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Joint Source-Channel Coding for Wireless Image Transmission based OFDM-IDMA Systems

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Abstract

The source and channel coding for wireless data transmission can reduce distortion, complexity and delay in multimedia services. In this paper, a joint source-channel coding is proposed for orthogonal frequency division multiplexing - interleave division multiple access (OFDM-IDMA) systems to transmit the compressed images over noisy channels. OFDM-IDMA combines advantages of both OFDM and IDMA, where OFDM removes inter symbol interference (ISI) problems and IDMA removes multiple access interference (MAI). Convolutional coding is used as a channel coding, while the hybrid compression method is used as a source coding scheme. The hybrid compression scheme is based on wavelet transform, bit plane slicing, polynomial approximation model and absolute moment block truncation. The wavelet transform is exploited to decompose the image into approximation and detail sub bands, while the polynomial model is used to code the approximation image band. Simulation results show that the proposed system reduces distortion efficiently (i.e., preserving image quality) and achieves a simple method for image multiuser transmission over wireless channels.

Keywords: OFDM-IDMA, Joint source-channel coding, Wireless image transmission.

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ترميز المصدر والقناة المشترك لنقل الصورة لاسلكيا باستخدام أنظمةOFDM-IDMA

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الخلاصة:

ترميز المصدر والقناة لنقل القيم لاسلكيا يمكن أن يقلل التشويش والتعقيدات وكذلك التأخير في خدمات الوسائط المتعددة. في هذا البحث، تم أقتراح ربط ترميز المصدر و القناة لأنظمة (OFDM-IDMA) لنقل الصور المضغوطة عبر القنوات المشوشة. يجمع OFDM-IDMA بين مزايا كل من OFDM و IDMA ، حيث OFDM يزيل مشاكل التشويش المتداخل ISI بينما IDMA يزيل مشاكل الوصول المتعدد MAI. الترميز التقليدي تم أستخدامه كترميز للقناة بينما طريقة الضغط الهجين تم أستخدامها كنموذج لترميز المصدر نموذج الضغط الهجين يستند على تحويل المويجات، بت تقطيع المستوي ،نموذج متعدد الحدود التقريبي والتقطيع اللحظي المطلق للبلوك. الموذج يستفاد من (WT) لتفكيك الصورة الى التقريب ومناطق تفاصيل الفرعية بينما نموذج المتعدد الخطي تم أستخدامه لترميز مناطق الصور المقربة. نتائج المحاكاة أظهرت بان النظام المقترح يقلل التشويش بشكل كفوء (يحفظ جودة الصورة) وينجز طريق بسيط لنقل الصور لعدة مستخدمين عبر القنوات اللاسلكية.

1. Introduction

The rapid growth of wireless communications has a request for robust multimedia transmission with high quality, coverage, more power and bandwidth efficiency. Due to restrictions on the wireless communication channels such as limited bandwidth increases the demand for efficient image communication system that does not consume more bandwidth in order to achieve better image quality [1,2]. Thus, compression may be required for image transmission over wireless channels, therefore, the compression is used to reduce the size of multimedia data transmitted over the communication channel via data compression techniques such as DWT, and may increase the performance of the communication systems [3]. When the redundant bits removed from the image it will fasting the data processing in the transmitter and receiver side. As well as, any data transmitted through a wireless channel may be corrupted because of the noise effect and another environment effects such as fading, multipath and thermal noise, and to minimize the error in received data there are many techniques are used to reconstruct the original transmitted data. One of these techniques can be used the channel coding and an efficient modulation technique for minimizing the bit error rate (BER) in the transmitted data [4,5]. Therefore, the design of an efficient communication system for progressive transmission of multimedia content such as images and video over wireless channels has recently attracted a lot of interests because of the growing demands for wireless applications.

