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Multi User Multi Antenna Wireless OFDM System with Efficient Channel Estimation using Pilot Assisted Scheme

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Abstract - Modern wireless communication system is getting better for the new generation of data communication technology, because it have to facilitates the user to communicate and share information through various wirelessly connected devices in moving. The research works are delicately exploring new dimensions of the technology and fixing the bugs day by day. The every researchers aim to explore new techniques and analyze the existing technologies to make technology easier for the subscribers having several features. In the same context this work also analyzing for estimation of channel with utilizing pilot assisted scheme and spatial diversity uses different number of antennas at the transmitter and receiver side to make system more efficient for random channel behavior. The methodology of this work having better error probability than the existing work done on the same context. The proposed system utilizes multi antenna diversity for 4xN and 2xN, configurations where N is number of receiving antennas and modulation scheme is m-PSK, m is 4, 8, 16, 32 & 64.

Keywords - multiple input multiple output, m-PSK, - Pilot Scheme, BER, MSE.

I. INTRODUCTION

Communication, the activity of conveying information, is the distinctive ability which has made possible the evolution of human society. The history of communication is mankind‟s search for ways to express itself, to share knowledge and to prosper.

Humans live related to each other. The initial challenge for a man was to put forth his thoughts. As gestures and body language became inadequate to convey one‟s thoughts, languages were invented. Language is a tool which portrays thoughts in the form of words, though not a very effective tool; it has become a basic necessity for everyone to use it. But as humans explored the world around, more knowledge was dwelled which were to be shared, and, texts and speech alone became insufficient for transferring the vastness of what is known.

Orthogonal frequency division multiplexing (OFDM) has emerged as an attractive technique for achieving high-bit-rate data transmission with high bandwidth efficiency in frequency-selective multipath fading channels.

In wireless communication systems, where reliable transmission techniques at high data rates is a requirement, an appropriate signal detection in the receiver can only be achieved by using highly efficient synchronization techniques in which joint channel and frequency offset estimation is performed. Known data symbols called the pilot symbols is a practical method used to provide the receiver with the required information about the channel. For time-invariant channels, the pilot symbols can be sent in a burst mode as preambles, postambles, or midambles. However, for time-variant channels, pilot symbols are usually inserted periodically within the data block in a process known as pilot symbol aided modulation (PSAM) to keep up with the channel variations.

Gradually replacing single-carrier communications systems, orthogonal frequency division multiplexing (OFDM) has been a driving force behind the latest high speed standards in wired as well as wireless communications. The ability to divide a wide spectrum into narrowband subchannels, where data could possibly be multiplexed for different users, has provided a number of different possibilities, including but not limited to, reducing or eliminating the inter symbol interference (ISI), using simple equalizers and employing flexible channel estimators.

The pilot patterns are usually categorized into continuous and scattered variants. For instance, continuous pilots in the form of preamble have been proposed in IEEE 802.11n [1] for high speed data communications through Wireless Local Area Network (WLAN). For systems experiencing higher amount of fading, such as Long Term Evolution (LTE) [2], scattered pilots are usually employed. The presence of scattered pilots not only aids instantaneous estimation of the channel but also provides the possibility for tracking channel variations in time.

Scattered pilots can be thought of sampling a 2-D grid. For example, if a number of consecutive OFDM symbols, extending over the time axis, are unfolded in the frequency direction a 2-D time-frequency grid is constructed. The building blocks in the constructed grid are tones where one tone is a subchannel in a given OFDM symbol. In addition, if the grid is sampled according to some random or deterministic pattern, a subset of points, called pilot tones, is collected which can be used to assist a number of signal processing operations in a transceiver. For instance, one of the main applications is to aid the estimation of the wireless channel, known as pilot- aided channel estimation by convention.

The communications channels in wireless environments are characterized by the reflection of the transmitted radio signal from the objects in the environment. In the event of a line-of-sight (LOS) communications, the secondary reflections from the objects in the environment may have a negligible effect on the performance of the radio communication. However in many scenarios, there is either no LOS component or the reflections from the objects are too strong to be ignored.

