852 941 1209 1336 1477];

digit = ['1', '2', '3'; '4', '5', '6'; '7', '8', '9'; '\*', '0', '#'];

number = [];

for i = 1 : numDigit

divisions = x((i-1)\*(sampleRate\*duration)+1:i\*(sampleRate\*duration));

for i = 1:length(fa)

k(i) = round(fa(i)\*N/sampleRate);

end

v= [];

for i = 1:length(fa)

a = [1 -2\*cos(2\*pi\*k(i)/N) 1];

v = filter(1, a, [divisions,0]);

magX(i) = v(end)^2-2\*cos(2\*pi\*k(i)/N)\*v(end)\*v(end-1)+v(end-1)^2;

end

[Max, row] = max(magX(1:4));

[Max, column] = max(magX(5:7));

number = [number, digit(row, column)];

end

Record the |X[k]|^2 for each of the 7 tones when detecting each of the digits. Was your detection correct?

Yes, the detected digits were correct. I tested this with other cases—other numbers, more/less digits, and the result remained correct.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequencies and their detected magnitudes | | | | | | |
| 697 | 770 | 852 | 941 | 1209 | 1336 | 1477 |
| Detected Digits | ‘1’ | 147757.647285623 | 145.767587068627 | 38.1674760658031 | 13.3445319637168 | 142950.350779503 | 74.5464518301297 | 11.6277797556817 |
| ‘5’ | 270.138167278010 | 107067.287580392 | 64.7067781884160 | 32.8840561255501 | 96.7859902327644 | 160322.941523516 | 8.13180322930366 |
| ‘4’ | 325.560026891307 | 105610.031501991 | 32.2297853515027 | 21.3730987865994 | 141823.373234292 | 113.918381921133 | 28.1989583710104 |
| ‘8’ | 39.0092893183105 | 32.0697283094950 | 160454.413135797 | 200.981513652631 | 83.4128444763995 | 161168.370206086 | 12.1430381455631 |