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Performance Evaluation of image transmission over physical layer of IEEE 802.16d with antenna diversity scheme

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Abstract— The image is becomes a fundamental data for communication which needs high data rate for transmission. The image transmission over wireless communication system suffers from distortion due to the adverse effect of channel. In Multiple-Input Multiple-Output based wireless system is a promising high data rate interface technology and wireless multipath fading. In a method based on Space-Time Block Coding (STBC) with Multiple-Input Multiple-Output set-up for use in wireless channels. A comparison is made between the diversity gain of MIMO systems in terms of BER for High QAM modulation scheme. In this paper, performance of WIMAX physical layer is simulated and bit error rate (BER) performance is observed. In BER level is depend on the modulation type, then SNR value and channel behavior. The Modulation schemes that we have used in this paper are QPSK, QAM-8 and QAM-16 which further improved using MIMO technique. The poor bit error ratio (BER) at receiver also calculated as poor PSNR with received image. The results have been shown in the paper for the simulation over various diversity.

Keywords— WiMAX, OFDM (Orthogonal Frequency Division Multiplexing), MIMO, QAM (Quadrature Amplitude Modulation), AWGN.

I. INTRODUCTION

Wireless network is a type of network that utilizes some form of wireless link to communicate the text, speech and image data with each other. Wireless network comprises of different nodes which communicate with each other over a wireless communication channel, this wireless channel may be in the form of radio wave or infra-red wave, which is responsible for establishment of wireless channel or wireless link between nodes [1]

All emerged based on wireless technology to provide the higher throughput, longer range, mobility and robust backbone to thereat. The number of telecommunications innovations grew rapidly during the last half of 20th century. Currently there is widespread and growing use of cellular phones, cordless phones, digital satellite systems, and personal mobile radio networks. There are various technology comes in the picture to improve the performance of the wireless communication system like single carrier communication and multicarrier based communication [1].

In this paper we have worked out on WiMAX system, to make the system more reliable using digital communication technique. These techniques that provide many advantage over analog communication technique, forget easy to detect error in digital communication by adding Forward error correction code or backward error correcting code, which is not possible in analog communication. In digital communication first we converted data into signal using source coding, this source coded data is further encoded by using channel coding, which is used for error detection or error correction, in our thesis we have work of channel coding called convolution code. WiMAX implementations that use MIMO technology have become important model. It is use of MIMO technology improves the reception and allows for a better reach and rate of transmission. They have implementation of MIMO also gives WiMAX systems a significant increase in spectral efficiency.

OFDM is a multicarrier modulation technique used for high data rate in wireless applications that is suitable for eliminating ISI .The main merit of OFDM is the fact that the radio channel is divided into many narrow-band, frequency-nonselective sub-channels or subcarriers and low-rate, in multiple symbols can be transmitted in parallel, maintaining a high spectral efficiency.

For each subcarrier may deliver information for a different user, and resulting in a simple multiple access scheme known as Orthogonal Frequency Division Multiple Access (OFDMA). This enables different media such as speech, text, video, graphics, or other data to be transmitted within the same radio server, depending on the specific types of services and their Quality-of-Service (QoS) requirements.

An Orthogonal Frequency Division Multiplexing (OFDM) is a special case of multicarrier transmission, in a single data stream is transmitted over a number of lower rate subcarriers. They have single carrier system if signal get fade or interfered then entire link gets failed where as in multicarrier system only a small percentage of the subcarriers will be affected. An main reason to use OFDM to increase the robustness against the selective fading or narrowband interference.

