DS – CDMA
A New Method to Combine the Spreaded Users

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Abstract

In all the CDMA systems (all types of CDMA systems), the signal to be transmitted through the channel is real valued signal. In this research the signal is complex and can be sent on I – Q carrier of the same frequency, it is possible to send the real valued signal by the same method mentioned above but it must be normalized before sending it. In this method it doesn't need to be normalized. The bit error rate as compared to the conventional method was very good. The program was written in Matlab 2009b.

الخلاصة

إن عمليه إرسال اشاره خلال قناة،وفي جميع أنواع أنظمة (CDMA) نحتاج أن تكون الإشارة ذات قيمه حقيقية ،في هذا البحث تم اخذ إشارة مرّكبة نستطيع إرسالها على شكل موجة حاملة (I-Q) وبنفس التردد. من الممكن إرسال إشارة ذات قيمه حقيقية باستخدام نفس الطريقة أعلاه لكن يجب أن تعدل بشكل (Normalized) قبل الإرسال بينما في استخدام الاشاره المركبة (complex) لا نحتاج أن تكون (Normalized) أن نسبة الخطأ (BER) تكون ممتازة جداً إذا ما قورنت بالطريقة الأخرى.البرنامج قد كتب ونفذ باستخدامMatlab 2009b

Keyword: Modelling ,multi waiting line multichannel queue, single waiting line multichannel queue, simulation.

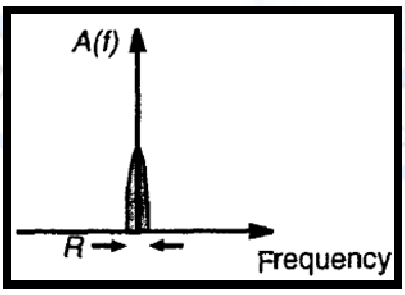
Introduction

Spread-spectrum communications is a secondary modulation technique. In a typical spread-spectrum communication system, the message signal is first modulated by traditional ways of separating signals amplitude, frequency and phase techniques are relatively simple was of making sure that the signals are orthogonal and no interfering. However, in CDMA, different users occupy the same band width at the same time, but are separated from each other via the use of a set of orthogonal waveforms, sequences , or codes .A pseudorandom noise (PN) signal is then applied to spread the modulated waveform over a relatively wide bandwidth. The PN signal can amplitude modulate the message waveform to generate direct-sequence spreading, or it can shift the carrier frequency of the message signal to produce frequency-hopped spreading[1], as shown in Figure (1.1).

The direct-sequence spread-spectrum signal is generated by multiplying the message signal d(t) by a pseudorandom noise signal pn (t):

$$g(t)=pn(t)d(t) \qquad (1.1)$$

In most cases, the PN signal is a very high rate, nonreturn-to-zero (NRZ)[2] pseudorandom sequence that chops the modulated message waveform into chips, as shown in Figure (1.2). The spreading code is a critical component of spread-spectrum communications.



(a)

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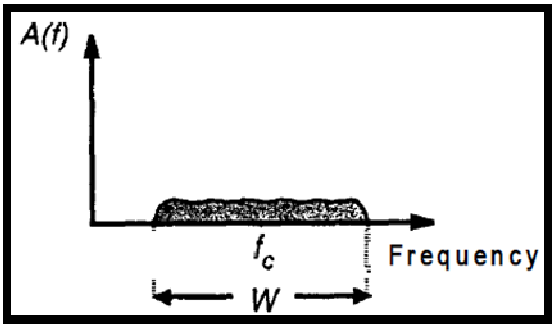
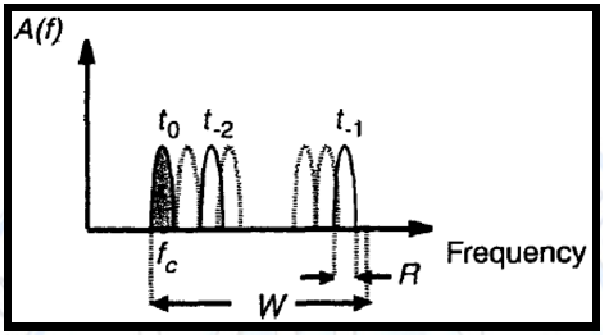


(b)



(c)

Figure (1.1): Spread-spectrum signals: (a) message signal, (b) direct-sequence signal, and (c) frequency-hopped signal.

