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A Performance Analysis of Index Modulation in MIMO System

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Abstract: Multi-carrier transmission is a key technology in wireless and broadband digital communication systems Use noise and interference to eavesdrop on or interfere with wireless networks. These difficulties are solved by cryptography and cryptography. The development of 5Gandbeyond wireless network can support a large number of devices and elements, and does not require encryption. The Key.4G wireless system offers several features for today's fast-paced world of wireless communications. We need to find solutions that increase interest in high data rates, better QoS, fully optimized mobile systems, and lower latency. The system is currently expected to be ten times more energy and spectrally efficient than 4G systems. In 5G will also support maximum data rates 10Gbps. Orthogonal Frequency Division (OFDM) stands out as the most widely used technique in wireless networks (reuse). Divide the fading channel of the wideband frequency option into sub and channels with flat arrows. In recent years, another transmission technique has been developed that integrates OFDM and index modulation. Orthogonal Frequency Division Multiplexing using OFDM-IM (Index Modulation).In this paper, we study, observe and analyze that OFDM-IM outperforms conventional OFDM for small values of m. influences. Various modulation types for OFDM-IM performance are also considered

Keywords: Modulation, Orthogonal Frequency Division Multiplexing, M-ary Modulation, Cyclic Prefix.

1. INTRODUCTION

Orthogonal Frequency Division Multiplexing effectively combats the problem created by frequency selectivity of wireless channel such as Intersymbol Interference and is similar to Frequency Division Multiplexing. It has three transmission principles namely Multirate, Multi symbol and Multicarrier [1-5]. Data is distributed over large number of carriers spacing

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them apart by a specified frequency. Subcarrier signal has orthogonally property [6]. This prevents the signals from overlapping each other without introducing any interference or noise. OFD is abused in the following widely known IEEE802.16 standard Mobile global interoperability microwave systems for next generation wireless communication systems and their Long Term Evolution project [7-10].Index Modulation is energy efficient. Suitable for high frequency spectrum signals. Index modulation is a modulation technique that applies a keying scheme. Mapping symbols to subcarriers and switching communication blocks on or off has been done [11-12]. these communications Modules can be antennas, relays, matrices, distribution devices, mixers. Modulation techniques with multiple inputs and outputs, such as MIMO, or single-input, single-output, such as SISO, can be used. It can also be a quad rature or non-orthogonal system, single-phase or multi-phase. In some cases, a single building block [13-15].

Antennas for spatial modulation are used to steer signal subcarriers in OFDM state[2][3]. The higher the number of building blocks, the higher the spectral efficiency. No data is passed here: The array of M-line signals is the same as in conventional OFDM, but additionally selectively exposed by subcarrier indexing [16-18].

Enabled by an accessible data bit. Given an index selection bit, a subset of the subcarriers can be accessed when activated, the remaining subcarriers are set to zero and are not used to transmit data with normal modulation [19]. OFDM-IM is a multi-carrier transmission scheme. In most cases, frequencies are used for optional fading channels [20]. This ability to add optional subcarriers helps ensure physical layer security. This helps prevent eavesdropping. Make data more secure during transmission [4]. The information stream is divided into subcarrier index selection bits. Enable and redisplay certain subcarriers based on application Therefore, OFDM-IM divides the data like OFDM and transmits the original information [21]. Exponential modulation is also one of the green communication technologies driving the growth of Spectrum and energy efficiency [22].

System Model

The input data stream is converted into parallel data sequence. After which the output is multiplied with spreading codes. Base band modulation is one on data in every subcarrier by IFFT and it is converted again to serial data. guard interval. It is inserted between data symbols to avoid inter symbol interference due to multidirectional fading. This signal is up-converted at RF and transmitted. At the receiver, the signal needs to be down-converted and then m-subcarrier component which corresponds to the received data is detected coherently through FFT, parallel to serial conversion is done on the data and the original data isobtained.Figure1showstheOFDMtransmit and receive structure.

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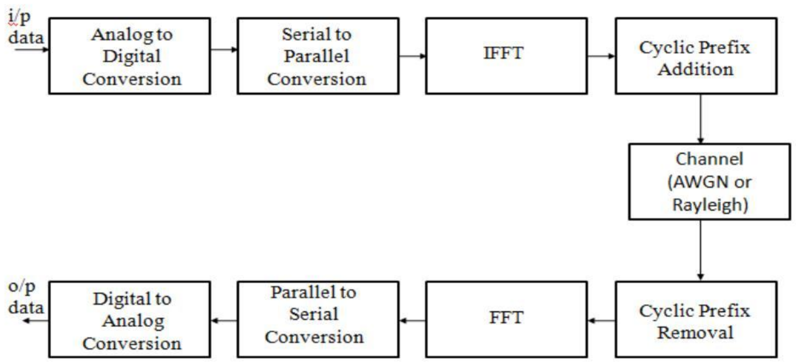