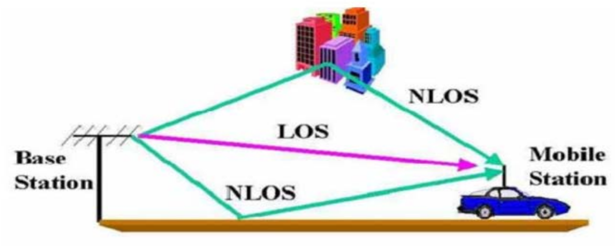

Fig.1.1 Illustration of multipath environment.

Multiple Input Multiple Output (MIMO) communications techniques have been studied from a long time approximately more than one decade. it has been proved that theoretically that Communication system that use multiple antennas at both the transmitter and receiver have been the subject of much recent research because theoretically they offer improved capacity, coverage, reliability, or combinations compared to systems with a single antenna at either the transmitter or receiver or both. MIMO also offer different benefits, namely beam forming gain, spatial diversity and multiplexing. With beam forming, transmit and receive antenna patterns can be focused into a specific angular direction by the choice of complex baseband antenna weight. To achieve effective wireless communication a multi user multi antenna wireless OFDM system with efficient channel estimation using pilot assisted scheme has reported in this examination work.

II. MIMO-OFDM SYSTEM

Orthogonal Frequency Division Multiplexing (OFDM) is a multi-carrier modulation technique, in which a single high rate data-stream is divided into multiple low rate data-streams and is modulated using sub-carriers which are orthogonal to each other [3]. Major advantages of OFDM are its multi-path delay spread tolerance and efficient spectral usage by allowing overlapping in the frequency domain. Also another significant advantage is that the modulation and demodulation can be done using IFFT and FFT operations, which are computationally efficient [4]. In addition to above, OFDM has several favorable properties like high spectral efficiency, robustness to channel fading, immunity to impulse interference, uniform average spectral density, capacity to handle very strong echoes and non-linear distortion [5,6]. Hence, OFDM is a promising modulation technique which can be used in many new broadband communication systems.

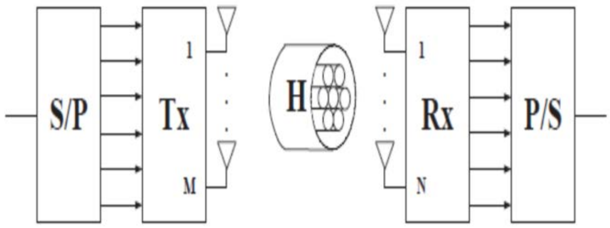

Fig.2.1 MIMO System modeling.

Here the system uses 'M' number of transmit antennas at the transmitter and 'N' number of receiving antennas at the receiver. The data stream is first converted to parallel data streams and then processed through the antennas. Here 'H' stands for the channel matrix. Channel capacity

Channel capacity is the measure of the maximum amount of information that can be transmitted over a certain channel and can be received with a certain probability of error or less than that. For a memory less channel, if represent the input as X and the output as Y then the capacity may be defined as the maximum of mutual information between X and Y. Mathematically that is represented by

$$C = \max_{p(x)} I(X, Y) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2.1)$$

Here p(x) is the probability distribution function (pdf) of the input variable X.

A channel is said to be memory less or having zero memory if the probability distribution function (pdf) of the output depends upon the input only at a time and is conditionally independent of previous inputs and outputs.

Mathematically, it can be represented the input output relations of a single user narrowband MIMO channel as

$$y = Hx + n \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (2.2)$$

Where

'X' is the transmit vector of size (nT x 1) 'y' is the (nR x 1) receive vector

'n' is the additive white Gaussian noise at a particular instant of time having size (nR x 1).

