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IMPLEMENTING CHANNEL ESTIMATION AND MODULATION TECHNIQUES USING MIMO-PSK

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A B S T R A C T

Abstract— Wireless communication must be designed with the inbuilt characteristics inclusive of high data rates, transmission efficiency, high quality of data transmission and multimedia transmission in communication framework. In order to improve the spectral efficiency, higher bandwidth, demand in performance and efficiency MIMO system is used. MIMO system with multiple array of antennas utilize maximum spectrum and increase the spectral bandwidth, improve performance, efficiency and bandwidth. This paper aims to design the channel multiplexing based on MIMO PSK modulation and demodulation scheme. MATLAB tool is used to obtain design specifications. Xilinx FPGA is used to implement obtained design specifications using RTL coding.

1. INTRODUCTION

With growing population, the incorporation of wireless communication is found to be difficult. Properly designed wireless communication is the robust way for transmitting data over longer distance. The selection of proper way of communication helps in changing the lifestyle of the people whether urban or rural. Reliable communication with minimal interference is the key expectations of the wireless communication. The proposed work identifies the fading channel bit error rate with OFDM and Channel estimation techniques. To increase the bandwidth efficiency and to have an enhanced bandwidth, OFDM Techniques are utilized, where the data are modulated with various subcarriers being orthogonal to each other. The interference being the major concern in the wireless communication, the incorporation of cyclic prefix in the OFDM makes the communication system resistant to inter symbol interference and inter-carrier interference. Least mean square channel helps in reducing the impact of the multipath fading. The proposed work targets at improving the signal to noise ratio by reduced interference which the digital system fails to achieve. Added to the interference, error control gains more attention. The proposed system also helps in transmitting the data with reduced error pattern and thus more efficiency is achieved. The transmitter, receiver and the channel are the major components of the wireless communications. The data being encrypted, modulated and coded are thus transmitted with the help of transmitter antenna. The coded data is thus transmitted via the channel. Being wireless communication, channel understanding is the key aspect and the data security, interference and errors are the parameter constraints. The way by which the data is affected is referred as non - linearity's or imperfections. A communication system must be designed in a way

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that it causes less Noise and less distortion to the data. This way of communication device design helps to improve the quality of the signal. Thus with the perfect channel design, process, the enhanced data can be transmitted successfully with the well designed channel.

Ensuring the optimal signal processing is the critical aspect of wireless communication, along with the design of channel. The quality assurance is important in the utilization of signal processing techniques for any wireless communication. The proposed technique helps in retaining the integrity of the system by mitigating the noise and distortion of the signal all along the process of communication. These signal processing algorithms supports in reducing the impact of interference, imperfections and nonlinearities. Thus for building the strongest wireless communication system, the signal processing algorithm has to be added to the system.

2. LITERATURE SURVEY

A set of research articles has been reviewed and it is explained in detail. With a limited number of measurements, compressed sensing (CS) method helps in the efficient reconstruction of sparse signals (Ian Graffiths et al., 2005). It attracts more research implementation and also finds suitable for pilot-based channel estimation in wireless communication. A typical sparse reconstruction scenario (John G.Proakis et al 2021) evaluates the parameter vector and helps in reconstructing the data transmitted (Bernard Sklar et al., 2003). OFDM with rigid qualities helps to construct the strongest mobile communication system (Chia-Liang Lui et al., 1998).It supports for improved data rate and high data security, and thus helps in building strongest modulation scheme. An algorithm based strengthened wireless data communication is supported with OFDM. The channel information is estimated with the pilot- based channel estimation from all sub carriers. (Changchuan Yin, Jingyu Li, Xiaolin Hou and Guangxin Yue et al., 2006) proposed a comparative between digital modulation schemes such as FSK, ASK and PSK, where it is indentified as less effective and doesn't match the requirements of the real time wireless communication system. So alternate with improved support to high data rate and reduced interference is demanded which can be achieved with MIMO techniques. Based on the survey, to satisfy the demands of wireless communication system, MIMO based system is proposed in this paper.