The effects of compressed image transmission through additive-white Gaussian noise (AWGN) channels are studied in [6] and [7], using binary phase shift key (BPSK) modulation. The image is compressed using wavelet transform and it takes less time and space to pass through the channel as compared to the original image. The utilization of unequal error protection and median filter for the transmission of compressed images is investigated in [1] through noisy wireless channels typically encountered through cellular mobile networks. The hierarchical quadrature amplitude modulation (HQAM) is used in the transmitter side to provide unequal error protection (UEP) for image data transmission, while the Median filter is used in the receiver side to eliminate the noise in the received image. However, future systems may need to provide support for each speech service and package data. Packet mode service probably includes high data rate transmission with each of the bandwidth resources allocated to a single user, which is moderately simple for orthogonal frequency division multiple access (OFDMA) system, but not for code division multiple access (CDMA) system. Because of its spread spectrum characteristics, CDMA is not suitable for high data rate transmission via a single user [8]. Plain OFDM is vulnerable to vanishing in subcarriers. Individual solution to this problem is the utilization of forward error correction (FEC) coding over subcarriers. A different solution is OFDM-CDMA, in which all information bits are spread and transmitted through a number of subcarriers. OFDM-CDMA allows multiple users to divide common subcarriers. This avoids data rate loss, although at the cost of reintroducing multiple access interference (MAI), multi- user detection (MUD) is a convenient solution to the MAI difficulty. In the past, MUD is viewed as a expensively choice, but the situation has changed in recently growth in iterative processing techniques. Especially, the interleave division multiple access (IDMA) system allows a very small cost chip by chip (CBC) MUD method to be utilized. A disadvantages of IDMA is that its receiver difficulty still increases linearly with the number of paths, which can be a source of concern for very wideband systems [9,10]. Therefore, this work is dedicated to the investigation of the OFDM-IDMA system that combines most of the characteristics of the multiple access schemes such as (OFDMA, CDMA, OFDM-CDMA and IDMA).

In this paper, the main contribution holds in the consideration of the OFDM-IDMA system with joint hybrid compression techniques [11] and convolutional coding for image transmission. The system has been rarely studied and tested with such joint coding in wireless channels. In Section 2, the proposed OFDM-IDMA system with joint source-channel coding is described. Section 3 is devoted to the simulation results and discussion. Conclusions are drawn in Section 4.

2. Joint Hybrid Compression- Channel Coding Based OFDM-IDMASystem

The transmitter-receiver of the proposed OFDM-IDMA system with K simultaneoususers are illustrated in figure-1 and figure-2, respectively. The system encoder can be divided into a source encoder (compression), a channel encoder (i.e. convolutional encoder) and modulator. The source encoder reduces or eliminates the redundancy in the original information. A simple hybrid lossy image compression scheme in [11] is used as a source encoder, it is based on combining effective techniques, wavelet transform, bit plane slicing, polynomial approximation modeland absolute moment block truncation. Wavelet transform is used to decompose the image signal followed by polynomial approximation model. The errors caused by applying polynomial approximation is coded using bit plane slice coding. The absolute moment block truncation coding is exploited to code the detail sub bands. Then, the compressed information is encoded using LZW, run length coding and Huffman coding techniques. However, the used compression scheme is simple to implementand it can produce a balance between the compression performance and preserving the image quality.

The channel encoder introduces redundancy in a controlled manner in order to combat errors that may arise from channel defects and noise. It increases the reliability of transmission and reduces power transmission requirements. Simple channel coding schemes allow the receiver of the transmitted data signal to detect errors, while more sophisticated channel coding schemes provides the ability to recover a limited about of corrupted data. This result in more reliable communication, and in many cases, removes the need for retransmission. The channel decoder will detect and correct the errors. There are many algorithms used for channel coding such as convolutional coding, Reed Solomon codes and turbo codes. One way to compare algorithms is to compare their performance in terms of the speed with which they solve the problem [12].

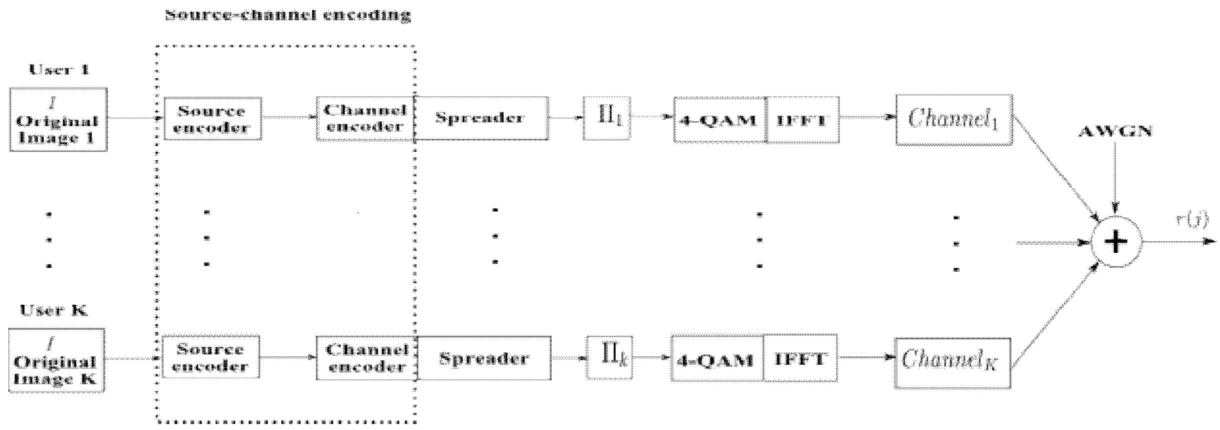


Figure 1-The Proposed transmitter structure of the OFDM-IDMA scheme with K active users.

