Massive Multiple-Input Multiple-Output Generalized OFDM with Index Modulation For 5G Networks

S.Nivetha[1], Mr. D. Sellathambi[2]
[1, 2] Department of ECE
[1, 2] Parisutham Institute of Technology & Science, Thanjavur

Abstract- *In Massive Multiple-input multiple-output generalized orthogonal frequency division multiplexing with index modulation (MIMO-GOFDM-IM) is a multicarrier transmission novel technique which is an alternative to the classical massive MIMO-Generalized OFDM. In this project, Generalized OFDM with index modulation (GOFDM-IM) is combined with MIMO transmission to take the advantages of these techniques. The error performance analysis and the implementation of MIMO Generalized OFDM-IM scheme refers for the 5G networks. Maximum likelihood (ML) is used, and their theoretical performance are investigated. It has been shown via extensive computer simulations that MIMO-Generalized OFDM-IM scheme provides a trade-off between the error performance and spectral efficiency which achieves better error performance than classical massive MIMO-Generalized OFDM using ML detector and under realistic conditions.*

Keywords- MIMO systems, Maximum Likelihood (ML), Generalized OFDM, Modulation.

I. INTRODUCTION

Multiple-input multiple-output is a digital modulation techniques, its transmission having their advantages over a single system antenna can be improved the data rate and efficiency. MIMO having the modulation process of spatial and index modulations. This multicarrier transmission can be increasing the high data rate in the communication systems.The next generation networks require large system capacity for high data rate and services in multimedia.

The radio frequency is a resource it can desirable to increase spectral efficiency and the use of MIMO systems is one of the most popular approaches to achieve the goal [8]. Spatial modulation (SM) is based on the transmission of information bits by means of indices of the active transmission antenna of the system. It can be attracted the attention of significant for researchers in the communication side.

Index modulation is a technique for the subcarrier indices available in massive MIMO systems. The only subset of the subcarrier available in the active information bits, it remains their inactive subcarriers are set as zero. It can be achieve a potential to better performance of error and efficiency. It can be communicate through the machine to machine (M2M) systems, requires less power consumption. High data rate in wireless access can be demanded in many applications and they having high bandwidth for transmission required for higher rate of data. Their limitations in the spectral it will often the very expensive to increase their bandwidth. Transmit in multiple antenna can used to transceiver the multiple channels of the MIMO systems.

The challenge in realization practical of the MIMO system in wireless lies the efficient implementation of the detector can be needs to separate the multiplexed data streams in spatially modulation. It can be offering the various trade-offs in between the complexity computation and the performance.

II. MIMO

The data of reception is transmitted over serially in the dispersive medium of complex of channel presence to induced the interference. Many techniques reducing the complexity of the optimal reception in a receiver. In a 4×4 MIMO channel, input data can be transmitted in the sequence[6].In the first time slot, M1and M2 can be send from the first and the second antenna. In second time slot, M3and M4can be send from the first and the second antenna, and M5and M6in the third time slot and so on.

A variety of these techniques are evaluated using different predetermined performance and complexity. MIMO detection techniques are categorized into linear schemes, successive interference cancellation, and tree-search techniques. Linear schemes are easy to implement but leads to high degradation in performance. Successive interference cancellation schemes transmitted the extract symbol according to a certain permutation depending on channel matrix.

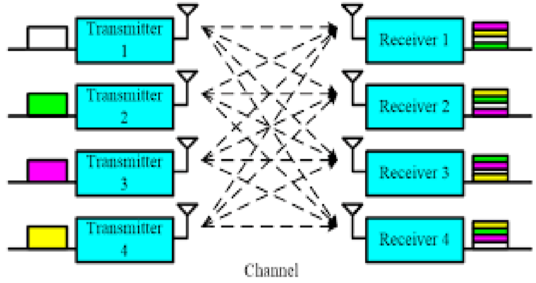

Figure 1: MIMO system

III. MIMO-GOFDM-IM

The block diagram of the system is given in Fig 2, is the configuration of MIMO. A MIMO system with transmit (T) and receive (R) antenna. The system can be transmit total of nT information bits enter in the MIMO frame [8]. These nT bits are spilt into T groups.

$$y_r = \sum_{t=1}^{T} diag(x_t) h_{r,t} + w_r$$

Where..,

t = transmit antenna, r = receive antenna,

$h_{r,t}$ & w_r =vector of noise samples.

