The Tent Chaotic Mapping: Analysis for Generation of Binary Codes for Better Performance by Using MATLAB

Annepu .Venkata NagaVamsi
Dept of E.I.E, AITAM, Tekkali -532201, Andhra Pradesh, India.
E-mail: vamsikrishna_avn@yahoo.co.in
G.S.S.S.S.V.K.Mohan
Dept of E.I.E, AITAM, Tekkali -532201, Andhra Pradesh, India.
E-mail: g_k_mohan@yahoo.com
M.S.Pradeep Kumar Patnaik
Dept of E.I.E, AITAM, Tekkali -532201, Andhra Pradesh, India.
E-mail: patnaik_mspk@yahoo.com

Received: October 29, 2011
Accepted: October 30, 2011
Published: November 4, 2011

Abstract:

In this paper, the Tent map is analyzed as a source of pseudorandom bits. To evaluate the performance of the proposed pseudorandom bit generator, different issues were considered, such as the period length, the discriminator value and the merit factor. The Tent mapping is a suitable alternative to other tradinational low-complexity pseudorandom bit generators.

Keywords: Tent map, discrimination value, merit factor, chaotic signal.

1. Introduction

The generation of random numbers is required in several applications, including measurement and testing of digital circuits and telecommunication systems (eg, to perform their functional verification and evaluate their immunity to noise), the aim is to achieve a satisfactory tradeoff among the best merit factor. 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

$$s_c(t) = \begin{cases} Ae^{i2\pi\left(fo+\frac{\Delta t}{2t(t)}-\frac{\Delta f}{2}\right)t} & \text{if } 0 \le t < T \\ 0 & \text{otherwise} \end{cases} \quad \text{...........1.1}$$

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 paper, good binary codes are generated using Tent –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.

2. How can chaotic waveform help?

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) long spreading 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 while both systems remain bounded by the operation of the non-linearity a property useful in efficient high power transmission.

Chaotic systems have a very sensitive dependence on their initial conditions. This sensitive dependence can be demonstrated by giving two very close initial points to the iterative map. After a few iterations, the two resulting sequences will look completely uncorrelated. Hence; an abundant source of almost uncorrelated signals has been discovered: a slight change in the initial condition will produce a completely different signal.

3. Tent mapping-Chaotic Equation

Here in this paper we are dealing with the Tent mapping. A deal of chaotic behaviour can be described by one simple, fairly innocuous looking equation, the Tent map as shown in the Figure1.,and the bifurcation for the tent map in Figure 2.

The chaotic mapping is as follows

$$X_{n+1} = f(x_n) \qquad \text{.........1.1}$$

Tent mapping:

$$X_{n+1} = A - (B(x_n)) \quad A>1 \qquad \text{.....1.2}$$

The chaotic regime:

$$X_n \text{ belongs to } [A(1-B), A] \quad 0<B<2 \qquad \text{......1.3}$$

4. Proposed technique for code generation

As the Tent chaotic mapping, we can generate different sequences and by selecting the best sequence among the sequences, the best sequence is taken and is been coded in binary for the best results.

The threshold for the binary codes is done as below

$$X(n) > 0 \quad xx(n) = 1 \qquad \text{..........1.4}$$

$$X(n) < 0 \quad xx(n) = -1 \qquad \text{..........1.5}$$

The applied function is auto –correlation pattern

X (n) is an N length sequence the auto correlation function is defined as

$$R(k) = \sum x(n)\, x(n+k) \text{ limits from } n = 0 \text{ to } N-1-k \qquad \text{......1.6}$$

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

$$D = \frac{R(0)}{\mathrm{Max}(R(k))} \qquad \text{Where } k \neq 0 \text{ ....1.7}$$

5. Side lobe Reduction Using Window function

The main disadvantage of pulse compression is the appearance of side lobes in the autocorrelation function which will mask the weak reflections from other targets, this can be overcome by reducing the side lobes, there are various techniques for this purpose, and one such is the windowing techniques.

The following window functions have been applied.

1. Hamming window-

$$W(n) = 0.54+0.46\cos(2pi*n/N+1), \ 0 \le n \le N$$

2. Hanning window-

$$w(n) = 0.5+0.5*\cos(pi*n/N+1), \ 0 \le n \le N$$

3. Triangular Window-

$$W(n) = 1-n/2(N+1) \qquad 0 \le N \le N+1$$

5.1 Results for binary codes and its response to a matched filter is show in the Table 1.

6. Results and Conclusion

Good binary codes were generated using Tent map. At different lengths, good sequences were obtained and it was found that the discrimination factor increases with the length of the sequence. At lower lengths the performance with the hanning and hamming windows function were found to be superior compared to triangular window. The best sequences were found from the triangular window function at higher lengths. Further improvement in the result can be obtained by reducing the incremental value in the algorithm and search for new good codes.