Figure 1: OFDM Block Diagram

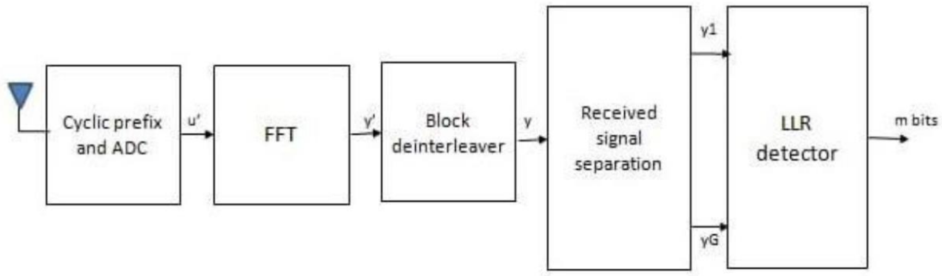

Figure 2: OFDM-IM-Transmitter structure

The block diagram of the OFDM-IM transmitter is shown in Figure 2. frequency channel. The first "B" bits are divided into "G" groups, each with a "p" bit. The "p" bits are promoted to one of the "G"th OFDM sub-blocks, each of length "n". OFDM subcarriers N = nG[2][3]. In OFDM, all n subcarriers of the sub-b block are kept active, while in OFDM-IM. The selected subcarrier remains active. If a subcarrier has no value, it is called inactive. In OFDM-IM, not only dynamic subcarriers but also dynamic Subcarriers convey information [2-5].

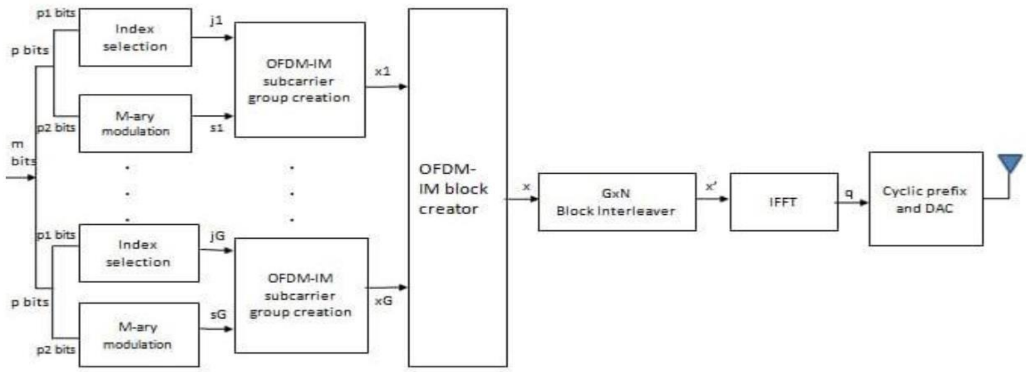

Figure 3: Receiver structure of OFDM-IM

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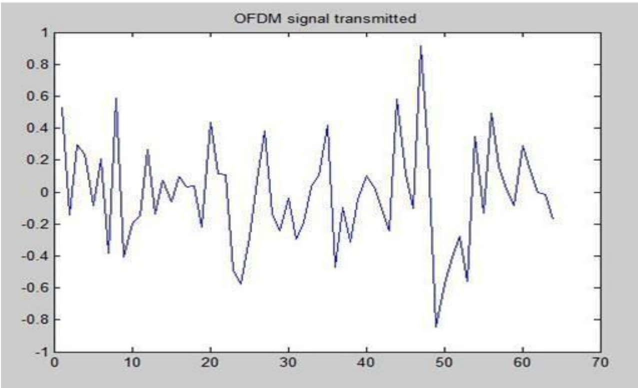
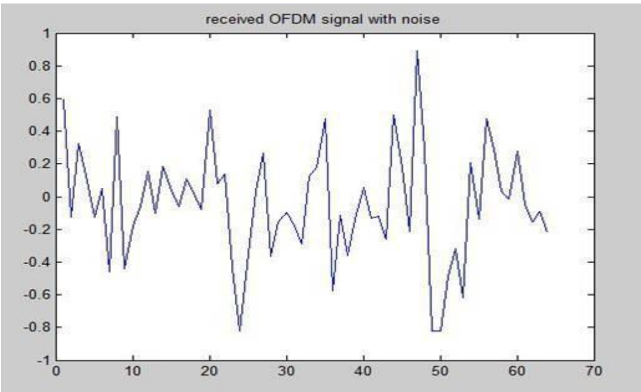
The receiver sees the data bits for the active subcarrier and the index bits for the selected subcarrier. Used to determine whether a subcarrier is active or inactive. [3] The reverse effect of the transmitter structure is Analog-to-digital conversion (ADC), CP removal, fast Fourier transform (FFT), and block de inter leaving. Different subblocks cannot be separated due to index bits so the subblock is realized as a whole. High complexity ML detector is used to realize all Subcarrier Activation Patterns (SAPs). It also detects all the complex data. Finally Low Complexity likelihood Detector (LLR) is used to handle each subcarrier independently. Detection of Active/Inactive Subcarrier is one first then corresponding data symbol is detected.