Vector received signals

$$y_r = [y_r(1)\ y_r(2) \ldots\ldots\ldots y_r(N_F)]^T$$

$y_r = \sum_{t=1}^{T} diag(x_t) h_{r,t} + w_r$, r=1,2,….,R

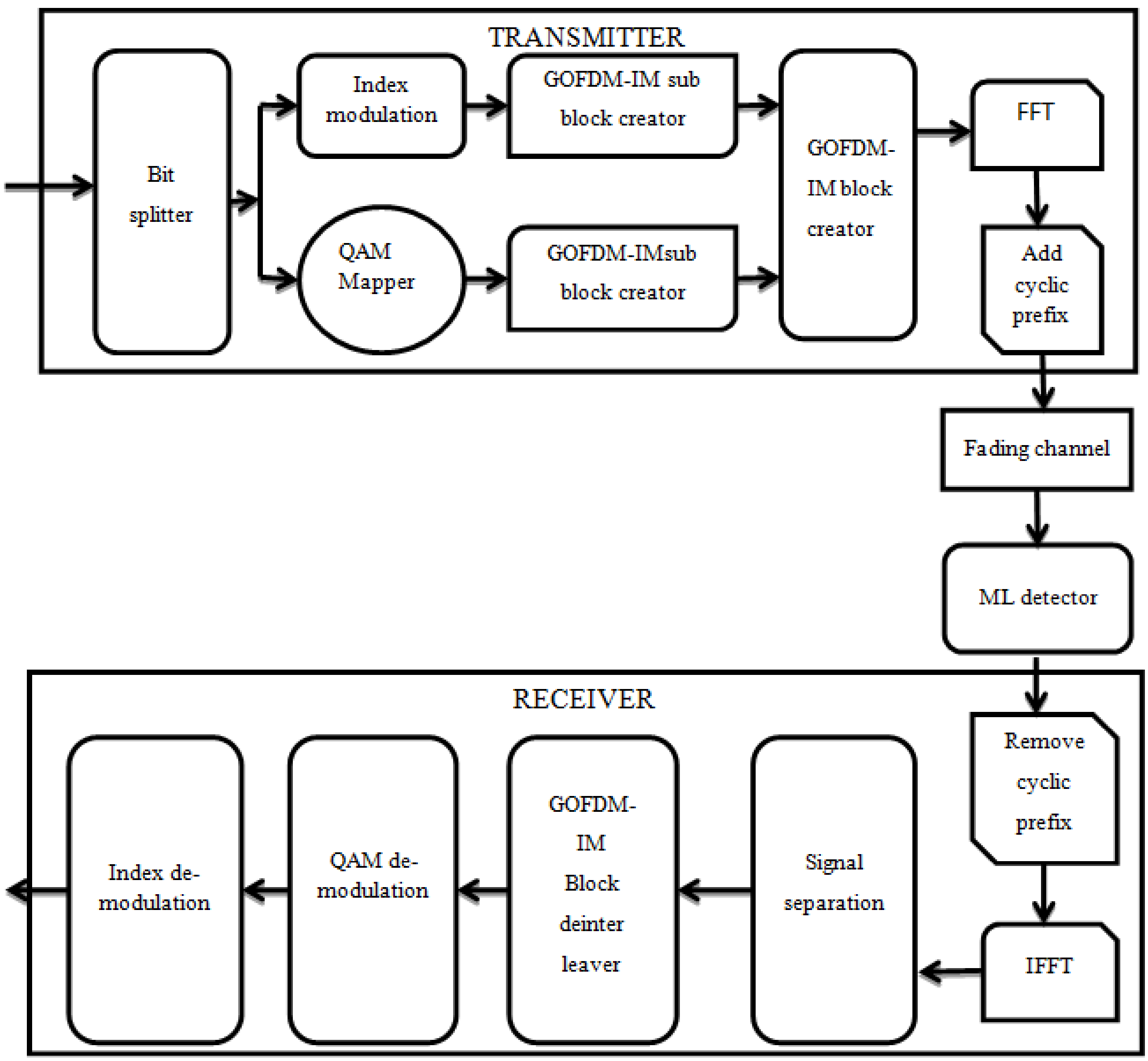

Figure 2: Block diagram of MIMO-GOFDM

Multiple input, multiple output- Generalized orthogonal frequency division multiplexing (MIMO-GOFDM) is the dominant interface with air for 4G and 5G broadband wireless communications. It combines multiple input, multiple output (MIMO) technology, which multiplies capacity for transmitting different signals over multiple antennas, and GOFDM, which divides a radio channel into a large number of spaced sub-channels to provide more reliable communications at high speeds.

Index modulation (IM) is a digital modulation with high spectral and energy efficiency.The indices of the blocks of the systems communications are used to convey additional information bits. It is a novel multicarrier transmission. Only a sub-set of available subcarriers are selected as active while the remaining subcarriers is inactive are not used and set to zero.

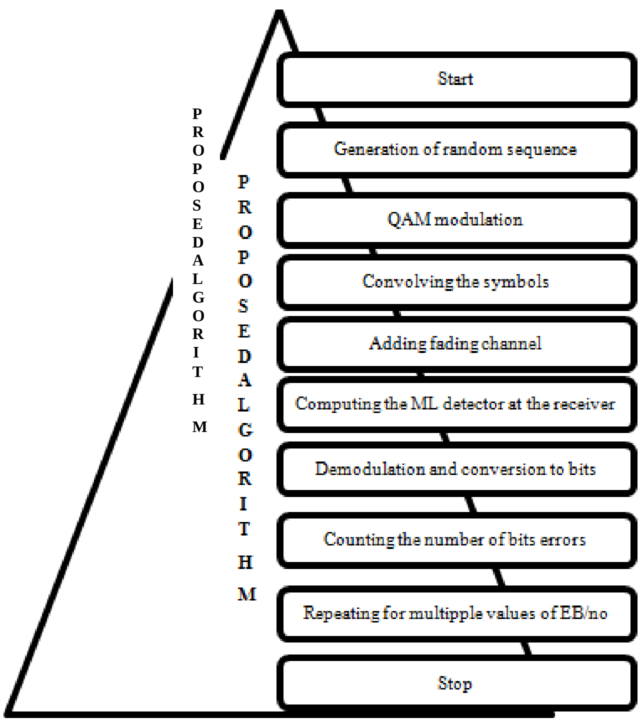

Figure 3: Flow of proposed algorithm

IV. SIGNAL DETECTOR

The signal detection techniques include spatial and successive interference cancellation for the maximum likelihood (ML) detectors. In the spatial system pre-whitening inputs, interferers detection joint the multiple users or inputs is optimal. This detection is forbidding complexity in computations. The maximum likelihood decoding for spatial pre-whitening for massive multiple input multiple output (MIMO)-orthogonal frequency division multiplexing (OFDM), it can be reduce the complexity detection.

In successive interference cancellation can be introduced pre-whitening for the space-time codes for MIMO-OFDM. The optimal maximum likelihood detector estimates transmit sub-streams to choosing the symbol combination associated with the minimum distance among the possible combination [10].

$$X_{ML} = \arg\min \left\| r - \sqrt{P/NH\,.S^{N}} \right\| \ldots(1)$$

Where $\|a\|$ is the norm of vector a.

To reduce the complexity, we proposed to implement a maximum likelihood detection scheme. Then the basic idea of the paper is to perform likelihood test over the reduced number of symbol combinations instead of all symbol. The scheme is operated over the detection algorithm.

