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Effect of length on Correlation of PN sequence and Gold sequence

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ABSTRACT: Spread spectrum modulation technique is different from the conventional communication system. A good correlation property and large linear period of Pseudo-random sequence is the basis of spread spectrum communication systems intern CDMA (code division multiple access communication systems). 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, in this paper we examine autocorrelation of PN sequence, GOLD sequence and compares the simulated autocorrelation with theoretical measured autocorrelation function at different value of N.

KEYWORDS*:* Autocorrelation-sequence, MATLAB, PN sequence, Spread spectrum communication, Pseudo-noise.

I. INTRODUCTION

Spread Spectrum is a method of transmission in which the data sequence occupies a bandwidth in excess of the minimum bandwidth necessary to send it [1]. Spread spectrum techniques are used in many military communication systems to provide some combination of ranging capabilities, anti-jam protection, low probability of detection and interception, and multiple-access capability [4]. The spread spectrum communication has many advantages like strong anti-interference ability, low bit error rate, good hiding, low intercept, high confidentiality, etc [2].

Spread spectrum communication has two characteristics first one is the bandwidth of the signal transmission is much larger than the bandwidth of the original information signal and the second is that the transmission signal bandwidth is decided by the spreading codes (and the spreading codes are usually the pseudo-random code) [1]. There are several techniques by which spread spectrum can be implemented. One technique is called direct-sequence and the other technique is a PN (pseudo-noise) code which exhibits random-like properties which are necessary for providing good spectral characteristics and security [5]. A long PN code is frequently used for uplink channelization in the CDMA mobile communications [3]. Pseudo-random sequences with good correlation property, large linear complexity, and balance statistics are widely used in modern communication [6].

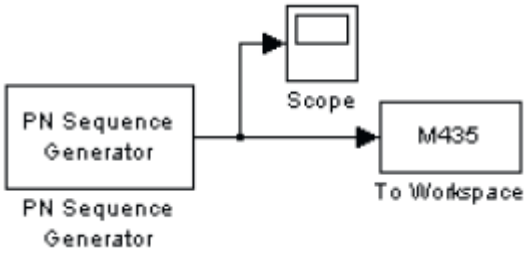

Figure 1. M sequence generation circuit simulation model[3]

Spread spectrum data transmission system using orthogonal codes has some difficulties mainly its autocorrelation property is often poor so a new method by which data are modulated onto PN codes generated from PN generators having the same feedback logic and different initial phases are generally used [7]

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In a Direct Sequence Spread Spectrum (DSSS) system, random binary data having bit rate of r_b bits per sec is Exclusive Ored by a pseudorandom binary waveform, which is at much higher rate and it provides the frequency spreading operation. This pseudorandom binary source outputs symbols called chips at a constant chip rate r_C chips per sec .Each bit in the pseudorandom binary sequence is known as a chip and the inverse of its period as chip rate. The chip rate is always higher than the bit rate, and the ratio of the chip rate to the bit rate is known as the processing gain [8]

M sequence is commonly used pseudo-random sequence, which is the longest linear sequence shift register. Such 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[1].

PN Sequence Generator generates a sequence of pseudorandom binary numbers by using shift register, as shown in Figure 2. There are r registers in the generator which update their values at each time step depending on the 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, $g_rz_r+g_{r-1}z_{r-1}+.....+g_0$. 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.

