Australian Journal of Basic and Applied Sciences, 7(5): 40-44, 2013
ISSN 1991-8178

Mobile Radio Channel Performance Analysis of the Transmitted Video Signal by using OFDM Modulation Technique

[1]Tariq A. Fadil, [1]Shahrul N. Yaakob, [1]Badlishah Ahmad and [1]Abid Yahya

[1]School of Computer & Communication Engineering University Malaysia Perlis (UniMAP), Campus Pauh Putra 02600, Arau, Perlis, Malaysia

Abstract: In this paper, an integrated system model of MPEG-2 video compression/decompression system and OFDM transceiver system has been designed and implemented to investigate and study the impact of various parameters on the quality of the transmitted video signal. MPEG-2 codec system has been used to compress the original video signal to present it in a compressed form. OFDM modulation technique has been used to transmit the compressed video signal into receiver side. OFDM system model design parameters are set with respect to video sample size of 176 × 144 (QCIF standard format) and with 30 frames per second**.** Results indicate clearly that by increasing$E_b/N_o$to 12 dB and 23 dB for AWGN channel test and Rayleigh fading channel test, the video quality measure (PSNR) will enhance to 32.6432 dB and 28.8333 dB, and BER decreases to 7.6819e-07 and 1.5346e-006 respectively.

Key words: AWGN, MPEG-2, OFDM, Rayleigh Fading, PSNR.

INTRODUCTION

Transmission of Modern multimedia communication technology such as image, audio and video becomes more widely used in our daily life. Compression of digital video signal becomes very important in video transmission applications because the amount of data associated especially for video signal is very huge to be handled by a limited bandwidth channel. Digital video information is present perhaps the greatest challenges to designers of communication networks and systems. Real-time digital video transmission has a number of demanding requirements; it needs a high transmission bandwidth; it must be transmitted with minimal delay, and it cannot tolerate a high error rate (Riley, M.J., 1997). Visual communication is an important part of multimedia services for third and fourth generations of personal communication services. The concept of the next generation includes a small handset, which allows users to communicate with each other from anywhere in the world, and by various data formats (e.g., voice, text, images, video, and sound). Many technical problems remain to be solved in order to make this imagination a reality. However, wireless video communication is particularly in great demand. Powerful compression algorithms must be used to deliver digital video since the available is limited (Sadka, A.H., 2002). The data rate requirements are aggravated if multiple terminals demand video transmission from a signal access point, serving a given wireless cell. The high data rate requirements of such applications require wireless transmission technologies that can support them. One especially promising approach here is the Orthogonal Frequency Division Multiplexing (OFDM) which does not only provide high data rates over wireless channel, but also supports a notion of resources sharing between multiple wireless terminals by dividing the wireless bandwidth into so-called “subcarriers”, which can be individually assigned to different terminals (Gross, J., *et al*., 2004). The transmission of compressed video signal through mobile radio channels need to be addressed carefully. The mobile radio channel introduces errors that may corrupt the compressed bit stream. This issue has been addressed in this paper. The rest of the paper is organized as follows; MPEG-2 video codec system was described in section 2. OFDM modulation technique was described in section 3. In section 4; the efficiency of whole system model was investigated and analyzed by applying two tests. Finally section 5, concludes the whole work.

Mpeg-2 Video Codec System:

MPEG-2 codec system standard has been developed to support a wide range of digital video applications, including home entertainment and broadcast applications. MPEG-2 video codec system is illustrated at Figure (1) (Riley, M.J., 1997).

● *MPEG-2 Video Compression:*

As shown in Figure (1), the frame store contains a reconstructed copy of the previous encoded frame: this is used as a reference for temporal prediction. The motion estimator calculates motion vectors for each block of the current frame. A motion-compensated version of the previous frame is subtracted from the

Corresponding Author: Tariq A. Fadil, School of Computer & Communication Engineering University Malaysia Perlis (UniMAP), Campus Pauh Putra 02600, Arau, Perlis, Malaysia
E-mail: eng_tariq_adnan@yahoo.com

current frame to create a difference or error frame. Each block of this difference frame is then transformed using Discrete Cosine Transform DCT and the coefficients are quantized and, together with the motion vectors, are entropy coded. At the same time, the quantized coefficients are rescaled (the IQuant block) and inverse transformed (IDCT) to create a local copy of the encoded and decoded frame. This is used as the prediction reference for the next frame. (This ensures that the encoder and decoder use identical reference frames for motion compensation).