In general, the spreading signal is a binary waveform with values specified at the chip rate. The binary waveform allows easy implementation without sacrificing performance and enables synchronization of the transmitter to the received signal[3]. It is possible to achieve a continuous-time waveform by passing the binary signal through a linear filter. There are some types of the spreading codes such as Walsh code which will be used in this paper and we will not go deep to discuss these codes as it is out of the scope of this paper.

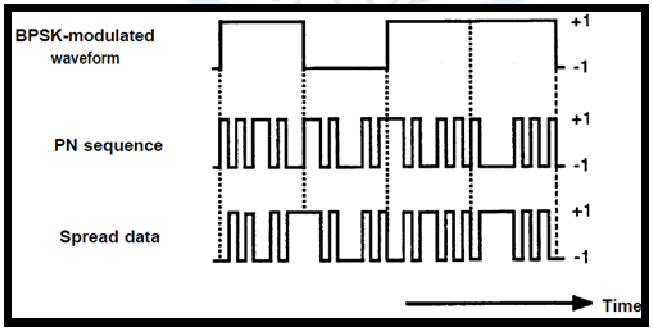


Figure (1.2): Direct-sequence spread-spectrum signals.

Hence, Spread-spectrum modulation and CDMA techniques allow several users to share the radio interface; thus, the received waveform becomes the sum of *K* user signals and noise :

$$r(t)=\sum_{n=1}^{K} pn_n(t)A_n d_n(t)\cos(wt+\theta_n)+n(t) \quad (1.2)$$

Where r(t) is the receiver wave form, pn is a pseudo random noise signal, d(t) is the message signal, A is the amplitude of carrier frequency ,W is angular frequency ,θ is phase shift and n(t) is the noise. The receiver retrieves the message signal by despreading the received signal. It does that by synchronizing its correlator to a specific spreading sequence, pn (t), that is unique to the user and different from those of other users. As a result, the other user signals appear noise like . The noise ($\mathbf{N_\tau}$) seen by the correlator is the signal energy received from the *k* - 1 users and thermal noise, that is[2],

$$N_\tau=\sum_{n=1}^{k-1} S_n + WN_\circ \quad (1.3)$$

Where $\mathbf{S_n}$ is the received power from the n^{th} user, $\mathbf{N_\circ}$ is the thermal noise power spectral density (psd), and **W** is the channel bandwidth. If the received power from each user is assumed equal and *k* is large, such that *k* - 1 can be approximated by *k*, then

$$N\tau \approx KS+WN_\circ \quad (1.4)$$

Furthermore, the interference generally is much larger than the integrated thermal noise ($\mathbf{KS} >> \mathbf{WN_\circ}$), so that

$$N\tau \approx I = kS \quad (1.5)$$

From this result, two important observations are made. First, the interference of the spread-spectrum system increases linearly as the number of users is added. Second, the performance of the system suffers when any user transmits extra power, a problem known as the near-far effect.

A simple block diagram for the CDMA system is shown in figure (1.3)[2].

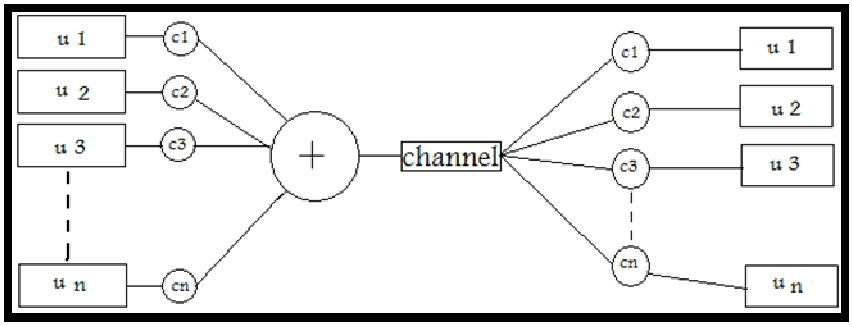


Figure (1.3): A simple baseband CDMA system

1. New Technique:

So far, it is very clear that the spreaded users will be added together to construct the final signal which will send through the channel [3],[4].

The new technique is to replace the summation process by multiplication, but before that, the spreaded signal for each user must be n – rooted before multiply it by the other signals. The root must be of power 1/*i*, so, the root of first user is 1/*i* = 1, and the root of the second user is ½, for the third user will be 1/3 and so on for the others as given in the following conclusion equation:

$$u_i = \sqrt[i]{\text{(User's data X spreading code)}} \qquad i=1,2,3,\ldots,N \quad (2.1)$$

Where u_i is the i^{th} user.

