



Hybrid Images Compression and Transmitted Using MC-CDMA System

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Abstract

In this paper, the combined source coding with Multi Carrier Code Division Multiple Access (MC-CDMA) system is proposed, where the transmission of the compressed image produced from source coding through Additive White Gaussian Noise (AWGN) channel for a single user and multi users. In which the (MC-CDMA) system removes Inter Symbol Interference (ISI) and Inter Carrier Interference (ICI). The hybrid compression system of Discrete Cosine Transform (DCT) and predictive coding (PC) technique are integrated as a source coding. The simulation results indicates that the transmission system of a single user was much better than the transmission system of multi users. When the number of users increased, the Bit Error Rate (BER) increased. For a single user the BER = 8.5×10^{-7} while the BER = 3×10^{-6} for multi users. Signal to Noise Ratio (SNR) value is used to measure the performance of the MC-CDMA system, when SNR increased thus, BER decreased and preserve image quality and vice versa. Simulation results show that the BER = 8×10^{-2} at SNR = 0dB for block size (4×4) and (8×8), when SNR increase the BER decrease as in SNR = 10dB the BER = 8.5×10^{-7} for block size (4×4) and BER = 4×10^{-7} for the block size (8×8).

Keywords: DCT, Predictive Coding, MC-CDMA system, Wireless Channel.

ضغط الصور الهجين وارسالها باستخدام نظام MC-CDMA

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الخلاصة:

يقدم هذا البحث طريقة لدمج ترميز المصدر مع نظام MC-CDMA ويركز على نقل الصورة المضغوطة المنتجة من ترميز المصدر خلال قناة ضوضاء كاووس البيضاء AWGN لمستخدم واحد او عدة مستخدمين. نظام MC-CDMA يزيل مشاكل تداخل الرموز ISI ومشاكل تداخل النواقل ICI. نظام الضغط الهجين يتكون من تقنية DCT وتقنية الترميز التنبؤية PC التي تستخدم كنموذج لترميز المصدر. نتائج المحاكاة للنظام المقترح تشير الى أن نظام الارسال لمستخدم واحد افضل بكثير من نظام الارسال لعدة مستخدمين، وبالتالي فان النظام المقترح يظهر عند زيادة عدد المستخدمين تزداد نسبة الخطأ BER. في حالة مستخدم واحد قيمة نسبة الخطأ BER تساوي 8.5×10^{-7} بينما قيمة نسبة الخطأ BER تساوي 3×10^{-6} في حالة عدة مستخدمين. قيمة نسبة الإشارة الى الضوضاء SNR تستخدم لقياس أداء النظام المقترح MC-CDMA عندما تزداد قيمة SNR بالتالي تنخفض نسبة الخطأ BER مع الحفاظ على جودة الصورة والعكس بالعكس. تبين نتائج المحاكاة أن قيمة نسبة الخطأ BER تساوي 8×10^{-2} في حالة قيمة نسبة الإشارة الى الضوضاء SNR = 0db في حجم كتلة (4×4) و (8×8)، عندما تزداد قيمة نسبة الإشارة الى الضوضاء

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SNR نقل نسبة الخطا BER كما في حالة نسبة الإشارة الى الضوضاء SNR=10Db فان نسبة الخطا BER تساوي 8.5×10^{-7} في حجم كتلة (4×4) ونسبة الخطا BER تساوي 4×10^{-7} في حجم كتلة (8×8).

1. Introduction

Today, the increasing request of the digital multimedia application have the most importance for transmission the robust image over wireless channels. In many applications, error correction technique is needed because it is important to guarantee the correct error in the transmitted bit from the transmitter side and entered to the receiver side contains errors may be random, and also to protect image data from loss [1,2]. To transmit an image, it needs a wide bandwidth because of its huge size, hence it was necessary to reduce transmission bandwidth and also to reduce the Bit Error Rate (BER) [3]. In image compression, the core is to remove the data redundancy which may exist between neighbouring pixels of an image [4]. Compression provide a means to minimize the size of data in order to ensure the speed of transmission [5]. The data redundancies involves of three essential redundancies: inter-pixel redundancy, coding redundancy and psycho-visual redundancy. The image compression techniques have been classified into two categories: lossless and lossy compression [6,7]. The lossless is also known as (error free information preserving). As their name indicates, include no loss of information. Where the compressed image is reconstructed exactly identical to the original uncompressed image. For lossy compression, some information may be lost through the processing, the original image can not be reconstructed exactly from the compressed data but there is some degradation on image quality [8,9]. The well known Discrete Cosine Transform (DCT) ideally worked with JPEG standard that efficiently utilized the transformed domain of frequency based [10,11]. On the other hand, the predictive coding utilized the image directly within the spatial domain that based on modeling concept, basically mathematically simple effective technique [12,13]. Multi Carrier Code Division Multiple Access (MC-CDMA) is used as a means for high speed wireless transmission and can also provide a choice to avoid the issue of Inter Symbol Interference (ISI) that also used as frequency diversity. MC-CDMA adopted to support multiple users with high speed data transmissions [14,15]. Lord presented analyzed the BER performance under Rayleigh fading channel conditions of MC-CDMA in presence of AWGN (Additive White Gaussian Noise) using BPSK modulation [16]. Ghadah proposed an adaptive selective predictive coding method for intraframe coding techniques. The adopted techniques overcome the complexity residual ideal case (i.e., residual does not become random noise) where the residual still suffers from the existence of redundancy [13]. Saleh et al presented the Bit Error Rate (BER) performance of different spreading codes (Walsh-Hadamard code, Orthogonal gold code and Golay complementary sequences) using Forward Error Correction (FEC) of the proposed system. The data is analyzed and is compared among different spreading codes in both coded and uncoded cases [17]. Haider and Zainab proposed a hybrid lossy image compression technique, based on integrating wavelet transform with polynomial prediction and bit plane slicing [18]. Loay and Bushra proposed a simple and fast hybrid method for compressing color image based on using wavelet transform. The proposed method is based on decomposing the color image and then applying polynomial on the approximation of image band to produce the error image, therefore, the error image and the detail sub-band data are coded using both quantization and quadtree coding followed by using the entropy encoder [19].

This paper is dedicated to the integration of image compression system that exploited the DCT along with the predictive coding and channel coding to the investigation of the joint source coding and MC-CDMA System.

This paper is organized as follows, section 2 illustrates the basic theory of the proposed algorithm. Section 3 explained the proposed system of joint source coding and MC-CDMA system. Section 4 contains simulation results and discussion. Conclusions are shown in Section 5.

