Analysis of Ternary and Binary High Resolution Codes Using MATLAB

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Abstract: It is feasible to achieve simultaneously superior performances in detection range and range resolution using the proposed Chebyshev mapping based binary and ternary codes. The performance parameter for the high resolution codes is discrimination factor which has been estimated with and without windowing functions and the results are analysized with each sequence. This simulation results show that the ternary high resolution codes are good in performance, which brings our sequences closer to practical application than others.

Keywords: Chebyshev chaotic mapping equation; Auto-correlation; discrimination factor.

I. Introduction

For given radar system the range resolution, which is the ability to discriminate nearby targets, can be improved by using very short pulses. But, utilizing sort pulses decreases the average transmitted power and hence the range. Pulse compression allows us to achieve the average transmitted power of a relatively long pulse and the resolution of a short pulse but, range side lobes will be introduced to the compressed waveform due to the pulse compression technique. The range side lobes are highly undesirable because they may mask he presence of the weaker but useful echo signals. Pulse compression schemes using linear FM have seen wide applications, has very high peak side lobe level and the width of the main lobe is relatively large, which limits the range resolution. Windowing techniques are usually applied to suppress the side lobe level. The performance of range resolution radar depends on the autocorrelation pattern of the coded waveform which is nothing but the matched filter output. For best performance, the autocorrelation pattern of the optimum coded waveform must have a large peak value for zero shift and zero value for non-zero shifts. In this work, good binary codes and ternary codes are generated using Chebyshev –map equation to achieve a low PSL. It is possible to generate infinite number of codes at larger lengths easily, by changing the initial conditions by very small increment, threshold level and bifurcation factor.

II. Pulse compression

Pulse compression by linear frequency modulation How can one have a large enough pulse (to still have a nice SNR at the receiver) without having a lousy resolution? This is where pulse compression enters the picture.

The basic principle is the following:

A signal is transmitted, with a long enough length so that the energy budget is correct this signal is designed so that after matched filtering, the width of the inter-correlated signals is smaller than the width obtained by the standard sinusoidal pulse, as explained above (hence the name of the technique: pulse compression).

In radar or sonar applications, linear chirps are the most typically used signals to achieve pulse compression. The pulse being of finite length, the amplitude is a rectangle function. If the transmitted signal has a duration T, begins at t = 0 and linearly sweeps the frequency band Δf centered on carrier f_0, it can be written:

$s_c(t)$= {A$e^{i2\pi\left(fo+\frac{\Delta t}{2t(t)}-\frac{\Delta f}{2}\right)t}$ if 0≤t<T

0 otherwise 1.1

III. Chaotic Wave Form

They are deterministic (defined by an iterative map or differential equations), and can therefore be practically implemented. They are non – periodic, which suggests there are potential advantages in security and can be used as (infinitely) large sequences. They are sensitive to initial conditions so that the behaviour of two systems with small difference in the initial system state (or) a parameter diverges exponentially in time.

Mapping methods: Chaotic map where chosen for analysis, the parameter for each map are chosen so that the map falls in its chaotic regime

Different maps: logistic map, quadratic map, exponent map, Bernoulli map, hopping map, chebyshev map, congruent map etc.

map	⎢g! (x)⎥
logistic	⎢r(1-2x)⎥
Quadratic	8⎢x⎥
Exponent	(1-Bx)exp(B(A-x))⎥
Tent	r x≠0
Bernoulli	r x≠0
Chebyshev	Cos(Aacrcos(x(n)) A>2
Congruent	B x≠±A

IV. Cheb-Chaotic Equation

Here in this paper we are dealing with the Chebyshev mapping. A deal of chaotic behaviour can be described by one simple , fairly innocuous looking equation, the Chebyshev map.

The chaotic mapping is as follows

Xn+1 = f (xn) 1.1

Chebyshev chaotic mapping

Xn+1 = cos (Aacrcos (xn)) A>2 .....1.2

To simulate and analyze, the density of its orbit point is:

ρ(x) = 1/Π√1-x^2 -1<x<1

0 otherwise 1.3

V. *Proposed technique*

By Chebyshev chaotic mapping we can generate different sequences and can select the best sequence among the sequences and thus by slightly changing initial values and bifurcation value we can generate a new different sequence

The best sequence is taken and is been coded in binary and ternary for analysis.

The threshold for the binary codes is done as below

X (n) >0 xx (n) = 1 ....1.4

X (n) <0 xx (n) = -1 ....1.5

And for ternary code

X (n)>= 0.3 xx (n) =1 ....1.6

X (n) <=-0.3 xx (n) =-1 else xx (n) = zero 1.7

By applying,

The Function thus been applied is auto –correlation

X (n) is an N length sequence the auto correlation function is defined as R (k) = ∑ x (n) x(n+k) limits from n= 0 to N-1-k 1.8

From the autocorrelation pattern, the discriminator factor (D) can be formed as,

D = R (0)/max(R (k)) where $k \neq 0$ 1.9

For all the lengths,

The performance parameter of Chebyshev mapping binary and ternary codes which is discrimination factor has been estimated with and without windowing functions and the results are compared. At every lengths the best sequence having the highest discrimination factor are found

Results for binary codes and its response to a matched filter.