In the conventional method (summation process), the signal comes from the summation must be normalized before the transmission. In the new method (multiplication), there is no need to normalize the signal as because the maximum and minimum values are (±1, ±j), hence, the signal is complex.

2. Simulations and Results

The two methods will be simulated here in this section. *The algorithm for the conventional method (summation process) is simply*;

Transmitter: generate the random data for each user, line coding the binary data to a non – return to zero (NRZ) format, generate the spreading code (Walsh code), multiply each user's data by its assigned spreading code, ***add all the spreaded signals together***, normalize the resultant signal by dividing it by the number of users, and finally send the final signal through the AWGN channel.

Receiver: down – sample the received signal, de – spreads the signal to re – produce the data for each user by multiplying the received signal by the Walsh code for each user, and finally calculate the bit error rate (BER). These procedures are shown in the block diagram of figure (2.1).*The algorithm for the new method (multiplication process) is depicted below;* ***Transmitter:*** generate the random data for each user, line coding the binary data to a non – return to zero (NRZ) format, generate the spreading code (Walsh code), multiply each user's data by its assigned spreading code, ***take the*** i^{th} ***root for each spreaded user, multiply all the spreaded signals together***, and finally send the final signal through the AWGN channel

Receiver: down – sample the received signal, de – spreads the signal to re – produce the data for each user by multiplying the received signal by the Walsh code for each user, in the block diagram of figure (2.2).

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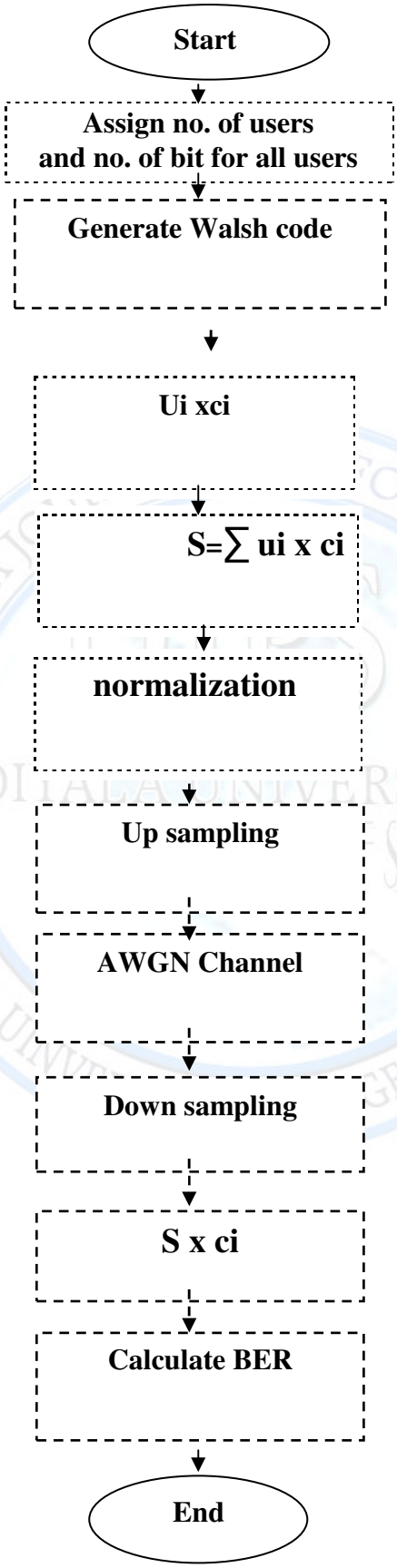

