International Journal of Advanced Trends in Engineering, Science and Technology(IJATEST) Volume.4,Special Issue.1Dec.2016

An Analytical Approach to Improve the Performance of Image Transmission over Mobile WiMAX Networks

T. Harikala[1]
Research Scholar, ECE, SVU, Tirupati, India[1]

Dr. R.V.S. Satyanarayana[2]
Professor, SVU, ECE, Tirupati, India[2]

Abstract

The aim of this paper is to analyze the bit error rate (BER) performance of WiMAX physical layer with the implementation of concatenated channel coding schemes under 16QAM digital modulations over realistic channel conditions (i.e. noise and multipath fading).In this paper an analytical approach is introduced to evaluate the effect of Reed-Solomon (RS) and convolution encoder over WIMAX wireless communication system with transmission of 16-QAM encoding digital colour image signal over AWGN and fading channel models. Both analysis and simulation results are presented for 16-QAM modulation scheme and both AWGN and fading channels. By using RS-CC code, we can get the effect of improving the total BER, PSNR. The resulting scheme is tested for the transmission of images over noisy channels. The results are evaluated in terms of Bit Error Rate, and Peak Signal to Noise Ratio for various values of Signal to Noise Ratio.

Keywords: Digital Modulation, Fading channel, WiMAX. , Image transmission, BER, PSNR.

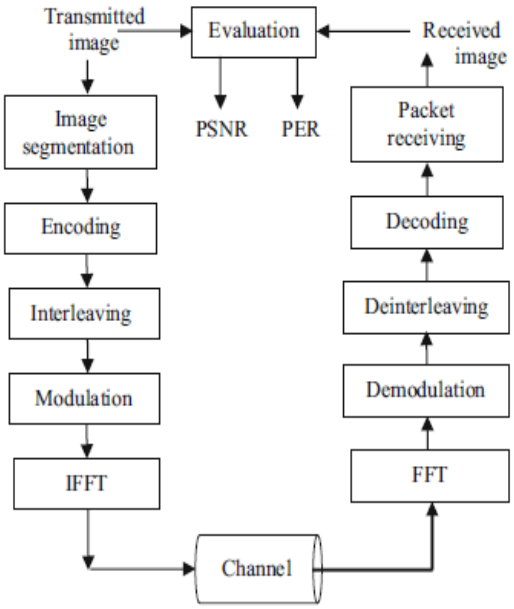
1 Introduction

Worldwide Interoperability for Microwave Access (WIMAX) [1] is a wireless communication system designed by the WiMAX Forum in 2001. The WiMAX system consists of two main parts; Base Station (BS) and Subscriber Station (SS). The BS consists of electronic devices and WiMAX towers that broadcast the signals. The WiMAX towers are connected together using microwave link and connected to the Internet using high bandwidth wired connection. The SS receives the signals from the BS and sends data to WiMAX enabled computers or routers. WiMAX systems have many advantages such as; high speed voice and data transfer over long distances, where the distance between the BS and the SS can be extended up to 50 km for fixed stations and 5–15 km for mobile stations [2] and provides data rates up to 70 Mbps [3]. The limitations of using WiMAX systems are: high installation and operational costs are needed; it can be affected by weather conditions or by other wireless equipments and it can be affected by errors due to the propagation conditions resulting from the mobility characteristics [4]. WiMAX is classified into fixed WiMAX (IEEE.802.16d standard) and mobile WiMAX (IEEE.802.16e standard). The fixed WiMAX is based on the line of sight condition in the frequency range of 10–66 GHz, while the mobile WiMAX is based on the non line of sight condition that works in 2- 11 GHz frequency range, a comparison between fixed WiMAX and mobile WiMAX can be found in [5]. The WiMAX defined two layers; Physical layer and Medium Access Control (MAC) layer. The physical layer based on performing coding, interleaving, modulation and Orthogonal Frequency Division Multiplexing (OFDM). The MAC layer describes the Internet protocol and the asynchronous transfer mode traffic and it converts the traffic into the MAC data units. The WiMAX network simulations are used as a tool for the performance evaluation. The most popular network simulator is the Network Simulator (NS-2), some modules for WiMAX network simulation have been carried out for the NS-2 [6, 7]. Simulation of the WiMAX physical layer using Simulink and Matlab is described in [8].Performance improvement of WiMAX networks has been studied by many researchers before; Kaur et al. [9] used three modulation techniques; BPSK, QPSK

