Channel Estimation of MIMO-OFDM through Wavelet Transform to Improve the Spectral Efficiency and Data Transmission Rate

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Abstract. We define a new wavelet transform that is based on a recently defined family of scaling functions: the fractional B-splines. The interest of this family is that they interpolate between the integer degrees of polynomial B-splines and that they allow a fractional order of approximation. The approximation can determine noise in communication signals and help in signal reconstruction and channel estimation in MIMO receiver system. In free space optical communication links, the turbulent atmospheric channel causes fluctuations in both intensity and phase of the transmitted optical signal which degrades their performance. In order to make free space optical communications commercially viable, there is a need for characterizing the atmospheric effects on the received signal statistics, and possibly correcting for the signal degradation using physical optics principles and advanced real-time signal processing techniques. As part of this work, we have constructed an experimental free space optical link over 100 meters so as to characterize the effects of inner-scale and outer-scale turbulence effects, and used it as the platform for carrying out the above objectives. Through these techniques, we have demonstrated bit error rate (BER) reduction and propose to estimate channel accurately.

Key words: OFDM, MIMO, BPSK, BER.

1. Introduction

Free space optical communication has drawn considerable attention recently for a variety of high data rate applications due to its large bandwidth potential (> 10 Gbps), availability of fast switching optical sources and detectors, unregulated spectrum, ease of re-deployment and the potential for low bit error rate (BER<10⁻⁹) through coding techniques [1]. However, such optical links are susceptible to atmospheric wave propagation effects such as scattering (dust, rain, fog, and snow), scintillations and beam wandering. Out of these potential impairments, scintillations and beam wandering are due to refractive index fluctuations caused by thermal gradients in the atmosphere along the beam propagation path as shown in Figure 1. Such refractive index fluctuations result in random variation in the received signal. These signal variations at the receiver leads to increase the bit error probability, thereby limiting...
the system performance in free space optical links. In order to optimize the system performance, one has to characterize the atmospheric turbulence effects and build a model that relates the scintillations and beam wandering induced signal variance to atmospheric parameters. A key challenge is to separate out the relative contributions of scintillations and beam wandering from the overall received signal. Subsequently, specific techniques have to be developed to mitigate the atmospheric turbulence effects and thereby demonstrate improved link performance. In this paper, we have characterized the link with respect to the atmospheric conditions and also provided a solution for mitigating the atmospheric turbulence effects on received signal, alternatively on signal statistics [2-9].

![Figure 1. Schematic diagram of a free space optical link.](image)

The specific issues addressed in this paper are as follows:

1. Characterization of atmospheric turbulence effects. Setting up an outdoor free space optical link and automation data collection. Characterization of signal variance due to scintillations and beam wandering. Correlating the above variances with atmospheric parameters.
2. Mitigation of signal degradation effects due to atmospheric turbulence. Aperture averaging to reduce signal variance due to scintillations. Wavelet-based signal processing to counter beam wandering-related signal variance.

2. Multiple Antenna techniques

**SISO**

Single-Input Single-Output is the classical method in wireless communication and the most common antenna configuration, using one antenna at transmitter and one at the receiver. It is used in radio, TV broadcast and in technology as WiFi, Bluetooth.

**SIMO**

Single-Input Multiple-Output is the system using one antenna at transmitter and multiple antennas at the receiver. It provides receiver diversity which receive the strongest signal from several transmit antennas. Generally, it is used in Uplink environment. In Multiple-Input Single-Output two or more number of antennas are used in the transmitter and one antenna at the receiver. It provides transmit diversity because of multiple antenna at a transmitter side. MISO technology has applications in WLAN, MAN and digital television (DTV). Commonly, it is used in downlink scenarios.