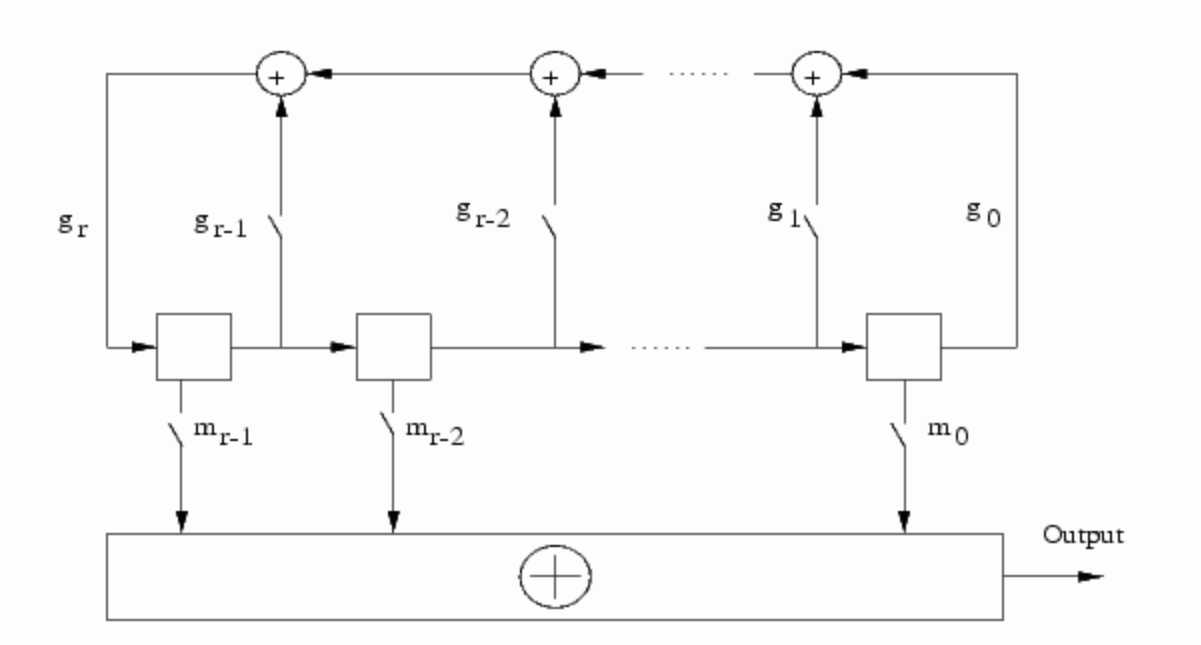

Figure 2. M-Sequence Generator Structure [2]

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. The remainder of this paper is organized as follows: Section 2 presents the material and method of the designed system for generation of m sequence and its autocorrelation in MATLAB. Section 3 gives a detailed discussion on the results obtained. The final section concludes and describes the future scope of this work.

II. RELATED WORK

Kumar, R. et.al. [2014] presents MC-cdma (Multi Carrier-cdma, which is a very promising candidate for multiple access schemes in Fourth Generation wireless communication candidate, because it provides data rate up to 10mbps. Afaq Ahmad et. al. [2013] presented in the paper "On Properties of PN Sequences Generated by LFSR – a Generalized Study and Simulation Modeling" a study and developed simulation models for testing properties of pseudo-noise sequences. Chithra R et. al. [2012] discusses in paper "A PN Sequence Generator based on Residue Arithmetic for Multi-User DS-CDMA Applications" PN sequence generation based on Residue Arithmetic with an effort to improve

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the performance of existing interference-limited CDMA technology for mobile cellular systems. Rishija Misra et. al. [2011] presents in paper "Code and Carrier Tracking Loops for GPS C/A Code" details of GPS signal structure, its application in satellite based navigation system. They also highlight the need of code and carrier tracking loops in GPS. Suzi Seroja Sarnin et. al. [2010] highlights in the paper " Performance Study of BPSK and 8-PSK Using Cyclic Codes in CDMA Environment" the performance of BPSK and 8-PSK in Code Division Multiple Access (CDMA) environment by using Cyclic Codes as the Forward Error Correction (FEC). Amin, S.A. et. al. [2009] presents in the paper "Performance Analysis of Multi-carrier DS-CDMA Wireless Communication System" regards performance analyses of Direct Sequence Code Division Multiplexing (DS-CDMA), Multi-Tone (MT) CDMA, Multi-Carrier (MC) CDMA and MC-DS-CDMA transmission systems are carried out in a mobile radio environment. Deergha Rao, K. et. al. [2006] proposes a new M-estimator based robust multiuser detector using spatiotemporal chaotic spreading sequences in the paper "Improved Robust Multiuser Detection in Non-Gaussian Channels Using a New M-Estimator and Spatiotemporal Chaotic Spreading Sequences". Ajeesh P. Kurian et. al. [2005] proposed in his paper "Performance Enhancement of DS/CDMA System Using Chaotic Complex Spreading Sequence" a direct sequence/spread spectrum (DS/SS) communication system. Hikino, O. et. al. [2002] introduces in the paper "Code optimization for direct sequence spread spectrum and SAW-matched filter implementation" a new optimization algorithm for the minimization of the time side lobes of the correlation function of a pseudo noise (PN) sequence by applying dynamic weighting to the sequence. Miller, C.S. et. al. [1997] in the paper "A technique for rapid detection of spread spectrum sequences" In systems using direct sequence spread spectrum signals (DSSS) it is often necessary to monitor activity and to detect the presence of code sequences of interest. Kwon, H.M. et.al. [1992] establishes that a false pseudo-noise (PN) code lock can happen with high probability for very strong signals if a Gold sequence is employed for the PN-spreading.

