Survey of Multiple-Input Multiple-Output OFDM with Index Modulation: Low-Complexity Detector Design

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***Abstract*— Multiple-input multiple outputs orthogonal frequency division multiplexing with index modulation (MIMO-OFDMIM) is novel multicarrier transmission technique which has been proposed recently as an alternative to classical MIMO-OFDM. The main idea of OFDM-IM is the use of the indices of the active subcarriers in an OFDM system as an additional source of information. In this paper different papers are surveyed related to Multiple-Input Multiple-Output OFDM with Index Modulation: Low-Complexity Detector Design. In this discuss about MIMO system.**

***IndexTerms*— OFDM with index modulation (OFDM-IM), spatial modulation (SM), MIMO systems, sequential Monte Carlo (SMC), maximum-likelihood (ML) detection**

I. Introduction

Multiple-input multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) could be a key technology for several wireless communication systems, owing to its high spectral efficiency [6]. Recently, large-scale multiuser MIMO systems with tens to many antennas at the base-station (BS) have gained vital attention. The motivation to think about such large-scale MIMO systems is their potential to satisfy the growing demands for higher output and improved quality-of-service of next-generation multiuser wireless communication systems [6]. because the signal of every user is required to be extracted from the received interfered signal at the BS receiver [6], one key issue within the style of a sensible receiver for large-scale MIMO-OFDM systems is the way to reduce the quality of detection while not much compromise in performance.

Orthogonal frequency division multiplexing (OFDM) has become one among the most common multicarrier transmission techniques for wideband wireless communications in recent years. Because of its benefits like efficient implementation and strength to frequency selective fading channels, OFDM has been enclosed in several standards like long term Evolution (LTE), IEEE 802.11x wireless local area network (LAN), digital video broadcasting (DVB) and IEEE 802.16e-WiMAX. Considering the benefits of multiple-input multiple-output (MIMO) systems over single antenna systems like improved rate and energy efficiency, the mixture of OFDM and MIMO transmission techniques seems as a robust different for future wireless standards like 5G and beyond.[4]

OFDM with index modulation (OFDM-IM) [10] can be a new multicarrier transmission method that has been planned as another to classical OFDM. Stimulating from the SM conception, in OFDM-IM, index modulation techniques are applied for the indices of the offered subcarriers of an OFDM system. In OFDM-IM method, only a set of available subcarriers are preferred as active consistent with the data bits, whereas the remaining inactive subcarriers are set zero. In different words, the data is transmitted not only by the information symbols selected from M-ary signal constellations, however additionally by the indices of the active subcarriers. Not like classical OFDM, the quantity of active subcarriers may be adjusted within the OFDM-IM scheme, and this flexibility within the system style provides a stimulating trade-off between error performance and spectral efficiency. Moreover, it's been shown that OFDM-IM has the potential to realize a more robust error performance than classical OFDM for low-to-mid spectral efficiency values. Due to its adjustable range of active subcarriers, OFDM-IM may be a potential candidate not just for high speed wireless communications systems however additionally for machine-to-machine (M2M) communications systems that need low power consumption.[3].

II. Literature Survey

Beixiong Zheng et al.[1] "Multiple-Input Multiple-Output OFDM with Index Modulation: Low-Complexity Detector Design", in this paper proposed two low-complexity detectors derived from the SMC theory for the MIMO-OFDMIM system. The first proposed subblock-wise detector draws samples at the subblock level, exhibiting near-optimal performance for the MIMO-OFDM-IM system. The second proposed subcarrier-wise detector draws samples at the subcarrier level, exhibiting substantially reduced complexity with a marginal performance loss. An effective legality examination method has been also developed to couple with the subcarrier wise detector. Computer simulation and numerical results have validated the outstanding performance and the low complexity of both proposed detectors.

Ertuˇgrul Bas¸ar et al.[2] “Multiple-Input Multiple-Output OFDM with Index Modulation”, A novel scheme called MIMO-OFDM with index modulation has been proposed as an alternative multicarrier transmission technique for 5G networks. It has been shown via extensive computer simulations that the proposed scheme can provide significant BER performance improvements over classical MIMO-OFDM for several different configurations. The following points remain unsolved in this study: i) performance analysis, ii) the selection of optimal N and K values, iii) diversity techniques for MIMO-OFDM-IM, and iv) Implementation scenarios for high mobility.

Ertugrul Basar et al.[3] “On Multiple-Input Multiple-Output OFDM with Index Modulation for Next Generation Wireless Networks”, In this study, the recently proposed MIMO-OFDM-IM scheme has been investigated for next generation 5G wireless networks. For the MIMO-OFDM-IM scheme, new detector types such as ML, near-ML, simple MMSE, MMSE-LLR-OSIC detectors have been proposed and their ABEP have been theoretically examined. It has been shown via extensive computer simulations that MIMO-OFDM-IM scheme 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 wireless networks. The main features of MIMO-OFDM-IM can be summarized as follows: i) better BER performance, ii) flexible system design with variable number of active OFDM subcarriers and iii) better compatibility to higher MIMO setups. However, interesting topics such as diversity methods, generalized OFDM-IM cases, high mobility implementation and transmit antenna indices selection still remain to be investigated for the MIMO-OFDM-IM scheme.