'H' is the (nR x nT) channel matrix.

$$H = \begin{bmatrix} h_{11} & \cdots & h_{1nr} \\ \vdots & \ddots & \vdots \\ h_{nR1} & \cdots & h_{nRnr} \end{bmatrix} \dots\dots\dots\dots\dots\dots\dots.. \quad (2.3)$$

III. PROPOSED METHODOLOGY

The adopted system model in this examination work is a multiple-input multiple-output (MIMO) OFDM system operating in a wireless environment. Channel estimation is an essential part of coherent data detection in OFDM systems. A lot of work has been carried out for channel estimation in wireless communications. Fig. 3.1 shows the block representation of proposed work. In the majority of practical cases the transmitter and receiver should have a priori knowledge of the transmitted data for the purposes of channel estimation. Thus, the transmitter and receiver agree on a subset of data which is called pilot-data by convention and is extensively used in practical system implementations. The pilots are inserted in specific locations in the transmitted signal. They appear either in continuous or scattered patterns. The contiguous scheme is usually employed in wireless systems where little fading is expected. Contrary, if the wireless channel experiences a considerable amount of fading, e.g., movements in the environment, scattered pilots distributed both in time and frequency need to be used so that the channel variations over time and frequency can be tracked. In proposed model a pilot assisted channel estimation schemes is used. The proposed model has implemented and descried in following individual parts and their functioning. As illustrated in Fig. 3.1 first input signal is generated and fed to m-PSK modulation block then OFDM modulation (IFFT) the modulated OFDM signal is encoded by pilot assisted encoding and transmitted through three different Antenna configuration 2-input:2-output,2-input: 4-output, 4input :4-output. The transmitted signal from multiple antenna configurations is passed through wireless channel and received on same antenna configuration; a pilot assisted decoding is applied on received signal, further OFDM demodulation and m-PSK demodulation is applied to detect original information.

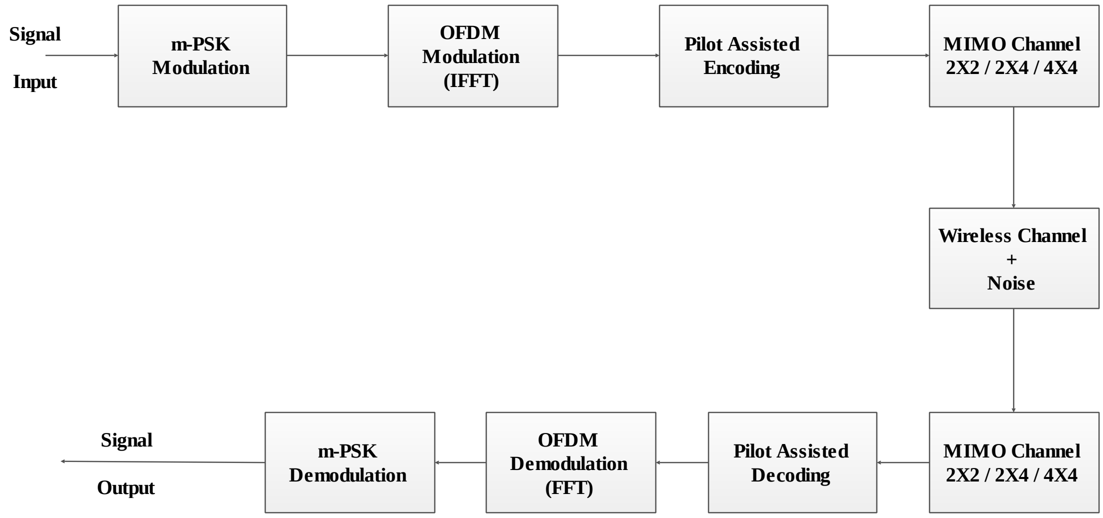

Fig.3.1 Block diagram of proposed work.

1. m-PSK Modulation

In provided signal for processing through proposed model first an m-PSK modulation is applied on it. Multi-level modulation techniques permit high data rates within fixed bandwidth constraints used to modulate generated input signal. In this modulation scheme data bits select one of mphase shifted transmit data

2. OFDM Modulation

Basically OFDM modulation block comprises of IFFT block that processes inverse of fast fourier transform of the input signal or data data. The IFFT operation is mathematically indistinguishable to OFDM job. Subsequently one might say this is the block that really implements OFDM. Before feeding the data samples to the

IFFT block, the information data stream ought to be organized with the goal that the complete number of input samples is a power of 2 as is required by the IFFT block. So as to do this a multiport selector block is utilized to choose the columns and afterward unit data samples are added among it to keep up consistency.

