Abstract

The primary objective of this thesis is to identify the impact of the source correlation on multi-user detection (MUD). The necessary condition of correlated sources transmitted over multiple access channel (MAC) is still an open question in Network Information Theory, hence instead of pursuing pure information theoretic approach, the empirical methods are taken in this thesis. Since the interleave division multiple access (IDMA) has excellent spectral efficiency, bit-interleaved coded modulation using iterative decoding (BICM-ID) based IDMA with soft successive interference cancellation (SSIC) is chosen as the multiple access scheme. Bit-flipping model and a very simple irregular repetition (IrR) code are exploited as the correlated sources generation method and the channel code in this thesis, respectively.

First of all, this thesis investigates the case that channel decoding for different users are performed independently. The system model of BICM-ID based IDMA with SSIC for investigation is presented under additive white Gaussian noise (AWGN) channel assumption based on fundamental principles and techniques. A frequency domain soft cancellation minimum mean square error (FD-SC-MMSE) turbo equalizer is jointly utilized in the system model to eliminate inter-symbol interference (ISI) in frequency selective fading channel. Simulation results show that, with independent decoding performed at the receiver, the source correlation does not make any impact on system bit error rate (BER) and/or frame error rate (FER) performance in the presented IDMA system.

This thesis then investigates the joint decoding process which aims to utilize the source correlation at the receiver to improve system BER and/or FER performance. By using extrinsic information transfer chart (EXIT chart), it is shown that, with relatively high source correlation, joint decoder can significantly increase the *extrinsic* log likelihood ratio (LLR) to help decoding process. Simulation results show the same conclusion that the system performance can be significantly improved with relatively high source correlation. Moreover, in the frequency selective fading channel, if sources are not fully correlated, the diversity order does not increase, only a parallel shift of FER curves is observed. However, with fully correlated source, the diversity order increases to twice.

Furthermore, a trade-off between rate-sum and performance gain is then analysed through Slepian-Wolf (S-W) and MAC rate region based on the sufficient condition of the problem of correlated sources transmitted over MAC. This trade-off analysis indicates that with limited physical resources the excellent transmission efficiency and excellent reliability can not be achieved at the same time. Particularly, this analysis result can also help us to flexibly allocate power and transmission rate in cooperative communication systems.

Keywords: source correlation, S-W region, MAC, IDMA, BICM-ID, AWGN channel, frequency selective fading channel, FD-SC-MMSE, joint decoder, IrR, rate-sum / performance gain trade-off