2. IMPLEMENTATION RESULTS AND DISCUSSION

This section comprises of implementation results and discussion. For OFDM, the carrier frequency used is 3.6 GHz and the number of subcarriers is 64. Table-1 shows all the simulation parameters used for OFDM simulation.



(a)



(b)

Figure 4.a) OFDM -Transmitted Signal b) OFDM - Received Signal

The OFDM transmitted and received signals are shown in figures 4a and b. A comparison between original and recovered message signal are shown in Figure 5.

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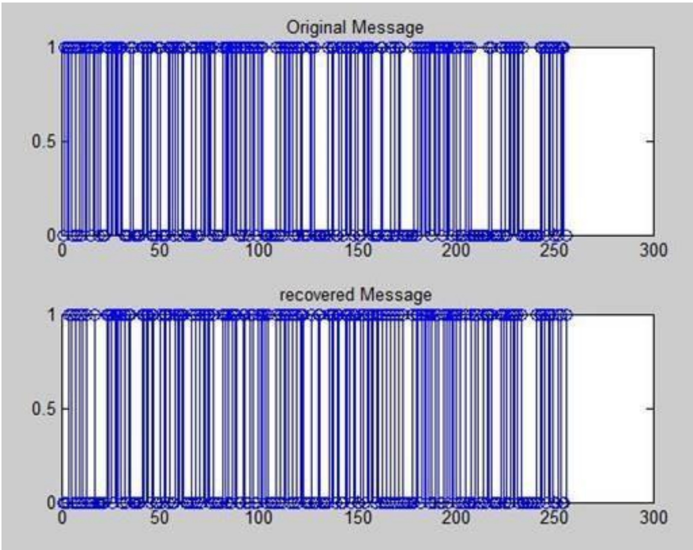
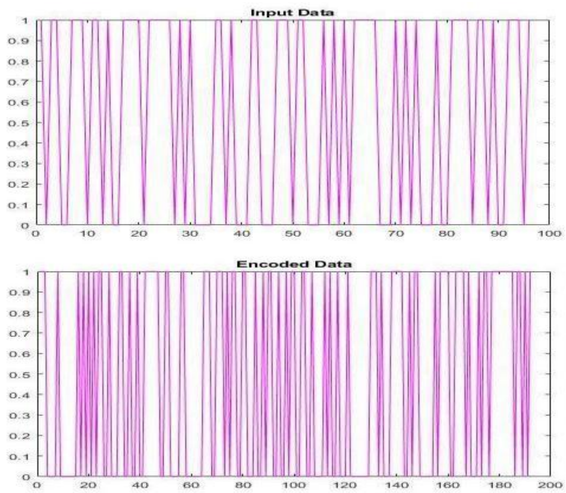
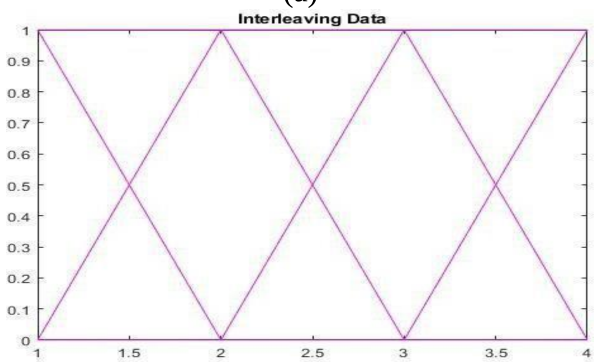


Figure 5: Comparison of original message and received message



(a)



(b)

Figure 6: a) Input and Encoded Data Signals b) Interleaved Data

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Figure 6.a. shows the input data and the data after encoding using a convolution encoder for error detection and correction. Interleaver is used to spread out the burst errors and convolution interleaving also helps in reducing the memory requirements. Hence a convolution interleaver has been used and the interleaved data is as shown in Figure 6.b. The modulated data is shown in Figure-7.