The use of ML detector which can be realized for each sub-blocks g as

$$\left(X1^{g},\ldots,XT^{g}\right)ML =$$

$$\arg\min \sum_{r=1}^{R} \left\| Yr^{g} - \sum_{t=1}^{T} diag(Xt^{g})hr.t^{g} \right\|^{2} .(2)$$

The ML detector has to make a search over all transmit antennas due to interference between the sub-blocks of different transmit and receive antennas. The average bit error probability of MIMO-Generalized-OFDM-IM is derived by the pairwise error probability calculation for MIMO-GOFDM-IM sub-blocks.

$$Y^{g}=H^{g}X^{g}+W^{g}$$

error probability

$$P(X^{g}\rightarrow e^{g}/H^{g}) = \frac{1}{\pi}\int_{0}^{\frac{\pi}{2}} \exp\left(-\left\|\frac{Hg\,(xg-eg)}{4N0,F\sin 2\theta}\right\|\right)d\theta$$

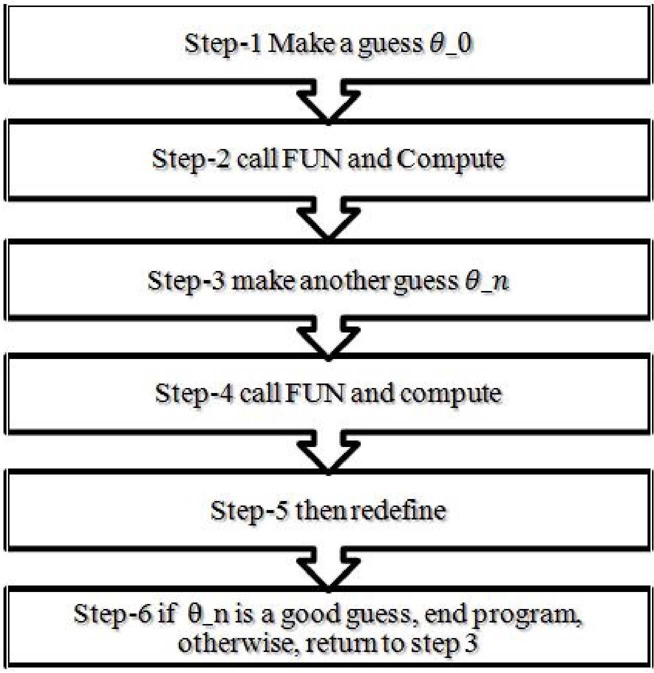

Figure 4: ML detector algorithm

V. SIMULATION RESULTS

The simulation results of the scheme are presented in terms of the bit error rate (BER) performance of the ML detector that the data is QAM modulated. The performance of the ML-decoder operating on quantized channel measurements (ML) and its approximation terms of bit error rate (BER) averaged over 90000 Rayleigh fading channel realizations, the conventional ML-detector. Then the exact ML-detector and its naive version outperform the conventional ML-detector when operating on quantized data especially at high SNR.

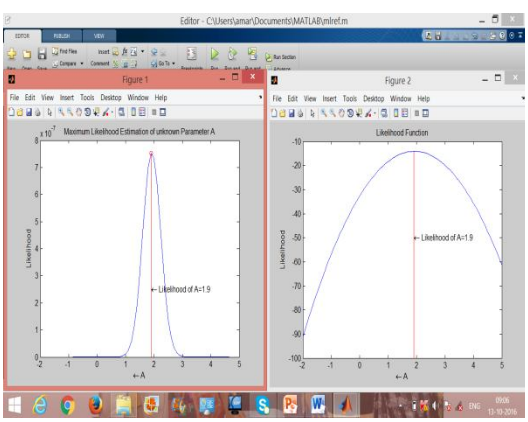

Figure 5: ML detector

This is because the effect of quantization error is more pronounced at higher SNR values. Moreover, we see that the performance of the naive approach is very close to the exact one in spite of the complexity reduction. The performance of our modified also plotted, for comparison. Since these receivers are not consistent, they perform inherently worse than the ML-decoder at high SNR. The equalizer leads to a considerable performance gain compared to the filter while retaining a comparable complexity but is still quite far from the ML performance. The dashed line corresponds to the BER curve for the ML-decoder if no quantization is applied.

