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Maximizing SNR in A CDMA System

Umer Farooq, Sachin Talan, Ajay Kumar

***Abstract:** Signal to Noise Ratio (SNR) is an important index for wireless communications. There are many methods for increasing SNR. In CDMA systems, spreading sequences are used. To increase SNR, we have to improve spreading sequences. In classical approaches, the expression of SNR is not differentiable in terms of the parameter of the spreading sequences even in no fading situations. Thus, we express it as the differentiable form and construct the non-linear programing for maximizing SNR. In particular, we solve the problem of maximizing SNR numerically by obtaining spreading sequences whose SNR is guaranteed to be high. Also we use MATLAB programming for the same.*

***Keywords:** MATLAB, Noise Ratio (SNR), CDMA, differentiable.*

I. INTRODUCTION

Code Division Multiple Access (CDMA) is used as a multiple access technique in telecommunications radio system that can transport multimedia traffic at high data rates. The communications researchers have studied CDMA and are further developing it. This has come out because of the various reasons which contributed to evolution in wireless technology. They include:

- Need for highly reliable telecom network and most important and security against eavesdropping and cryptanalysts.
- Implementation of inexpensive data network.
- End users need new services, like new telephony and internet services.
- Explosive growth of data leading to market growth.
- Introduction of new services imposed by technology changes.

CDMA is used for the 3G mobile communication system. In CDMA systems, we use spreading sequences as codes to communicate each other in the same band of the frequency. This is a big feature of CDMA systems. We can efficiently use the frequency band with CDMA. Recently, the number of people who communicate each other has been dramatically increasing. However, the band of frequency we can use is limited. The new method to communicate which has high capacity is required. In this paper, our topic is about designing direct spreading sequence based CDMA (DS-CDMA) . In general, high Signal to Noise Ratio (SNR) has been demanded for achieving high spectral efficiency .In CDMA, crosscorrelation is a key component of interference noise. It is necessary to reduce crosscorrelation to achieve high capacity. Autocorrelation is related to code synchronization at receiver side.

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Umer Farooq, Department of Electronics and Communication Engineering, Maharshi Dayanand University, Rohtak (Haryana), India, E-mail: aayatjaan240@gmail.com

Mr. Sachin Talan, Assistant Professors, Department of Electronics and Communication Engineering, Maharishi Dayanand University, Rohtak (Haryana), India, E-mail: Sachintalan86@gmail.com

Mr. Ajay Kumar, Assistant Professors, Department of Electronics and Communication Engineering, Maharishi Dayanand University, Rohtak (Haryana), India, E-mail: Ajaykd64@yahoo.com

It is desirable that the first peak of crosscorrelation and the second peak in autocorrelation should be kept low. The expression of the SNR formula is obtained. To increase SNR, we have to reduce the denominator of SNR, namely, variance of interference noise. If there are two users in the channel, we obtain the highest SNR to solve problem. Direct Sequence CDMA Direct sequence (DS) CDMA is used in the third-generation mobile communication standard to provide high capacity and high transmission rate over conventional schemes such as frequency division multiple access and time-division multiple access. However, due to inherent wide bandwidth of the spread spectrum systems, severe frequency selective fading degrades system performances. When transmitting data in the downlink, DS CDMA relies on the orthogonality of the spreading codes to separate the different user signals. However, it suffers from inter channel interference (ICI) and it destroys the orthogonality among users, giving rise to Multi User Interference (MUI). Since the multi user interference is in actual fact caused by the multipath channel, it can be suppress by linear chip level equalization, followed by correlation with the user's spreading code. Here is the diagram for transmitter and reciever side of DS-CDMA system(fig 1and 1.1). At the transmitter, the information is encoded using codes. The encoded information is then transformed into a data modulated symbol sequence with a baseband modulator. The modulated symbol sequence is spread in time domain by a chip sequence of orthogonal code generator, usually Walsh code and PN sequence. The information is shaped and passed through a channel for transmission. At the receiver, the information is multiplied with the chip sequence by the correlators in the rake receiver. The information is then summed and multiplied by local generated spreading code, which is despreading. The information is demodulated and decoded and original data can be recovered.