**MIMO**

Multiple-Input Multiple-Output uses multiple antennas at both sides which provides transmit diversity and receiver diversity. It’s applicable in every kind of networks like PAN, LAN, WLAN, WAN, MAN. MIMO system can be applied in different ways to receive either a diversity gains, capacity gain or to overcome signal fading. The typical aspirations of a system designer are high data rate, low bit error rate, low power consumption, low cost and easy implement ability [2]. The MIMO system ensures us very high data rates even more than 1Gbps while minimizing the bit error rate. By Shanon’s theorem the rate of transmission is always less than or equal to the capacity. Practically it is less than the capacity. The capacity depends on the bandwidth of the channel and SNR of the channel. Both the bandwidth and signal to noise ratio are characteristics of the channel.
2.1 MIMO-OFDM
Orthogonal Frequency Division Multiplexing (OFDM) is one of the most promising physical layer technologies for high data rate wireless communications due to its robustness to frequency selective fading, high spectral efficiency, and low computational complexity. OFDM can be used in conjunction with a Multiple-Input Multiple-Output (MIMO) transceiver to increase the diversity gain and/or the system capacity by exploiting spatial domain. Because the OFDM system effectively provides numerous parallel narrowband channels, MIMO-OFDM is considered a key technology in emerging high-data rate systems such as 4G, IEEE 802.16, and IEEE 802.11n. MIMO communication uses multiple antennas at both the transmitter and receiver to exploit the spatial domain for spatial multiplexing and/or spatial diversity. Spatial multiplexing has been generally used to increase the capacity of a MIMO link by transmitting independent data streams in the same time slot and frequency band simultaneously from each transmit antenna, and differentiating multiple data streams at the receiver using channel information about each propagation path, future standards need to specify both bandwidth requirements and type of signaling that achieves the data rate required for minimal predefined qualities of services for future applications. That is the average bit error rate (BER) can be made arbitrarily close to zero by use of channel coding, for transmissions up to the maximum achievable rate. For mobile channels, that are time-varying and dispersive in time and frequency however the channel capacity derivation is still an open research area.

3. Literature survey
3.1 Transmission scheme for MIMO-OFDM system
This contribution introduces a new transmission scheme for multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) systems. The new scheme is efficient and suitable especially for symmetric channels such as the link between two base stations or between two antennas on radio beam transmission. The principle is based on the estimation of channel parameters of a pilot data sent by the receiver to the transmitter. Then, the transmitter codes the transmitted signal using the estimated channel parameters to adapt the signal to the channel variations. Conducted Monte-Carlo simulation results show that the proposed scheme has better performance, in terms of bandwidth efficiency and complexity, compared to the conventional MIMO-OFDM scheme methods in the case of a symmetric channel.

3.2 MIMO-OFDM wireless systems: basics, perspectives, and challenges
Multiple-input multiple-output (MIMO) wireless technology in combination with orthogonal frequency division multiplexing (MIMO-OFDM) is an attractive air-interface solution for next-generation wireless local area networks (WLANs), wireless metropolitan area networks (WMANs), and fourth-generation mobile cellular wireless systems. This article provides an overview of the basics of MIMO-OFDM technology and focuses on space-frequency signaling, receiver design, multiuser systems, and hardware implementation aspects. We conclude with a discussion of relevant open areas for further research.

3.3 Evaluation of BER for AWGN, Rayleigh and Rician fading channels under various modulation schemes
Several transmission modes are defined in IEEE 802.11 a/b/g WLAN standards. A very few transmission modes are considering for IEEE 802.11 a/b/g in physical layer parameters and wireless channel characteristics. In this paper, we evaluated the performance of available transmission modes in IEEE 802.11b. However, the performance analysis can be done Straight forward using the evaluation of IEEE 802.11b. The performance of transmission modes is evaluated by calculating the probability of Bit Error Rate (BER) versus the Signal Noise Ratio (SNR) under the frequently used three wireless channel models (AWGN, Rayleigh and Rician). We consider the data modulation and data rate to analyze the performance that is BER vs. SNR. We also consider multipath received signals. The simulation results had shown the performance of transmission modes under different channel models and the number of antennas. Based on simulation results, we observed that some transmission modes
are not efficient in IEEE 802.11b. The evaluation of performance confirms the increase in the coverage area of the physical layer in the 802.11b WLAN devices.