A. Transmitter Structure

At the transmitter side in figure-1, it is supposed there are K users, let d_k be the data stream of user-k. This data stream is encoded by a source encoder such as hybrid compression coding and channel encoder (forward error correction (FEC) code) such as convolutional coding. The output b_k is spreaded using repetition code to generate a chip sequence C_k . $C_k$is then interleaved by user specific interleaver $\{\Pi_k\}$ to produce a transmission code sequence X_k [13]. The chip sequence X_k is baseband modulated, various modulation schemes could be employed such as BPSK, QPSK and QAM. The modulation is performed on each parallel sub stream. The data symbols are parallelized in N different sub streams. Each sub stream will modulate a separate carrier through the inverse fast Fourier transform (IFFT) modulation block, which is in fact the key element of an OFDM [14]. The main role of the IFFT is to modulate each sub channel onto orthogonal carriers. The cyclic prefix (CP) is inserted in order to eliminate the (ISI) and inter-carrier interference (ICI). Acyclic prefix is a repetition of the first section of a symbol that is added to the end of the transmitted signal [15]. The resulted signal is then transmitted through the multiple access channel. These steps can be listed as

Step1: Load the input uncompressed gray scale image I of size $N\times N$, and apply two-layered wavelet transform.Then**,** perform the polynomial prediction for the (LL_2) subband using the following:

1- Partition the LL_2 into non-overlapped blocks of fixed size $n\times n$, and performs the polynomial representationusing equations (3,4,5) [16].

$$a_0 = \frac{1}{n \times n}\sum_{i=0}^{n-1}\sum_{j=0}^{n-1} LL_2(i,j) \quad \ldots (3)$$

$$a_1 = \frac{\sum_{i=0}^{n-1}\sum_{j=0}^{n-1} LL_2(i,j)\times(j-x_c)}{\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}(j-x_c)^2} \quad \ldots (4)$$

$$a_2 = \frac{\sum_{i=0}^{n-1}\sum_{j=0}^{n-1} LL_2(i,j)\times(i-y_c)}{\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}(i-y_c)^2} \quad \ldots (5)$$

where $LL_{2(i,j)}$ is the second approximation subband of the original image block and

$$xc = yc = \frac{n-1}{2} \quad \ldots (6)$$

2-Apply uniform scalar quantization to find the polynomial approximation coefficients, Q_{a_0}, Q_{a_1}, Q_{a_2} , using equations (7,8,9) [16].

$$Q_{a_0} = round\ (\frac{a_0}{SQ_{a_0}}) \rightarrow D_{a_0} = Q_{a_0} \times SQ_{a_0} \ldots (7)$$

$$Q_{a_1} = round\ (\frac{a_1}{SQ_{a_1}}) \rightarrow D_{a_1} = Q_{a_1} \times SQ_{a_1} \ldots (8)$$

$$Q_{a_2} = round\ (\frac{a_2}{SQ_{a_2}}) \rightarrow D_{a_2} = Q_{a_2} \times SQ_{a_2} \ldots (9)$$

where $SQ_{a_0}, SQ_{a_1}\ SQ_{a_2}$ are the quantization steps of the polynomial coefficients and D_{a_0} , D_{a_1} , D_{a_2} are polynomial dequantized values.

3- Construct the predicted image value $\tilde{I}$ using equation (10)and find the residual error using equation (11)

$$\tilde{I} = D_{a_0} + D_{a_1}(j - x_c) + D_{a_2}(i - y_c) \ldots (10)$$

$$R(i,j) = LL_2(i,j) - \tilde{I}(i,j) \ldots (11)$$

4- Mapping the residual image to positive values using equation (12) and then apply the bit plane slicing techniques.

$$X_i = \begin{cases} 2X & if\ X_i \geq 0 \\ -2X_i - 1 & if\ X_i < 0 \end{cases} \ldots (12)$$

5-Quantize the slice residual image of high order layers ($layer_4$ to $layer_7$) using equations (13-16) and thencreate the residual image $\tilde{R}(i,j)$ from the dequantized high layers.

