Development of Pilot Assisted Joint Channel Estimation for MIMO-OFDM System

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Abstract - Present day wireless communication system is showing signs of improvement for the new generation of information communication technology, since it need to encourages the client to impart and share information through different wirelessly associated gadgets in moving. The examination works are gently investigating new components of the technology and fixing the bugs step by step. The each analyst mean to investigate new strategies and break down the current advancements to make technology simpler for the supporters having a few highlights. In a similar setting this work likewise breaking down for estimation of channel with using pilot helped plot and spatial diversity utilizes distinctive number of radio wires at the transmitter and receiver side to make system increasingly productive for irregular channel conduct. 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

In wireless communication environment, the main challenge is to combat multipath fading. Multipath is a phenomenon that occurs due to the arrival of the transmitted signal through different paths. The signal arrives at the receiver through different angles, with different time delays and different frequency shifts. As a result, the signal power at the receiver fluctuate giving rise to fading. Apart from fading, constraints such as low power and limited bandwidth make the communication system designer's task of increasing data rate and reliability more challenging. MIMO technology can be used effectively to meet these requirements by taking advantage of multipath.

Orthogonal Frequency Division multiplexing (OFDM), the multi-carrier modulation (MCM) technique, has been seen to be very effective for communication over channels with frequency selective fading. It is very difficult to handle frequency selective fading in conventional communication receivers as the design of the receiver becomes hugely complex. OFDM technique efficiently utilizes the available channel bandwidth by dividing the channel into low bandwidth continuous channels. Instead mitigating frequency selective fading as a whole, OFDM mitigates the problem by converting the entire frequency selective fading channel into number of narrow bandwidth flat fading channels. Flat fading makes the receiver easier to combat channel tracking and Inter Symbol Interference (ISI) by employing simple equalization schemes.

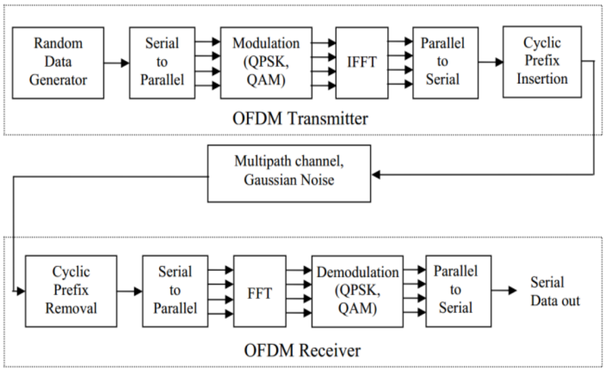

Fig 1.1 Block Diagram of OFDM Simulation Model.

Channel Estimation

In a typical scattering environment, a radio signal emitted from a transmitter is reflected, diffracted, and scattered from the surrounding objects, and arrives at the receiver as a superposition of multiple attenuated, delayed, and phase- and/or frequency-shifted copies of the original signal. Usually we call all these effects under one word: multipath. The superposition of multiple copies of the transmitted signal is the defining characteristic of many wireless systems. In the communication community, multipath is both a curse and a blessing. When a signal propagates through a wireless channel, it usually suffers fluctuations in the received signal strength which can affect the rate and also the reliability of communication.

Techniques of Channel Estimation

The methods to estimate multipath channels at the receiver can be classified into two classes: training-based channel estimation methods and blind channel estimation methods.

a) Training-Based Technique

In training-based channel estimation methods, the transmitter multiplexes signals that are known to the receiver (henceforth referred to as training signals) with data-carrying signals in time, frequency, and/or code domain, and CSI is obtained at the receiver from knowledge of the training and received signals. Training-based methods require relatively simple receiver processing and often lead to decoupling of the data-detection module from the channel-estimation module at the receiver, which reduces receiver complexity even further. See for an overview of training-based approaches to channel estimation.

b) Blind Technique

In blind channel estimation methods, CSI is acquired at the receiver by making use of the statistics of data-carrying signals only. Although it is theoretically feasible, blind estimation methods typically require complex signal processing at the receiver and often entail inversion of large data-dependent matrices, which also makes them highly prone to error propagation in rapidly varying channels. See for an overview of blind methods to channel estimation.

II. MIMO-OFDM SYSTEM

The transmission at high data rates in a wireless channel gives rise to Inter-Symbol Interference (ISI) which results in distortion in transmitted signal. A complex receiver structure is required to combat ISI. Orthogonal Frequency Division Multiplexing (OFDM) is a simple solution to this problem. OFDM transmits data simultaneously on multiple carriers, which are orthogonal to each other. Thus, a high data rate stream is converted into a number of small data rate streams and transmitted simultaneously on different subcarriers.

