International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-2, Issue-7)
Research Article
July 2013

Design a Scheme to Exhibit Spread Spectrum in Direct Sequence Spread Spectrum Technique Using PN code & Gold Code in MATLAB

Shaweta Narula[1]
[1] Student (M. Tech), ECE Deptt.
Applied College of Management & Engg. (ACME), Palwal, India

Sushil Malik[2]
[2] Asst.prof.ECE Deptt.
Applied College of Management & Engg. (ACME), Palwal, India

Anshul Khatter[3]
[3] Asst. Prof., Apeejay Stya University, Sohna- Palwal Road, Sohna,Gurgaon, India

Abstract-

Pseudo Noise (PN) sequences are widely used in digital communications and the theory involved has been treated extensively in this paper. This paper analyses some interesting properties of PN sequences. A good correlation property and large linear period of PN sequences is the basis of spread spectrum communication system. PN sequences has random like properties and reduces the correlation among the speech samplesIn this paper, out of several techniques to implement direct sequence spread Spectrum (DSSS), one technique PN (pseudo-noise) sequence/ code which is referred as the high rate digital code is generated on MATLAB. This generated m-sequence is then converted into polar format. Finally, this paper compares the simulated autocorrelation with theoretical measured autocorrelation function of an m-sequence.

Keywords-Autocorrelation, m-sequence, MATLAB, PN sequence, spread spectrum communication.

I. INTRODUCTION

Pseudo-Noise (PN) Sequences are periodic, deterministic and binary sequences with a noise like wave form. It's also known as Pseudo-random since it looks randomly for the user who does not know the code. The longer the period of PN spreading code, the harder to be detected sequence. This sequence can be generated using feedback shift registers which are made up of *m* flip-flops - that have two states memory stages and logic circuit as shown in fig. (1).

Generation of Pseudo-Noise (PN) Sequence:-

Let $s_j(k)$ denote the state of the j^{th} flip-flop after k^{th} clock pulse (can be 0 or 1) so the state of the shift register is defined by the set $\{s_1(k),\ s_2(k), ..., s_m(k)\}$. From the definition of the shift register, we can say that:

$s_j(k+1) = s_{j-1}(k)$Where $k \geq 0$ and $1 \leq j \leq m$

With a total number of *m* flip-flops, the maximum possible states of the shift register are 2^m. For a linear feedback shift register, the logic circuit must consist entirely of modulo-2 adders. But if the state of all flip-flops were zero, the shift register will continue to outputs the zero state then the output will consist of zeros. So, the zero state is not permitted. With that, for a linear feedback shift register with *m* flip-flops, the period of PN sequence cannot exceed $N= 2^m - 1$.

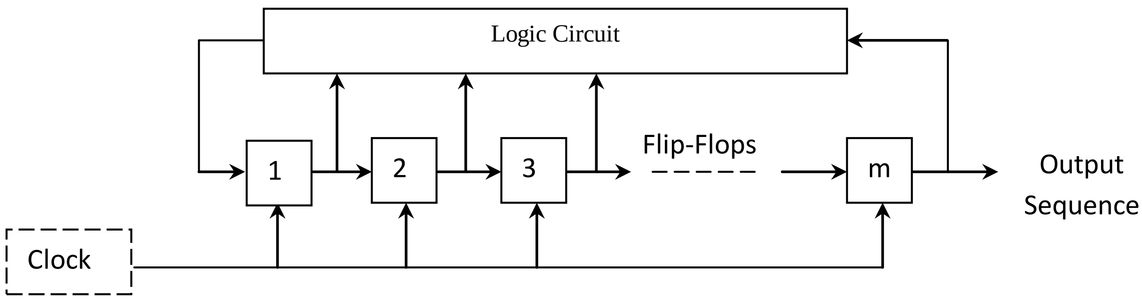

Figure 1: Feedback Shift Register.

