Abstract of Dissertation

Design and Analysis of Cooperative Spatial Multiplexing System in Wireless Relay Networks

（無線協調通信システムにおける空間多重方式の設計と解析に関する研究）

ダルマワン　アンドレアス
DARMAWAN, ANDREAS

Abstract

This dissertation presents and proposes a comprehensive concept of a particular type of cooperative communications called cooperative spatial multiplexing system. The main advantage of the system is that it allows for the realization of MIMO performance in single-antenna wireless terminals environment. This also means that the proposed systems will be superior to the currently existing SISO and MIMO schemes, especially in low-SNR conditions.

Transmission schemes for uplink/downlink amplify-and-forward and decode-and-forward relaying were investigated and proposed. In the amplify-and-forward scheme, non-regenerative relays are employed such that they only amplify and forward different portion of the received signal at a reduced data rate to the receiver (destination). While in decode-and-forward scheme, the regenerative relays actually decode the received signal before forwarding it to the destination sink. MIMO communication is established for relays to destination data transmission. For downlink transmission, the relays may opt to forward the data to the destination by utilizing simple TDM transmission or Alamouti's space-time coding. The combination of transmitter, relays, and receiver forms a virtual MIMO system in single-antenna wireless terminals environment. Symbol decoding at the destination sink is done by SNR (Signal-to-Noise Ratio) and LLR (Log-Likelihood Ratio) based detection ordering schemes, along with successive interference cancellation process.

Theoretical analysis on the performance of the different above-mentioned

transmission schemes based on Gram-Schmidt orthogonalization process is also presented. The analysis focuses on the outage probability and average BER performance of the system under Rayleigh fading environment. Closed-form solutions for 1x2x2 uplink and 2x2x1 downlink systems employing coherent BPSK modulation are presented. The theoretical analysis results are then confirmed with Monte-Carlo simulations in order to prove their validity and accuracy. We further derived the optimal and semi-optimal transmit power allocation schemes for the different systems by applying Lagrange multiplier optimization to the outage probability expressions. This allows the system to allocate power optimally between the source and relaying terminals, such that the outage probability and BER will be minimized for the given link conditions. Hence, as a result, performance improvements over the classical uniform power distribution scheme are expected.