Echoes
Little bit that I understand !

Fourier duality, ZC sequence and its application in LTE

Posted on October 1, 2015 by admin

Fourier duality of Zadoff-Chu (ZC) sequence is very important property. This can be stated as follows:"

> *Discrete Fourier transform of a ZC sequence is a time scaled conjugate of the ZC sequence, multiplied by a constant factor.*

This means a ZC sequence can be calculated directly in frequency domain without the need of DFT operation. This results in computational efficiency because this property allows the DFT of a ZC sequence of prime length P can be calculated with P instead of P*log(P) arithmetic operations.

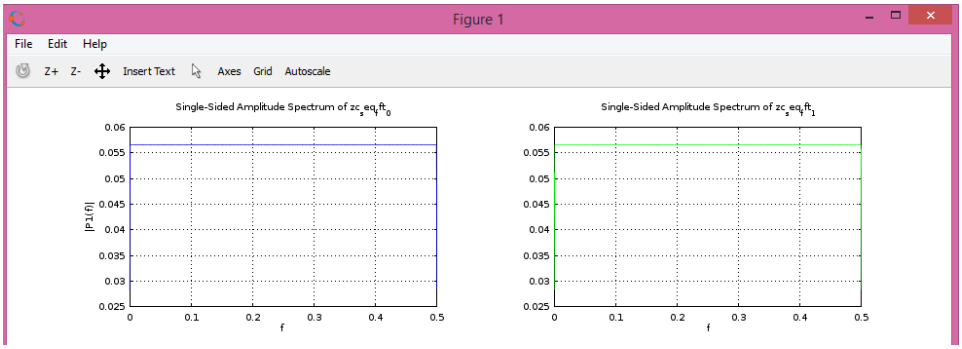
This is a useful property for LTE. Random access preamble signal uses DFT-spread OFDM that can be effectively computed with reduced dynamic range.

Here I wrote a small octave script to illustrate this property:

```
%Property-3 Discrete Fourier transform of a ZC sequence is a time scaled
%conjugate of the ZC sequence, multiplied by a constant factor.

clear all;
close all;
root = 140;
seq_length = 839;
L = 1024;

% Generate ZC sequence
for n= 0:seq_length-1
    zc_seq(n+1) = exp((-j*pi*root*n*(n+1)/seq_length));
end
zc_seq_fft_0 = fft(zc_seq);
%figure(1)
%plot(abs(zc_seq_fft_0));

P2 = abs(zc_seq_fft_0/L);
P1 = P2(1:L/2+1);
P1(2:end-1) = 2*P1(2:end-1);

f = (0 ☹ L/2))/L;
subplot(2,2,1),plot(f,P1)
title('Single-Sided Amplitude Spectrum of zc_seq_fft_0')
xlabel('f ')
ylabel('|P1(f)|')

% Generate ZC sequence with cyc_shift = 141
cyc_shift = 141;
zcShifted_0 = circshift(zc_seq,[0, cyc_shift]);

% Generate Constant Factor
zc_0 = sum(zc_seq);

% Multiply Cyclic shifted version with constant factor.
zc_seq_fft_1 = zc_0*zcShifted_0;
```

```
%figure(2)
%plot(abs(zc_seq_fft_1));

P2 = abs(zc_seq_fft_1/L);
P1 = P2(1:L/2+1);
P1(2:end-1) = 2*P1(2:end-1);

f = (0 :) L/2))/L;
subplot(2,2,2),plot(f,P1,'g')
title('Single-Sided Amplitude Spectrum of zc_seq_fft_1')
xlabel('f')
ylabel('|P1(f)|')
```

Given below is output that shows zc_seq_fft_0 and zc_seq_fft_0 are same, as expected.



Output

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