2. Basic Theory of the Proposed Algorithm

The Discrete Cosine Transform (DCT) helps separated the image into parts of differing importance (with respect to the image's visual quality). The DCT is similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain. The 2-D Discrete Cosine Transform (DCT) is an invertible linear transform and is widely used in many practical image compression systems because of its compression performance and computational efficiency. The general equation for a 2D (M by M image) DCT is defined according to equation (1) [10].

$$C(u, v) = a(u)a(v) \sum_{i=0}^{m-1} \sum_{j=0}^{m-1} I(i, j) \cos \left[\frac{\pi(2i+1)u}{2m} \right] \cos \left[\frac{\pi(2j+1)v}{2m} \right] \quad (1)$$

$C(u, v)$ is the transform coefficient at position u, v For $u, v, i, j=0,1,2,\dots,m-1$ and $a(u)$ and $a(v)$ also are defined as equation (2).

$$a(u), a(v) = \begin{cases} 1 & \text{for } u, v = 0 \\ \sqrt{2} & \text{for } u, v <> 0 \\ 1 & \end{cases} \quad (2)$$

the corresponding inverse 2D DCT transform is defined as equation (3) [10].

$$\hat{I}(i, j) = a(u)a(v) \sum_{u=0}^{m-1} \sum_{v=0}^{m-1} \hat{C}(u, v) \cos \left[\frac{\pi(2i+1)u}{2m} \right] \cos \left[\frac{\pi(2j+1)v}{2m} \right] \quad (3)$$

Where \hat{I} is the compressed image. The Predictive Coding Technique is also known as Autoregressive (AR) coding or differential coding. It is based on using the image directly within the spatial domain, by modeling the correlation or statistical dependency embedded between neighbouring pixels. Apply predictive coding technique of 5th casual order model of each block as shown in Figure-1 and illustrated the fifth casual order model of the predictive coding parameters that simply utilized the fifth neighbouring pixels on the Left, Top, Left Top, Second Left and Second Top, where P represent the predicted pixel while X represent the dependent pixel, where each pixel's value can be predicted or estimated from neighbouring pixels. The difference between the actual pixel value and the predicted pixel value is indicated to as the residual or prediction error that is encoded, due to the reduced image information compared to the original image, as described by equation (4) [13].

$$\tilde{I}(i, j) = (a_1 C(i-1, j) + a_2 C(i, j-1) + a_3 C(i-1, j-1) + a_4 C(i-2, j) + a_5 C(i, j-2)) \quad (4)$$

Where \tilde{I} is the predicted image as a linear combination of finitely specified neighbouring pixel values, a is the predictive coding parameters that estimated using the Least Square Approximation Method (LSM) based on minimizing residual between the real and the predicted values [13]. Find the residual image (difference between original and prediction image), as equation (5) [13].

$$R(i, j) = C(i, j) - \tilde{I}(i, j) \quad (5)$$

Where R is the residual image, C the transformed input image using the DCT transformation. Using uniform scalar quantization to quantize the estimated parameters and the residual, where each parameter is quantized using different quantization level, as equations (6-11) respectively.

$$Q_{a_1} = \text{round} \left(\frac{a_1}{QL_{a_1}} \right) \quad (6)$$

$$Q_{a_2} = \text{round} \left(\frac{a_2}{QL_{a_2}} \right) \quad (7)$$

$$Q_{a_3} = \text{round} \left(\frac{a_3}{QL_{a_3}} \right) \quad (8)$$

$$Q_{a_4} = \text{round} \left(\frac{a_4}{QL_{a_4}} \right) \quad (9)$$

$$Q_{a_5} = \text{round} \left(\frac{a_5}{QL_{a_5}} \right) \quad (10)$$

$$Q_{Residual} = \text{round} \left(\frac{Residual}{QL_{Residual}} \right) \quad (11)$$

Where $Q_{a_1}, Q_{a_2}, Q_{a_3}, Q_{a_4}, Q_{a_5}, Q_{Residual}$ are represented the quantized value of the 5th casual order model and residual respectively, while $QL_{a_1}, QL_{a_2}, QL_{a_3}, QL_{a_4}, QL_{a_5}, QL_{Residual}$ are represented the quantization levels of the parameters. Entropy coding is a technique for representing the quantized coefficients as compactly as possible. Therefore using symbol encoder to encode the compressed information that consists of estimated parameters ($a_1 - a_5$) and residual, the encoder use Lempel-Ziv-Welch (LZW) and information which is passed through Huffman coding. The compressed data entered into the source decoding to reconstruct the compressed image. Using symbol decoder to reconstruct the image information. Dequantization the residual and the 5th casual order model coefficients of equations (12-17) respectively [19].

$$DQ_{a_1} = Q_{a_1} \times QL_{a_1} \tag{12}$$

$$DQ_{a_2} = Q_{a_2} \times QL_{a_2} \tag{13}$$

$$DQ_{a_3} = Q_{a_3} \times QL_{a_3} \tag{14}$$

$$DQ_{a_4} = Q_{a_4} \times QL_{a_4} \tag{15}$$

$$DQ_{a_5} = Q_{a_5} \times QL_{a_5} \tag{16}$$

$$DQ_{Residual} = Q_{Residual} \times QL_{Residual} \tag{17}$$

Where $DQ_{a_1}, DQ_{a_2}, DQ_{a_3}, DQ_{a_4}, DQ_{a_5}, DQ_{Residual}$ represents the dequantization value of the estimated parameters and residual. Where Q represents the quantization steps [19]. Add quantized residual to the decoded predicted image to rebuild lossy image compression as equation (18), where \hat{C} is the inverse image [20].

$$\hat{C}(i, j) = Q_{Residual}(i, j) + \tilde{I}(i, j) \tag{18}$$

The compressed data is transmit through AWGN channel using MC-CDMA system. The MC-CDMA system consists of the combination of Orthogonal Frequency Division Multiplexing (OFDM) and Code Division Multiple Access (CDMA) and takes the benefits of both techniques. In MC-CDMA, data symbols which is consisting of modulated bits are spread by spreading codes then assigned into subcarriers of a MC-CDMA modem data symbol which is spread across frequency domain. The MC-CDMA and OFDM systems are commonly used in the existing third (3G) and fourth (4G) generation wireless networks [15,21]. In the MC-CDMA scheme, the same data symbol is transmitted in parallel (spread) over carriers, each multiplied by a different element of the spreading sequence assigned to user [22]. The MC-CDMA transmitter is similar to OFDM transmitter but were simple difference. Different symbols are transmitted by subcarriers in OFDM, while same symbol is transmitted by different subcarriers in MC-CDMA. To minimize the Multiple Access Interference (MAI) between users, orthogonal Walsh - Hadamard codes can be used for spreading codes [16].