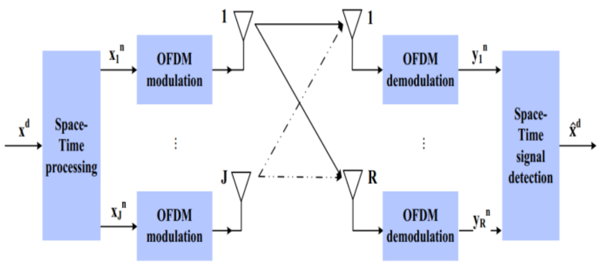

Fig. 2.1 MIMO-OFDM System.

The combination of MIMO and OFDM called as MIMO-OFDM has come out as an attractive air interface for many next generation wireless communication systems because of the advantages offered by them. OFDM directly extends to MIMO channels with IFFT/FFT and CP operations being performed at each transmit and receive antennas. Depending upon how MIMO coding is applied, there are three types of MIMO- OFDM systems. In Space-Time Block Coded (STBC) MIMO-OFDM system, the adjacent OFDM symbols are space-time coded. In Space Frequency Block Coded (SFBC) MIMO-OFDM system, the symbols on adjacent carriers are coded. In Spatial Multiplexing (SM) MIMO-OFDM system, no coding is used.

Consider a MIMO-OFDM system with transmit and receive antennas. The transmitter and receiver are shown in Fig. 3.1. Each OFDM symbol will have K subcarriers. The data to be transmitted is first modulated using M- PSK or M-QAM modulator. Then mapped symbols are grouped into groups of K symbols each to be transmitted on different antennas. The grouped symbols are coded and overlaid on K subcarriers depending upon the type of MIMO-OFDM system. The IFFT is applied to each group, and CP is added. The length of the CP is chosen to be greater than channel length L.

Pilot Joint Channel Estimation

The design of a second-order Kalman filtering method for fast fading channels based on pilot symbol aided modulation (PSAM) was introduced. However, as the fading rate increases, more pilot symbols are required to obtain sufficiently accurate channel estimates for reliable data detection. This reduces the overall data rate during fast fading to unacceptable levels for many applications. To improve the performance of PSAM, it is necessary to exploit iterative channel estimation and symbol detection approach.

The initial rough estimate of the channel using the pilot signals provides a low enough error rate for the detected data from the first iteration to be used as a ‘virtual’ pilot signal which is dense in the time domain. Data is detected and decoded before the channel is estimated again based on the detected data. Traditional decision directed channel estimation is sensitive to errors in previously detected data which can cause elevated error levels in data detected at later times, this is known as error propagation.

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.

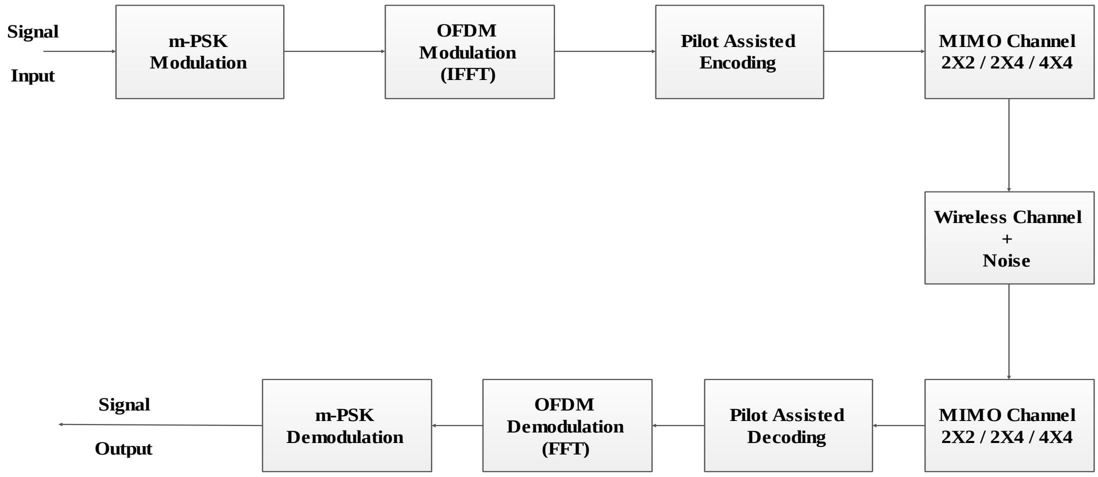

Fig.3.1 Block Diagram of Proposed Work.

