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Advances in single carrier block modulation with frequency domain processing

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This special issue focuses on single carrier block modulation (SC-BM) with frequency domain processing. This class of modulation and multiple access schemes complements the orthogonal frequency division multiple access (OFDMA) and its variations. For example, LTE (the long term evolution of the 3GPP standard), and LTE-Advanced, employ OFDMA in the downlink (base stations to mobiles) and SC-FDMA, a version of SC-BM in the uplink (mobiles to base stations). The main reason for adapting the technology of SC-FDMA for uplink LTE is the fact that OFDMA has high "peak-to-average power ratio" (PAPR), which is a disadvantage for mobile devices that are limited by power availability. Besides its advantage of low PAPR, SC-BM technology has a similar performance/complexity to that of OFDMA, and simple frequency domain equalization methods for combating dispersive channels.

There were 17 papers submitted to this special issue. All had merits, but the review process reduced the number of accepted papers to 9. The accepted papers cover a number of novel and advanced aspects of single carrier block modulation with frequency domain processing: near-optimal nonlinear and iterative equalization techniques; applications to CDMA, MIMO and ARQ; channel estimation; and application to free-space optical transmission. Following is a summary of the papers.

In the paper "Iterative Successive Interference Cancellation for Quasi-Synchronous Block Spread CDMA Based on the Orders of the Times of Arrival", Wang, Bocus, and Coon [1] describe an interference cancellation scheme based on the times of arrival of the signals from different users, and they show that for practical channels this ordering criterion is equivalent to ordering with respect to decreasing average SINR.

In "Complexity Reduced MLD Based on QR Decomposition in OFDM MIMO Multiplexing with Frequency Domain Spreading and Code Multiplexing", Nagatomi, Kawai, and Higuchi [2] propose a reduced-complexity maximum likelihood signal detection method for MIMO-OFDM systems with frequency-domain spreading and code multiplexing. They show how to exploit signal orthogonalization based on QR decomposition of the product of the channel and spreading code matrices in the frequency domain to obtain significant complexity reductions.

In "Frequency-domain Block Signal detection with QRM-MLD for Training Sequence-aided Single-carrier Transmission", Yamamoto, Takeda and Adachi [3] propose replacement of the cyclic prefix with a known training sequence. The object is to improve BER performance of an equalization scheme which uses QR decomposition with M-algorithm detection, while keeping the number of surviving paths low for reduced complexity. The scheme is especially effective for 16QAM and 64QAM modulation.

The paper "Joint Iterative Tx/Rx MMSE-FDE and ISI Cancellation for Single-carrier Hybrid ARQ with Chase Combining" by Takeda and Adachi [4] applies transmitter and receiver equalization and iterative intersymbol interference cancellation to a system with hybrid ARQ transmission, Chase combining and antenna diversity. The equalizer parameters at both transmitter and receiver are optimized for each retransmission.

The paper "Novel Techniques of Single Carrier Frequency Domain Equalization for Optical Wireless Communications" by Acolaste, Bar-Ness, and Wilson [5] investigates the application of single-carrier frequency-domain equalization to diffuse optical wireless communications and demonstrates its advantages over OFDM in terms of reduced PAPR and improved error rate in the presence of LED nonlinearity.

In the paper "Semi-Blind Channel Estimation for IFDMA in Case of Channels with Large Delay Spreads", Sohl and Klein [6] propose a subspace-based channel estimation algorithm which can cope with large delay spreads. In previous work on IFDMA, the number of

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channel taps that can be estimated was limited to the number of subcarriers per user. The subspace analysis in this paper relaxes this constraint and increases the number of taps that can be estimated.

The paper "Channel Frequency response Estimation for MIMO with Systems with Frequency-Domain Equalization " by Yang, Shi, Chew, and Tjhung [7] suggests a training-based channel frequency response (CFR) estimation scheme which is hardware efficient when integrated with and SC-FDE and space time coding (STC) in MIMO Systems. An MSE analysis of this CFR estimation scheme is provided, which considered linear estimators based on both LS and minimum MSE criteria. Also with a given constraint which effectively limits the transmit power of the training signals, the paper investigates the optimal design of training signals under different a *priori* knowledge of the channel statistics. For the special case of 2 transmit antennas, it was demonstrated that CFR estimation could be implemented in adaptive manner.

The paper by Dang, Ruder, Schober and Gerstacker [8], "MMSE Beamforming for SC-FDMA Transmission over MIMO ISI Channels", derives minimum mean squared error beamforming strategies for multi-antenna reception, as well as further modifications to reduce the transmitted peak to average power ratios.

The paper by Nishino, Tanahashi, and Ochiai [9], "A Bit Labeling Design for Trellis-Shaped Single-Carrier PSK with PAPR Reduction", investigates application of trellis shaping to reduce the PAPR of band-limited single-carrier PSK signals. The authors demonstrate that the uncoded bit error rate and PAPR reduction capability of trellis shaping is highly dependent on bit labeling. They propose a bit labeling scheme for high-order PSK constellation that can efficiently reduce PAPR while achieving BER performance comparable to that of Gray labeling.

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References

1. Yue Wang, Mohammud BocusZ, Justin CoonP, Iterative Successive Interference Cancellation for Quasi-Synchronous Block Spread CDMA Based on the Orders of the Times of Arrival. EURASIP Journal on Advances in Signal Processing (2011). 918046
2. Kouji Nagatomi, Hiroyuki Kawai, Kenichi Higuchi, Complexity-Reduced MLD Based on QR Decomposition in OFDM MIMO Multiplexing with Frequency Domain Spreading and Code Multiplexing. EURASIP Journal on Advances in Signal Processing (2011). 525829
3. Tetsuya Yamamoto, Kazuki Takeda, Fumiyuki Adachi, Frequency-Domain Block Signal Detection with QRM-MLD for Training Sequence-Aided Single-Carrier Transmission. EURASIP Journal on Advances in Signal Processing (2011). 575706
4. Kazuki Takeda, Fumiyuki Adachi, Joint IterativeTx/Rx MMSE-FDE and ISI Cancellation for Single-Carrier Hybrid ARQ with Chase Combining. EURASIP Journal on Advances in Signal Processing (2011). 569251
5. Kodzovi Acolatse, Yeheskel Bar-Ness, Sarah Wilson, Novel Techniques of Single-CarrierFrequency-Domain Equalization for Optical Wireless Communications. EURASIP Journal on Advances in Signal Processing (2011). 393768
6. Anja Sohl, Anja Klein, Semiblind Channel Estimation for IFDMA in Case of Channels with Large Delay Spreads. EURASIP Journal on Advances in Signal Processing (2011). 857859
7. Yang Yang, Zhiping Shi, Yong Chew, Tjeng Tjhung, Channel Frequency Response Estimation for MIMO Systems with Frequency-Domain Equalization. EURASIP Journal on Advances in Signal Processing (2011). 501703
8. Uyen Dang, Michael RuderA, Robert Schober, Wolfgang GerstackerH, MMSE Beamforming for SC-FDMA Transmission over MIMO ISI Channels. EURASIP Journal on Advances in Signal Processing (2011). 614571
9. Yuuki Nishino, Makoto Tanahashi, Hideki Ochiai, A Bit-Labeling Design for Trellis-Shaped Single-Carrier PSK with PAPR Reduction. EURASIP Journal on Advances in Signal Processing (2011). 792340

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