Walsh Hadamard code is the main part of the MC-CDMA system, it is generated from a matrix known as the Hadamard matrix which is a square matrix in which every row in the matrix is orthogonal to all rows, and every column in the matrix is orthogonal to all columns [23]. Orthogonality is the most important property of Walsh-Hadamard codes which provides the zero cross-correlation between any two Walsh-Hadamard codes of the same set when the system is synchronized [17]. To evaluate the performance of the proposed system based on the Compression Ratio (CR) which is the ratio of the original image to the reconstructed image and Peak Signal to Noise Ratio (PSNR) are used to evaluate the performance of the proposed source coding as shown in equations (19 and 20), while the Bit Error Rate (BER) and Signal to Noise Ratio (SNR) are used to evaluate the MC-CDMA system as shown in equations (21 and 22).

$$CR = \frac{\text{size of original image}}{\text{size of compressed image}} \tag{19}$$

$$PSNR = 10 \cdot \log_{10} \left[\frac{(255)^2}{\frac{1}{M \times M} \sum_{i=0}^{M-1} \sum_{j=0}^{M-1} [\hat{I}(i, j) - I(i, j)]^2} \right] \tag{20}$$

$$BER = \text{Error Bits/Total Number of Transmitted Bits} \tag{21}$$

$$SNR = E_b/N_o \tag{22}$$

Where E_b refers to bit energy and N_o is the noise power spectral density in decibels (dB).

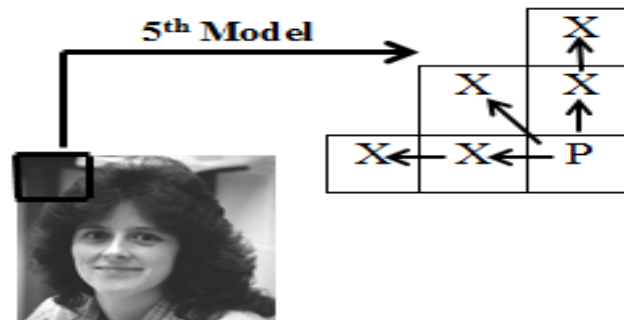


Figure 1-Illustrated the fifth casual order model of the predictive coding parameters [13].

3. Joint Source Coding and MC-CDMA Proposed System

The proposed system consists of the transmitter side, wireless channel and receiver side.

3.1 Transmitter Side

In general, the transmitter side consists of the following sections:

❖ Source Coding

The source coding of the proposed system are illustrated in Figure-2. In order to perform the proposed lossy image compression system, the following Algorithm-1 is applied:

Algorithm 1-Summarizes the proposed algorithm of the source coding.

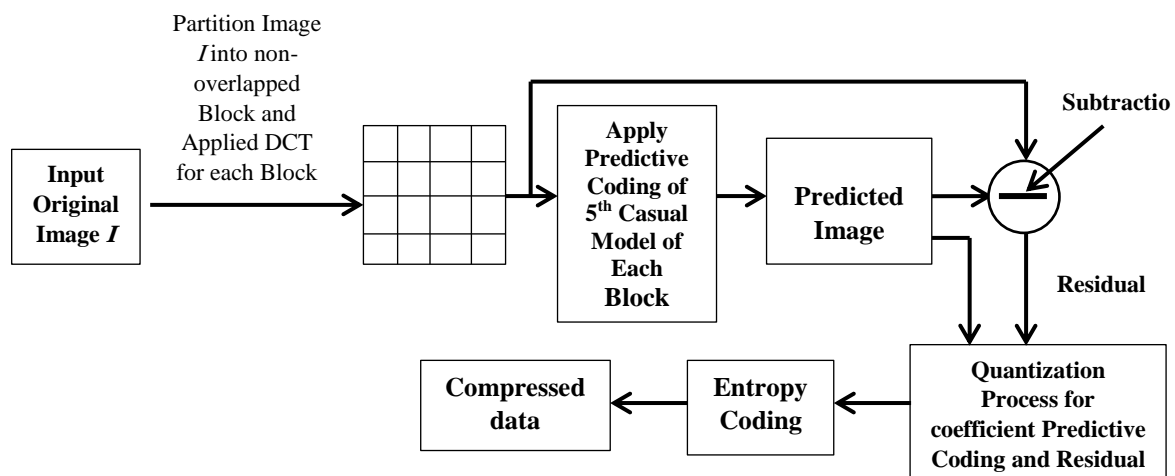
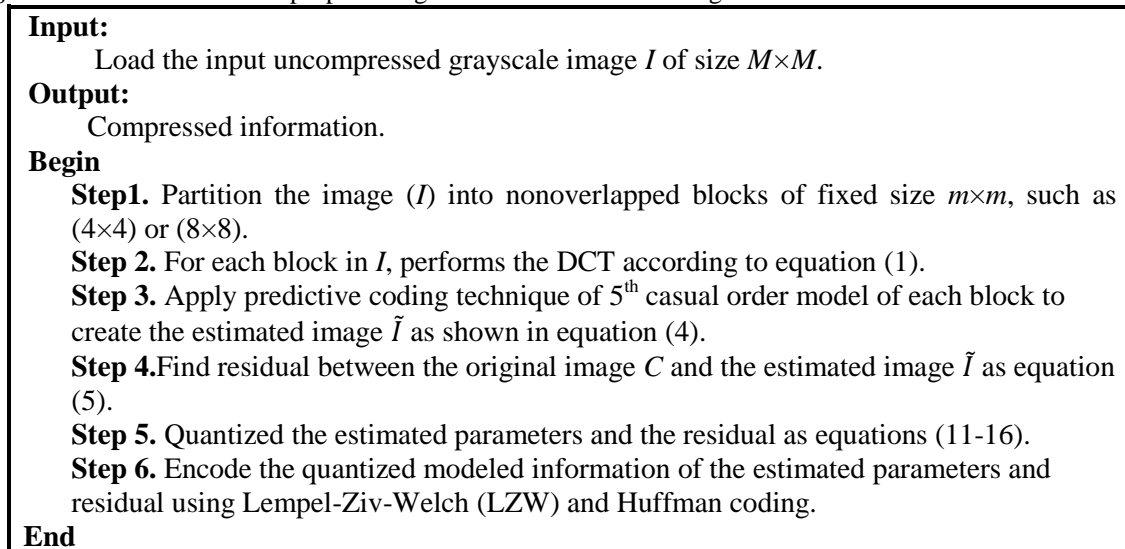


Figure 2 -The proposed compression system of source coding.

❖ MC-CDMA System

Figure-3 show the transmitter side of the MC-CDMA system. Algorithm-2 illustrates the steps of the proposed transmitter side of the MC-CDMA system.

Algorithm 2- Illustrates the proposed algorithm of the transmitter side.

Input:
Compressed information.

Output:
The transmitted bits.

Begin

Step 1. The compressed information bits are binary array of two dimensional that convert to a vector in the transmission over wireless channels.

Step 2. Using the MC-CDMA system to transmit the compressed data for a single and multi users over AWGN channel.

Step 3. Generation of Walsh–Hadamard codes algorithm to spreading the codes into the subcarriers.

Step 4. Modulation the vector using Binary Phase Shift Keying (BPSK) to alter the status information of 0 and 1 to 1 and -1, and also modification the transmitted signal phase.

Step 5. After modulation, the signal is spreading by multiplying the signal by the length of Walsh code.

Step 6. The OFDM system linked with the MC-CDMA system for converting the symbols from frequency domain to time domain samples by Inverse Fast Fourier Transform (IFFT) and allocate a subcarrier for each symbol. IFFT is also used to partition the bandwidth into orthogonal overlapping subcarriers.