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.

5. 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.

6. 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.

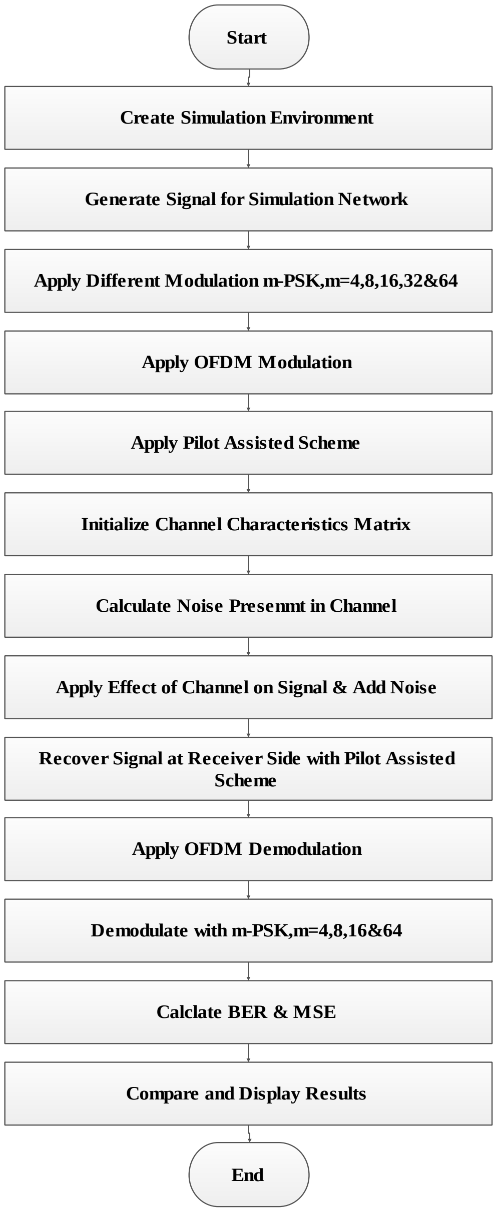

Fig.3.2 Flow chart of proposed work.

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).

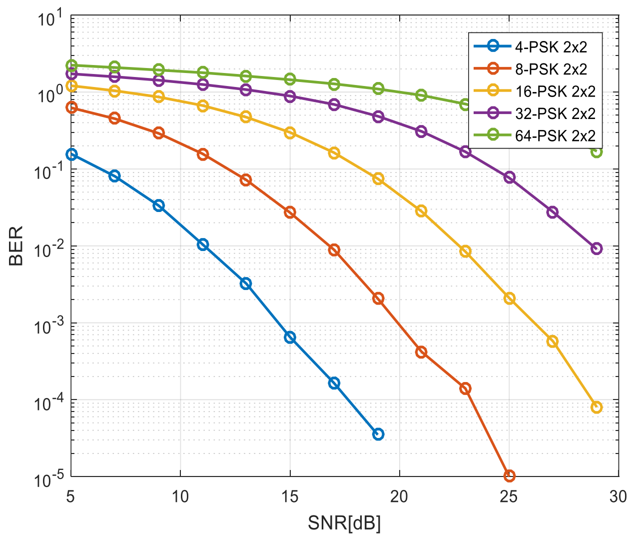

Fig.4.1 BER of the Proposed System with 2 Transmitting Antennas and 2 Receiving Antennas.

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.

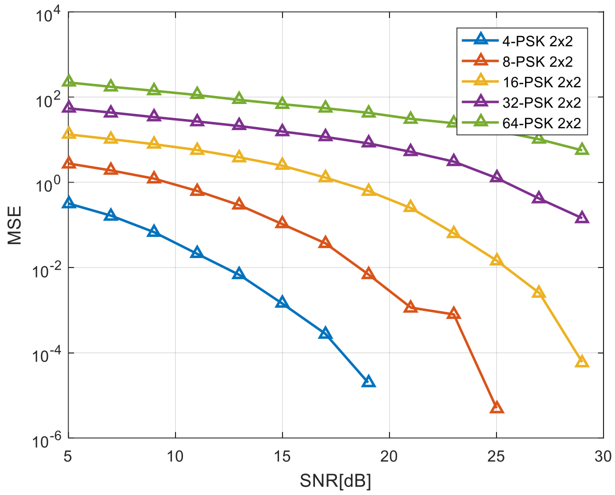

Fig.4.2 MSE of the Proposed System with 2 Transmitting Antennas and 2 Receiving Antennas.