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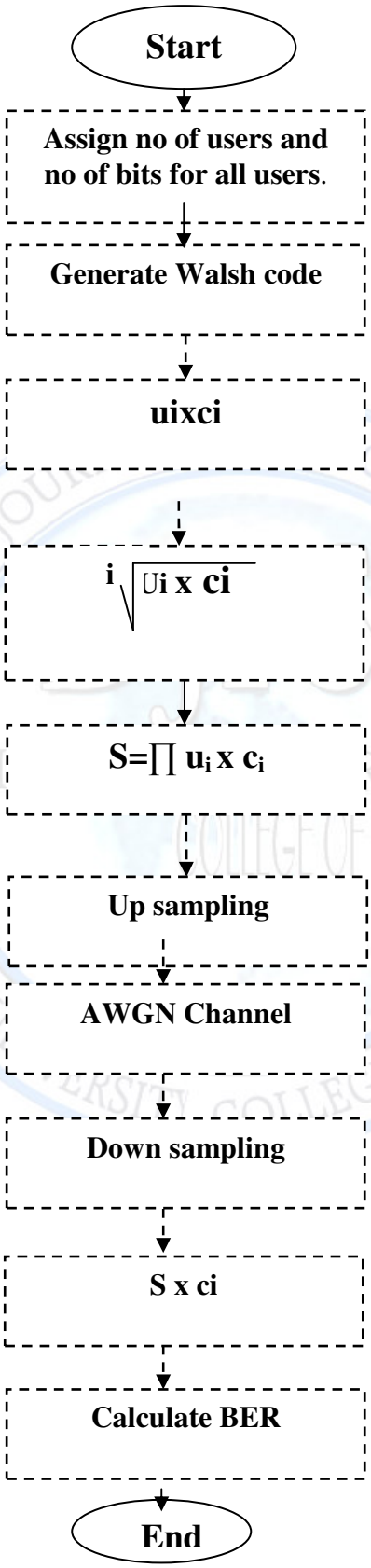
Figure (2.1) : Block diagram for the conventional method



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Figure(2.2) :Block diagram for the multiplication process

The program was written in Matlab 2009b. As an **simulation example** for the (summation method) which was executed for a loop of SNR starting at – 10 dB and ending at + 10 dB. Figure (2.3) is the results for the first method for 32 users (Walsh matrix of 32 × 32) and 2000 bit as a message for each user. The result show that the BER ratio (percentage) is 24 at -9 SNR(dB). These values are began to decreased until reach to zero at 4 (dB).

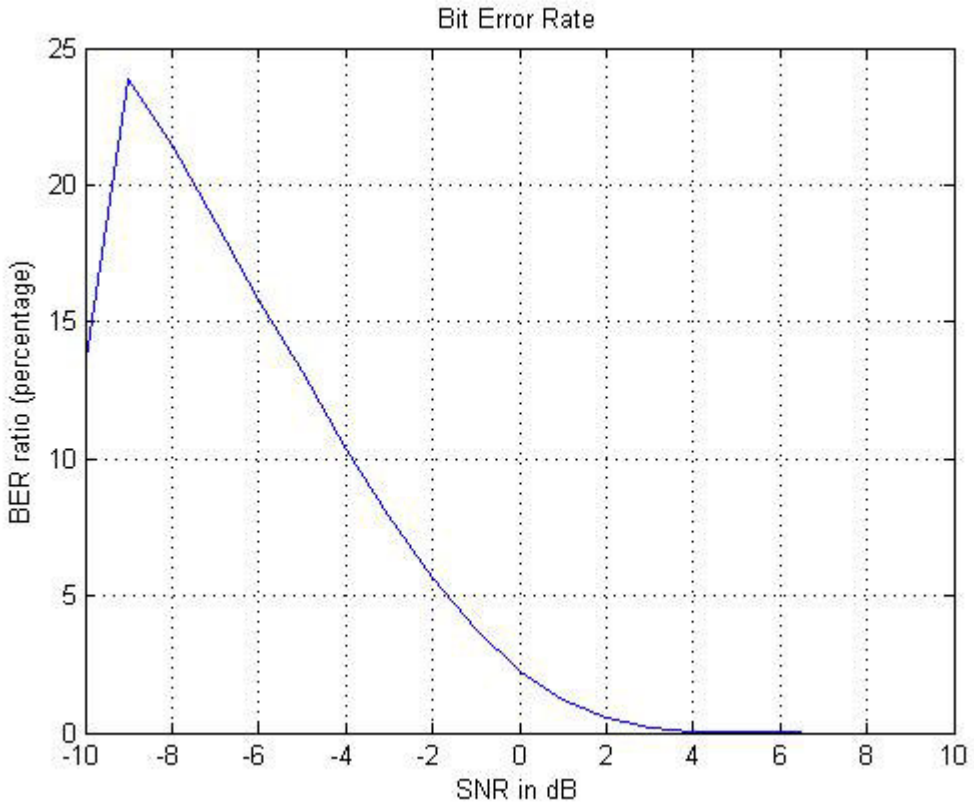

Figure (2.3): Bit error rates for 32 user and 2000 bits each (summation method).

