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Comprehensive Review on PN Sequence and their overall effects

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ABSTRACT

A PN sequence is a reference signal simulating the random samples of discrete digital information and generates the samples in a specific manner so that it follows the correlation property. A correlation and maximal length sequence of pseudo-random signals is the basis of spread spectrum communication systems intern CDMA. There are many sequences which can generate good quality output but still we have some scope to move toward other sequence which have good orthogonality then GOLD and kasami sequence and can provide reliable service. In this paper the author has studied the comparative review of PN sequence with theoretically measured correlation function at different value of total sequence.

INTRODUCTION

MC CDMA networks was proposed for fourth generation (4G) system, and it will be defined by the ability to integrate heterogeneous networks, especially radio mobile networks and wireless networks, which offers access to all services for all the time and everywhere. As there is a rapid growth of internet services and the increasing interest in portable computing devices are probable to create a strong demand for high speed wireless data services. To fully meet these evolution perspectives which are based upon the multi-carrier systems have become popular for their spectral efficiency and robustness against frequency-selective fading. Multi-carrier code division multiple access (MC CDMA) is the technique which combines the advantage of multi-carrier modulation with code division multiple access to offer reliable high data rate downlink cellular communication services. This system is used as it has proven to be better than conventional CDMA networks, FDMA and TDMA.

Spread spectrum (SS) techniques are the methods in which energy generated at a single frequency is spread over a wide band of frequencies. The basic spread spectrum technique is shown in Figure 1.1 which is done to achieve transmission that is robust against channel impairments, and to be able to resist the natural interference or jamming and to prevent hostile detection. These techniques were developed by military guidance and communication systems. The techniques are said to be spread spectrum when the transmission bandwidth is much greater than minimum bandwidth needed to transmit the information signal. Bernard Sklar defines the system to be achieving spread spectrum if it fulfills the following requirements:

As the number of users increasing, the MAI also growing significantly and the DS-CDMA system will be interference limited. Spreading of M & GOLD sequences in a DS-CDMA system needs to have a good cross-correlation as well as good autocorrelation characteristics. Main goal is to reduce the fading effect by supplying the receiver with several replicas of the same information signal transmitted over independently fading paths.

- Signal occupies bandwidth in excess of the minimum bandwidth necessary to send information.
- Spreading is accomplished by means of spreading code signal, independent of the data.
- At the receiver, de-spreading is accomplished by the correlation of the received spread signal with a synchronized replica of the spreading signal used to spread information.

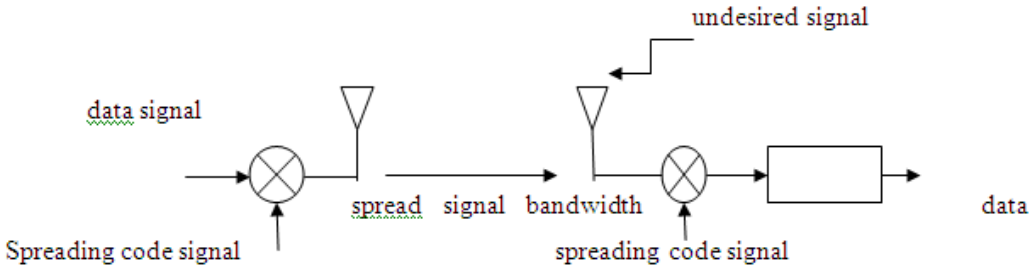

Fig.1: Model of basic spread spectrum technique

The Spread Spectrum is able to resist interference and jamming. The bottom center behind interference rejection capability of spread spectrum is achieved by:

1. Multiplying signal by spreading signal once spreads the signal bandwidth.
2. Multiplying signal by spreading signal twice recovers original signal.
3. Desired signal gets multiplied twice and interference gets multiplied only once, and that's makes signal recovering as the noise and information would not be at the same frequencies.