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 outputantennas 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.

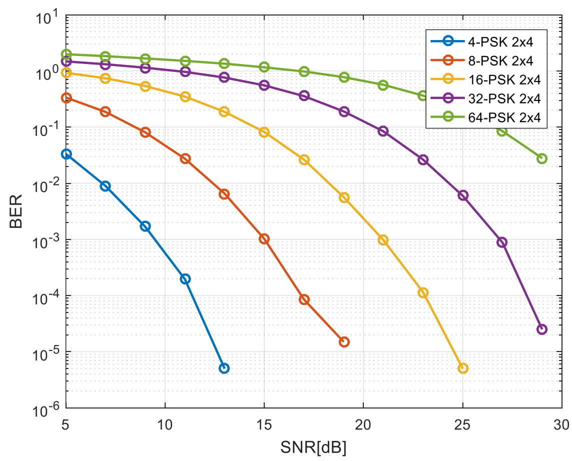

Fig.4.3 BER of the Proposed System with 2 Transmitting Antennas and 4 Receiving Antennas.

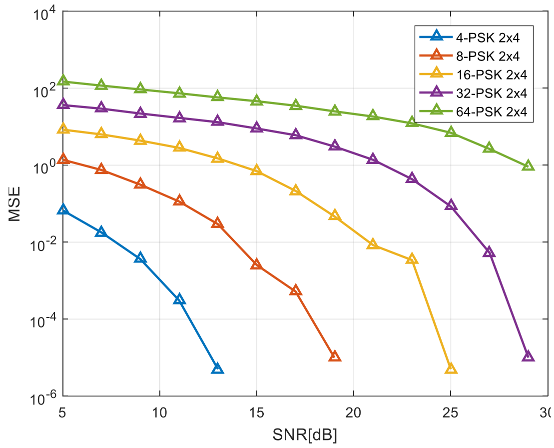

Fig.4.4 MSE of the Proposed System with 2 Transmitting Antennas and 4 Receiving Antennas

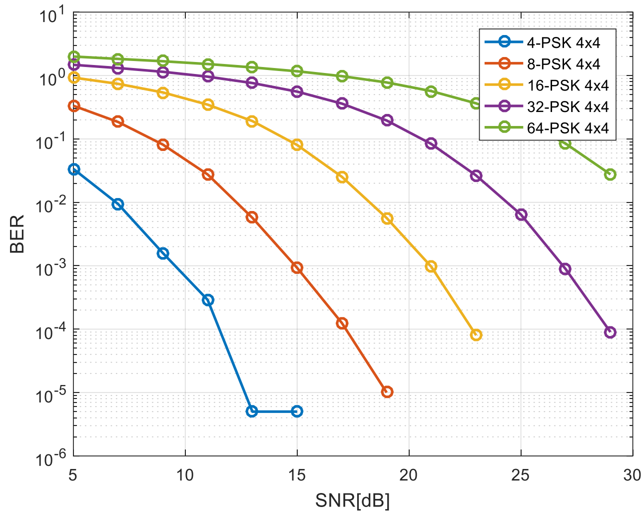

Fig.4.5 BER of the Proposed System with 4 Transmitting Antennas and 2 Receiving Antennas

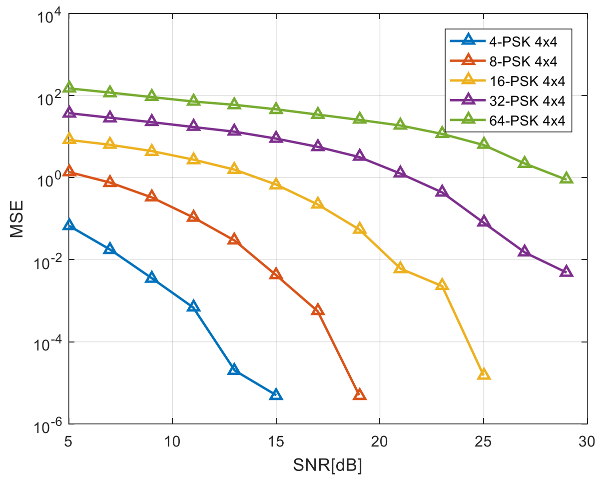

Fig.4.6 MSE of the Proposed System with 4 Transmitting Antennas and 4 Receiving Antennas

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.

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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