$$Qb_4 = round\ (\frac{b_4}{SQb_4}) \rightarrow Db_4 = Qb_4 \times SQb_4 \ldots (13)$$

$$Qb_5 = round\ (\frac{b_5}{SQb_5}) \rightarrow Db_5 = Qb_5 \times SQb_5 \ldots (14)$$

$$Qb_6 = round\ (\frac{b_6}{SQb_6}) \rightarrow Db_6 = Qb_6 \times SQb_6 \ldots (15)$$

$$Qb_7 = round\ (\frac{b_7}{SQb_7}) \rightarrow Db_7 = Qb_7 \times SQb_7 \ldots (16)$$

Step 2: For the other detail sub-bands $(LH_2, HL_2, HH_2, LH_1, HL_1\ and\ HH_1)$ the absolute moment block truncation coding (AMBTC) is exploited using the following.

1- Partition the subband into non-overlapped blocks of fixed size $m \times m$where $m<=n$.

2- Compute the mean of the partitioned block as

$$\bar{x} = \frac{1}{m}\sum_{i=1}^{m} x_i \ldots (17)$$

where x_i represent the i^{th} pixel value of the image block with total number of pixels m.

3-Divide the pixels in the image block into two ranges of values, upper range and lower range according to the equations (17,18) and then create the binary image$B$ using equation (19).

$$x_H = \frac{1}{K}\sum_{x_i > x}^{m} x_i \quad \ldots (18)$$

$$x_L = \frac{1}{number\ \ of\ \ pixel\ \ in\ block\ \ - K}\sum_{x_i < x}^{m} x_i \quad \ldots (19)$$

$$B = \begin{cases} 1 & x_i \geq \bar{x} \\ 0 & x_i < \bar{x} \end{cases} \quad \ldots (20)$$

where$K$ is the number of pixels whose gray level is greater than $\bar{x}$.

Step 3: Use encoder, LZW and Run Length Coding to code the compress information (B , detail subbands layers, the coefficients and quantized residual image), and then apply Huffman coding.

Step 4:The compressed information bits are protected by using convolutional channel encoder. In the channel coding, redundancy is introduced and the output is a codeword. The output of the encoder is further processed by a simple repetition code or spreader, which is utilized to give the system MAI protection.The coded bits are permuted by a user-specific interleaver, $\{\Pi_k\}$, to facilitate a chip detection strategy.

Step 5: Use QPSK modulation to modulate the code sequence before the IFFT, which is used to modulate each subchannel onto orthogonal carriers. The resulting signal is then transmitted over the wireless channels.

B. Wireless Transmission Channels

The wireless channels can be used to send a signal from the transmitter to the receiver. It usually causes signal dilution and introduces noise, which may lead to severe loss or degradation of the quality of the reconstructed signal [4]. The transmitted signals often do not reach the receiving end directly because of the obstacles blocking the line-of-sight (LOS) path. Multipath propagation occurs due to reflection, diffraction and scattering caused by buildings, trees and other obstacles. Therefore, the received signal consists of a sum of all the reflected and scattered waves. Depending on the effect of multipath, there are two main types of fading Rician Fading and Rayleigh Fading. The Rician fading occurs when there is a LOS path available along with the number of indirect multipath signals, while in Rayleigh Fading, there is no line of sight [17].