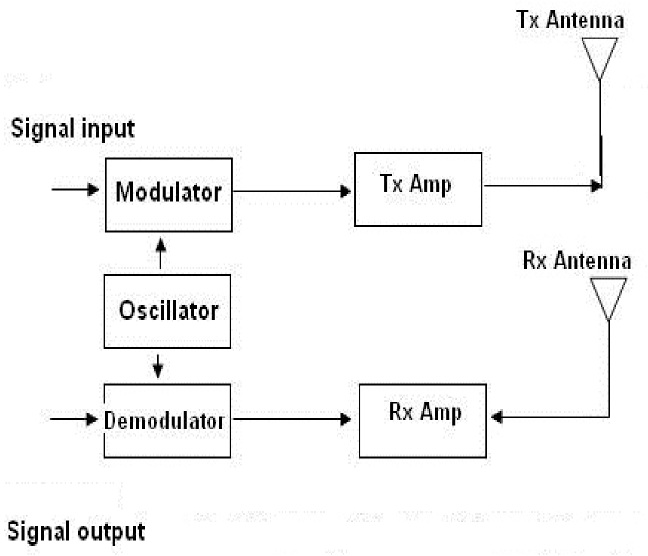

Fig 1.Wireless communication system

II. MIMO SYSTEM MODEL

Multi-antenna systems can be classified into three main categories. For Multiple antennas at the transmitter side are usually applicable for beam forming. In Transmitter or receiver side multiple antennas for realizing different diversity schemes. For the third class includes systems with multiple transmitter and receiver antennas realizing spatial multiplexing (often referred as MIMO by itself).

In radio communications MIMO means multiple antennas both on transmitter and receiver side of a specific radio server. The case of spatial multiplexing different data symbols are transmitted on the radio link by different antennas on the same frequency within the same time interval. In Multipath propagation is assumed in order to ensure the correct operation of spatial multiplexing and since MIMO is performing better in terms of channel capacity in a rich scatter multipath environment than in case of environment with LOS. . It is achieves this by higher spectral efficiency (more bits per second per hertz of bandwidth) and link reliability or diversity (reduced the effect of fading). The properties of MIMO is an important part of modern wireless communication such as IEEE 802.16

The main feature of MIMO systems is space-time processing. Space-Time Codes (STCs) are the codes designed for the use in MIMO system. Space-Time Block Codes signals are coded in both temporal and spatial domains. The different types of STCs, the orthogonal Space-Time Block Codes (STBCs) possess a number of advantages over other types of STCs and are considered in this book.

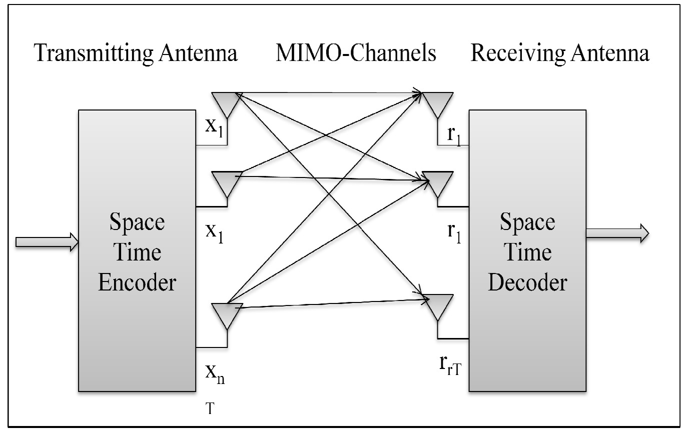

Fig 2. MIMO system

III. SPACE TIME BLOCK CODE

Space-time coding is a method used in multiple antenna systems to not only increase the reliability of the communication system, but also increase. Space-Time Codes (STCs) have been implemented in cellular communications as well as in wireless local area networks. The space time coding is performed in both spatial and temporal domain introducing redundancy between signals transmitted from various antennas at various time periods. In the research on Space Time Code focuses on improving the STBC system performance by employing extra transmits antennas. It can achieve transmit diversity and antenna gain over spatially un-coded systems without sacrificing bandwidth. In a general, the design of STC amounts to finding transmits matrices that satisfy certain optimality criteria.