III. MATERIAL AND METHOD

To generate PN sequence MATLAB v 7.0 is used. A PN sequence is generated by means of a feedback shift register. PN sequence generated is determined by the length m of the shift register, its initial state and the feedback logic. 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 & then to find autocorrelation. 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

$$Tb = N.Tc$$

Tc is the duration assigned to symbol 1 or 0 in the maximal-length sequence.
Autocorrelation function of a periodic signal c (t) of period Tb is

$$Rc(\tau) = \frac{1}{Tb}\int_{-Tb/2}^{Tb/2} C(t).C(t-\tau)dt$$

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

$$Rc(\tau) = \begin{cases} 1 - \dfrac{N+1}{N}|\tau|, & |\tau| \le Tc \\ -\dfrac{1}{N}, & for\ remainder\ period \end{cases}$$

This theoretically autocorrelation is then compared with simulated Autocorrelation.

III. RESULTS AND DISCUSSIONS

The resultant PN sequence (m-sequence) & polar format of that generated PN sequence is shown in Figure2. 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

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to time.

Figure 4 & 5 shows 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)

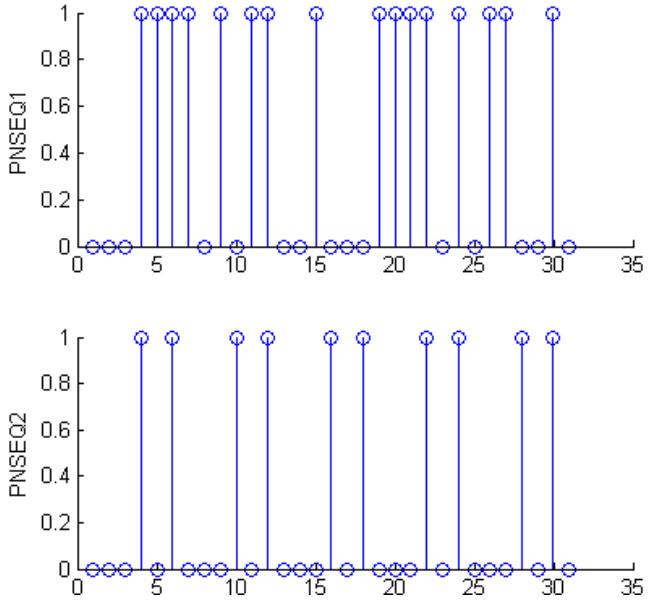

Figure 3. Generated m-sequence

Figure 4 shows autocorrelation function when the polynomial is x^5+x^2+1.This figure shows that autocorrelation function increases or decreases linearly with the lag, so autocorrelation function is triangular. 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.

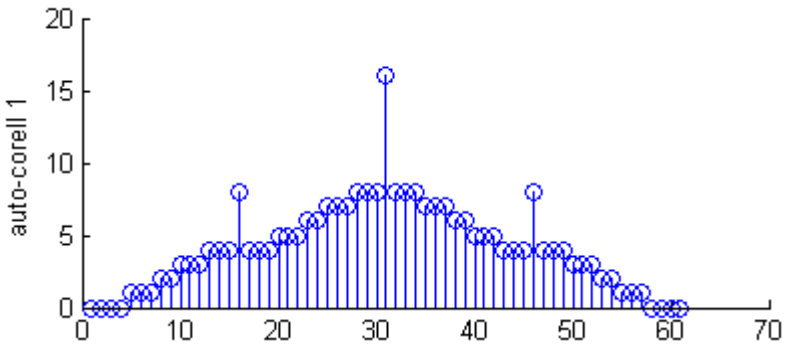

Figure 4. Comparison of theoretical & simulation values of autocorrelation for N=5

