

## SUMMARY OF Ph.D. DISSERTATION

School Fundamental Science and Technology	Student Identification Number	SURNAME, First name YANO, Toru
<b>Title</b> A statistical mechanics study of CDMA multiuser detection problems		
<b>Abstract</b> CDMA (code-division multiple-access) multiuser detectors based on the generalized posterior mean estimator (GPME), which is formulated by Bayesian inference, have been analyzed with a statistical mechanics method. Belief propagation (BP) based multiuser detection algorithms, which are approximations to GPME detectors, have also been investigated with another statistical mechanics method. However, these studies were done on the simplifying assumptions. Therefore it is necessary to consider whether statistical mechanics approach is effective for more general problem settings or not. The purpose of this paper is to investigate the effectiveness of statistical mechanics methods for general CDMA multiuser detection problems. An analysis of CDMA systems with error-control coding is presented. In addition, BP-based iterative algorithms for joint channel parameter estimation and user detection are studied. As the result of application of the statistical mechanics method to the coded CDMA systems, we obtain an analytical expression of the maximum spectral efficiency of the coded CDMA system with the GPME detector, where any encoding method for each user and any additive noise channel are dealt with. The statistical equivalent description of the coded CDMA system with the GPME detector is, in the large-system limit, provided in terms of a bank of scalar Gaussian channels whose variances in general vary at different code symbol positions. The study of the joint channel parameter estimation for the BP-based detector focuses on the problem of estimating Gaussian channel noise variance, for which two heuristic methods are formulated. One method utilizes leave-one-out tentative posterior mean estimates of information symbols, which are computed from the BP-based detector. The other method uses ordinary tentative posterior mean estimates of information symbols, also given by the BP-based detector. Their performances are compared by theoretical prediction of their dynamics. This analysis shows that the former method stably estimates a value near to the true noise variance and the latter method may induce unstable behavior in its dynamics. By using the theoretical prediction for the dynamics of the latter method, the stability region is determined. As stated above, the results of this paper indicate that statistical mechanics approach is useful for more general problem settings in CDMA multiuser detection.		