The conventional modulation schemes like frequency modulation and pulse code modulation also spread the spectrum of an information signal, but these techniques does not qualify as spread spectrum systems since they do not satisfy all the conditions as outlined. Spread spectrum techniques are implemented where transmission has to be operated without the information being detected by anyone other than the intended receiver, in other way we can say it directly means that information transmission through the spread spectrum is secure. Communications systems designed for this task are known as low probability of detection (LPD) or low probability of intercept filter (LPI). Spread Spectrum systems, designed to present LPI may also be designed to expose low probability of position fix (LPPF), thus even if the presence of the signal may be perceived, direction of the transmitter is difficult to pinpoint. The users can further be made to expose low probability of signal exploitation (LPSE), meaning that identification of source is difficult to determine.

The goal of these systems is to use minimum signal power and optimum signaling scheme so that minimum probability of being detected, intercepted or demodulated achieved. Spread Spectrum uses wide band, noise-like signals and because the signals are noise-like, they are hard to detect. Spread Spectrum signals are harder to jam than narrowband signals because this techniques use code signal to perform spreading and de-spreading, and these spreading code signals are called pseudorandom or pseudo noise codes. These codes are called pseudorandom because they are not random and are deterministic periodic signals that are known to both transmitter and receiver. As these signals are deterministic, they hold randomness properties and they appear random to unauthorized users. Spread spectrum techniques can be classified into three main categories namely direct sequence spread spectrum, frequency hopping spread spectrum and time hopping spread spectrum and the combination of two of the three techniques.

LITERATURE SURVEY

Kumar, R. et.al., 2014 in the paper "Performance of spreading code in MC DS CDMA system using HDL coding in CADENCE" 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. The DS-CDMA (Direct Sequence-CDMA) is expected to be the major medium access technology in the future mobile system owing to its potential capacity enhancement and the robustness against noise. On combining the techniques of MC-cdma and DS-cdma forms MC- DS-cdma (multi carrier direct sequence cdma) MC-DS-CDMA system. The spreading codes are an important parts of code division multiple access based wireless cellular system. There are many spreading codes avail for the system like PN sequence, Gold sequence, Kasami sequence and chaotic sequence. This system is evaluated in Nakagami fading channel model, which can be used to model urban and suburban environments. This system is designed under VLSI environment and so Verilog HDL and Vhdl are used for coding the system. CADENCE is used for verification and synpaper of the system. With CADENCE we can able to estimate area, power and elapsed timing calculation can be done easily.

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. A generalized approach is considered while presenting the study of properties of pseudo-noise sequences. The results for the counts of number of 1s and number of 0s as well as run lengths are checked. The waveforms and autocorrelation of PN sequences are studied through the developed models.

Shaweta Narula et. al. [2013] in the paper "Design a Scheme to Exhibit Spread Spectrum in Direct Sequence Spread Spectrum Technique Using PN code & Gold Code in MATLAB" analyse 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 samples.

Sowmy, I. et. al. [2013] in the paper "Simulation and analysis of MC-CDMA system using discrete wavelet transform" presents the Multicarrier Code Division Multiple Access (MC-CDMA) which is a combination of conventional Code Division Multiple Access (CDMA) and Orthogonal Frequency Division Multiplexing (OFDM). Better BER performances achieved by high code rate systems, which are achieved by MC-CDMA exploiting frequency diversity via the different subcarriers. Also time synchronization requirement is made much lower than traditional direct sequence CDMA schemes due to the spreading in the frequency domain. Performance of MC-CDMA under various channels like the AWGN channel and Rayleigh channel is analyzed using various spreading codes like Walsh codes, PN sequence and gold sequence. BER versus SNR graphs are plotted and their performance is studied.

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 the performance of existing interference-limited CDMA technology for mobile cellular systems. All spreading codes with residual number system proposed earlier did not consider external interferences, multipath propagation, Doppler Effect etc. The RNS based PN sequence has superior performance than most of the existing codes that are widely used in DS-CDMA applications. The proposed sequence offers provision to vary correlation threshold based on the channel properties and error tolerance unlike any existing techniques. It also inherits high dynamic key range such that it yields a PN sequence which has pragmatically a nether correlation. DS-CDMA performance in all of MAI-AWGN, Rayleigh flat fading and different stationary multipath channels has been evaluated. It offers MAI resistant operation in both synchronous and asynchronous MAI-AWGN channels, reducing co-channel interference and increasing capacity in a mobile cellular system. The joint effects of ideal auto-correlation function and good cross correlation function makes RNS based PN sequence superior to all other standard PN sequences like Gold codes, Kasami codes and Maximal Length sequence.