Step 7. Cyclic Prefix (CP) can be appended between the symbols to remove the inter-symbol interference (ISI) and the inter-carrier interference (ICI).

End

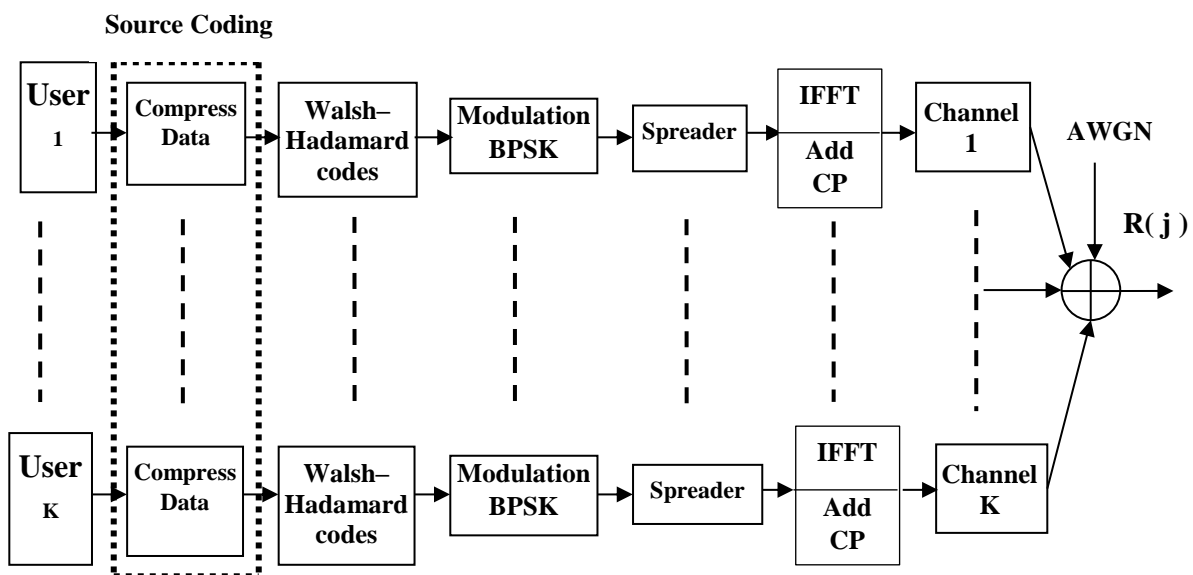


Figure 3-The proposed transmitter side of the MC-CDMA system.

3.2 Wireless Channels

Wireless channel consists of two parts, required the following steps:

1. Adding data for all users to passing data through the channel.
2. Adding noise from Additive White Gaussian Noise (AWGN) type to the transmitted bits, where an error occurs in the bits and correcting in the receiver side.

3.3 Receiver Side

❖ Correct Error

Basically receiver side includes error and correct the error. Figure-4 illustrated the receiver side of the proposed system. Algorithm-3 shown the steps of the proposed receiver side of the MC-CDMA system.

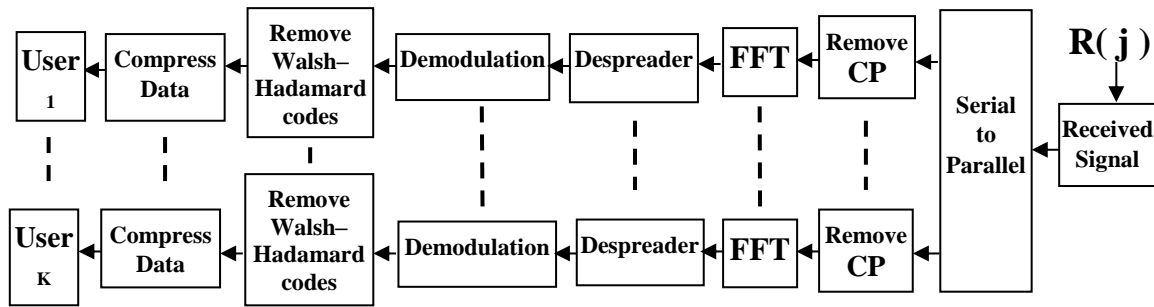
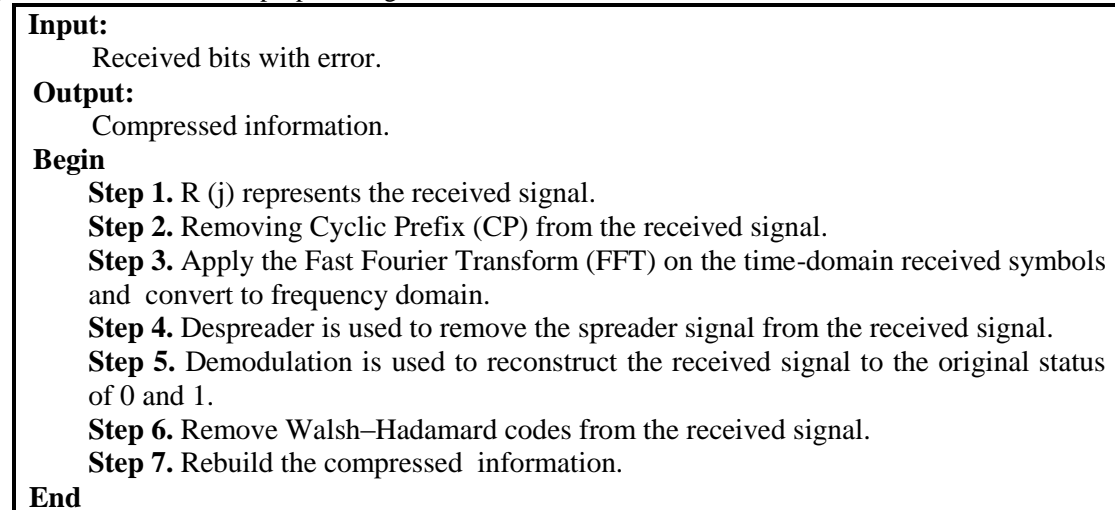


Figure 4-The proposed receiver side of the MC-CDMA system.