IV. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM)

Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on using multiple carrier frequencies. The Orthogonal frequency-division multiplexing has developed into a popular scheme for wideband digital communication systems, whether wireless or over copper wires system, used in applications are digital television, audio broadcasting, wireless networks, power line networks, DSL Internet access, and 4G mobile communications.

Digital communications systems require each channel to operate at a specific bandwidth and with a specific frequency. In fact, communication systems have evolved so that the largest amount of data can be communicated through a finite frequency range. we will focus on the recent evolution of communications systems into using various mechanisms for effectively using the frequency spectrum signals. More specifically, we will describe how frequency division multiplexing (FDM) and orthogonal frequency division multiplexing (OFDM) are able to effectively utilize the frequency spectrum. And in addition, we will distinguish the two and describe why OFDM systems are currently being implemented in some of the newest and most advanced communications systems.

$$Xn = \frac{1}{\sqrt{N}} \sum_{l=0}^{N-1} X_{le^{j\frac{2\pi}{N}ni}} \qquad 1$$

At the receiver, the received OFDM signal is mixed with local oscillator signal, and the frequency offset deviated from Δf the carrier frequency of the received signal owing to Doppler velocity or frequency estimation error, the received signal is given by:

$$\hat{x}_n = (X_n \otimes h_n) e^{j\frac{2\pi}{N} n\Delta fT} + z_n \qquad 2$$

Where output of the FFT in frequency domain signal on the k^{th} receiving subcarrier becomes:

$$\hat{X}_k = \sum_{l=0}^{N-1} X_1 H_1 Y_{1-k} + Z_k \qquad 3$$

$$= X_k H_k U_0 + \sum_{l=0, l\neq k}^{N-1} X_1 H_1 Y_{1-k} + Z_k \qquad 4$$

The first term of Equation (4) is a desired transmitted data symbol X_k. The second term represents the ICI from the undesired data symbols on other subcarriers in OFDM symbol H_k is the channel frequency response and Z_k denotes the frequency domain of z_n. The term $Y_{1-k}$is the coefficient of FFT (IFFT), is given by:

$$Y_{1-k} = \frac{1}{\sqrt{N}} \sum_{l=0}^{N-1} e^{j\frac{2\pi}{N} n(l-k+\Delta fT)} \qquad 5$$

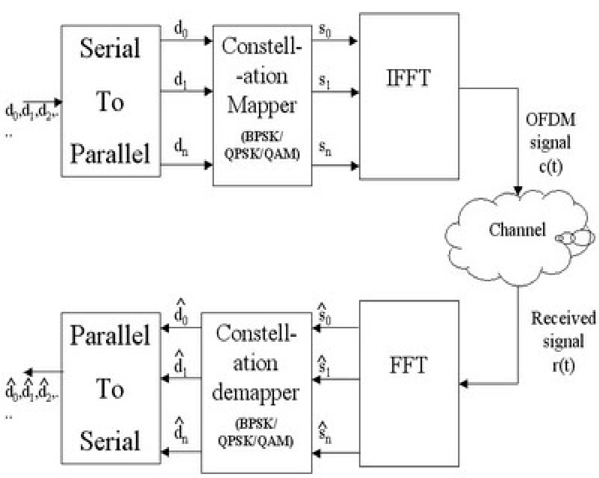

Fig 3.OFDM System Modle

Orthogonal Frequency Division Multiplexing (OFDM) is very similar to the well known and used technique of Frequency Division Multiplexing. Orthogonal Frequency Division uses the principles of FDM to allow multiple messages to be sent over a single radio. It is however in a much more controlled manner, an improved spectral efficiency. It is conventional broadcasting each radio station transmits on a different frequency, and effectively using OFDM to maintain a separation between the stations. An all the subcarriers within the OFDM signal are time and frequency synchronized to each other, allowing the interference between subcarriers to be carefully controlled. These multiple subcarriers overlap in the frequency domain.

RESULTS AND DISCUSSION

The system description for the simulation is given in fig 4. The image data are transmitted through the MIMO WiMAX system with FEC code .