and QAM for improving the BER of the WiMAX system. Ali et al. [10] studied the performance of different OFDM based WiMAX techniques. They evaluate the techniques from the point of the ability to support the multiple classes of service, bandwidth utilization, providing Quality of Service (QoS) guarantees and fairness amongst service classes. The results show that, no single technique can provide the desired performance with respect to all the QoS requirements. In this work we have implemented the physical layer of fixed WiMAX using digital modulation schemes (16QAM) under real fading IEEE standardized channels. The performance analysis of system was based on the Bit-Error-Rate (BER) curve. Following this introduction the remaining part of the paper is organized as follows. . In Sect. 2, the proposed image transmission over WiMAX network simulator is introduced. In sect.3, presents the encoding using RS-CC coding technique. In sect. 4, presents the modulation process using different modulation schemes. Finally, the conclusion is presented.

II Image Transmission over WiMAX Networks

For evaluating the performance image transmission over the WiMAX network, a simulator for the WiMAX physical layer has been carried out using MATLAB as shown in the block diagram



This figure clears the processing steps of the image transmission in details as shown in the following. At the transmitter, firstly the image has been segmented into small packets, then encoding techniques have been applied. The encoding stage has been followed by the interleaving process. Different modulation techniques, as specified in WiMAX physical layer have been carried out. The Inverse Fast Fourier Transform (IFFT) has been performed in converting the modulated data from the frequency domain into the time domain. Finally, the modulated data transmitted through the channels. At the receiver, the inverse stages of transmission have been performed and in the last step, the received image is reconstructed by the success received and decoded packets collection. To evaluate the received image quality, the evaluation block is added to measure the image quality and measure the error performance also. The fading channels are used for simulating the errors in WiMAX network; Additive White Gaussian Noise (AWGN), Rayleigh and Rician are the most widely used fading channels. AWGN channel is the simplest channel type, it has noise distribution with a constant power spectral density and Gaussian distribution over the channel bandwidth. The source of Gaussian noise may be coming from natural sources such as shot noise, black body radiation from the warm objects or thermal vibrations of atoms in antennas, and etc. Rayleigh channel has amplitude with Rayleigh distribution, the probability density function of Rayleigh channel can be given by

$$P_{Rayleigh}(r) = \frac{r}{\sigma^2}\exp\left(-\frac{r^2}{2\sigma^2}\right) \qquad (1)$$

where, r is the standard deviation and r is a random variable. The main source of the Rayleigh noise is the multipath propagation of the signal due to the indirect paths of the received signal at the receiver and no line of sight path exists between transmitter and receiver, so that, it considers the best model for the WiMAX network. The Ricean fading channel represents the multipath propagation of the signal and at least one line of sight path found between

the transmitter and receiver. The probability density function of Ricean channel can be given by

$$P_{Ricean}(r) = \frac{r}{\sigma^2}\exp\left(\frac{r^2+A^2}{2\sigma^2}\right)I_0\left(\frac{Ar}{\sigma^2}\right) \qquad (2)$$

where A is the amplitude of the signal and I0 is the zero order modified Bessel function. For performance evaluation of the image transmission over WiMAX network, BER and PSNR can be used. BER is normally used for determining the performance of the WiMAX physical layer. The BER can be calculated as:

$$BER = \frac{Number\ of\ received\ bits\ with\ error}{Total\ number\ of\ transmitted\ bits} \qquad (3)$$

BER affected by many factors such as noise, quantization errors, wireless multipath fading, bit synchronization channel noise, attenuation, interference, distortion, etc. The BER is inversely proportional to the SNR because the noise in transmission medium may disturb the information signal and causes data corruptions. For image transmission, the PSNR is the most visual tool used for evaluating the transmission quality, it is the ratio between the maximum possible power of the image and the power of corrupting noise that affects the image, PSNR is expressed in terms of a logarithmic decibel (dB) scale, and it can be defined by:

$$PSNR_{dB}(A_t, A_r) = 10\log_{10}\left(nm\left(\frac{\max\left(A_t^2(i,j)\right)}{\sum_{i,j}\left[A_t(i,j)-A_r(i,j)\right]^2}\right)\right) \qquad (4)$$

III. Image Segmentation

The goal of Segmentation is change the representation of an image into something that is more meaningful and easier to analyze. It is the process of image into multiple segments like pixels. This is typically used to identify object or other relative information in images. It is based on the different segmentation techniques like background & foreground, equi distant etc., Figure 2 shows an example of the received image through these experiments at SNR = 30 dB. The values of the PSNR and the BER have been calculated at different SNR , The results show that increasing the packet length enhance the image quality of the received image, and increase the PSNR, but at the same time increase the BER especially at high SNR. The results show that increasing the packet length enhance the image quality of the received image, and increase the PSNR, but at the same time increase the BER especially at high SNR.