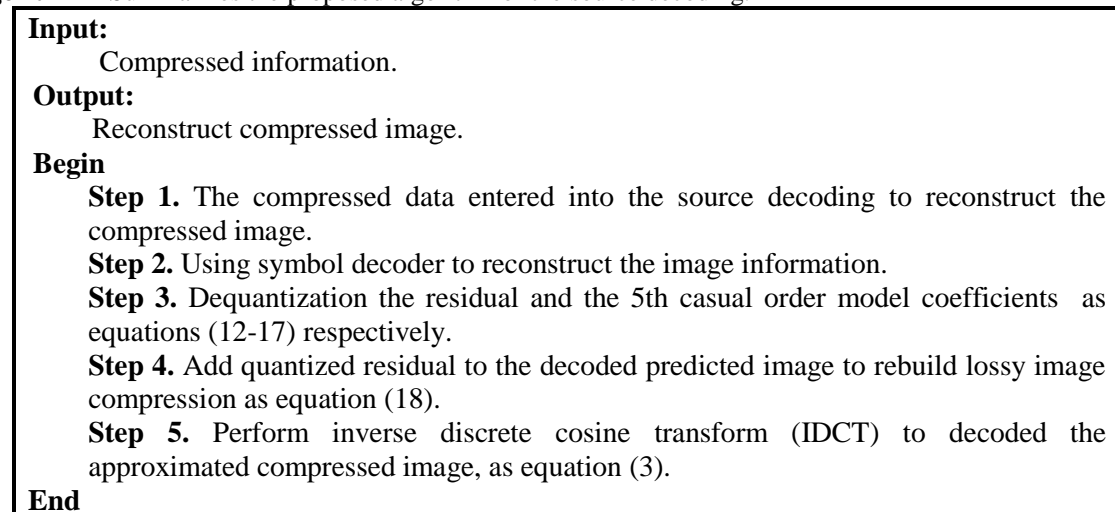
Algorithm 3-Illustrates the proposed algorithm of the receiver side.



❖ Source Decoding

Algorithm-4 summarizes the steps of the source decoding. Figure-5 illustrates the source decoding of the proposed system.

Algorithm 4-Summarizes the proposed algorithm of the source decoding.



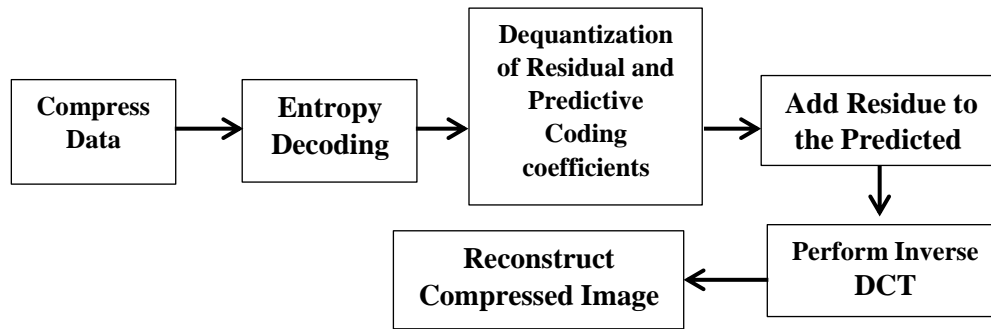


Figure 5-The proposed compression system of source decoding.

4. Simulation Results and Discussion

The proposed system is tested using three standard images of size 256×256 as shown in Figure-6. The proposed system explains the simulation results for transmission the compressed images through AWGN channel for a single user and multi users using MC-CDMA system.

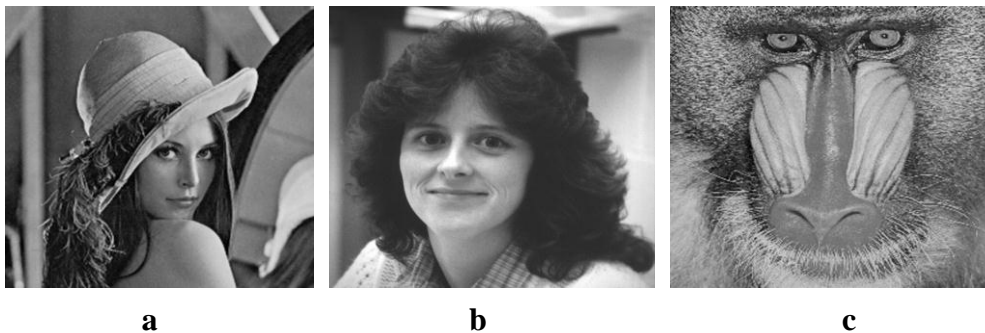


Figure 6 -Illustrate the tested images respectively,(a) Lena image, (b) Woman darkhair image, (c) Baboon image.

4.1 Simulation Results for Single User and Multi Users

The tested results in the source coding indicates that the block size plays an important role in the process, because the block size of (4×4) provides high image quality and less compression ratio while by increase the block size to (8×8) , the image quality becomes less and increase the compression ratio and vice versa. Also quantization level of the 5th predictive coding coefficients parameters and residual affects the quality of the compressed image and compression ratio. When increase the quantization level, the image quality also increased and provides the trade off between CR and PSNR. In the transmitter side for single user, after source coding unit is completed and produce the compressed data, the transmission system begins to transmit the compressed data through the AWGN channel using the MC-CDMA system for one user. The proposed system is tested for three different images and three different users, where each user sends only one image at various times. The simulation result indicates the compressed data is more vulnerable to AWGN channel errors, therefore using SNR to reduce the error value (i.e., reduced BER). When SNR equal to zero the BER value equal to 8×10^{-2} for Lena image, while SNR equal to 10 the $BER = 8.5 \times 10^{-7}$ but in SNR=12 does not exist error for Lena image and block size (4×4) . The test results for Woman-darkhair image and Baboon image are shown in Tables-1 and -2. Figures-7 and 8 are showed the received Lena images after transmission through AWGN of MC-CDMA system at different SNR values and block size (4×4) and (8×8) , respectively for single user with quantization levels equals to 64 for each coefficient. The simulation results indicate that when the SNR value increases, thus the BER decreases and preserving the image quality and vice versa. The block size also affected the value of the BER, when the block size is increased the BER decreased but, the quality of the received image becomes less. In figures 9 and 10, the $BER = 8 \times 10^{-2}$ and $BER = 8 \times 10^{-2}$ at SNR=0dB, while the BER decrease when SNR increase as in SNR=10dB the $BER = 8.5 \times 10^{-7}$ for block size (4×4) and $BER = 4 \times 10^{-7}$ for the block size (8×8) . Figures 9 and 10 are offered the simulation results and BER of the received Lena image for the block

size (4×4) and (8×8), respectively using the MC-CDMA system. Moreover, to offers the simulation results for transmission compressed images through AWGN channels and BPSK modulation using three different images and three different users, where each user selected image different from other images. Usually, the first user selects the Lena image, the second user selects Woman-darkhair image, while the third user select Baboon image. These images are compressed using source coding, where each user transmitted the compressed image at the same time. Table-3 indicates the parameters of the MC-CDMA system. The simulation results indicate that when increased the number of users the BER increased, but in the block size (4×4) the BER is larger than from (8×8), while the quality of image is decreased and vice versa, represent this values in Tables-4 and -5, where the SNR equal to 10 the BER = 3×10^{-6} for block size (4×4) but, in the SNR equal to 12 the BER does not exist. For high SNR values, the BER decreases and preserving the quality required as shown in Figures-11,-12,-13 and -14. These figures are represented the received different images transmitted by three different users and also different value of SNR.