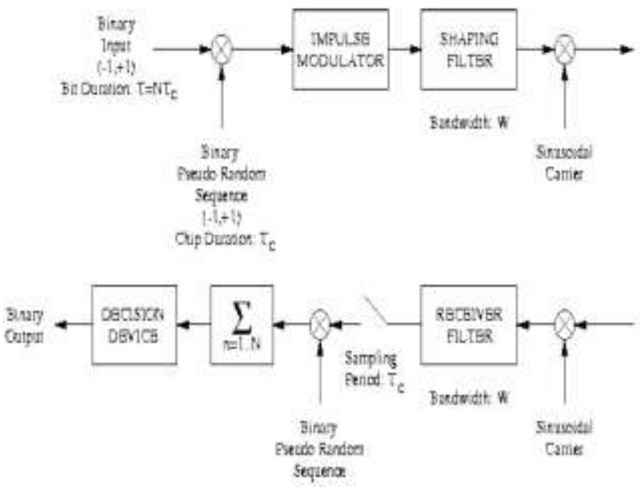

Fig-1 Diagram showing DSSS (transmitter and receiver)

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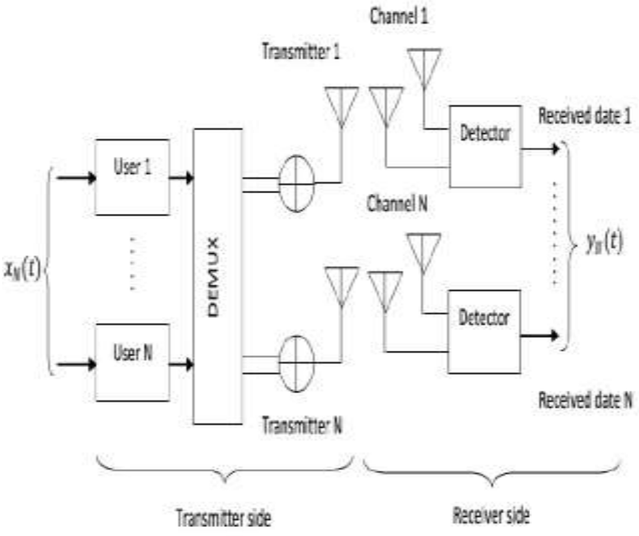