3.4 BER comparison of Rayleigh fading channel with Alamouti space time block coding and the method of MRC

This paper proposes a technique which uses chaotic communication system combined with Rayleigh fading channel, for secure communications and to improve the system performance by mitigating interference. For secure communications, chaotic sequences are used. Many chaotic communication systems have been proposed, but most of them show a poor performance of MIMO-OFDM system, Rayleigh fading channel is used. Evaluation and comparison of the performances of MIMO-OFDM system in the AWGN (Additive White Gaussian Noise) channel, Rayleigh fading channel and the MRC diversity methods are provided. Results are verified and analyzed for two cases, one when we used 1*2 and 2*1 diversity scheme for Rayleigh fading channel with Alamouti scheme is used in the proposed system and second when diversity method under realistic channel conditions (i.e. noise and multipath fading). This paper proposes a wireless communication structure based on two coupled chaotic systems. In order to enhance the error rate of MRC is used in the proposed system. Computer simulations are done to verify the performance of the proposed approach. A simulation tool with a Graphical User Interface (GUI) which implements these algorithms is also developed to provide ease in the execution.

4. Methodology

The broad objectives of this work were to characterize the behavior of the turbulent atmospheric channel and to mitigate the turbulence-induced degradation of the received signal. To carry out the work experimentally, we have analyzed signal form free space optical communication link of 100 meters’ length with automated data collection. A key aspect of our work related to the atmospheric channel characterization is the separation of the variance due to scintillations and beam wandering [3]. We observed such signal variance at different times of the day and correlated them to atmospheric parameters such as temperature, wind velocity; pressure and humidity with fractional spline wavelet transform technique. We have also investigated schemes for mitigating the turbulence-induced degradation of the received signal by analyzing signal losses in low frequency and high frequency with fractional spline wavelet transform.

Figure 2. Block Diagram of OFDM Transceiver

![Figure 2. Block Diagram of OFDM Transceiver](image-url)
5. Design Circuit

5.1 Binary Format
Binary format means that the sign (positive or negative) is in the leftmost bit of the field and the integer value is in the remaining bits of the field. Positive numbers have a zero in the sign bit; negative length of the field is from one to four digits; the compiler assumes a binary field length of 2 bytes. If the length of the field is from five to nine digits, the compiler assumes a binary field length of 4 bytes.

5.2 Input and Output Sizes
If the convolutional code uses an alphabet of \(2^n\) possible symbols, this block's input vector length is \(L \cdot n\) for some positive integer \(L\). Similarly, if the decoded data uses an alphabet of \(2^k\) possible output symbols, this block's output vector length is \(L \cdot k\). This block accepts a column vector input signal with any positive integer value for \(L\). For variable-sized inputs, the \(L\) can vary during simulation. The operation of the block is governed by the operation mode parameter.

5.3 Input Values and Decision Type
The entries of the input vector are either bipolar, binary, or integer data, depending on the Decision type parameter.

5.4 Fixed-Point Viterbi Decoding Examples
The following two example models showcase the fixed-point Viterbi decoder block used for both hard- and soft-decision convolutional decoding. If you are reading this reference page in the MATLAB® Help Browser, click Fixed-point Hard-Decision Viterbi Decoding and Fixed- point Soft-Decision Viterbi Decoding to open the models.

6. MATLAB
MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Experimental specifications
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building
- MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation. MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science [5]. In industry, MATLAB is the tool of choice for high productivity research, development, and analysis. MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology.
6.1 The MATLAB mathematical function library
This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

6.2 The MATLAB Application Program Interface (API):
This is a library that allows you to write C and Fortran programs that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

7. BER vs SNR
In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. The bit error rate or bit error ratio (BER) is the number of bit error divided by the total number of transferred bits during a studied time interval. BER is a unit less performance measure, often expressed as a percentage. The bit error probability is the expectation value of the BER. The BER can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors. The BER may be improved by choosing strong signal strength by choosing a slow and robust modulation scheme or line coding scheme, and by applying channel coding schemes such as redundant forward error correction code. Binary symmetric channel which is used in analysis of decoding error probability in case of non bursty bit errors on Additive white Gaussian noise (AWGN) channel without fading [6]. A worst case scenario is a completely random channel, where noise totally dominates over the useful signal. In a noisy channel, the BER is often expressed as a function of the normalized carrier-to-noise ratio measured denoted Eb/N0 that is energy permit to noise power spectral density ratio, or Es/N0 that is energy per modulation symbol to noise spectral density. As the name implies, a bit error rate is defined as the rate at which errors occur in a transmission system. This can be directly translated into the number of errors that occur in a string of a stated number of bits. The definition of bit error rate can be translated into a simple formula:

BER = number of errors / total number of bits sent

| MODULATION SCHEME | SNR   | BER  |
|-------------------|-------|------|
| BPSK              | 10dB  | 10^-5 |
| QPSK              | 10dB  | 10^-2.9 |
| QAM               | 10dB  | 10^-3 |
| 64-QAM            | 10dB  | 10^-1.8 |

Figure 3. Compare BER vs BPSK modulation
8. Comparisons between Hard and Soft-Decision Decoding

The two models are set up to run from within BER Tool to generate a simulation curve that compares the BER performance for hard-decision versus soft-decision decoding.
8.1 Serial to parallel converter
This is a simple method to convert a serial data that have been entered to the circuit into parallel one. The reverse parallel to serial can be done in a similar manner. In fact, the first one is useful in computer systems architecture. For example, in ALUs, data can be entered serially and the input, for ALU operations, can be applied in parallel.

8.2 QPSK Modulation and Demodulation
The QPSK (also sometimes called PRK, phase reversal keying, or 2PSK) is the simplest form of phase shift keying (PSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK. It does not particularly matter exactly where the constellation points are positioned, and in this figure they are shown on the real axis, at 0° and 180°. This modulation is the most robust of all the PSKs since it takes the highest level of noise or distortion to make the demodulator reach an incorrect decision. It is, however, only able to modulate at 1 bit/symbol and so is unsuitable for high data-rate applications [8]. In the presence of an arbitrary phase-shift introduced by the communications channel, the demodulator is unable to tell which constellation point is which. As a result, the data is often differentially encoded prior to modulation. BPSK is functionally equivalent to 2-QAM modulation.

8.3 FFT and IFFT
The OFDM transmitter and receiver contain Inverse Fast Fourier Transform (IFFT) and Fast Fourier Transform (FFT), respectively. The IFFT/FFT algorithms are chosen due to their execution speed, flexibility and precision. For real time systems the execution speed is the main concern. The IFFT block provides orthogonality between adjacent subcarriers. The orthogonality makes the signal frame relatively secure to the fading caused by natural multipath environment. As a result, OFDM system has become very popular in modern telecommunication systems. The main objective of this paper is to design IFFT/FFT blocks for OFDM, because are main blocks for modulation and demodulation in OFDM transmitter and receiver. The OFDM signal is generated by implementing the Inverse Fast Fourier Transform (IFFT) at the transmitter which is used to convert frequency domain to time domain and Fast Fourier Transform (FFT) which is used to convert time. Equation Where, N is the transform size or the number of sample points in the data frame. X(k) is the frequency output of the FFT at kth point where k=0, 1, …, N-1 and x(n) is the time sample at nth point with n=0, 1,…, N-1.

8.4 Pilot signal
"Pilot tone" redirects here. For pilot tones in motion picture sound recording systems, see Pilottone. In telecommunications, a pilot signal is a signal, usually a single frequency, transmitted over a communications system for supervisory, control, equalization, continuity, synchronization, or reference purposes. Spectrum of an FM broadcast signal. The pilot tone is the orange vertical line on the right of the spectrogram. In FM stereo broadcasting, a pilot tone of 19 kHz (19×2, the second harmonic of the pilot). The receiver doubles the frequency of the pilot tone and uses it as a phase reference to demodulate the stereo information. If no 19 kHz pilot tone is present, then any signals in the 23-53 kHz range are ignored by a stereo receiver. A guard band of ±4 kHz (15-23 kHz) protects the pilot tone from interference from the baseband audio signal (50 Hz-15 kHz) and from the lower sideband of the double sideband stereo information (23-53 kHz). The third harmonic of the pilot (19×3, or 57 kHz) is used for Radio Data System. In AM stereo, the bandwidth is too narrow to accommodate subcarriers, so the modulation itself is changed, and the pilot tone is infrasonic (below the normal hearing range, instead of above it) at a frequency of 25 Hz. In color television, the color burst placed between each pair of video fields is the pilot signal to indicate that there are color subcarriers present. In the NTSC television system, a pilot tone of 15.7342657 kHz issued to indicate the presence of MTS stereo.