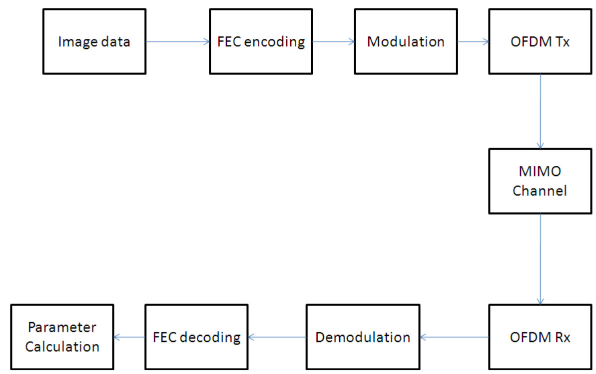

Fig 4.Image transmission block diagram

The BER performance graphs for the simulated WiMAX physical layer and MIMO-OFDM with the implementation of CC concatenated channel coding under 16 QAM digital modulation schemes over AWGN channel, Rayleigh and Rician multipath fading channels.

A. SYSTEM PERFORMANCE WITH MIMO 2X1 WiMAX

Fig 5.Transmit image for MIMO 2X1 with WiMAX

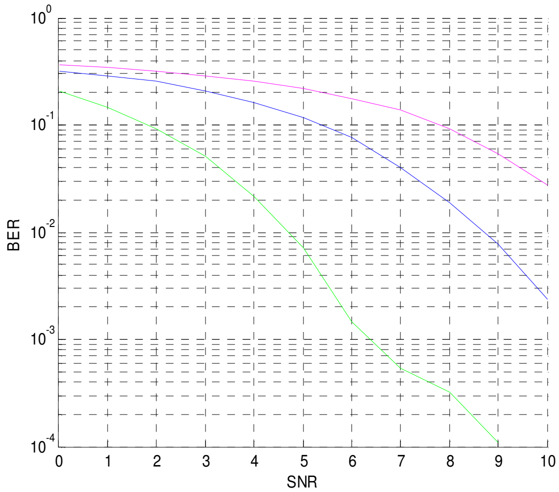

Fig 6.The Performance of BER Vs SNR

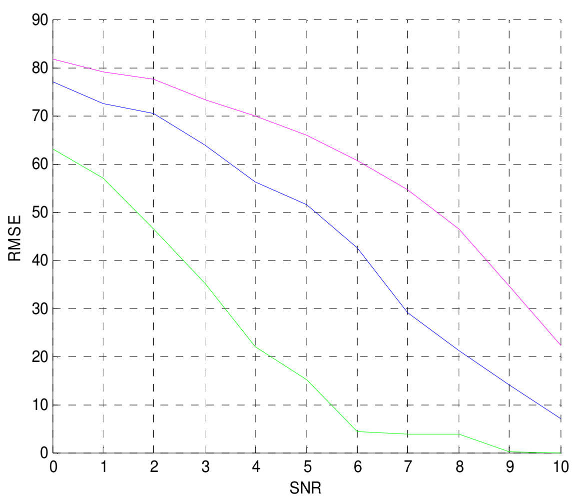

Fig 7.The Performance of RMSE Vs SNR

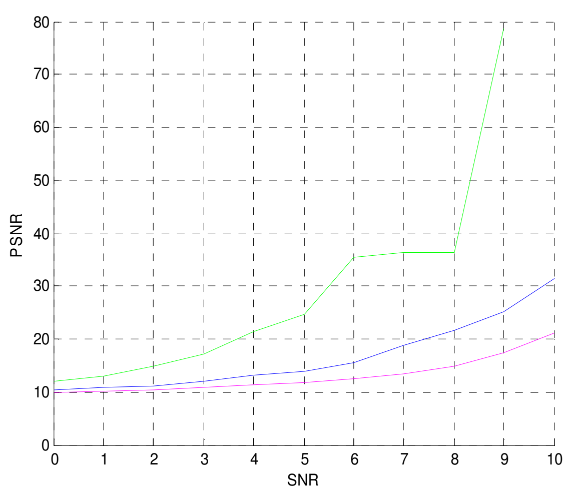

Fig 8.The Performance of PSNRVs SNR

B. SYSTEM PERFORMANCE WITH MIMO 2X2 WiMAX

Fig 9.Transmit image for MIMO 2X2 with WiMAX