3. PROPOSED SYSTEM

The improvisation of the signal parameters inclusive of frequency, amplitude and phase are the major concern in the design of wireless communication. The processing of these parameters with more attention improves the quality of the signal been transmitted. FSK is the technique that involves modulation process to improve any of the mentioned three signal properties. The advantages of these modulation process includes the size reduction of the antenna, avoids multiplexing with reduced SNR and thus supports for long distance communication. The FSK modulates the frequency of the signal with respect to the carrier signal. Alternatively, If modulation is performed with the amplitude , it is referred as amplitude shift keying.

Power extraction from any wireless device can be optimized with the characteristic impedance R of the load which is the ratio of voltage to current. The maximum efficiency is achieved at its inverse of the resistance value. Though the efficiency depends on R, it is not a fixed value rather a dynamic quantity with changing conditions inclusive of illumination, temperature and age of the cell. The power drawn from the device is less than the maximum potential of the device. This justifies that the device works less than its efficiency. This resistive approach based controller performs more computations to support for efficiency improvement. The P&O method referred as Perturb and observe method, offers more significance to the changing circumstances and lead to power output oscillations. The maximum power point is measured with the incremental conductance method. The comparison between the incremental and array conductance is performed with this method, represented as $I / V = I\Delta / V\Delta$. Current sweep method can also be used.

The proposed work starts with the comparison between the QPSK and FSK. The information with respect to phase is varied in QPSK and varied with respect to frequency in FSK. QPSK has less moderate bandwidth than FSK. Both has better noise immunity. The QPSK signals is represented in the figure 1.

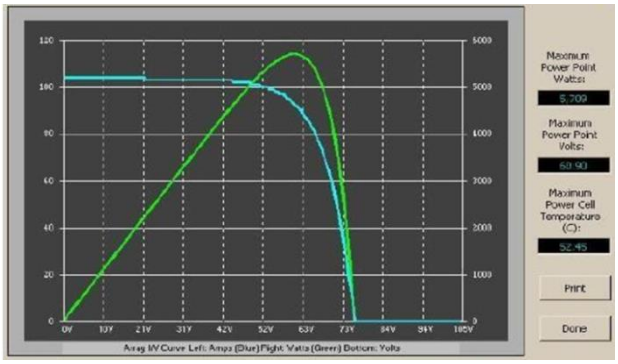

Figure 1. QPSK signals

The open voltage method is used to interrupt the power supply of the load with current being zero measured. The voltage is controlled at a fixed ratio with the help of the controller as 0.76 of voltage of the circuit at open condition. This is generally the value used to determine the maximum power point for expected operating conditions. PV array operating point is calculated and kept near the MPP by regulating the voltage matching it to the fixed voltage of Vref =KVOC. The Modulation

and demodulation technique of frequency shift keying is shown in the figure 2.

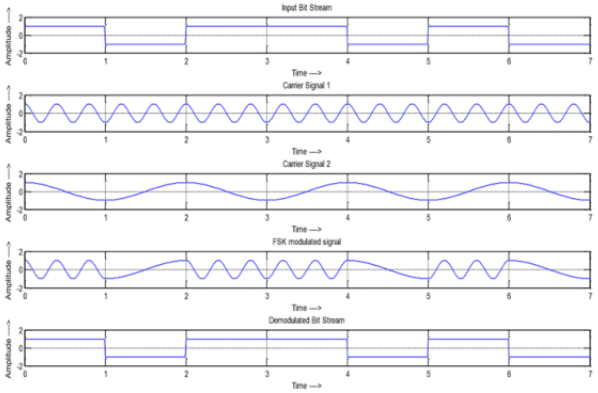

Figure 2. Frequency shift keying modulation and demodulation

The randomly generated data is modulated with the BPSK modulation technique. The channel being AWGN, the frequency to time conversion is performed with IFFT and the reverse with the FFT. The combination of IFFT, AWGN, FFT represent the OFDM system. BER is calculated for the transmitted data and displayed as a block. The error analyzed ranges as 5dB, 10dB and 15dB. The error rate is 0.4948, 0.4964 and 0.4938 respectively. The error rate is reduced with the help of BPSK with OFDM techniques. The BER is a parameter that improves the performance of the wireless data channel.