Ertuˇgrul Bas¸ar et al.[4] “Performance of Multiple-Input Multiple-Output OFDM with Index Modulation”, In this paper, proposed ML and near-ML detectors for the recently introduced MIMO-OFDM-IM scheme to improve its error performance compared to MMSE based detection. The ABEP upper bound of the MIMO-OFDM-IM scheme with ML detection has been derived and it has been shown that the derived theoretical upper bound can be used as an efficient tool to predict the BER performance of the MIMO-OFDMIM scheme. It has been shown via computer simulations that MIMO- FDM-IM scheme can provide significant improvements in BER performance over classical MIMO-OFDM using different type of detectors and MIMO configurations.

Beixiong Zheng et al.[5] “Low-Complexity ML Detector and Performance Analysis for OFDM With In-Phase/Quadrature Index Modulation”, In this letter, we've planned a low-complexity detector supported the milliliter criterion, that dispenses with a priori data of the noise variance and also the potential realizations of the active subcarrier indices. supported the framework of OFDM-I/Q-IM using the planned milliliter detector, the straight line ABEP and also the actual coding gain achieved by OFDM-I/Q-IM are derived, that absolutely matches the simulation results. Moreover, the exact coding gain including the spectral efficiency price has provided a clear plan of a basic trade-off between the system performance and also the spectral efficiency of OFDM-I/Q-IM by the adjustment of the quantity of active subcarriers.

Sheng Wu et al.[6] “Low-Complexity Iterative Detection for Large-Scale Multiuser MIMO-OFDM Systems Using Approximate Message Passing”, For the detection of large-scale multiuser MIMO-OFDM systems, we have proposed a range of low-complexity approximate message passing algorithms that can offer desirable tradeoff between performance and complexity. It is verified through extensive simulations that our proposed approximate message passing algorithms can achieve near optimal performance with low complexity. Compared with existing turbo detection algorithms, the proposed schemes can achieve or even outperform the performance of some complex algorithms, such as the iterative decoding based on STS-SD and MMSESIC. In addition, the number of iterations required to achieve near-optimal performance is small and does not increase with the system dimension..

III. MIMO SYSTEM

Digital communication using Multiple-Input Multiple-Output (MIMO) systems is one in all the most important technical breakthroughs in modem communication. MIMO systems are simply outlined because the systems containing multiple transmitter antennas and multiple receiver antennas. Communication theories show that MIMO systems will offer a probably very high capability that, in several cases, grows some linear with the quantity of antennas. Recently, MIMO systems have already been implemented in wireless communication systems, particularly in wireless LANs (Local area Networks). Completely different structures of MIMO systems have additionally been planned by industrial organizations within the Third Generation Partnership Project (3GPP) standardizations, as well as the structures planned. The core plans below the MIMO systems are that the ability to show multi-path propagation, that is usually an obstacle in typical wireless communication, into a profit for users.

The main feature of MIMO systems is space-time process. Space-time Codes (STCs) are the codes designed for the utilization in MIMO systems. Space-Time Codes (STCs) are the codes designed for the use in MIMO systems. In STCs, signals are coded in both temporal and spatial domains. Among different types of STCs, orthogonal Space-Time Block Codes (STBCs) possess a number of advantages over other types of STCs.

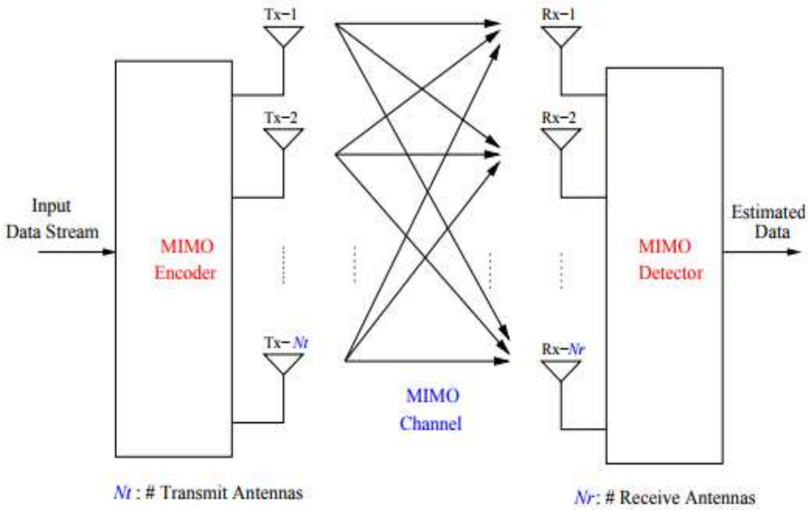

Fig.1: MIMO System

IV. Conclusion

This brief study on the Multiple-Input Multiple-Output OFDM with Index Modulation: Low-Complexity Detector Design of signal processing attempts to illustrate the recent research work that has been done in the field. Some research papers were discussed, all focusing on different aspects and techniques of signal processing. Although no experimental comparison was made the essence of the reviewed papers has been presented.

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