The un-coded BER achieved by the discussed ML and naive ML-detectors and the conventional ML-detector for a bit quantized MIMO-system. Due to the low resolution, a clear improvement in terms of BER performance can be achieved by considering the quantization process. We observe, moreover, that the naive ML approaches closely the performance of the exact solution at high SNR values. This confirms the usefulness of the naïve ML detector approach even under low resolution quantization.

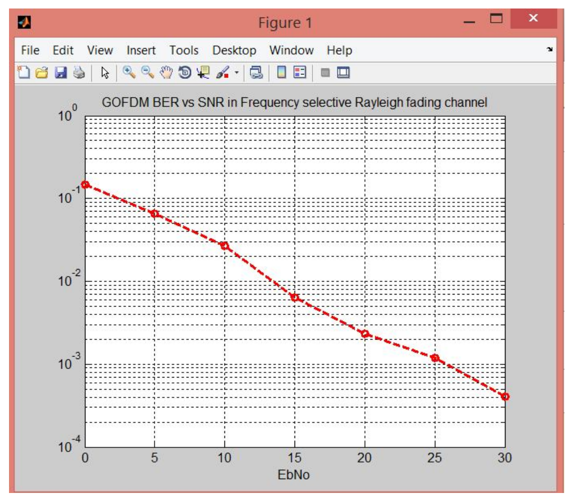

Figure 6: Fading channel

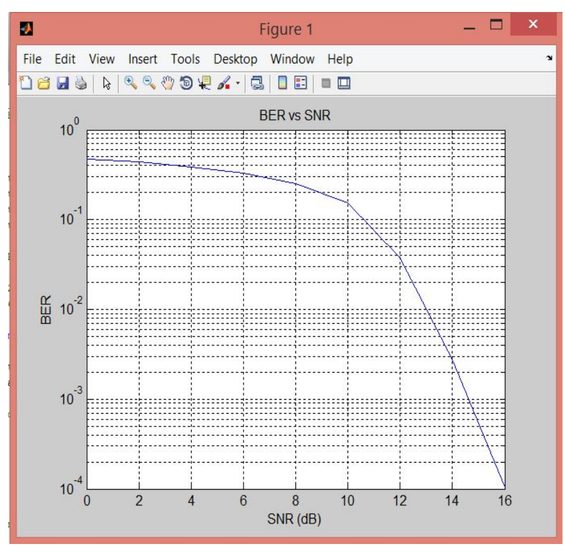

Figure 7: Bit Error Rate

VI. CONCLUSION

This paper, the recently proposed MIMO-GOFDM-IM scheme has been investigated for next generation networks. The MIMO-GOFDM-IM scheme, new detector maximum likelihood (ML) detectors have been proposed and their ABEP have been theoretically examined. It provides an interesting trade-off between complexity, spectral efficiency and error performance compared to classical MIMO-OFDM scheme and it can be considered as a possible candidate for 5G networks. The main features of MIMO-GOFDM-IM can be summarized as follows better BER performance, flexible system design with variable number of active OFDM subcarriers and better compatibility to higher MIMO setups. IM is an up and coming concept for spectral and energy-efficient next generation wireless communications systems to be employed in 5G wireless networks. IM techniques can offer low-complexity as well as spectral and energy-efficient solutions towards the massive MIMO, and cooperative communications systems to be employed in 5G networks.

The interesting topics such as diversity methods, generalized FDM, high mobility implementation and transmit antenna indices selection be the future work for the MIMO-OFDM-IM scheme. In this article, we have reviewed the basic principles, advantages, recent advances, and application areas of massive MIMO and OFDM-IM systems.

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