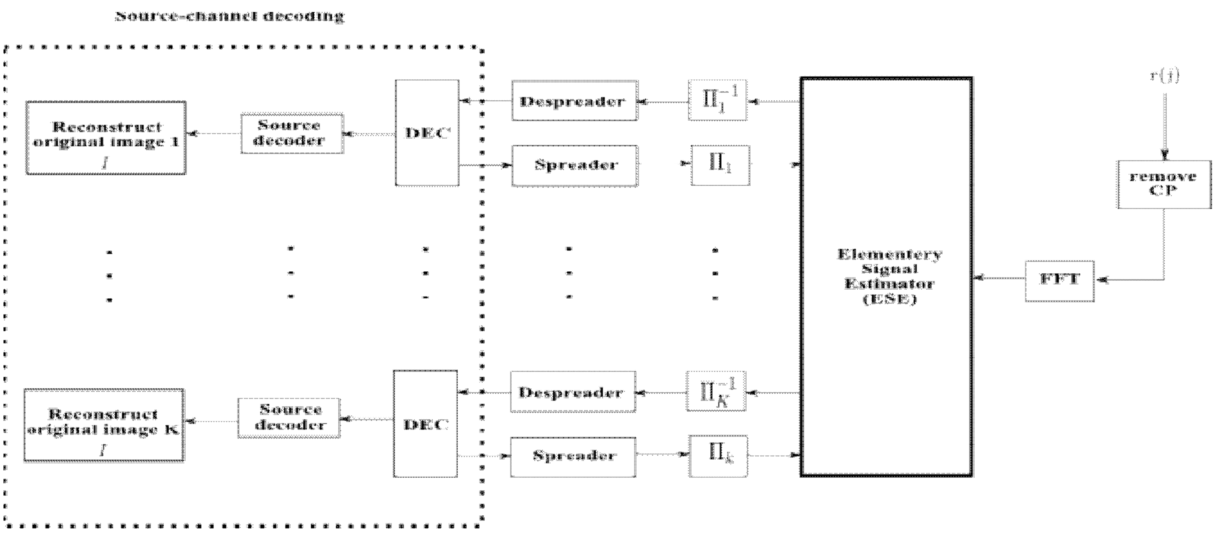


Figure 2- The proposed receiver structure of the OFDM-IDMA system.

C. Receiver Structure

The received signal is passed through OFDM demodulation before iterative multiuser detection process as shown in figure-2. The demodulation process includes fast Fourier transform (FFT) and removal of CP. The received signal after OFDM demodulation can be written as

$$r(j) = \sum_{K} H_K(j) X_K(j) + Z(j) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (21)$$

where $Z(j)$ is the FFT of the additive Gaussian white noise (AWGN)with variance σ^2 in each dimension, i.e. $Z(j) = FFT(z(j))$; $H_k(j)$ is the channel fading coefficientsin frequency domain of jth carrier. Then, the signal passes through iterative turbo detection of IDMA. The iterative detection consists of elementary signal estimator (ESE) and channel decoders (DEC_S).The ESE unit generates posterior log-likelihood ratio (LLR_S), $e_{ESE}(x_K(j))$ of the given signal $x_k(j)$ as

$$e_{ESE}(x_K(j)) = \log \left\{ \frac{P_r(x_K(j) = +1)}{P_r(x_K(j) = -1)} \right\}, \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (22)$$

The $e_{ESE}(x_k(j))$ is sent to the decoders after user-specific deinterleaving and despreading operations. The decoders generate the bit-level extrinsic LLRs $e_{DEC}(x_k(j))$, which are also processed by the interleavers and the spreaders [13,18]. The ESE is used to reduce MAI and the interference generation process regenerates the interference due to user k by reconstructing the original transmitted signals of one or more users.As the operation progresses, the estimates of the MAI improves and, in later stages of the iterative scheme, the data estimates after source decoding of all the users have been obtained. The detection process for receiver is carried out as follows:

Step 1: Apply the FFT on the time-domain received symbols after removing the cyclic prefix, where the duration of CP is assumed to be longer than the maximum channel delay.

Step 2: After OFDM demodulation, the detection algorithm in [20] for complex single-path channel can be applied. The iterative process includes two main operations

1. Estimate the signal that is carried out by the elementary signal estimator (ESE) under the Gaussian approximation.
2. Process the outputs of the ESE using the posteriori probability decoder error correction (DEC). The channel decoding is used to reconstruct the original information bitstream using the protection bits inserted by the channel encoder. The results are used to refine the estimatesof signal to be used in the next iteration.

Step 3: The compressed data after last iteration is entered to the source decoder to reconstruct the image $\hat{I}$, using hybrid compression system in [11]. The reconstruction unit of source decoder, starts by applying the inverse process that reconstruct the detail sub bands by replacing the 1 with $X_H$and 0 with $X_L$as

$$X = \begin{cases} X_L & B = 0 \\ X_H & B = 1 \end{cases} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

The coefficients with the residual are utilized to reconstruct the approximation subband of the second layer as

$$\hat{L}_{L2}(i,j) = \tilde{R}(i,j) + \tilde{I}(i,j) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

Finally, applying the inverse wavelet transform to reconstruct the original imageusing

$$x_i = \begin{cases} x/2 & if\ x_i \ge 0 \\ (x+1)/2 & if\ x_i \prec 0 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (25)$$

a b c d

Figure 3-(a, b, c & d)- Overview of the tested images of size 256×256, gray scale images, Lena, Pepper, Camera-Man and Girl respectively.