Fig-1.1: Diagram for DSSS using demux

II. RESULTS

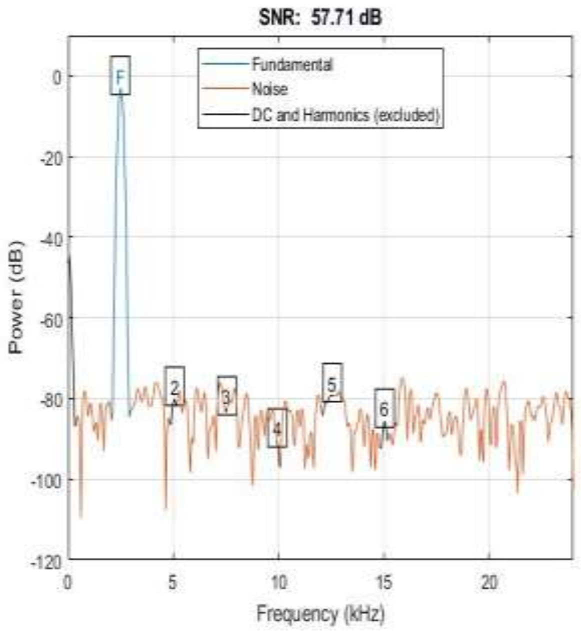


Fig 2.snr of one user using sinusoid wave

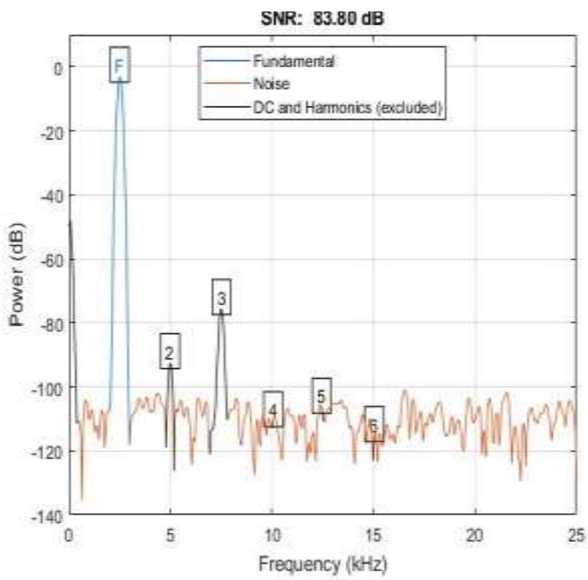
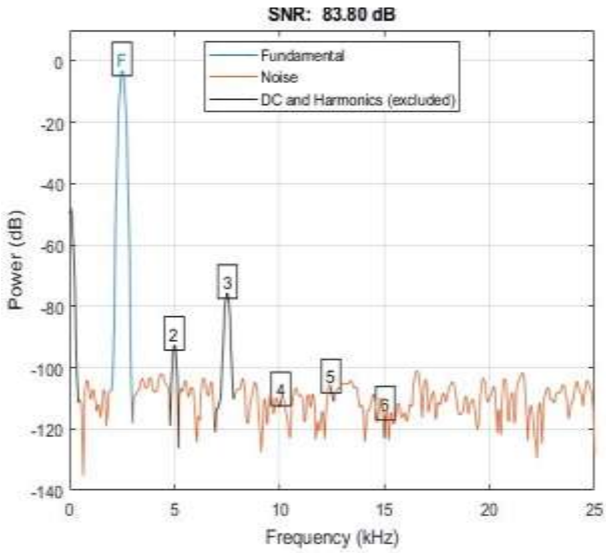


Fig 2.1 increased snr



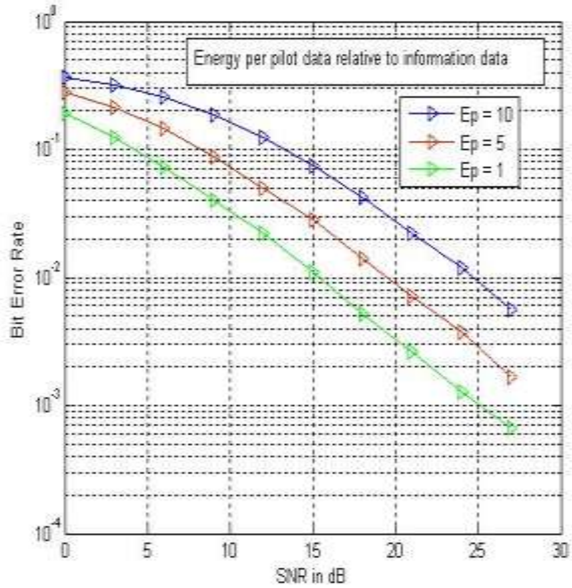


Fig 2.3 Quantitative analysis of SNR vs BER

III. DISCUSSIONS

SNR can be either positive and negative value if we represent it in dB scale. Negative SNR means that Signal power is lower than the noise power. we may think communication would be impossible in the negative SNR condition, but in reality there is communication system (technology) which is designed to work mostly in such a condition (e.g, CDMA, WCDMA). SNR is one of the most important indicator to represent signal quality. we may think Signal Power is the most important factors for signal quality, but in theory Signal power alone does not mean anything in terms of representing signal quality which help you predict how much error will happen for our communication system . I think above plots would give you an intuitive understanding of this. As you see, as SNR decreases the quality of the signal gets poorer (higher noise level). As a result, Bit Error Rate (BER) will increase and Sensitivity will decrease.

In the above plots, the red dots indicate the ideal constellation with almost no error and the black dots represents the statistical location of each data points with noises. we can say, the farther a black dot is from the red dots, the higher probable errors (Bit Error) occur. In this example, you see three cases of QAM constellation and each case is exposed to error with different SNR. You would notice that as SNR goes lower the range of constellation spread goes wider. It means.. with the same modulation scheme as SNR goes lower, the probablity of error goes higher.

IV. CONCLUSION

In this paper, we showed the new expression of the SNR formula and the numerical approach to obtain the spreading sequences whose SNR is high. With this approach, we can design the spreading sequences without an explicit generation mechanism such as return maps and they are guaranteed to have high SNR. Here, we assume that there is no fading signals and that there are only two users when we solve this SNR maximization problem, such as the first step to solve the optimization problem for maximizing SNR in a very general setting. The remaining issues are to obtain an optimization problem: maximize SNR in a general situation.

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