SUMMARY OF Ph.D. DISSERTATION

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Title

A Study on Iterative Signal Processing for Multi-Carrier MIMO Transmission

Abstract

Because of the rapid growth of multimedia services, a high speed data transmission technique up to 1 Gbps is demanded in the future wireless communication systems. Multi-carrier transmission such as orthogonal frequency division multiplexing (OFDM) and multi-carrier-code division multiple access (MC-CDMA) is robust against the severe inter-symbol interference. Its high frequency efficiency is also well known. However, the use of the multi-carrier transmission only cannot achieve the 1Gbps transmission with a limited frequency bandwidth. Thus, a combination of the multi-carrier transmission technique and multiple-input multiple-output (MIMO) spatial multiplexing that uses multiple transmit and receive antennas is indispensable. In MIMO spatial multiplexing, the received signal is a superposition of the signals transmitted from different antennas and thus, the efficient signal detection technique is an important research topic. Accurate channel estimation between a transmitter and a receiver is also necessary. Furthermore, reduction of inter-code interference owing to the orthogonality distortion among the spreading codes is an important topic for MC-CDMA transmission. It has been known that iterative signal processing using decision feedback is an effective technique to improve the channel estimation accuracy and signal detection quality of multi-carrier MIMO spatial multiplexing system.

This thesis studies the iterative signal processing to improve the transmission performance of multi-carrier MIMO spatial multiplexing system. The thesis consists of 6 chapters as follows.

In chapter1, the fundamental research topics of future wireless communication systems are identified and then, the motivation of the thesis is stated.

In chapter 2, a study on the iterative channel estimation for OFDM transmission is introduced. Although there have been several theoretical works on the iterative channel estimation, most of them assumed the ideal decision feedback. However, in a realistic condition, there exist decision feedback errors. Thus it is very important to take into account the decision feedback errors in the bit error rate (BER) analysis. In this study, a BER expression is derived using the variances of the channel estimate and noise, and the correlation between the channel estimate and the actual channel when decision feedback errors are taken into account.

In chapter 3, an iterative signal detection method using antenna-wise cyclic redundancy check (CRC) decoding results is proposed to improve the signal detection of MIMO multiplexing. In MIMO spatial multiplexing, channel coding and error detection coding are performed per transmit antenna. The received signal quality is different for the signal transmitted from a different transmit antenna. If the correctly received signal can be subtracted from the received signal, the signal detection quality of the erroneously received signal can be improved. The effectiveness of the proposed method is evaluated by computer simulation.

In chapter 4, a virtual MIMO system is proposed which uses the propagation paths having different time delays as virtual antennas. In a wireless communication system, the frequency components of the received signal are phase rotated according to the time delay of the path. This can be exploited in separating the signals received via different paths by inverse phase rotating the received signal in the frequency domain. The inter-code interference (ICI) problem encountered when code multiplexing is used can be eliminated by an iterative ICI cancellation scheme. The effectiveness of the proposed virtual MIMO system using the proposed iterative ICI cancellation scheme is evaluated.

In chapter 5, the theoretical upper-bound of the throughput, i.e., the channel capacity, is derived by taking into account the degree of residual interference. Based on the Gaussian approximation of the residual interference, the conditional signal-to-interference plus noise power ratio (SINR) is obtained, from which the channel capacity is derived. The capacity comparison between MC-CDMA and OFDM is presented.

Chapter 6 concludes the dissertation.