3. Simulation Results and Discussion

In this section, simulation results of the gray image transmission using OFDM-IDMA system with the source-channel coding are presented and compared with those of OFDM-IDMA system without channel coding over wireless multipath channels.The bit error rate (BER) and signal to noise ratio (SNR) are used to evaluate the performance of the transmission system using the formula given in [7, 19].

$$BER = Error\ Bits / Total\ Number\ of\ Transmitte\ d\ Bits \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

$$SNR = E_b / N_o \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (25)$$

whereE_b is the bit energy and $N_o$is the noise power spectral density in decibels (dB). *BER* is inversely related to SNR, as SNR increases the BER decreases and vice versa.For the transmitter side, four standard imagesof 256 gray levels (8 bits/pixel) - Lena, Pepper, Camera-Man and Girl– shown in figure3 a-d for four active users are compressedusing hybrid compression approach, coded using convolutional, spread by repetitive code, interleaved and modulated before IFFT, finally mixed together to go into the wireless channels. The channels have been modeled by using Rayleigh mode for flat fading channel, which has three different paths one chip delay between first path, second, and third path for each user. For the receiver on the wireless base-station side, we will try to restore the transmitted images. In the simulation, 4-QAM has been used as the modulation technique. CP is considered to overcome or decrease the nulls that result from fading channels in addition to the usage of equalizer.The simulation parameters are summarized in Table 1.

Table 1-OFDM-IDMA system Parameters

Parameters	**Values**
Digital modulation	4-QAM
Block size for the image	2×2
Quantization step for the polynomial coefficients	64, 64, 64
Quantization step for the residual	32, 32, 32, 32
FEC codes	Convolutional coder
Code Rate, Constraint length of convolution	1/2, 5
Generator polynomial, dfree	$[23\ 35]_8$, 5
Number of users (K)	4
Block size	100
Spread length	8
Bandwidth	4 KH
Number of paths	3

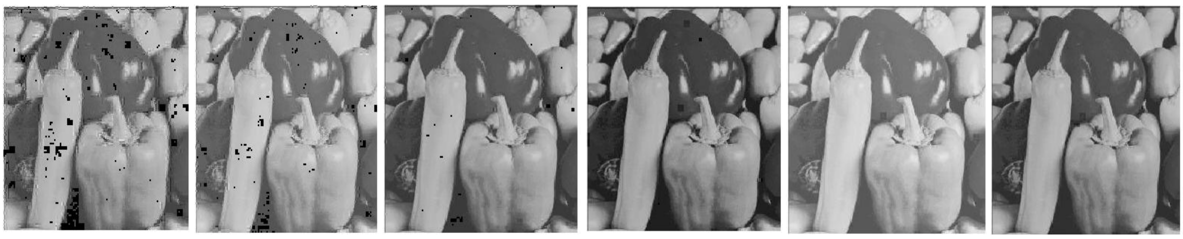
Figure 4- The received images of OFDM-IDMA system at different SNR values and for four different users without convolutional coding.

The block size plays an essential role in the process, the block size of (2×2) gives high image quality, while increase the block size to (4×4) the image quality become less[11]. Therefore, the quantization step for the polynomial coefficients was selected to be 64 levels for block size (2×2). In other words, increase the block size gets better compression ratio with high bit errors and vice versa. Figure-4 illustrates the received images of OFDM-IDMA system at different SNR values and for four active users without convolutional coding. The figure also shows the effect of noise in the channel for all reconstructed images, when SNR=0 dB the BER is 1.5×10^{-1} and BER is equal to 5×10^{-5} at SNR=10 dB. For low SNR values, the data of transmitted images is corrupted and the hybrid lossy image compression method was affected by such noisy channel that blurred the signal details (i.e., degradation in the quality of image), then it is difficult to reconstruct high quality images. For high SNR values, the BER decreases and preserving the quality required. From these images, we could also see that there are interference which look like a black-points of each of the four images. Thus for certain blocks of the transmission the overall interference caused by the fading effect might be more severe than for other blocks. Due to the nature of image signals, we could not simply add a low-pass filter at the final receiving stage, since this would blur the edge detail of the image. However, the compressed stream is more vulnerable to channel errors, thus error control coding techniques are used along with images to reduce the effects of channel errors.

The simulation results of the coded OFDM-IDMA with the same fading and MAI conditions is shown in Figure-5. The receiver can recover the original signal almost perfectly. The images restored in figure-4 at less than 4 dB were severely damaged. To handle this interference, channel coding is used and we can see that these images in figure-5 have best performance than those in figure-4. It is also obvious from comparison BER performance in figure-6 for Lena image that, coded system works quite well, while uncodedsystem performs the worst. The convolutional coding is utilized efficiently to minimize BER, as example, the BER for the uncoded scenario is 6×10^{-3} at SNR=5 dB and 7×10^{-6} for coded scenario. In case of uncoded system, the performance does not drop highly as the subcarriers have already overcome the fading problems. Further, by small increase of the power of signal or SNR, the picture would be received quite perfect and the distortion would be decreased in the reconstructed images.As the number of active users increases, the residual MAI impairs detection, which in turn effects the amount of ISI removed, and more iterations in the MUD are generally needed to achieve excellent performance.