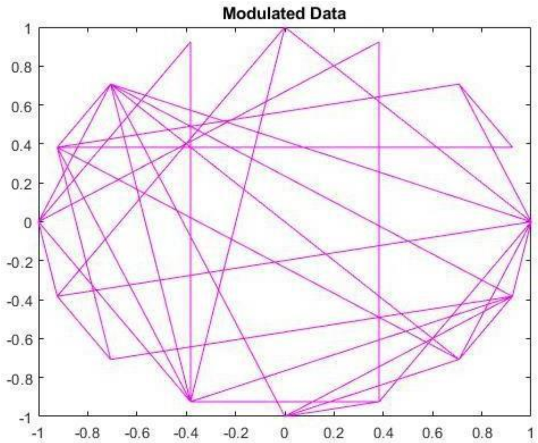

Figure 7: Modulated Data

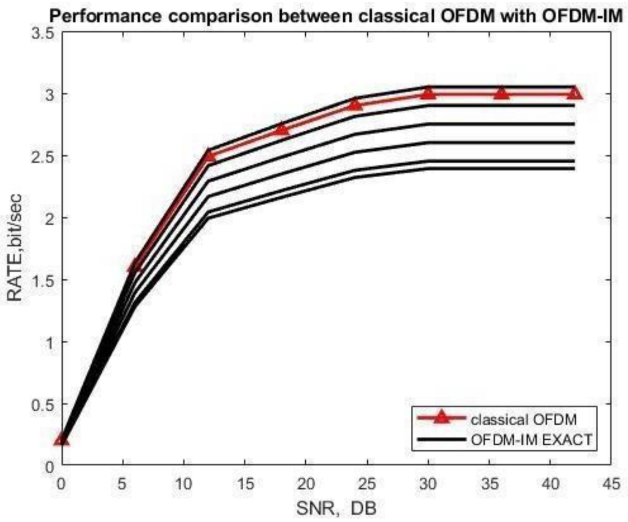

Figure 8: Comparison based on Performance

In order to compare the performance analysis of classical –OFDM and OFDM-IM, achievable rate has been used as one of the performance parameter. The decoding reliability of modulated symbol varies in accordance with the order of constellation. Figure 8 shows this variation in performance for different values of m for an 8-PSK system and L=8 where L are the number of subcarriers. It can be seen that for m=1, both classical OFDM and OFDM–IM have same entropy at the input. For the cases m=2 and 3, the input entropy is smaller for OFDM-IM ,still it can outperform classical OFDM but as m increases ,the input entropies are

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smaller and hence are unable to exploit the channel. In such a case, the achievable rate for OFDM-IM becomes smaller than classical OFDM.

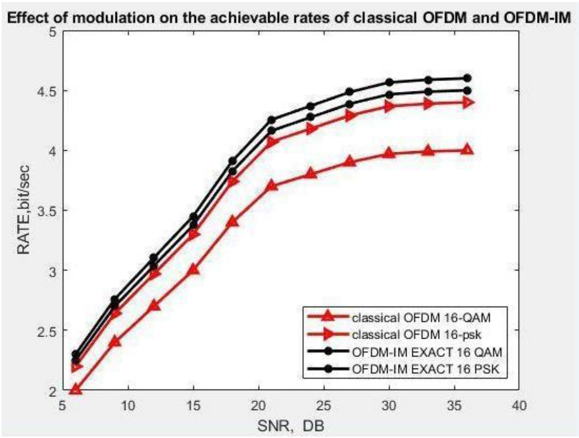

Figure 9: Effects of Different Modulation Techniques on Achievable rate

Figure 9.Shows the effect of type of modulation on the achievable rates for both classical OFDM and OFDM-IM modulation techniques used are 16 QAM and 16-PSK. It is seen that OFDM–IM shows a SNR gain in both the cases of modulation types but 16-QAM seems to give more favourable results than 16PSK. There have been various studies regarding the comparison traditional OFDM and OFDM-IM. Also, some work related to performance analysis and optimization of OFDM-IM is available in literature. In [2], the authors have used BER as the performance parameter for comparing these two techniques where as this paper uses achievable rate as the performance metric. Similarly in [3] performance comparison of classical –MIMO and MIMO-OFDM has been done on the basis of bit error rate in a Rayleigh fading environment. In [5], localized and interleaved grouping has been used to get the achievable rates. This paper shows the effect of different modulation methods on the achievable rates for both OFDM and OFDM-IM. BER performance has been compared in Rayleigh fading channel in [7]. In [8], authors have discussed about the drawbacks of spatial modulation and frequency index modulation. Performance evaluation of OFDM-IM is done on the basis of BER performance for the case in which all subcarriers are active in [9]. A variation of OFDM-IM i.e dual mode OFDM has been studied in [10].This paper concentrates on the achievable rates of both the techniques for different modulation techniques.

3. CONCLUSION

Although, OFDM and OFDM–IM are techniques, both of which use subcarriers for data transfer, but OFDM-IM has an edge over OFDM as activated subcarriers are utilized. This is a recent concept which is used for spectral efficient wireless communication for next generation networks. This paper gives simulations results for performance analysis of OFDM –IM with respect to classical OFDM with achievable rate as the performance metric. Performance comparison for these two methods is also done for different modulation types.

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