Athar Ravish Khan [2012] in the paper "PERFORMANCE EVALUATION OF DS-CDMA SYSTEM USINGMATLAB" evaluated the performance of synchronous DS-CDMA systems over multipath fading channel and AWGN Channel. The synchronous DS-CDMA system is well known for eliminating the effects of multiple access interference (MAI) which limits the capacity and degrades the BER performance of the system. He investigated the bit error rate (BER) performance of a synchronous DS-CDMA system over AWGN and Rayleigh channel, which is affected by the different number of users, as well as different types spreading codes. The promising simulation results explored the comparative study of different DS-CDMA system parameter and showed the possibility of applying this system to the wideband channel.

Meghna Sharma et. al. [2012] in the paper "A Method to Generation and Simulation of PN Sequence in MATLAB"examines autocorrelation of PN sequence and compares the simulated autocorrelation with theoretical measured autocorrelation function at different value of N. 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 cross correlation simulation also give the code integer. The code is simple and efficient, and has strong skills.

Yongpeng Wei et. al. [2012] proposed a new algorithm for combined Independent component analysis (ICA) and data reuse blind equalization in the paper "Blind estimation of PN sequence of DS-CDMA signal in multipath" in order to solve the problem of blindly estimation of pseudo random (PN) sequence of DS-CDMA signal in multipath channel, On the basis of asynchronous DS-CDMA signal model. In multipath channel, the estimation of ICA is the

overlapped form of PN sequences of different paths, then data reuse blind equalization is introduced to eliminate the influence of the multipath, and the PN sequences of each user can be estimated from the result of blind equalization. This algorithm is no limit to the type of PN sequence, which is effective to m sequence, Gold sequence, M sequence and so on. The computer simulation shows that the algorithm performs well when the Signal to Noise Ratio (SNR) is even below 0dB.

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. Various architectures for code and carrier tracking loops are also presented. The derivations for transfer function of Costas loop for carrier tracking and Delay lock loop for code tracking is presented. The loop coefficients are determined by simulating various conditions. The loop functionality is tested with simulated test signal generated from AWR system simulation tool. Hence the complete study of the demodulation process was verified in this project.

S.Kalita, P.P Sahu [2011] have proposed in his paper " A New Modified Sequence Generator for Direct Sequence Spread Spectrum (DSSS)" a designed and simulate a new sequence generator which shows the properties similar to that of both Gold sequence and Kasami sequence and will be designed for the compatible of multichannel DSSS system. To get the desired result they have analyzed first the different sequence generator such as m-sequence, Gold sequence and Kasami sequence respectively. The proposed sequence generator simulated circuit will be little bit complex than the Gold sequence but less than the Kasami sequence and the performance will also be better than both the sequence generator.

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). The model presented by them consists of transmission medium, transmitter and receiver. Cyclic codes is use to encode and decode the digital signal of the two channels before modulation and after demodulation process. The result shows that the 8-PSK is more powerful compared to BPSK. CDMA, which uses multiple accesses for BPSK and 8-PSK, is likely to overcome some issues regarding noise and interference in the channel by introducing the spread spectrum signal. From the results, it has been proven that the 8-PSK satisfy 100% of the better performance comparing BPSK. By using CDMA, more capacity and bandwidth can be achieved and it is very effective for applications in modern communication.

MULTIPLE ACCESS TECHNIQUES

Multiple access techniques are used to allow a large number of mobile users to share the allocated spectrum in the most efficient manner. As the spectrum is limited, so the sharing is required to increase the capacity of cell or over a geographical area by allowing the available bandwidth to be used at the same time by different users. And this must be done in a way such that the quality of service doesn't degrade within the existing users.

Code Division Multiple Access

In CDMA, the same bandwidth is occupied by all the users, however they are all assigned separate codes, which differentiates them from each other (shown in Figure 8.3). CDMA utilize a spread spectrum technique in which a spreading signal (which is uncorrelated to the signal and has a large bandwidth) is used to spread the narrow band message signal.