7. Graphical Results

The graphical result shows the exactly the differences in the rectangular window, hanning window, hamming window and triangular window as in the Figure 3,Figure 4,Figure 5,Figure 6 and the tent map out put in the Figure 7

References

"Ling cong, Sun Songgeng. A chaotic spreading sequence generator," Chinese journal ACTA ELECTRNICASINICA.vol.20, no.2, pp. 235-239, 1998

Ghobad, H.B. Chaotic signals for digital communication.Ph.D Thesis for Purdue University, 1992

"Radar signal processing" LEWIS, B.L, BAUEL, INC, 1996, PP325-329.

"Base band model for distance and bearing estimation", A.bauel, proc.IEEE, ISCAS-3, MONTERY, California, pp. 275-278, 1998.

Chaotic Phase Code for radar pulse compression Xinwu, Weixian Liu, Lei Zhao and Jeffrey S.Fu, IEEE Radar Conf.2001, pp 279-283.

AJ Fenwick C Williams S A Harman "Chaotic signals in radar and sonar" Proc. Of the international conferences on Waveform Diversity and Design 2006 January 2006 Kuhai USA.

Base band model for distance and bearing estimation", A.bauel, proc.IEEE, ISCAS-3, MONTERY, California, pp. 275-278, 1998.

Ternary Pulse Compression Sequence", INST, MOHORIR, P.S.RAJA RAJESWARI and VENKATA RAO.K, PP.146-149, 1998.

A Chaotic Sequence Spread-Spectrum" IEEE Transactions on Communications. vol. 25(2/3/9), pp. 1126-1129, 1996.MAKOTO ITOH,

Ternary Pulse Compression Sequence by logistic map" ", IEEE, MOHORIR, PP.2512-2515, 1998

Direct Sequence –Radar Communication System" vol.19, pp 529- 531, 2008

International Journal on Chaotic Signals ", vol.12, no.23, pp.236-239, 1999

D. Middleton, *An Introduction to Statistical Communication Theory*. New York: McGraw-Hill, 1988.

"Chaotic pulse code for radar pulse compression "IEEE Radar Conference, 2001, LEIZHAO and JEFFREY, PP 279-283.

G. Heidari-Bateni and C. D. McGillem, "A chaotic direct-sequence spread-spectrum Communication system," *IEEE Trans Commun.*, vol.42, pp. 1524– 1527,Feb./Mar./Apr. 1994