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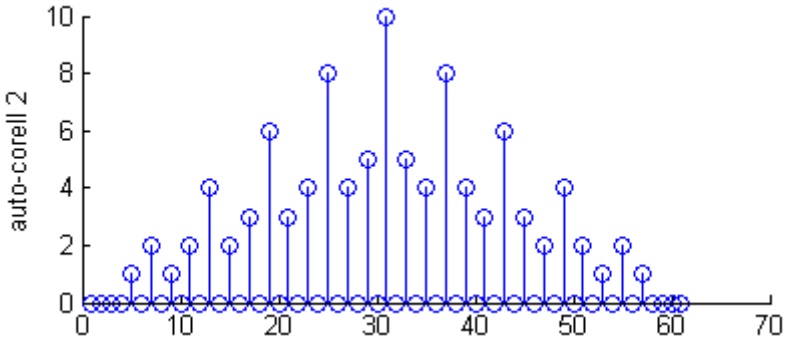

Figure 5. Comparison of theoretical & simulation values of autocorrelation for N=6

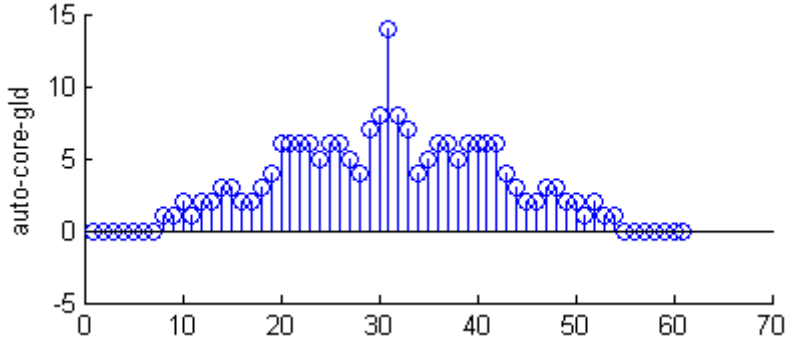

Figure 6. Cross correlation of gold sequence with other gold sequences when no. of sequence is 5.

IV. CONCLUSIONS AND FUTURE SCOPE

The system developed shall provide a PN sequence (msequence) which is widely used in varied application areas like military applications, telecommunications etc. An attempt has been made in this work to generate m-sequence and then find autocorrelation of that series. Algorithm is developed in MATLAB. The comparison of simulated & measured values proves that sequences have excellent autocorrelation property. At the same time, for some basic character of m sequence such as autocorrelation and crosscorrelation simulation also give the code integer. The code is simple and efficient, and has strong skills

REFERENCES

[1] Niu Yixia , Zhuang Ziqiang , Song Jijiang , Li Yueran , "*Pseudorandom Sequence Correlation Simulation Based on MATLAB* '',2011 IEEE International Conference on Computer Modeling and Simulation 2010 DOI 10.1109/ICCMS.2010.166 , 978-0-7695-3941- 6/10 ,pp 23-25.
[2] Niu DongWen, Zhang BaoHui, Liang Dong, Z.Q.Bo, A.Klimek, "*Application of Spectrum-spread Technology in Power Line Communication* '', UPEC2010 31st Aug - 3rd Sept 2010 .
[3] 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.
[4] Wei Wang, Chuncheng Wang and Yanling Hao , "*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.
[5] James P. Stephens, Lt.Cd David M. Norman, "*DIRECT SEQUENCE SPREAD SPECTRUM SYSTEM* '', pp 462-466.
[6] Jian Ren, "*Design of Long Period Pseudo-Random Sequences from the Addition of m-Sequences over Fp* '', EURASIP Journal onWireless Communications and Networking 2004:1, 2004 Hindawi Publishing Corporation ,pp 12-18.
[7] 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
[8] Wireless Network Evolution 2G to 3G by Vijay K.Garg,Pearson Education.
[9] Communication Systems by Simon Haykin,John Wiley & Sons.