3. Pilot Assisted Encoding

In MIMO system, the transmitter modulates the message bit sequence into m-PSK and distinctive modulation plans, performs Inverse Fractional Fourier Transform (IFFT) on the symbols to change over them into time-domain signals, and sends them out through a (wireless) channel. The received signal is normally degraded by the channel attributes. Each subcarrier can be viewed as a free channel, as long as no ICI (Inter-Carrier Interference) happens, and in this way conserving the orthogonality among subcarriers. The orthogonality permits each subcarrier part of the received signal to be communicated as the result of the transmitted signal and channel frequency response at the subcarrier.

4. MIMO -Wireless Channel

In in order to show the real transmission channel both the AWGN and Rayleigh fading channels are associated in series. The signal to noise proportion of the AWGN channel can be adjusted by fluctuating the SNR parameter esteem. The rayleigh fading block gives additional parameters like doppler shift, path delay gain and so on to influence the channel to take after the genuine channel as intently as could be allowed. Multiple antennas arrangement is utilized to transmit and get signal.

6. Pilot Assisted Decoding

By estimating the response of channel the transmitted signal can be recovered exactly at each subcarrier. Basically, estimation of channel can be done by utilizing a pilot or preamble symbols known to both transmitter and receiver, which utilize different interpolation approaches in order to estimate the channel response of the subcarriers among pilot tones. Data signal along with training signal, or both, can be utilized for channel estimation generally, So as to select the channel estimation strategy for the MIMO framework under consideration.

7. OFDM Demodulation

This operations performed by this block is essentially inverse to that performed by the OFDM modulator block. At first the cyclic prefix is removed by utilizing an evacuate cyclic prefix removal block and afterward FFT block is utilized to locate the fast fourier transform of the data samples. At last select columns block is once again used to remove the pilot samples added and outcome the precise data samples.

8. m-PSK Demodulation.

To retrieve original information from the received signal a reverse m-PSK modulation or m-PSK demodulation is applied on it. After demodulation original signal has received.

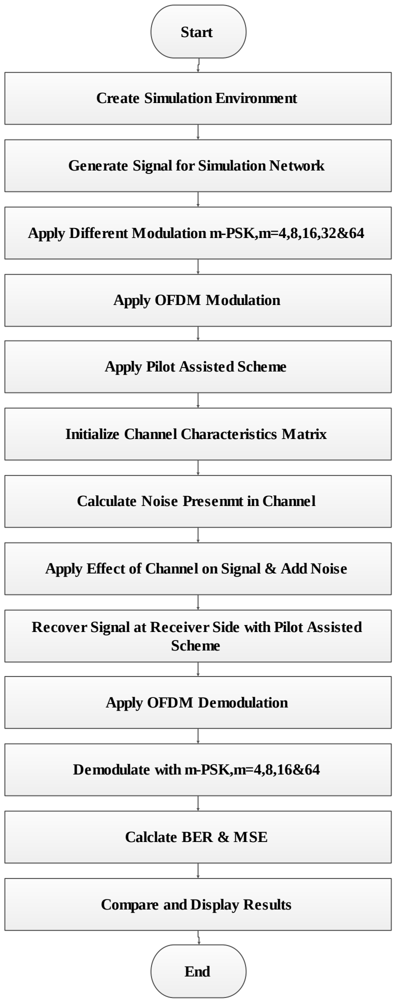

Fig.3.2 Flow chart of proposed work.

IV. SIMULATION RESULTS

The simulation of proposed model is done in MATLAB simulation environment and the simulation outcomes are shown. From the results it can be analyzed that the proposed system with different spatial diversity i.e. multiple input multiple output (MIMO) enhances the estimation performance of system and reduces error. The simulation results were plotted in terms of performance of the OFDM system that is Bit Error Rat (BER). Primarily the modulation procedures of m-PSK, were utilized to see the tradeoff between framework limit and framework robustness. The standard BER that was utilized to determine the base execution of the OFDM framework is least BER for voice transmission framework for example 10-3. Examination was finished by observing the simulation result and arranging the observing result to make it increasingly helpful to read. The examination of simulation results are divided in three sections for three different configurations and convenience. In this examination the performance of MIMO-OFDM technique in mobile radio channel has been studied. Its execution in the presence of noise and various fading effects like frequency selective fading, multipath fading, and Doppler Effect has been analyzed.