● ***MPEG-2 Video Decompression:***

The coded data is entropy decoded and the coefficients are rescaled ("inverse quantization") and inverse transformed to recreate the difference frame. A motion-compensated reference frame is created using the previous decoded frame and the motion vectors for the current frame. The current frame is reconstructed by adding the difference frame to this reference frame. This frame is displayed and is also stored in the decoder frame store.

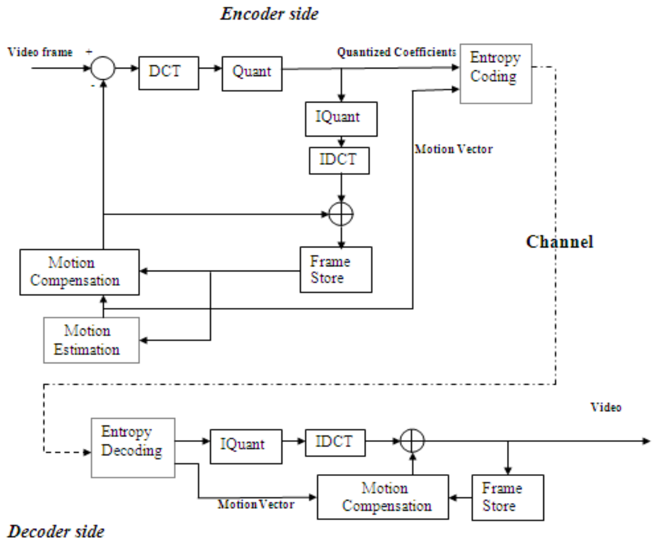


Fig. 1: MPEG-2 Video Codec System

Ofdm Modulation Technique:

OFDM is a modulation scheme that allows digital data to be efficiently and reliably transmitted over radio channel, even with presence of multipath environments. OFDM transmits data by using a large number of narrow bandwidth carriers. The frequency spacing and time synchronization of these carriers are chosen in such a way that these carriers are orthogonal, meaning that they do not interfere to each other. The name "OFDM" is delivered from the fact that the digital data is sent by using many carriers, each of different frequency (Frequency Division Multiplexing) and these carriers are orthogonal to each other, hence Orthogonal Frequency Division Multiplexing. Figure (2) shows the comparison between conventional multicarrier technique and orthogonal multicarrier technique. OFDM has been adopted in wide band digital communication applications, like digital audio and video broadcasting DAB and DVB (Sun, Y., 2001).

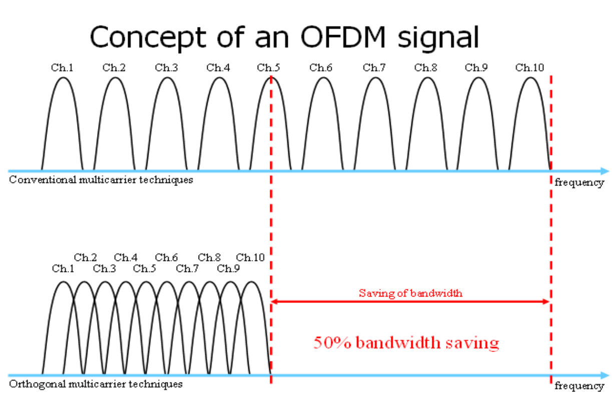


Fig. 2: Comparison between Conventional Multicarrier and Orthogonal Multicarrier technique

System Model Design:

In this section, MPEG-2 video codec system is used together with OFDM transceiver system as shown in Figure (3). A video quality measure performance is developed by performing an objective fidelity measures like PSNR. The whole system model is tested by using a video sample size 176 × 144 (QCIF standard format) and with 30 frames per second.This system model is used to simulate the transmission of compressed video signal over mobile radio channel by using OFDM modulation technique. In this model, the input video signal is first compressed using MPEG-2 compression system then the resultant encoded bit stream is transmitted using OFDM transmitter, the output signal from OFDM transmitter is transmitted through mobile radio channel. At the receiver side the received signal is demodulated using OFDM receiver to reconstruct the received encoded bit stream, which then passes through MPEG-2 decoder system to reconstruct the resultant video signal. Parameter values used in this simulation are listed in Table (1). System model performance results and analyses are described using the following tests at section 4.1 and 4.2 respectively.