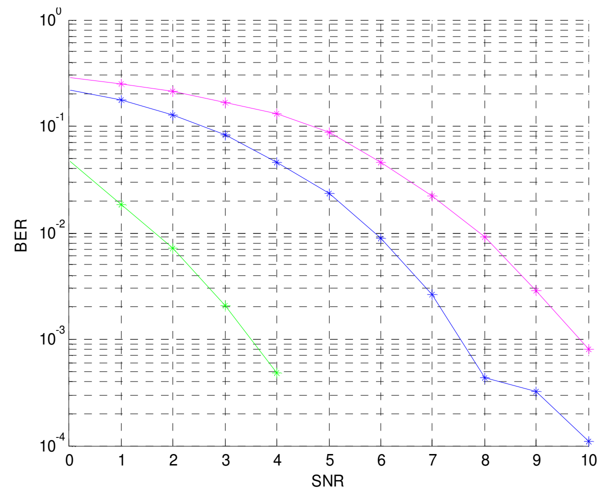

Fig 10. The Performance of BER Vs SNR

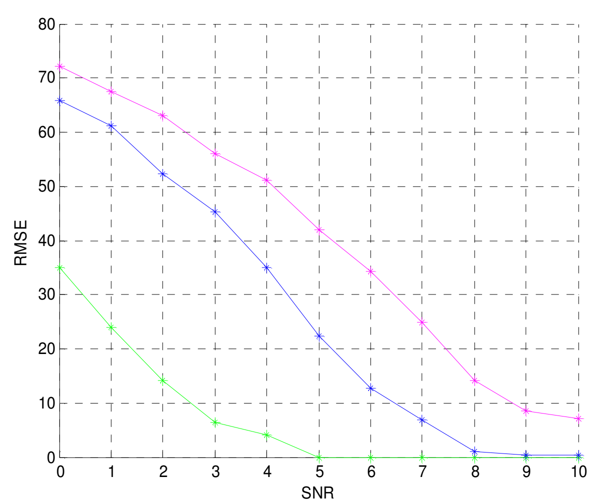

Fig 11. The Performance of RMSE Vs SNR

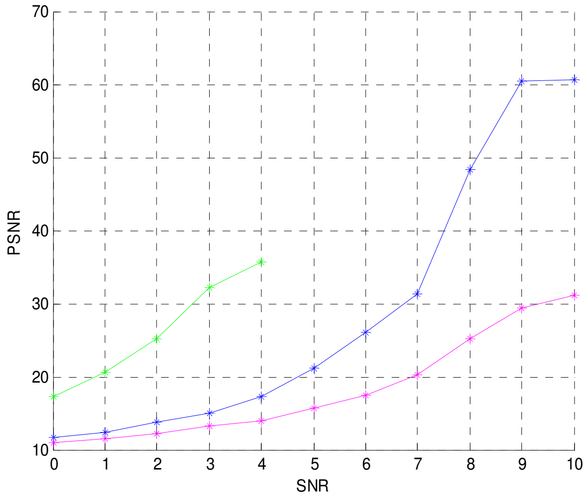

Fig 12. The Performance of PSNR Vs SNR

CONCLUSION

The simulation results shows that the use of MIMO with WiMAX system gives better performance for image transmission. The simulation results also show that the image can be recovered at the receiver even at very low SNR values. It is found that with increase of modulation order the capacity enhancement but BER are degraded, the can be recovering with the increase in number of receiver antennas.

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