8.5 Parallel to serial
When data is to be sent over a large distance then the parallel data are send serially over single wire (plus ground). To send parallel data serially from microprocessor or microcontroller or DSP chips,
parallel to serial converter is required. Not only is parallel to serial converter required at the microprocessor chip level but also in other parts of communication system. For telephone system for example, parallel to serial and serial to parallel converters are required for implementing modulation/demodulation.

8.6 Add cyclic prefix

The term cyclic prefix refers to the prefixing of a symbol with a repetition of the end. Although the receiver is typically configured to discard the cyclic prefix samples, the cyclic prefix serves two purposes. As a guard interval, it eliminates the inter symbol interference from the previous symbol. As a repetition of the end of the symbol, it allows the linear convolution of a frequency selective multipath channel to be modeled as circular convolution, which in turn may be transformed to the frequency domain using a discrete Fourier transform. This approach allows for simple frequency-domain processing, such as channel estimation and equalization. In order for the cyclic prefix to be effective (i.e. to serve its aforementioned objectives), the length of the cyclic prefix must be at least equal to the length of the multipath channel. Although the concept of cyclic prefix has been traditionally associated with OFDM systems, the cyclic prefix is now also used in single carrier systems to improve the robustness to multipath propagation.

![Figure 7. Functional diagram of Cyclic prefix code](image)

8.7 OFDM Transmitter IFFT and Receiver FFT

The IFFT transform a spectrum (amplitude and phase of each component) into a time domain signal. An IFFT converts a number of complex data points, of length that is power of 2, into the same number of points in time domain. Each data point in frequency spectrum used for an FFT or IFFT operation is called a bin. The Inverse Fast Fourier Transform (IFFT) performs N-Point IFFT operation for the received constellation points from the QPSKM appear. The output is of N time domain samples. After N-point computation these values are passed through parallel to serial converter FFT Converters time domain to frequency domain. The parallel symbols which are received from serial to parallel converter perform N-Point FFT operation and sends to de mapped.

8.8 Symbol Detection

Symbol detection in multi-input multi-output (MIMO) communication systems using different particles warm optimization (PSO) algorithms is presented. This approach is particularly attractive as particles warm intelligence is well suited for real-time applications, where low complexity and fast convergence is of absolute importance. While an optimal maximum likelihood (ML) detection using an exhaustive search method is prohibitively complex, PSO assisted MIMO detection algorithms give near-optimal bit error rate (BER) performance with a significant reduction in ML complexity. The input serial binary data will be processed by a data scrambler and then channel coding is applied to the input data to improve the BER (bit error rate) performance of the system. The encoded data stream is further interleaved to reduce the burst symbol error rate. Dependent on the channel condition like fading, base modulation
modes such as BPSK (binary phase shift keying), QPSK (quadrature phase shift keying) and QAM are adaptively used to boost the data rate. The modulation mode can be changed even during the transmission of data frames. The resulting complex numbers are grouped into column vectors which have the same number of elements as the FFT size, N. To combat the multipath delay spread in wireless channels, the time-domain samples $s(m)$ is cyclically extended by copying the last $N_g$ samples and pasting them to the front, as shown in figure 8.

\[ N_{\text{tot}} = N + N_g \]  

Figure 8. OFDM symbol with cyclic extension with its wave form

Let $u(m)$ denote the cyclically extended OFDM symbol as

\[
\tilde{u}(m) = \begin{bmatrix}
    u(mN_{\text{tot}}) \\
    \vdots \\
    u(mN_{\text{tot}} + N_{\text{tot}} - 1)
\end{bmatrix} = \begin{bmatrix}
    CP \\
    \tilde{s}(m)
\end{bmatrix}_{N_{\text{tot}} \times 1}
\]

\[ N_{\text{tot}} = N + N_g \]  