IV Interleaving

Interleaving is a technique for making forward error correction more robust with respect to burst errors here data in the time interval blocks. It is a technique for improving the speed of access to blocks on disk storage. Interleavers are two types one is Block interleavers another one is convolotional interleavers. Convolution interleavers are used to reduce memory requirements.

V. Modulation

The image transmission over communication system using digital modulation techniques are performed and the results are obtained through a high level technical language called MATLAB was introduce for designing and implementing wireless digital communication system. Like many of the other wireless digital communication systems, the performance of this system is acceptable that, up to a certain level of noise from the critical channel. In other words, if the noise level is raised above this critical level, the performance of the system cannot very rapidly. The advantage of the currently designed system is that, when the channel is under a condition of high noise, the system generates a quality of image worse rather than completely lose the transmitted image. The simulation results are performed, when SNR value is 30 dB. By using 16-QAM modulation technique, which carries higher data rates, this is essential for image transmission. Modulation techniques such as 16-QAM provide better results than the other modulation techniques such as BPSK, QPSK and QAM.

VI Results:

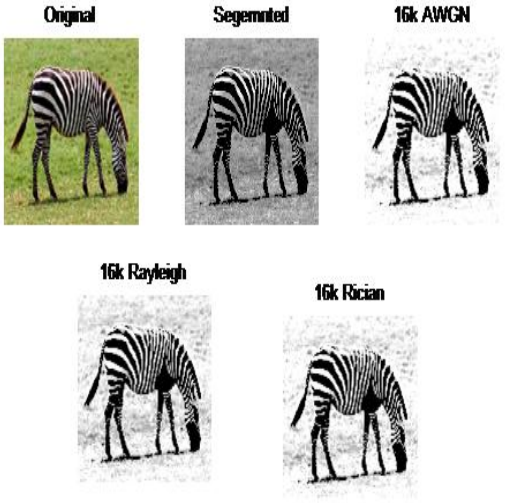
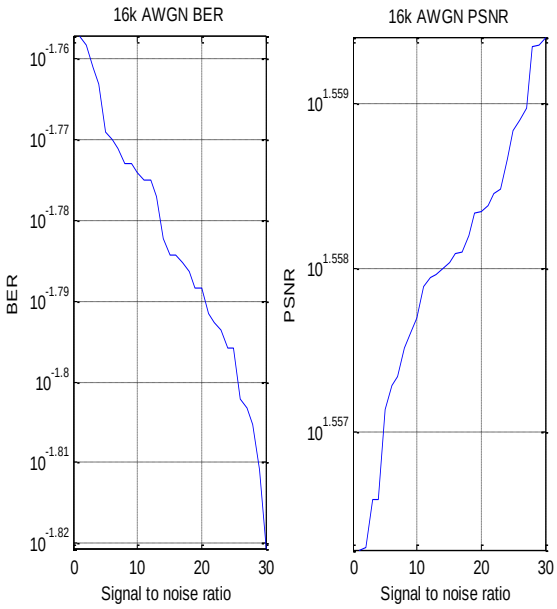
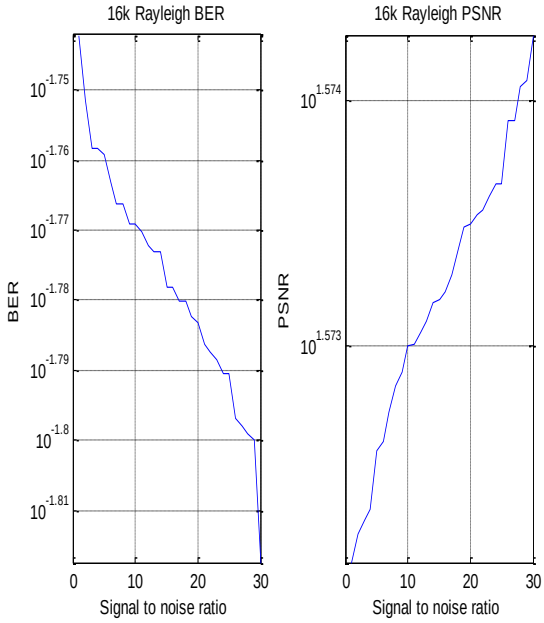