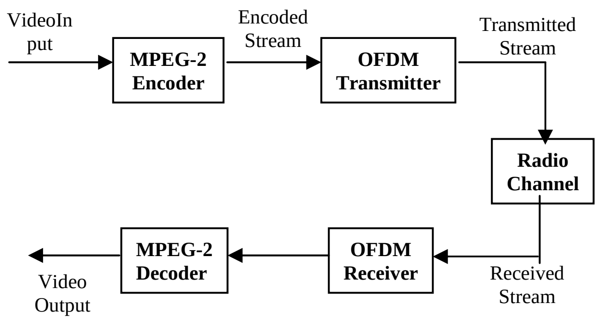


Fig. 3: Overall System Model

Table 1: Simulation Parameter Values

Parameter	Value
Video Format	QCIF (176 × 144) Pixels, 30 Frame/Second
FFT length nFFT	128
Bandwidth BW	2MHz
Subcarrier Spacing Δ f=BW/nFFT	15.625 KHz
IFFT/FFT Period T_s=1/ Δ f	64µs
Subcarriers Number	128
Doppler Shift	4Hz
Bit Rate	2Mbps
Number of Paths	2
Delay Spread	[0 0.05]µs
Average Path Gain	[0 -8]dB
Guard Interval Length	0.1 of OFDM Symbol Period

Awgn Channel Test:

In this test, the radio channel is assumed to be an AWGN channel. The modulation type used is BPSK modulation scheme. In this test, different values of signal to noise ratio (E_b/N_o) are used and the PSNR value for each E_b/N_o is measured. Figure (4) shows the decoded frame for different values E_b/N_o. Investigating these results highlight the following: the PSNR approaches the target of acceptable video quality when E_b/N_o become on or above 12 dB. The BER is estimated here by comparing the transmitted bit stream with the received bit stream.

Table 2: Variation of PSNR and BER for different values of E_b/N_o through AWGN Channel

E_b/N_o (dB)	PSNR(dB)	BER
10	7.3211	5.6078e-05
11	10.24	6.9137e-06
11.5	12.8646	3.0728e-06
12	32.6432	7.6819e-07

Original Frame

E_b/N_o=12 dB E_b/N_o=11.5 dB

E_b/N_o=11 dB E_b/N_o=10 dB

Fig. 4: Original and Decoded Frame for different values of E_b/N_o for AWGN channel

Frequency Selective Rayleigh Fading Channel Test:

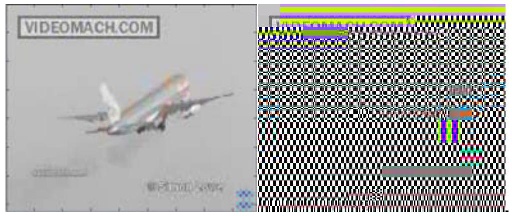
In this test, the radio channel is assumed to be a frequency selective Rayleigh fading channel. The modulation type used here is BPSK modulation scheme. Figure (5) shows the original and decoded video signal for different values of E_b/N_o. Table (3) lists the variation of PSNR and BER for different values of E_b/N_o. Investigating these results highlights the following: the PSNR approaches the target of acceptable video quality when E_b/N_o become on or above 23 dB.

Table 3: Variation of PSNR and BER for different values of E_b/N_o through Frequency Selective Rayleigh Fading Channel

E_b/N_o (dB)	PSNR(dB)	BER
17	5.4	1.2755e-04
19	16.7552	9.4487e-05
21	25.4983	3.5337e-05
23	28.8333	1.5346e-006

Original Frame

E_b/N_o =23 dB E_b/N_o =21 dB



E_b/N_o =19 dB E_b/N_o =17 dB

Fig. 5: Original and Decoded Frame for different values of E_b/N_o through Frequency Selective Rayleigh Fading Channel

Conclusion:

In this paper, an integrated system model of MPEG-2 video compression/decompression and OFDM transceiver system has been designed and implemented. The system model was used to simulate the transmission of the compressed video signal over wireless mobile channel by using OFDM modulation technique to investigate the impact of various parameters on quality of video signal. It has been shown from analyses results that video signal quality was very sensitive to bit error rate of 5.6078e-05 and 1.2755e-04 for AWGN and Rayleigh fading channel respectively. It has been concluded that simple error rate propagation will lead to video corruption and quality degradation for whole video frames. The planned future work is to discover and investigate the effect of video frames arrangement to whole system model specially for bit error rate decreasing.

REFERENCES

Gross, J., J. Klaue, H. Karl and A. Wolisz, 2004. "Cross-Layer Optimization of OFDM Transmission Systems for MPEG-4 Video Streaming", Telecommunication Networks Group, Technical University of Berlin.

Riley, M.J., 1997. "Digital Video Communications", Artech House, Boston, London, ISBN 0-89006-890-9.

Sadka, A.H., 2002. "Compressed Video Communication" John Wiley and Sons, England, ISBN 0-470-84312-8.

Sun, Y., 2001."Bandwidth-Efficient Wireless OFDM", IEEE Journal on Selected Areas in Communication, 19(11): 2267-2278.