Maximal-Length Sequence (*m*-Sequence):-

It's a linear PN sequence that looks like a random binary sequence. The m-sequence is commonly used pseudo-random sequence, which is the longest linear PN sequence generated by Linear feedback shift register (LFSR). This sequence has good autocorrelation characteristics. Shift register sequence is a periodic sequence, its cycle not only relate to the degree of the shift register, but also relate to the linear feedback logic and shift register initial state.

Maximum-length sequences have many properties such as:

1. Balance property: that is in each period the number of 1s is one more than the number of 0s.
2. Correlation property: that is the autocorrelation function is periodic and binary valued.
3. Run property: that is the total number of runs is (N+1)/2.

By using shift-register, PN Sequence Generator generates a sequence of pseudorandom binary numbers, as shown in Figure2.

There are r registers in the generator to update their values at each time step depending on value of the incoming arrow to the shift register. The shift register is described by the Generator Polynomial parameter, which is a primitive binary polynomial in z, $g_r z_r + g_{r-1} z_{r-1} + \ldots\ldots\ldots + g_0$. The coefficient g_i is 1 if there is a connection from the i^{th} register. The leading term g_r and the constant term g_0 of the Generator Polynomial parameter must be 1. The adders perform addition modulo 2. The period of a PN sequence produced by a linear feedback shift register with m flip flops cannot exceed 2^m -1.When the period is exactly 2^m -1, the PN sequence is called a maximal length sequence or m-sequence.

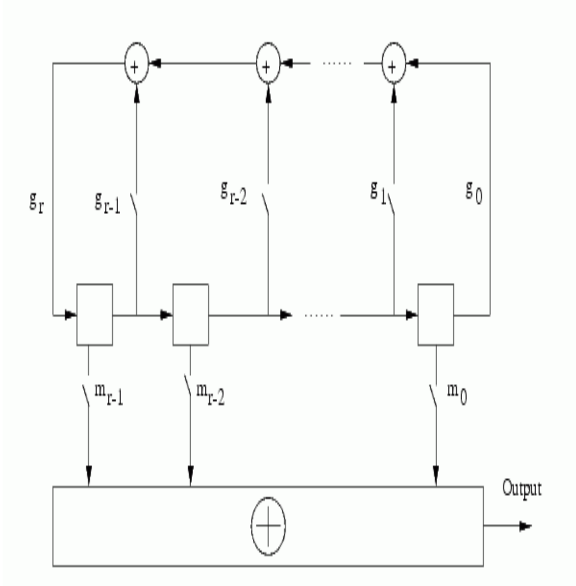

Figure2. M-Sequence Generator Structure

The remainder of this paper is organized as follows: Section II presents the material and method of the designed system for generation of m sequence and its autocorrelation in MATLAB. Section III gives a detailed discussion on the results obtained. The final section concludes and describes the future scope of this work.

II. MATERIAL AND METHOD

To generate PN sequence MATLAB v 7.0 is used. A PN sequence is generated by means of a linear feedback shift register (LFSR). The generated PN sequence is determined by the length m of the shift register, its feedback logic and its initial state. The procedure followed in this work is detailed below. Firstly, NRZ encoder is used to get encoding data streams. There are three methods of encoding: Manchester, unipolar &polar. In this paper, Polar method is used. This data stream is used to generate m-sequence & thenautocorrelation of generated m-sequence is simulated & measured theoretically.

Next step is to define the polynomial & m-sequence is generated. Then find autocorrelation of m-sequence by simulation. Autocorrelation also be calculated theoretically.

Method to calculated autocorrelation theoretically is

Period of an m-sequence is defined by

$N=2^m-1$

m- Length of the shift registers.

Let c (t) is the resulting waveform of the maximum-length sequence. Period of the waveform c (t) is

$T_b=N\ T_c$

T_c is the duration assigned to symbol 1 or 0 in the maximal-length sequence.