(a) 2x2 Antenna Configuration, (b) 2x4 Antenna Configuration, (C) 4x4Antenna Configuration the performance are evaluated in terms of BER (bit error rate) and MSE (mean squared error).

It is examined that in a MIMO-OFDM system the performance is better than previous OFDM system for multi carrier multi-user environment, in case of OFDM, the receiver may require a very large dynamic range for the purpose of handling large signal strength in between various users.

A. 2x 2 Antenna Configurations:

For a two input two output antenna configuration BER and MSE of proposed model has carried out. The graphical examination of BER of proposed model has shown in Fig.4.1the modulation schemes used are 4-psk,8-psk,16-psk,32psk and 64-psk.

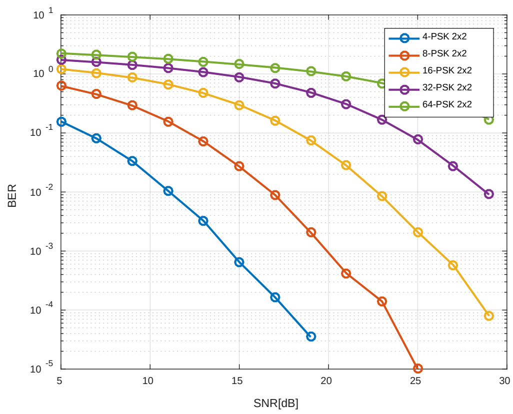

Fig.4.1 BER of the Proposed System with 2 Transmitting Antennas and 2 Receiving Antennas.

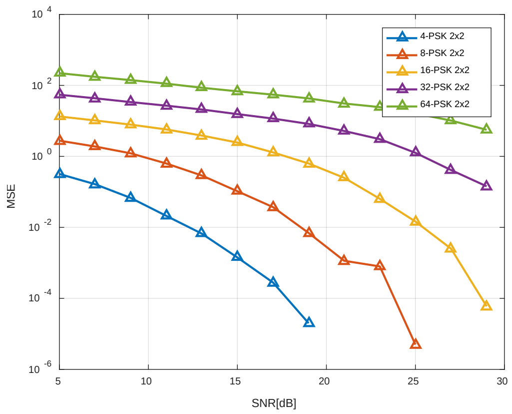

Fig.4.2 MSE of the Proposed System with 2 Transmitting Antennas and 2 Receiving Antennas.

For the same modulation scheme and antenna configuration MSE of the proposed system with 2 transmitting antennas and 2 receiving antennas are shown in Fig.4.2.

B. 2x4 Antenna Configuration:

For another antenna configuration a two input and four output antennas BER and MSE of proposed model has plotted. The graphical examination of bit error rate BER of proposed model has shown in Fig.4.3 the modulation schemes used are 4-psk,8psk,16-psk,32-psk and 64-psk. For the same modulation and antenna configuration MSE of the Proposed System with 2 transmitting antennas and 4 receiving antennas has shown in Fig.4.4.

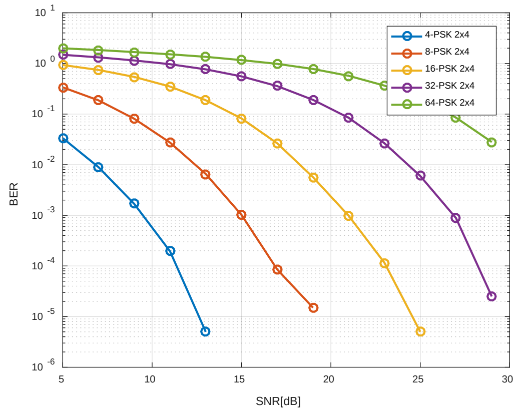

Fig.4.3 BER of the Proposed System with 2 Transmitting Antennas and 4 Receiving Antennas.