Direct Sequence Spread Spectrum (DS-SS)

This is the most commonly used technology for CDMA. In DS-SS, the message signal is multiplied by a Pseudo Random Noise Code. Each user is given his own codeword which is orthogonal to the codes of other users and in order to detect the user, the receiver must know the codeword used by the transmitter. There are, however, two problems in such systems which are discussed in the sequel.

CDMA and Self-interference Problem

In CDMA, self-interference arises from the presence of delayed replicas of signal due to multipath. The delays cause the spreading sequences of the different users to lose their orthogonality, as by design they are orthogonal only at

zero phase offset. Hence in despreading a given user's waveform, nonzero contributions to that user's signal arise from the transmissions of the other users in the network. This is distinct from both TDMA and FDMA, wherein for reasonable time or frequency guardbands, respectively, orthogonality of the received signals can be preserved.

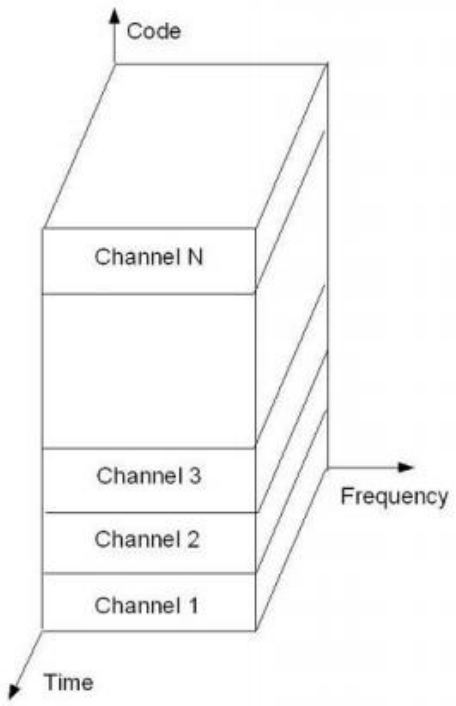

Figure 2: The basic concept of CDMA.

CDMA and Near-Far Problem

The near-far problem is a serious one in CDMA. This problem arises from the fact that signals closer to the receiver of interest are received with smaller attenuation than are signals located further away. Therefore the strong signal from the nearby transmitter will mask the weak signal from the remote transmitter. In TDMA and FDMA, this is not a problem since mutual interference can be filtered. In CDMA, however, the near-far effect combined with imperfect orthogonality between codes (e.g. due to different time sifts), leads to substantial interference. Accurate and fast power control appears essential to ensure reliable operation of multiuser DS-CDMA systems.

CONCLUSIONS

It has been observed that GOLD sequence has better orthogonality then PN sequence and energy is centralised towards mean position and less toward edges and can be concluded that as the modulation order increase the bit error rate for increase in SNR increases and at lower modulation order the number of error are more at lower SNR, but as the order increase response towards bit error rate in consult of SNR gets poorer and response to the SNR becomes weaker. It can also be concluded that as the modulation order increase the bit error rate for increase in SNR decreases and at lower modulation order the number of error are more and response to SNR remains uniform with change in order of modulation.

FUTURE SCOPE

Corporate world is moving fastly and methods of communicating the information are changing day by day, the data is used to transfer the information via noisy channel and in terms of new technique with which intruder wants to intercept and harm the data. There is a need of securing the data with new methods. For reliable secure and higher data rates transmission it is necessary to move some scheme other than the GSM, and DSSS technique has gained a boom in the field of communication. From the above work it can be analyzed although there are many sequence which can generate good quality output but still we have some scope to move toward other sequence which have

good orthogonality then GOLD and kasami sequence and can provide reliable service. As the number of user doesn't affect the allotted bandwidth used by a person so this way of communication is faster and reliable. There is always a huge role of mathematician in generation and analysis of a system, so here also a need of cope up with the mathematician or a good technical and analytical mind can improve the corelation properties of system. As in general this sequence can be used in communication system as well as secured data transmission and digital authentication, these sequences can be used.

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