Autocorrelation function of a periodic signal c (t) of period T_b is

$$R_c(\tau) = \frac{1}{T_b}\int_{-T_b/2}^{T_b/2} c(t)c(t-\tau)\,dt$$

Where the lag τ lies in the interval (-Tb /2, Tb /2).Using this formula autocorrelation is represented as

$$R_c(\tau) = \begin{cases} 1 - \frac{N+1}{NT_c}|\tau|, & |\tau| \leq T_c \\ -\frac{1}{N}, & \text{for the remainder of the period} \end{cases}$$

This theoretically measured autocorrelation is then compared with simulated Autocorrelation& is concluded in Section IV.

III. Results And Discussions

The resultant PN sequence (m-sequence) & polar format of that generated PN sequence is shown in Figure3. This figure shows that number of binary 0s are differ by number of 1s by one chip only, which is the property of m-sequence. In first part of the figure, generated m-sequence is shown with respect to chip index and second part of the figure shows when this generated m-sequence is coded in polar format. In polar format, output is shown with respect to time. Figures 4 & 5 show the comparison of autocorrelation function of m-sequence simulated values with measured values of autocorrelation function for different values of lag τ. These autocorrelation plots shows the number of agreements minus disagreements for the overall length of the two sequence (one is generated m-sequence and other is its time shifted sequence)

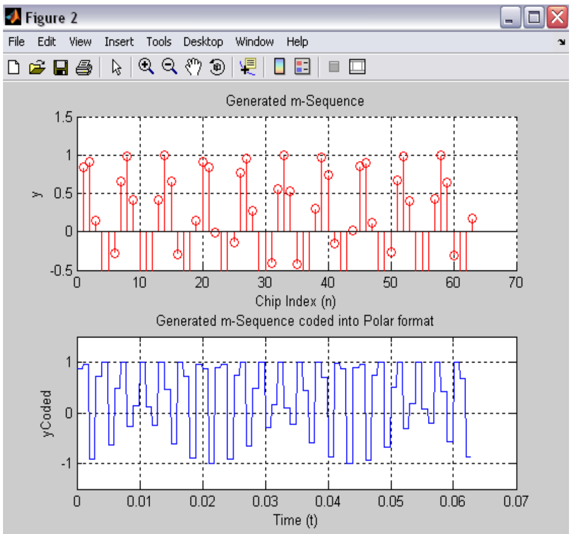

Figure3. Generated m-sequence & its polar format

Figure 3 shows autocorrelation function when the polynomial is x^3+x^1+1.This figure shows that for autocorrelation function increases or decreases linearly with the lag so autocorrelation function is triangular.

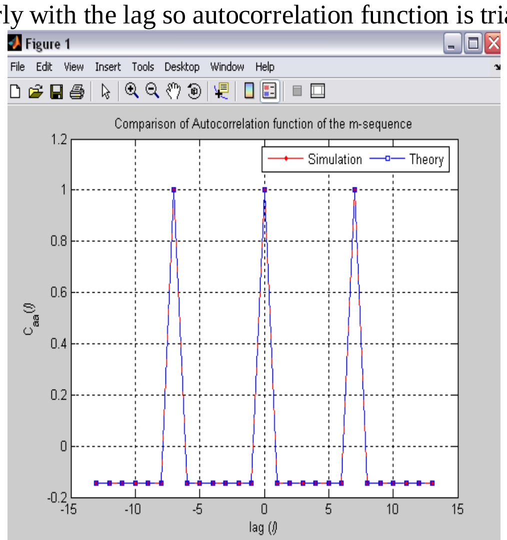

Figure4. Comparison of theoretical & simulation values Of autocorrelation for N=3