However, the images can be transmitted by using the proposed receiver, through the MAI environment and recover the data with high accuracy with using the channel protection. If combined with equalization techniques to trace the channel coefficients, this method also have good performance in high noisy environments. All the simulations were implemented on a PC with thefollowing specification;Pentium 4,CPU@ 2.20GHz and RAM 8.00GB. The hybrid compression transforms of images as well as OFDM-IDMA receiver were implemented by Matlab, other parts of the simulation program including convolutional coding were implemented by C.

a)SNR=0dB, User1 b)SNR=2dB, User1 c)SNR=4dB, User1 d)SNR=6dB, User1 e)SNR=8dB, User1 f)SNR=10dB, User1



a)SNR=0dB, User2 b)SNR=2dB, User2 c)SNR=4dB, User2 d)SNR=6dB, User2 e)SNR=8dB, User2 f)SNR=10dB, User2

a)SNR=0dB, User3 b)SNR=2dB, User3 c)SNR=4dB, User3 d)SNR=6dB, User3 e)SNR=8dB, User3 f)SNR=10dB, User3

a)SNR=0dB, User4 b)SNR=2dB, User4 c)SNR=4dB, User4 d)SNR=6dB, User4 e)SNR=8dB, User4 f)SNR=10dB, User4

Figure 5- The received images of OFDM-IDMA system at different SNR values and for four different users with convolutional coding.

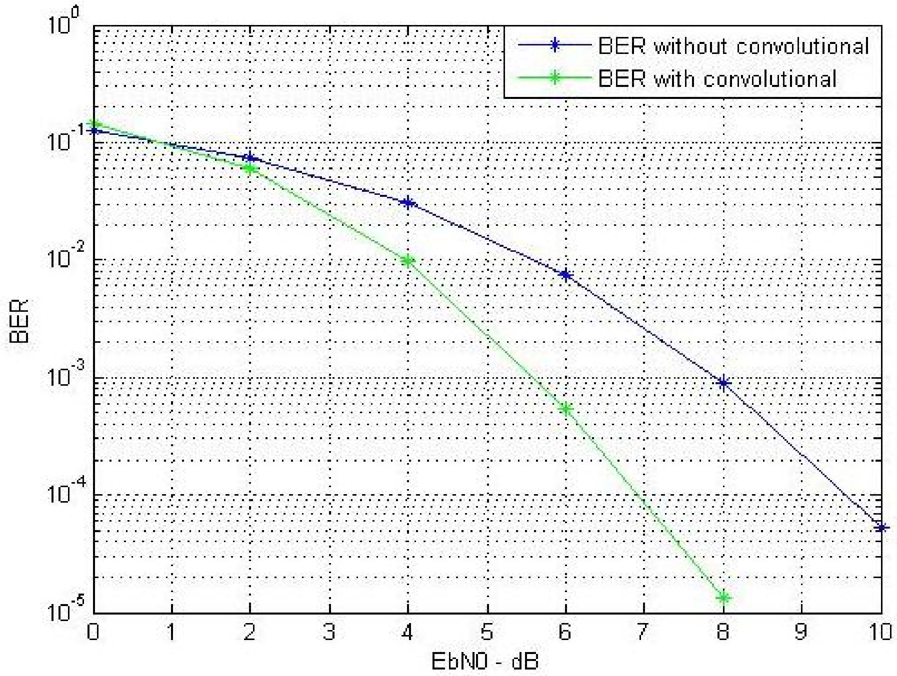


Figure 6- BER comparison performance after four images transmitting with four users over multipath fading channel using OFDM-IDMA system.

4. Conclusions

In this paper, hybrid compression technique and convolutional coding based OFDM-IDMA system is proposed for image transmission over wireless multipath fading channels. The simple hybrid lossy image compression scheme is used to reduce the redundancy in the original information. The scheme is based on wavelet transform, bit plane slicing, polynomial approximation model and absolute moment block truncation. However, the compressed streams are extremely sensitive to the bit errors, which can severely degrade the quality of the transmitted images. Therefore, the application of error control codes such as convolutional coding is very useful and can improve the performance under MAI and recover the images contaminated by MAI to their original shape. The simulation results have shown that the image quality and BER value are inversely related to the SNR value. The system with channel coding performs better than the system performance without coding under the same MAI and channel conditions. However, these results clearly show the efficiency of the proposed multicarrier transmission system, which can be used as an attractive technique for high speed data transmission.

