Takano, Yasuhiro, Spectrally efficient turbo reception technologies for single-carrier broadband wireless communications.

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Abstract

Future broadband wireless communication systems are expected to increase both their transmission (TX) rate and their spectrum efficiency under the constraints of low TX power and a low computational complexity. In general, a data sequence is transmitted together with overheads such as training sequence (TS) required to perform energy- and computationally-efficient reception techniques. We hence have a trade-off between the spectral efficiency and the receiver performance. The objective of this thesis is to enhance robustness of the receiving algorithms with reasonable complexity, aiming to improve the trade-off.

For this purpose, ℓ1 regularized channel estimation techniques are studied under an assumption that broadband wireless channels observed at a receiver does not fully exhibit dense nature in a low to moderate signal-to-noise ratio (SNR) regime. This thesis proposes a novel conditional ℓ1 regularized minimum mean square error (MMSE) channel estimation and chained turbo estimation (CHATES) algorithms to solve the inter-block-interference (IBI) problem incurred as the result of pursuing spectral efficiency. A new ℓ1 least squares (LS) and ℓ2 MMSE-based hybrid channel estimation algorithm is also proposed to solve the tracking error problem often observed with intermittent transmission. Moreover, performance analysis shows that an ℓ1 regularized MMSE channel estimation algorithm can achieve the Cramér-Rao bound (CRB) asymptotically even when random TSs are used.

This thesis further studies frequency domain turbo equalization techniques without cyclic prefix (CP) transmission to improve the spectral efficiency. The previously-proposed chained turbo equalization, referred to as CHATUE1, allows us to use a lower rate code. However, it can suffer from the noise enhancement problem at the equalizer output. As a solution to the problem, this thesis proposes a new algorithm, CHATUE2. The theoretical analysis supported with simulation results shows that the proposed CHATUE2 can solve the problem after performing enough turbo iterations by utilizing a new composite replica constructed with the conventional soft replica and received signals.

Keywords: Subspace-based channel estimation, compressive sensing, turbo channel estimation, turbo equalization, spectral efficiency.