Table 1- Illustrated the results of three images for block size (4×4) of different values of the quantization levels, were selected between 32 to 64 for residual and 5th order coefficients, while the range of SNR value selected from 0 to 12

| Test Images | Quantize Level of Residual | Quantized Level of the coefficients | | | | | Block Size {4×4} SNR_dB=10 | | |
|------------------|----------------------------|-------------------------------------|---------|---------|---------|---------|-------------------------------|---------|----------------------|
| | | Q Residual | Q a_1 | Q a_2 | Q a_3 | Q a_4 | Q a_5 | PSNR | CR |
| Lena | 64 | 32 | 32 | 64 | 64 | 32 | 31.9314 | 31.2970 | 9×10^{-6} |
| | 64 | 32 | 64 | 32 | 32 | 64 | 31.4683 | 30.8841 | 1.5×10^{-5} |
| | 64 | 64 | 64 | 64 | 64 | 64 | 33.5680 | 28.1997 | 8.5×10^{-7} |
| Woman _ darkhair | 64 | 32 | 32 | 64 | 64 | 32 | 34.7069 | 44.6431 | 1.5×10^{-5} |
| | 64 | 32 | 64 | 32 | 32 | 64 | 35.1309 | 43.5745 | 1.5×10^{-5} |
| | 64 | 64 | 64 | 64 | 64 | 64 | 35.6851 | 39.2902 | 8×10^{-7} |
| Baboon | 64 | 32 | 32 | 64 | 64 | 32 | 32.9891 | 24.4720 | 7×10^{-6} |
| | 64 | 32 | 64 | 32 | 32 | 64 | 33.3490 | 24.2726 | 8×10^{-7} |
| | 64 | 64 | 64 | 64 | 64 | 64 | 34.2615 | 22.4285 | 7×10^{-6} |

Table 2- Illustrated the results of three images for block size (8×8) of different values of the quantization levels, were selected between 32 to 64 for residual and 5th order coefficients, while the range of SNR value selected from 0 to 12.

| Test Images | Quantize Level of Residual | Quantized Level of the coefficients | | | | | Block Size {8×8} SNR_dB=10 | | |
|------------------|----------------------------|-------------------------------------|---------|---------|---------|---------|-------------------------------|---------|--------------------|
| | | Q Residual | Q a_1 | Q a_2 | Q a_3 | Q a_4 | Q a_5 | PSNR | CR |
| Lena | 64 | 32 | 32 | 64 | 64 | 32 | 30.6229 | 58.7240 | 4×10^{-7} |
| | 64 | 32 | 64 | 32 | 32 | 64 | 30.2929 | 57.5888 | 4×10^{-7} |
| | 64 | 64 | 64 | 64 | 64 | 64 | 31.2761 | 53.0227 | 4×10^{-7} |
| Woman _ darkhair | 64 | 32 | 32 | 64 | 64 | 32 | 32.1723 | 78.9590 | 4×10^{-7} |
| | 64 | 32 | 64 | 32 | 32 | 64 | 32.5784 | 78.3923 | 4×10^{-7} |
| | 64 | 64 | 64 | 64 | 64 | 64 | 32.7549 | 70.7732 | 4×10^{-7} |
| Baboon | 64 | 32 | 32 | 64 | 64 | 32 | 30.3023 | 46.3479 | 4×10^{-7} |
| | 64 | 32 | 64 | 32 | 32 | 64 | 30.3309 | 46.0872 | 4×10^{-7} |
| | 64 | 64 | 64 | 64 | 64 | 64 | 30.4198 | 42.3907 | 8×10^{-7} |

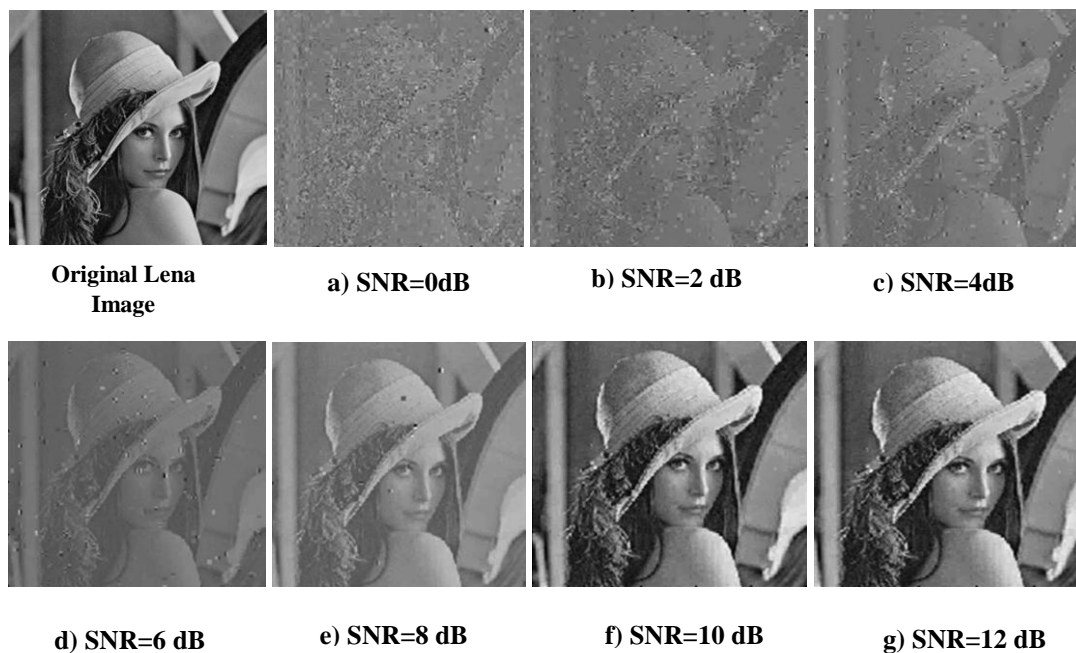


Figure 7 -The received Lena images at different SNR values and block size (4×4), quantization level equal 64 for each parameters after transmitting using MC-CDMA system.