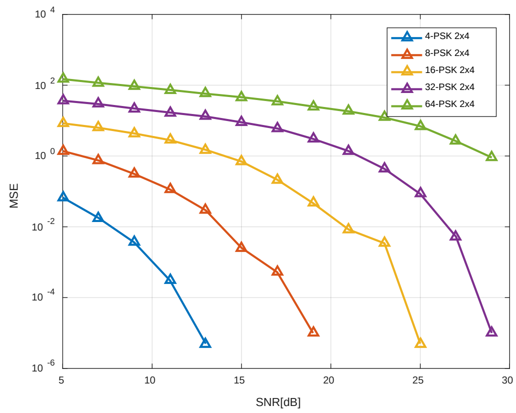

Fig.4.4 MSE of the Proposed System with 2 Transmitting Antennas and 4 Receiving Antennas

C. 4x4Antenna Configuration:

For a symmetric 4-input: 4-output antenna configuration BER and MSE of proposed model has shown in below figures. The graphical examination of BER of proposed model has shown in Fig.4.5 the modulation schemes used are 4-psk,8-PSK,16-PSK,32-PSK and 64-PSK.

For the same modulation and antenna configuration MSE of the proposed system with 4 transmitting antennas and 4 receiving antennas has shown in fig.4.6.

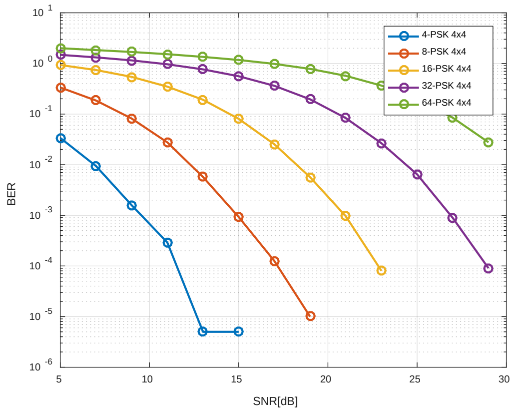

Fig.4.5 BER of the Proposed System with 4 Transmitting Antennas and 2 Receiving Antennas

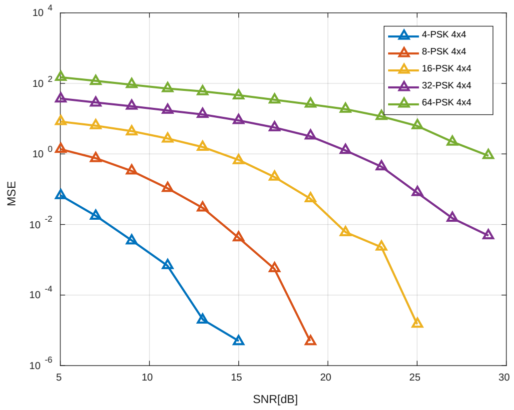

Fig.4.6 MSE of the Proposed System with 4 Transmitting Antennas and 4 Receiving Antennas

V. CONCLUSION AND FUTURE SCOPE

In this research work a MATLAB based model of multi user MIMO-OFDM system efficient channel estimation using pilot assisted scheme has reported. High-data-rate wireless communication has turned out to be increasingly more essential for military and business applications. Orthogonal frequency division multiplexing (OFDM) is by all accounts a promising answer for expanding a communication framework's data rate by using the accessible bandwidth in the most productive way. Besides, the utilization of multiple get and transmit antennas significantly expands the channel limit and the execution over frequency-selective channels. The simulation of proposed model has done on MATLAB simulation environment. The performance of proposed work has examined based on two important parameters used in communication system are BER and MSE. Matlab graph for various configurations of antenna and modulation has plotted to evaluate the performance and to compare it with existing work. From the observation of BER plot of proposed work and previous work it can be concluded that proposed model has better performance,

The proposed examination work basically concentrated on MIMO-OFDM and the study of its performance in the mobile radio channel in terms of BER and MSE. However there is a lot of work needs to be done to study the forward error correction schemes for OFDM system.

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