

Echoes

Little bit that I understand !

Understanding Zadoff-chu sequence- 1

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Zadoff-chu sequence is a polyphase sequence which is widely used in LTE for Primary synchronization signal, PRACH, PUCCH MDRS, PUSCH DMRS and sounding reference signals(SRS).

This is because ZC sequence has the following properties.

1. The Auto correlation of a prime length ZC sequence with a cyclic shifted version of itself has a zero auto correlation. It means that the auto correlation is non-zero only at one instant which corresponds to the cyclic shift. This also means that two generated sequences are orthogonal to each other. In communication systems use of orthogonal sequence is wide spread and using this property of ZC sequence, orthogonal sequences can be easily generated; just by cyclically shifting a ZC sequence.

This is small octave script I wrote to illustrate this property.

```
% Property 1 :
% The Auto correlation of a prime length ZC sequence with a
% cyclic shifted version of itself has a zero auto correlation.
% It means that the auto correlation is non-zero only at one
% instant which corresponds to the cyclic shift.
clear all;
close all;
root = 140;
seq_length = 839;

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

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

% Generate ZC sequence with cyc_shift = 20
cyc_shift = 20;
zcShifted_20 = circshift(zc_seq,[0, cyc_shift]);

% Generate ZC sequence with cyc_shift = 40
cyc_shift = 40;
zcShifted_40 = circshift(zc_seq,[0, cyc_shift]);

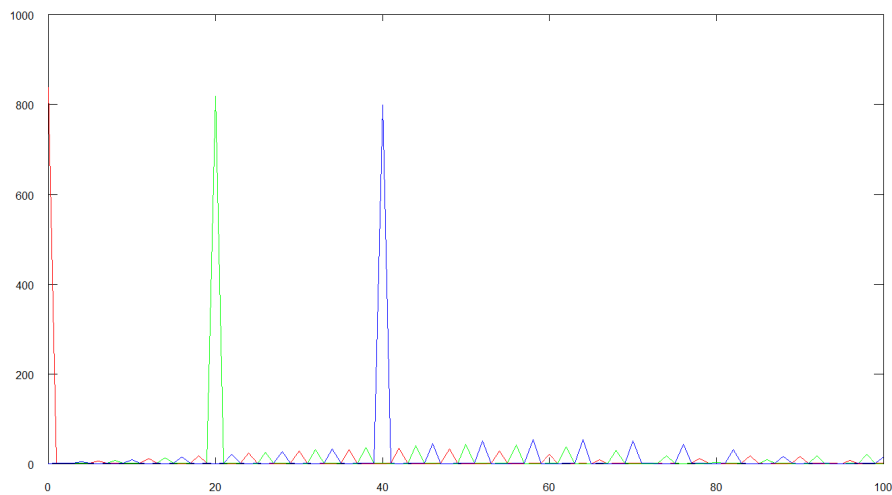
% The Auto correlation of ZC sequence with a cyclic shifted
% version of itself.
[corr lag] = xcorr(zcShifted_0,zc_seq);
plot(lag,abs(corr),"1");
xlim([0 100]);
hold on;

% The Auto correlation of ZC sequence with a cyclic shifted
```

```
% version of itself.
[corr lag] = xcorr(zcShifted_20,zc_seq);
plot(lag,abs(corr),"2");

% The Auto correlation of ZC sequence with a cyclic shifted
% version of itself.
[corr lag] = xcorr(zcShifted_40,zc_seq);
plot(lag,abs(corr),"3");
hold off;
```

And here is output. It can be seen that for red plot, the auto correlation is non-zero only at zero instant which corresponds to the cyclic shift. For green plot, the auto correlation is non-zero only at lag 20 which corresponds to the cyclic shift. For blue plot, the auto correlation is non-zero only at lag 40 which corresponds to the cyclic shift.



Output of octave script

~~ Continued in next post

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