Table 1. BER vs. SNR comparison of Image Transmission using BPSK with and without channel estimation

SNR (dB)	Without Channel Estimation	With Channel Estimation
5	0.4948	0.099
10	0.4964	0.033
15	0.4938	0.0072

The Table I represents the comparative analysis of BER and SNR of BPSK modulation. This comparison is made with channel and without channel estimation. Channel estimation has the key significance in the wireless channel design. The well designed channel improves the performance of the channel by properly transmitting the data with minimal error and high data rate. The least mean square estimation is used for the channel estimation to reduce the effect of multipath fading. The bit errors can be reduced by applying the channel estimation technique. The comparison of SNR with channel and without channel estimation is performed and tabulated for analysis. Another digital technique for wireless communication design is the PSK, represented in the figure 4. It is widely used in telecommunication and data transmission. The phase of the carrier is changed to decode the data, resembling the phase modulation. The data in its binary form are represented as phase shifts. PSK holds derivative as BPSK, QPSK. The performance of the system is evaluated with the BER. PSK can be coherent or non-coherent.

Channel estimation for 2x2 is used for MIMO design implementation. Two transmitters and 4 channels are considered and the same is represented in the figure 3. An alamouti encoder and decoder is not used in the proposed system, instead diversity technique is implemented.

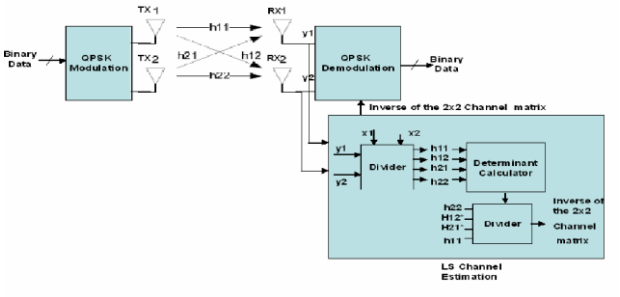

Figure 3. Block showing QPSK modulator/demodulator with LS channel estimation

The figure 3 represents the channel estimation block diagram. The 2x2 channel estimation with tx2 as transmitter is implemented in the proposed system. The data obtained at the receivers rx1 and r2 are well defined with the equations and algorithms. This makes the system rigid with better performance. The transmitted bits are decoded and represented in

$$h = y/x \quad (1)$$

The most commonly preferred digital modulation technique is the PSK represented in the figure 4. The derivatives of PSK are widely used with fixed amplitude and fixed phase. A phase modulation scheme, QPSK is used for constellation mapping. The QPSK modulator takes input as symbols and converts them to complex values. This is how QPSK generates its complicated value using only 4 symbols.

D = (I +jQ)*KMOD Where KMOD = 1/1.414.

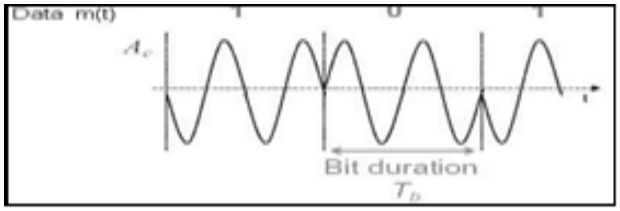

Figure 4. PhaseShiftKeying

QPSK modulator and demodulator are some of the different blocks that make up the 2x2 MIMO system represented in the figure 5. Binary bits are provided to the QPSK modulator. The input bits are treated as symbols in this case. For example, the four input symbols for QPSK are 00, 01, 10, and 11. The complex values of the input symbols are represented in the Table II. Communication channel for 2x2 MIMO system is shown in Fig:6