References:

1. Kader, M. A., Ghani F., and Ahmad, R. B., **2013**. Image Transmission over Noisy Wireless Channels Using HQAM and Median Filter .*International Journal of Information and Electronics Engineering*, 3(5), pp: 529-532.
2. Pereira, M., Antonini, M., and Barlaud M., **2003**.Multiple Description Image and Video Coding for Wireless Channels. *Signal Processing Journal : Image Communication*, 18, pp: 925-945.
3. Olivier, W. H. C., Deforges, M. B. O., and Lorenz, H.B. P., **2009**.LAR Image Transmission Over Fading Channel: A Herarchical Protection Solution.The Second International Conference on Communication Theory, Reliability, and Quality of Service, Colmar: France, 1(3), April.

4. Youssef, C.**2004**. Efficient error protection for image and video transmission over noisy channels. Ph. D. Thesis. FachbereichInformatik& Information wissenschaft. University Konstanz.
5. Kumawat H. L., and Sharma S., **2012**.An Implementation of A Forward Error Correction Technique Using Convolutional Coding with Viterbi Decoding. *International Journal of Soft Computing and Engineering (IJSCE),* 2(5), pp: 95-99.
6. Bajaj A., Basha, S. J., and Patidar, P., **2012.** Performance of Image Over AWGN Channel Using BPSK Modulation**.** *International Journal of Computer Technology and Electronics Engineering (IJCTEE),* 2(6), pp: 14-17.
7. Charde R., **2012**. Image Performance over AWGN Channel Using PSK System. *International Journal of Engineering and Innovative Technology (IJEIT),* 2(1), pp: 336-340.
8. Li, P,.Qinghua, G. and Jun, T**.**, **2007.** The OFDM-IDMA approach to wireless communication systems. *IEEE Wireless Communications Magazine*, pp: 18-24.
9. Jun, T,.Qinghua, G. and Li, P. **2008**. Performance analysis of OFDM-IDMA systems with peak-power limitation. IEEE International Symposium on Spread Spectrum Techniques and Applications (ISSS 08), pp: 555-559.
10. Lihai, L,. Jun, T. and Li, P. **2006**. Analysis and optimization of CDMA systems with chip-level interleavers. *IEEE Journal on Selected Areas in Communications*, 24(1), pp: 141-150.
11. Al-Khafaji G., Aliesawi S. and Rajab M. A., **2014**. A Hybrid Lossy Image Compression based on Wavelet Transform, Polynomial Approximation Model, Bit Plane Slicing and Absolute Moment Block Truncation. *International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE),* 4(7).
12. Sarkar A. R, and Majhi S., **2012.** Comparison of Channel Coding Techniques Reference to Image Storage and Retrieval**.** *International Journal of Engineering and Innovative Technology (IJEIT)*, 1(5), pp: 144-151.
13. Zhen-hua, W,.Ge-fei, Y,. Xi, C,.Jie, Y. and Yin-ting, W**. 2013.** Study on simulation performance of OFDM-IDMA system. Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering (ICCSEE), pp: 0301- 0303.
14. Nishar, A. G**. 2006.** Evaluation of channel coding in OFDM system.M. Sc. Thesis. Telematics and Signal Processing, Dept. Electronics and Communication Engineering, National Institute of Technology, Rourkela, Orissa.
15. Noura, Y. A**. 2010.** Transmission of compressed images over power line channel.Ph.D. Thesis, Dept. School of Electrical and Computer Engineering, Science, Engineering and Technology Portfolio, RMIT University.
16. Loay, E, G. and Bushra, A, S**. 2011.** Image compression based on wavelet, polynomial and quadtree. journal of applied computer science & mathematics, 11(5), pp: 15-20.
17. Torki M., **2009**. JPEG 2000 Transmission Over Wireless Channels Using Unequal Power Allocation. M. Sc. Thesis, Engineering science, Simon Fraser University.
18. A. Mary, J. and S, J**. 2013.** Concert investigation of novel deterministic interleaver for OFDM-IDMA system.*Indian Journal of Computer Science and Engineering (IJCSE),* 4(5), pp: 353-363.
19. Babu A. S., and Rao K. V. S., **2011**.Evaluation of BER for AWGN, Rayleigh and Rician Fading Channels Under Various Modulation Schemes. *International Journal of Computer Application,* 26(9), pp: 23-28.
20. Guo Q., Yuan, X. and Ping, L., **2008**. Single- and multi- carrier IDMA schemes with cyclic prefixing and zero padding techniques. *European Trans. On Telecomm.*