Table 1

Si. No	**Length**	**Drec value**	**Dhan value**	**Dham value**	**Dtri value**
1	20	6.6667	10.831	9.8325	8.3099
2	50	7.1429	9.0304	8.4854	8.9976
3	100	8.3333	9.3569	9.1214	9.3730
4	500	12.820	13.135	12.475	12.594
5	1000	15.384	15.669	15.465	15.426
6	1500	17.6471	17.657	16.604	17.648
7	2000	19.4175	19.227	18.105	20.176

8	2200	20.0000	19.540	18.724	21.200
9	2500	20.4918	20.329	19.372	21.502
10	2700	21.6000	20.681	20.183	22.071
11	3000	22.5564	21.700	20.820	23.687
12	3200	23.0216	22.609	21.658	24.087
13	3500	23.4899	22.331	22.718	25.224
14	3700	23.8710	22.824	22.158	25.009
15	4000	25.1572	23.443	22.690	25.882

Results of Ternary codes and its response to a matched filter.

Table II

SI. No	***Length***	***Drec***	***Dhan***	***Dham***	***Dtri***
1	20	*9.5000*	*12.20*	*13.550*	*9.723*
2	50	*8.2000*	*9.909*	*9.8885*	*9.178*
3	100	*8.7778*	*10.21*	*9.6901*	*9.500*
4	500	12.6774	13.46	12.960	13.35
5	1000	16.0392	16.41	16.307	16.40
6	1500	18.2727	18.51	17.25	18.786
7	2000	20.0625	20.00	19.406	21.272
8	2200	20.8140	20.09	19.608	21.871
9	2500	22.1304	21.44	20.155	22.350
10	2700	22.6563	23.54	20.988	22.881
11	3000	23.3689	22.96	23.431	24.032
12	3200	24.2336	23.00	23.507	24.676

13	3500	24.5913	23.96	22.945	25.594
14	3700	24.9832	24.24	23.949	26.139
15	4000	25.6667	24.79	23.936	26.485

VI. Results and Conclusion

At different lengths, good sequences were obtained and it was found that the discrimination factor increases with the length of the sequence for binary and ternary codes. Better sequences are found using ternary codes.

Different window functions were used to modify the impulse response coefficients of the matched filter to reduce the side lobe level and the correlation i.e. the output response of the matched filter are found. It was found that the response with the triangular window function showed good results at larger lengths compared to the other window functions.

At lower lengths up to 1000 length the performance with hanning window were found to be superior compared with the other windows.

VII. Graphical Results

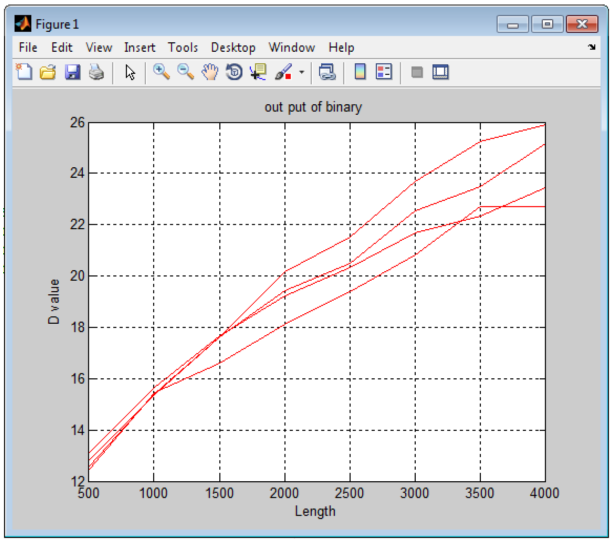

FIG 1.OUTPUT OF BINARY

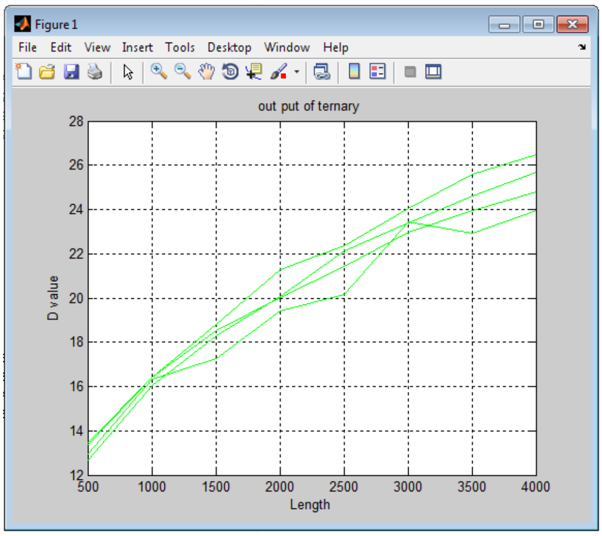

FIG 2.OUT PUT OF TERNARY

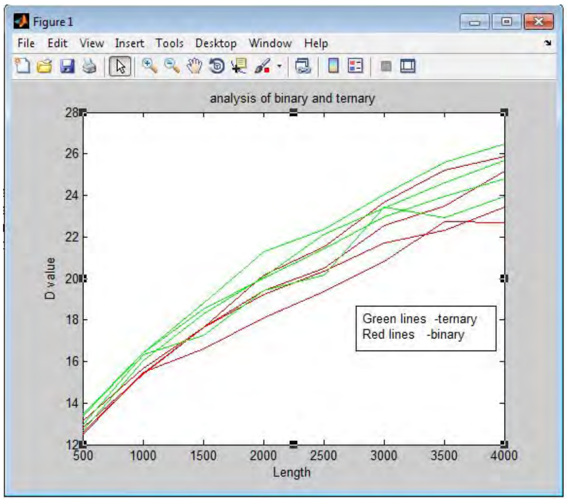

FIG 3.ANALYSIS OF TERNARY AND BINARY

VIII. References

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