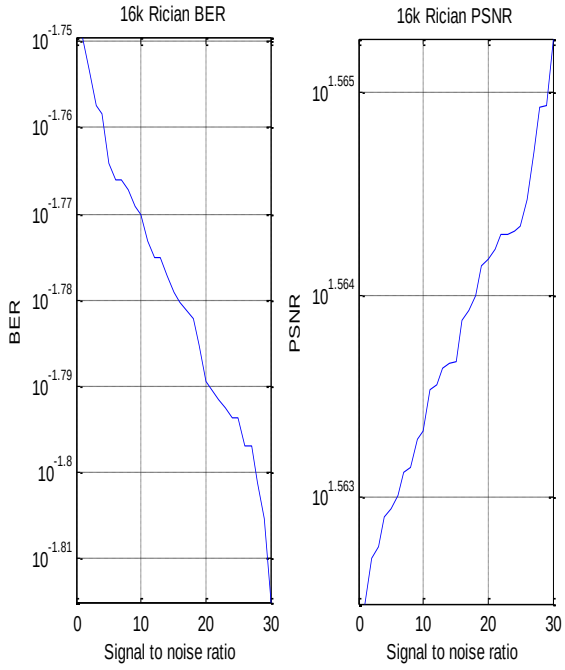
Fig. 2 The received image over AWGN and different fading channels for the 16kbit packet lengths at channel SNR = 30 dB



(a). BER Verses SNR Over AWGN Channel PSNR Verses SNR Over AWGN Channel



(b) BER Verses SNR over Rayleight channel PSNR Verses SNR over Rayleight channel



(c) BER Verses SNR over Rician channel PSNR Verses SNR over Rician channel'

Fig. 3 (a), (b), (c) PSNR and BER of the received image samples with the 16kbit packet length over AWGN and different fading channels.

VII Conclusion

The image transmission under the WIMAX is a difficult task to be performed for better communication. The adaptive modulation used in Mobile WiMAX are Quadrature Phase Shift Keying (QPSK), 16 Quadrature Amplitude Modulation (16- QAM), for modulating the signal according to IEEE 802.16e standard. Based on these modulation techniques the Bit Error Rate (BER) and Signal to Noise Ratio (SNR) were investigated in AWGN channel, Rayleigh channel and Rician channels condition. The proposed models shows better results than the previous techniques in terms of PSNR and MSE

References:

[1] Mobile WiMAX–Part I: A Technical Overview and Performance Evaluation, Aug. 2006, Copyright 2006 WiMAX Forum.

[2]. Agarwal, A., Behera, C., & Agarwal, K. (2013). Effect of guard time on BER performance of OFDM based WIMAX (IEEE 802.16d) system. International Journal of Electronics and Communication Engineering, 6, 41–55.

[3]. Rekha, S. M., & Manoj, P. B. (2013). Comparing the BER performance of WiMAX system by using different concatenated channel coding techniques under AWGN, Rayleigh and Rician fading channels. International Journal of Engineering and Advanced Technology, 2(6), 8–14.

[4]. Kunst, R., Both, C. B., Granville, L. Z., & Rochol, J. (2011). On the impact of hybrid errors on mobile WiMAX networks. Computer Networks, 55, 3659–3671.

[5]. Naqvi, A. N., Abbas, A. M., & Chouhan, T. A. (2012). Performance evaluation of fixed and mobile WiMAX networks for UDP traffic. International Journal of Advanced Research in Computer and Communication Engineering, 1(8), 563–569.

[6]. Belghith, A., & Nuaymi, L. (2008). Design and implementation of a QoS-included WiMAX module for NS-2 simulator. In Proceedings of the 1st international conference on Simulation tools and techniques for communications, networks and systems. Brussels, Belgium.

[7]. Borin, J. F., & da Fonseca, N. L. S. (2008). Simulator for WiMAX networks. Simulation Modelling Practice and Theory, 16, 817–833.

[8]. Khan, M. N., & Ghauri, S. (2008). The WiMAX 802.16e physical layer model. In IET International Conference on (pp. 117-120).

[9]. Kaur, S., & Singh, K. (2014). Performance evaluation of bit error rate in WiMAX using different modulation techniques. International Journal for Technological Research in Engineering, 1(10), 1135–1138.

[10]. Ali, N. A., Dhrona, P., & Hassanein, H. (2009). A performance study of uplink scheduling algorithms in point-to-multipoint WiMAX networks. Computer Communications, 32, 511–521.

[11]. Mobile WiMAX–Part II: A Comparative Analysis, May 2006, Copyright 2006 WiMAX Forum

[12]. Hasan, Mohammad Azizul," Performance Evaluation of WiMAX/IEEE 802.16 OFDM Physical Layer", Master's Thesis at Helsinki University of Technology, Espoo, June 2007.