The results for the second method will be displayed below but one point must be mentioned, which is the up – sampling for this method was increased about four times of the first method and the results was very close to the first method. Figure (2.4) is the results for the 32 users and 2000 bits for each user as a message . The result show that the BER ratio (percentage) is 23 at -9 SNR(dB). These values are began to decreased until reach to zero at 4 (dB).The difference between the values of SNR in the two ways are in range from 1 to 0.01 until reached zero at 4dB, but in each value of SNR the 2nd way is relatively better than the 1st way.

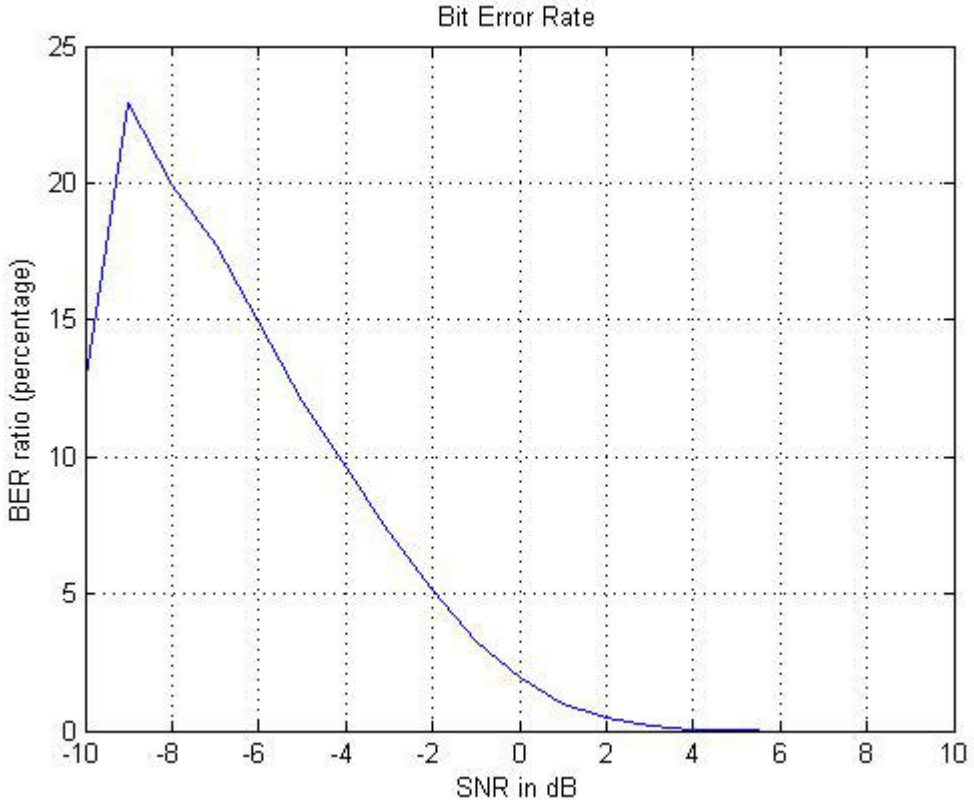

Figure (2.4): Bit error rates for 32 user and 2000 bits each (product method).Conclusions:

The results from equation 2.1 are complex signals, these signals will be multiplied (element by element) to produce the signal which will be up sampled to send it through the channel, but the signal here is complex and if the real part only will be used, a very high bit error rate will be occurred and it may reaches 80 percent so that all the signal must be used to recover the data. The bit error rate for the two methods was compared and they show close results for the two ways . CDMA technique has many advantages in mobile communication such as to provide the following: resistance to intentional jamming by other source , a means for more than one user to use the same transmission channel and range measurement capability [5]. CDMA techniques offer several advantages over other multiple access techniques, such as high spectral reuse efficiency, exploitation of multipath fading through RAKE combining, soft handoff, capacity improvements by the use of cell sectorization, and flexibility for multirate services [6],[7]. Also CDMA has some problems as in the near far problem and the partial correlation problem. The reuse factor in CDMA is one but in Advanced Mobile Phone

System (AMPS) is seven .More complicate electronic circuits to implement the 2nd way high time resolution ,these the factors make the cost of 1st method is less than 2nd method .Also accuracy of result is relatively better in 1st because (summation) is more than accuracy (multiplication).

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