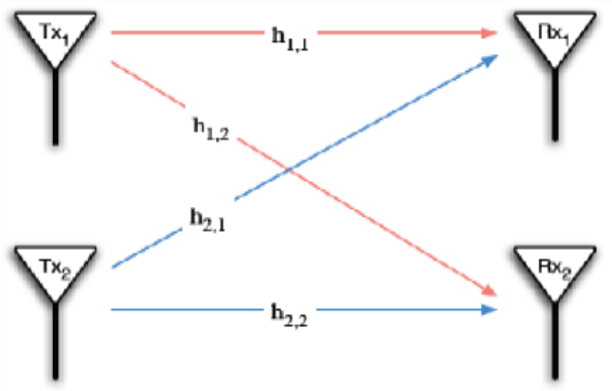

Figure 5. Communication Channel for 2x2 MIMO System

Table 2. Inputs and Outputs of QPSK Modulator

Input Bits	I-out	Q-out
00	-1	-1
01	-1	+1
11	+1	-1
10	+1	+1

When the channel doesn't consider the noise, it is accepted as a ideal channel. Diversity technique helps in increasing the reliability of the system. This helps in transmitting the same information across multiple channels. If one of the channels is not used or if the data is lost in space then the information/data can still be recovered from redundant transmission over the channels and hence the reliability of the communication system is improved.

4. RESULTS AND DISCUSSIONS

The goal is to evaluate channel estimation performance; we presume that synchronization is excellent. Guard interval increase with reference to the delay spread at the maximum helps in avoiding the inter-symbol interference. Different values of SNR ratios and the doppler spreads are simulated and graphed for analysis of the performance. QPSK and 16 QAM modulation is implemented along with OFDM other than rayleigh channel. This is been simulated with the MATLAB. The BER of the Block-type pilot-based channel estimation in OFDM is implemented with 16 QAM and QPSK respectively. LMMSE and SVD rank of 16 and 20 have better results than LS estimator and SVD with rank 5. MATLAB performing comb-type pilot based channel estimation with 16 QAM and QPSK modulation respectively. The Interpolation with cubic spline performs better than linear and second order interpolation.

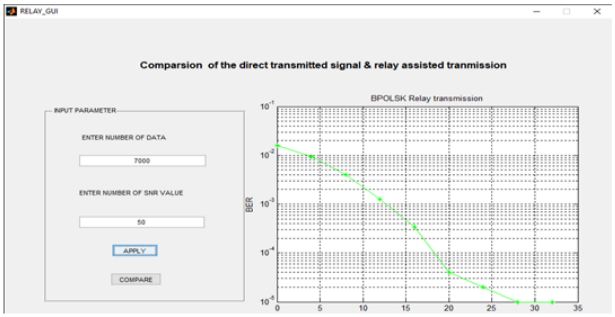

Figure 6. QPSK signal

Table 3. Simulation Parameters

Parameters	Specification
FFT Size	74
No. of used Sub carriers	63
No. of OFDM Symbols	17
Constellation	BPSK / QPSK
Channel model	AWGN , FNS, Multipath
No. of Taps/ Mutipath	10

Thus QPSK, FSK and PSK has been compared for the proposed algorithm. Better results with reduced signal to noise ratio is achieved in PSK.

5. CONCLUSION

When compared to QPSK,FSK and PSK the results obtained shows that the Signal to noise ratio is decreased and efficiency is increased in Phase shift keying when compared to other modulation techniques. Spectral efficiency is increased and Bandwidth parameters are increased using 2x2 MIMO techniques. This is achieved with the help of design simulator using MATLAB and RTL coding using Xilinx software.

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