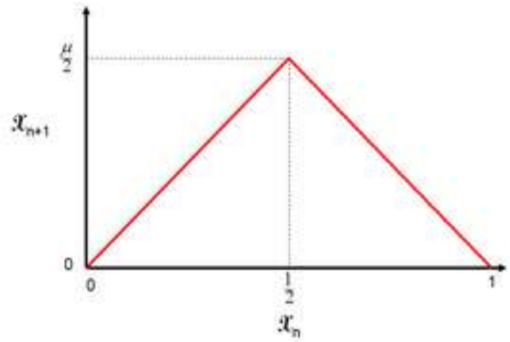

Figure 1. Graph of Tent map function

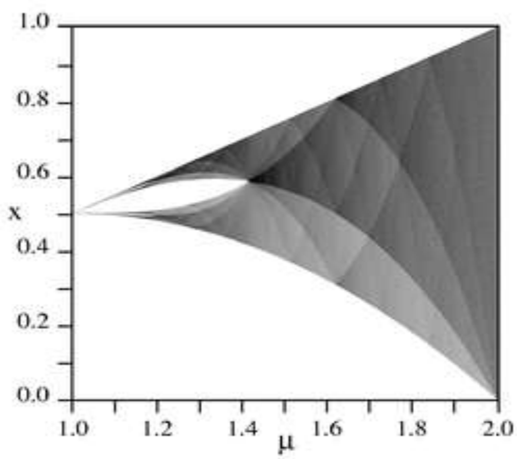

Figure 2. Bifurcation diagram for the tent map

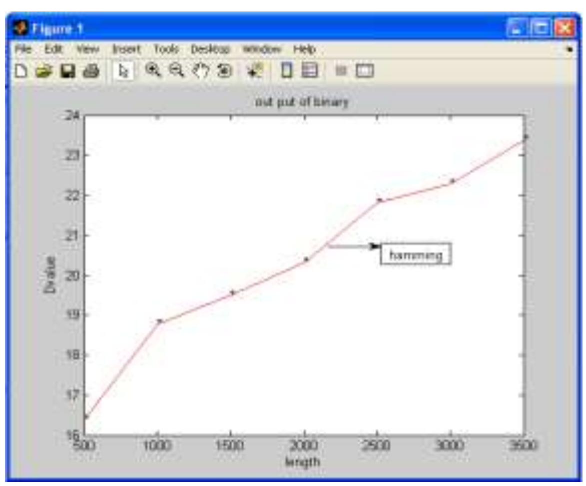

Figure 3. Discrimination curve for the hamming window

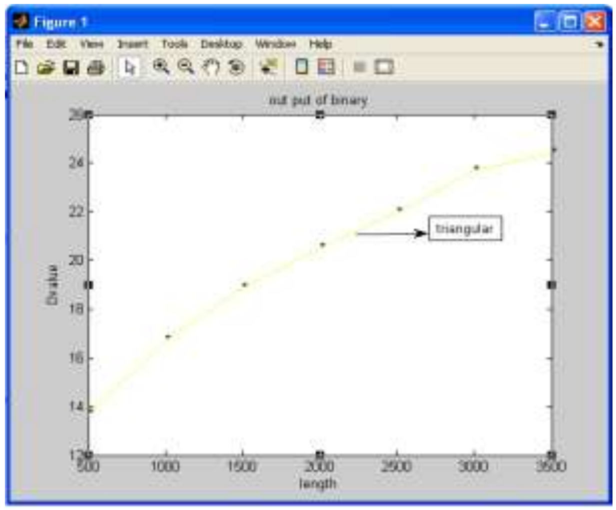

Figure 4. Discrimination curve for the Triangular window

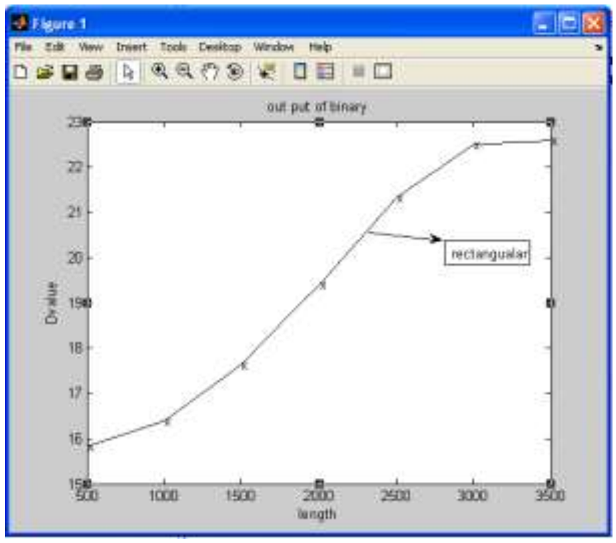

Figure 5. Discrimination curve for the rectangular window

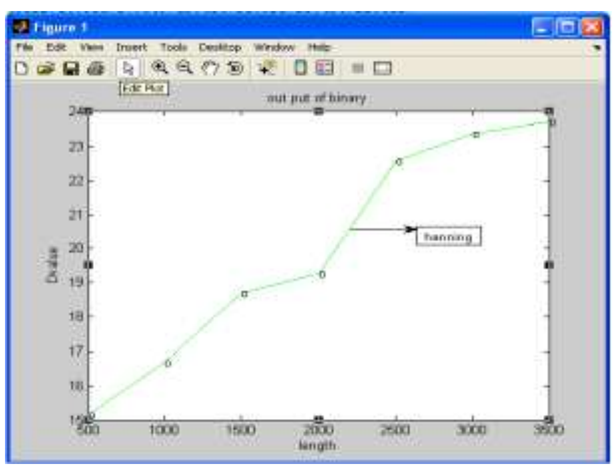

Figure 6. Discrimination curve for the hanning window

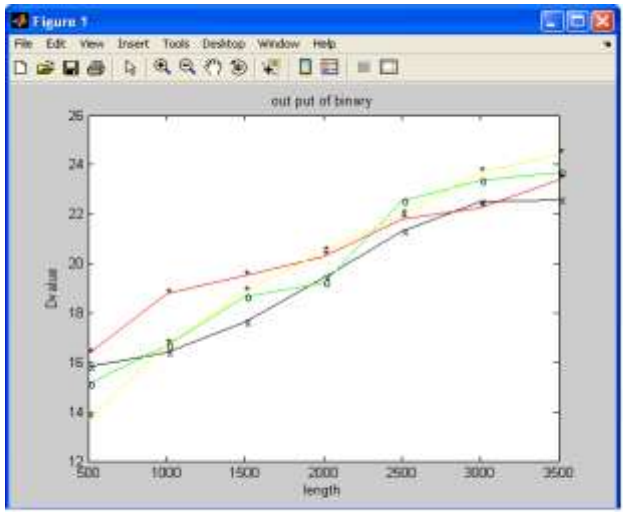

Figure 6. Output for Tent mapping

Table 1

Length	DISCRIMINATION FACTOR			
	Drec value	**Dhan value**	**Dham value**	**Dtri value**
20	7.665	9.761	10.822	8.309
50	8.142	9.034	12.385	8.996
100	12.353	13.236	15.221	9.473
500	15.822	15.145	16.375	13.694
1000	16.381	16.679	18.765	16.726
1500	17.643	18.667	19.504	18.848
2000	19.414	19.237	20.305	20.476
2500	21.321	22.560	21.824	21.960
3000	22.496	23.359	22.272	23.702
3500	22.602	23.691	23.383	24.432