Where; is the length of $u(m)$. In the form of matrix, the CP insertion can be readily expressed as a matrix product of $s(m)$ and an $N \times N$ matrix $ACP$. By straight computation, it holds that: One of the challenges from the harsh wireless channels is the multipath delay spread. If the delay spread is relatively large compared to the symbol duration, then a delayed copy of a previous symbol will overlap the current one which implies severe ISI. To eliminate the ISI almost completely, a CP is introduced for each OFDM symbol and the length of CP, $N_g$ must be chosen longer than the experienced delay spread, $L$, i.e., $N_g > L$. In addition, CP is capable of maintaining the orthogonality among subcarriers which implies zero ICI. It is because the OFDM symbol is cyclically extended and this ensures that the delayed replicas of the OFDM symbol always have an integer number of cycles within the FFT interval, as long as the delay is smaller than the CP. No matter where the FFT window starts, provided that it is within the CP, there will be always one or two complete cycles within FFT integration time for the symbol on top and at below respectively. For the wireless channel, it is assumed in this thesis as a quasi-static frequency-selective Rayleigh fading channel. It indicates:

\[
r(mN_{\text{tot}} + n) = \sum_{l=0}^{L-1} h_{l,m} u(mN_{\text{tot}} + n - l) + v(mN_{\text{tot}} + n)
\]

that the channel remains constant during the transmission of one OFDM symbol. Suppose that the multipath channel can be modeled by a discrete-time baseband equivalent $(L/1)^{th}$-order FIR (Finite impulse response) filter with filter taps.

\[ \{h_0, h_1, \ldots, h_l, \ldots h_{L-1}\} \]
It is further assumed that the channel impulse response, i.e., the equivalent FIR filter taps, are independent zero mean complex Gaussian
\[ \{ p_0, p_1, \ldots, p_L \} \] \hspace{1cm} (4)
random variables with variance of per dimension. The ensemble of is the PDP (power delay profile) of the channel and usually the total power of the PDP is normalized to be 1 as the unit average channel attenuation. Denote the CIR (channel impulse response) vector \( h_m \) as
\[
\bar{h}_m = \begin{bmatrix}
    h_{0,m} \\
    . \\
    . \\
    . \\
    h_{L-1,m}
\end{bmatrix}_{L \times 1} \] \hspace{1cm} (5)
Where, the subscript \( m \) is kept to imply that the channel may vary from one OFDM symbol to the next one. Then the complex baseband equivalent received signal can be represented by a discrete-time convolution.

9. Results and Discussion
For \( Eb/No=10 \text{dB} \), Bit Error Rate=3.87x10^{-06}

![Figure 9. Simulated Output BER vs Eb/SNR](image-url)
10. Conclusion
MIMO-OFDM is a powerful modulation technique used for high data rate, and is able to eliminate ISI. It is computationally efficient due to the use of FFT techniques to implement modulation and demodulation functions. The performance of using MATLAB/SIMULINK tool box. Computer simulations are done to verify the performance of the proposed approach. A simulation tool with a Graphical User Interface (GUI) which implements these algorithms is also developed to provide ease in the execution. Performance analysis of FFT-OFDM and is done using BPSK under AWGN channel. STBC-MIMO system is implemented for 2*2 diversity scheme. STBC-MIMO system as we increase number of receive antennas BER performance of system is improved. System complexity is reduced and the transmission rate is increased. So, the combination of MIMO system and FFT-OFDM system will improve the BER performance of wireless communication system. MIMO-OFDM system with BPSK scheme is suitable for low capacity, short distance application. While the OFDM with higher modulation scheme is used for large capacity, long distance application at the cost of slight increase inEb/No. BER is large in BPSK as compared to QAM and it generally depends on applications. In this project, we implemented and optimized the 2x2 MIMO-OFDM transmitter and receiver for different embedded platform. We reduced the bit error rate of MIMO-OFDM from 10^-2 to 10^-5 using 2x2 array. We concluded that BPSK modulated MIMO - OFDM system achieves better BER results than QPSK/QAM and other modulated MIMO - OFDM systems for the same bandwidth efficiency.

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