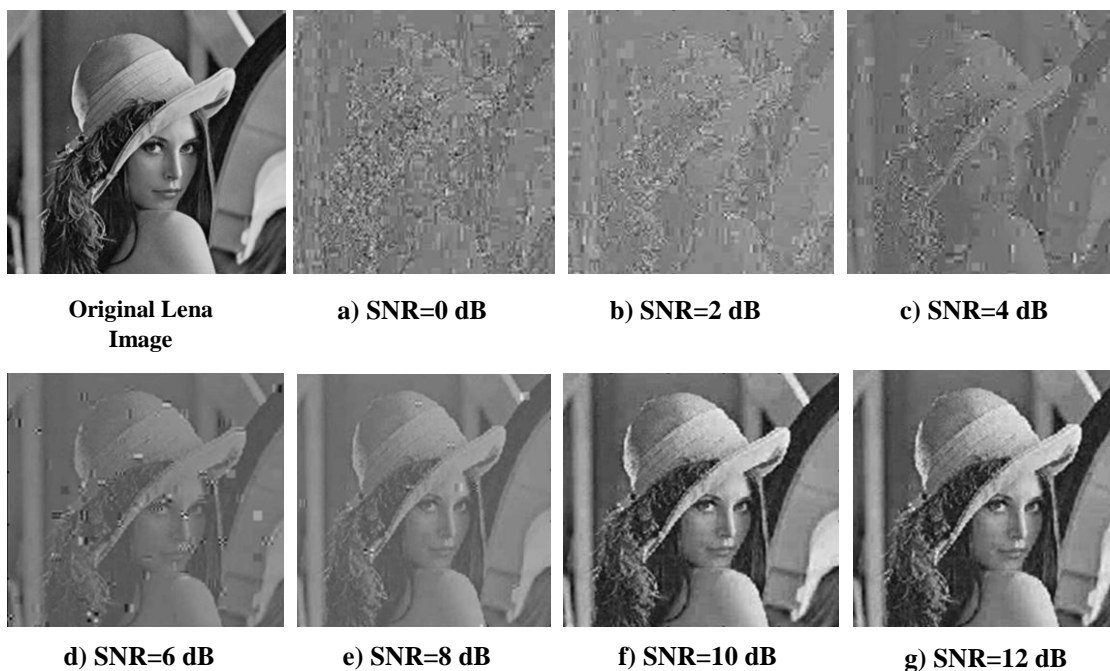


Figure 8- The received Lena images at different SNR values and block size (8×8), quantization level equal 64 for each parameters after transmitting using MC-CDMA system.

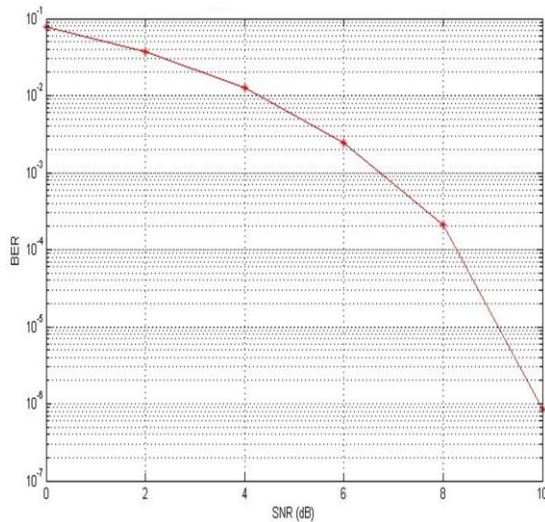


Figure 9 Simulation results and BER after Lena image transmitting for single user and block size (4×4), using MC-CDMA system.

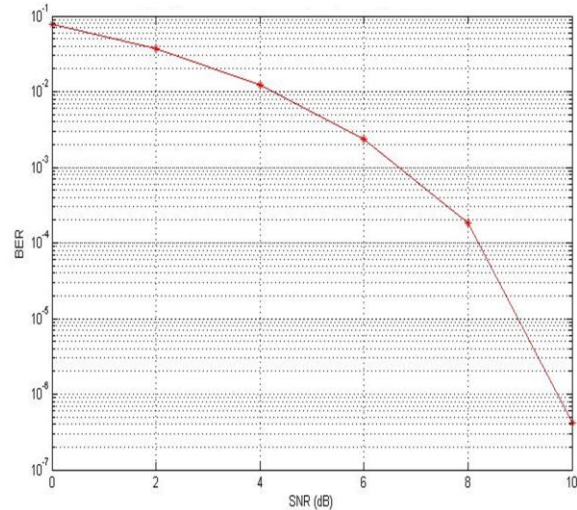


Figure 10 Simulation results and BER after Lena image transmitting for single user and block size (8×8), using MC-CDMA system.

Table 3- MC-CDMA system parameters

| Parameters | Values |
|----------------------|---------------------|
| Modulation Technique | BPSK |
| Range of SNR in dB | 0 to 12 |
| Number of users | 1 and 3 |
| Spreading | Walsh hadamard Code |
| Spreading Length | 8 |
| Noise | AWGN |

Table 4- Explain the results for block size (4×4)

| Test Images | Quantize Level of Residual | Quantized Level of the coefficients | | | | | Block Size {4×4} SNR_dB=10, for Three users | | |
|--------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|---------------------|--|----------|--------------------|
| | | Q a ₁ | Q a ₂ | Q a ₃ | Q a ₄ | Q a ₅ | PSNR | CR | BER |
| Three Images | 64 | 64 | 64 | 64 | 64 | 64 | 23.9852 | 272.0298 | 3×10 ⁻⁶ |

Table 5- Explain the results for block size (8×8)

| Test Images | Quantize Level of Residual | Quantized Level of the coefficients | | | | | Block Size {8×8} SNR_dB=10, for Three users | | |
|--------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|---------------------|--|----------|--------------------|
| | | Q a ₁ | Q a ₂ | Q a ₃ | Q a ₄ | Q a ₅ | PSNR | CR | BER |
| Three Images | 64 | 64 | 64 | 64 | 64 | 64 | 21.9310 | 480.0597 | 5×10 ⁻⁷ |