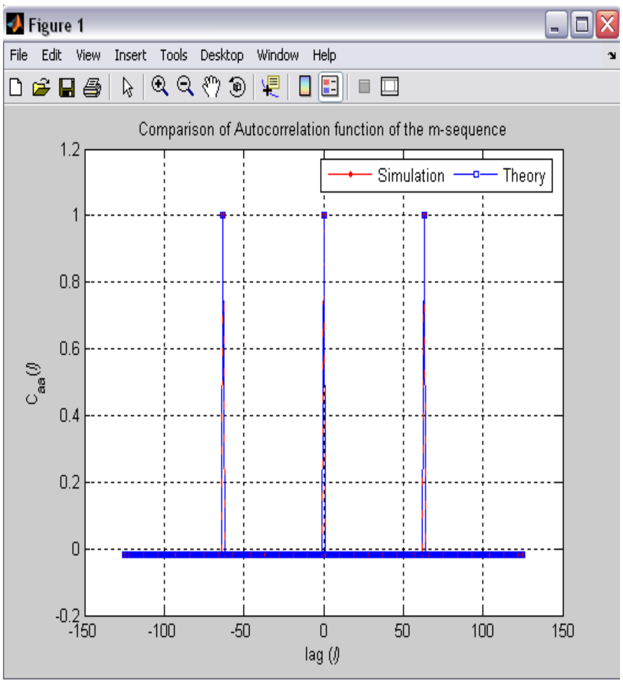

Figure5. Comparison of theoretical & simulation values Of autocorrelation for N=6

Figure 5 shows autocorrelation function when the polynomial is x^6+x^1+1. This figure shows that when the degree of polynomial increases autocorrelation function gives spike values. The increase in the degree of polynomial demands for more number of shift registers cascaded linearly as shown in fig 1.The above result shows that as the polynomial degree are increased the Tc (chip rate of sequence) increases rapidly thereby increasing the frequency spectrum which in turn generates spikes

IV. Conclusion And Future Work

The above system proposes an effective and efficient use of PN m-sequence in the one of the most versatile techniques of Spread Spectrum popularly known as DSSS. This scheme shows that the autocorrelation coefficients of PN m-sequence are well suited for Spread Spectrum as application in DSSS used in W-CDMA. However, a comparison of simulated & measured value proves that it has excellent autocorrelation property.

References

[1] Masaya Tanigawa ,Taka 0 Hara,Mamoru Fukui and Heiichi Yamamoto, "FAST ACQUISITION AND LOW CORRELATION MULTI-COMPONENT CODE '', 0-7803-8523-3/04,2004 IEEE. ,pp 2454-2457.
[2] JianRen, "Design of Long Period Pseudo-Random Sequencesfrom the Addition of m-Sequences over Fp '', EURASIP Journal onWireless Communications and Networking 2004:1, 2004 Hindawi Publishing Corporation ,pp 12-18.
[3] Wei Wang, Chuncheng Wang and YanlingHao , "A Hardware Design of Navigation ReceiverSignal Processing Platform '',IEEEInternational Conference on Robotics and Biomimetics,Bangkok, Thailand, February 21 - 26, 2009,DOI 978-1-4244-2679-9/08,pp 2139-2143.
[4] NiuYixia ,ZhuangZiqiang , Song Jijiang , Li Yueran , "Pseudo-random Sequence Correlation Simulation Based on MATLAB '', 2010 IEEE International Conference on Computer Modeling and Simulation 2010 DOI 10.1109/ICCMS.2010.166 , 978-0-7695-3941-6/10 ,pp 23-25.
[5] NiuDongWen, Zhang BaoHui, Liang Dong, Z.Q.Bo, A.Klimek, "Application of Spectrum-spread Technology inPower Line Communication '', UPEC201031st Aug - 3rd Sept 2010.
[6] Li chuan& Li Chengshu, "Performance analysis of M-ary Spread Spectrum Data Transmission System Based on Phase Modulating a PN Sequence",DOI 0- 7803-2916- 3.pp 607-610
[7] James P. Stephens,Lt.Cd David M. Norman, "DIRECT-SEQUENCE SPREAD SPECTRUM SYSTEM '', pp462-466.
[8] Communication Systems by Simon Haykin,John Wiley & Sons.
[9] Wireless Network Evolution 2G to 3G by Vijay K.Garg,Pearson Education.