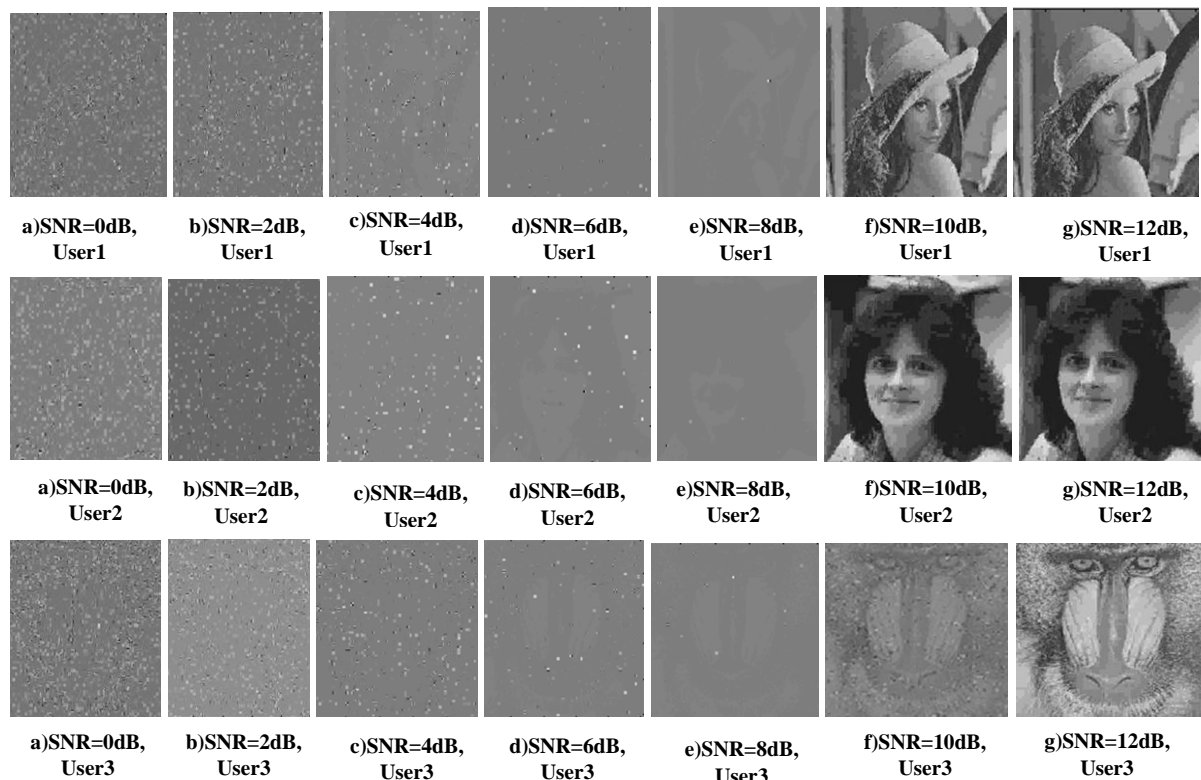


Figure 11- The received three different images of MC-CDMA system at different SNR values and for three various users and block size (4×4).

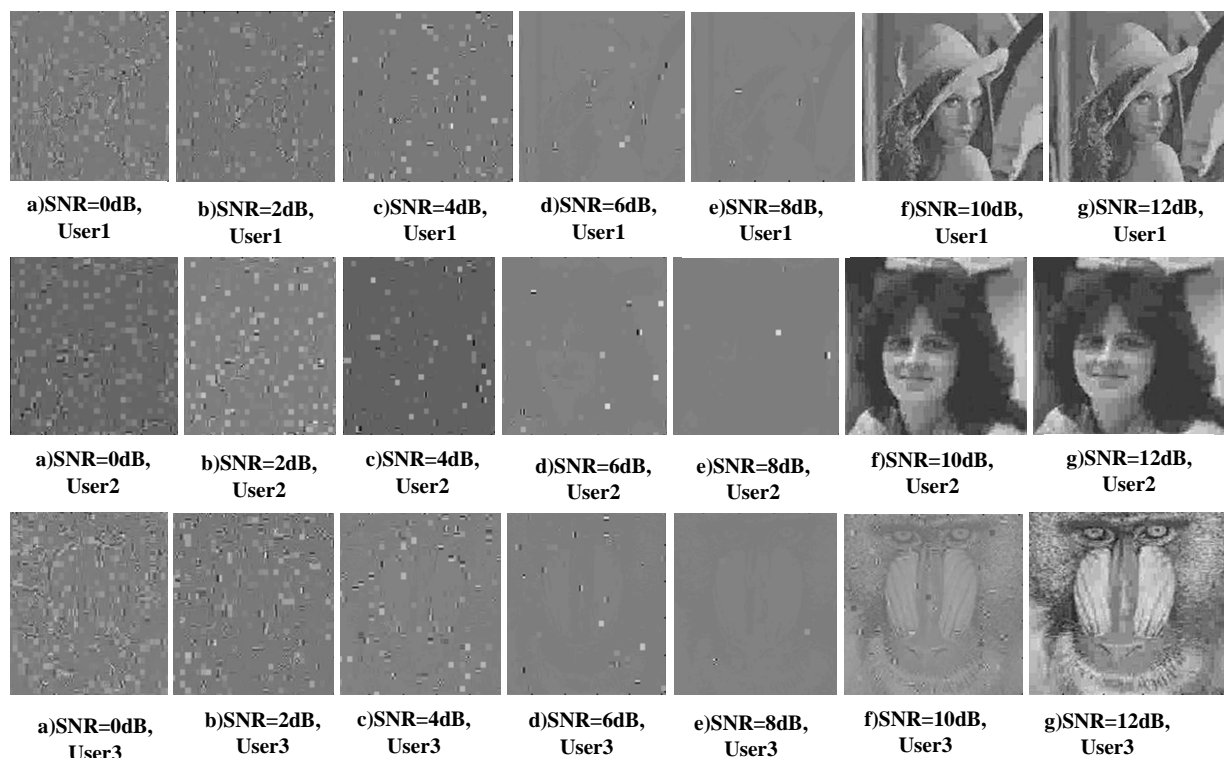


Figure 12- The received three different images of MC-CDMA system at different SNR values and for three various users and block size (8×8).

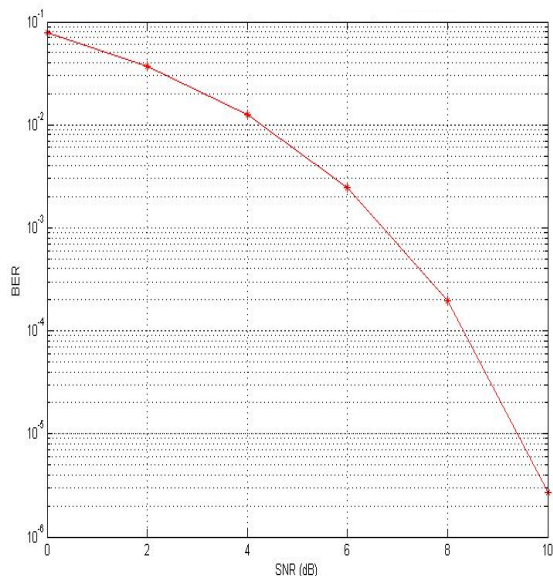


Figure 13- Simulation results and BER after three images transmitting with three users and block size (4×4) using MC-CDMA system.

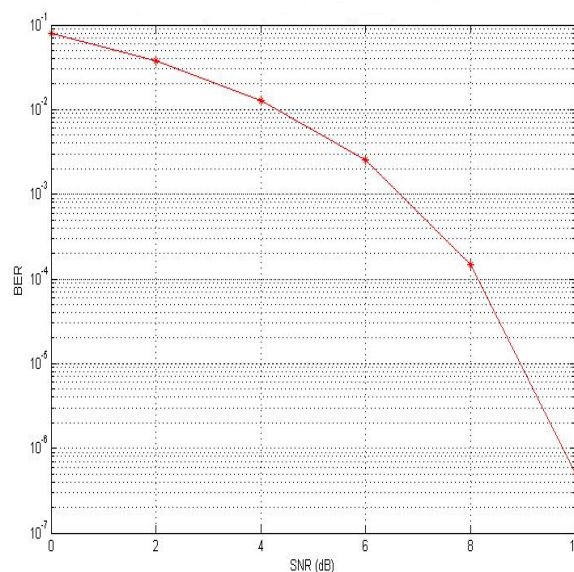


Figure 14- Simulation results and BER after three images transmitting with three users and block size (8×8) using MC-CDMA system.

5. Conclusions

This paper attempts to show the performance of source coding and MC-CDMA system in AWGN channel using BPSK modulation technique for a single user and multi users. The simulation results clearly showed that as SNR increases, the BER decreases and vice versa. Also the performance of a single user is better than multi users from many aspects as BER is increased and image quality become less. Lastly shown when increase the block size the BER decreased and also reduced image quality.

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