SUMMARY OF Ph.D. DISSERTATION

School	Student Identification Number	SURNAME, First name
Graduate School of Science and Technology		ARIYOSHI, Masayuki

Title

Performance and Efficiency Improvements in Mobile Multimedia Communication Systems Using Trellis Coded Modulation and Code Division Multiple Access

Abstract

Technologies and environments for the usage of the mobile communication systems have been highly and rapidly developed for recent years. Accordingly, the demands for the mobile multimedia communication have been increased, i.e., huge amount of variable multimedia traffic needs to be sent and received at high speed in various environments. This dissertation focuses on several core elemental technologies that play important roles of the developments in the recent mobile multimedia communication systems. Particularly in this dissertation, technologies for improving performance and system efficiency have been studied on coded modulation schemes, code synchronisation for Code Division Multiple Access (CDMA) communications, interference suppression techniques for CDMA systems, and channel coding schemes.

In Chapter 1, a general introduction is given which includes a brief technological history of mobile communication systems and outlines of the technologies related with this dissertation: Trellis Coded Modulation (TCM), spread spectrum and CDMA communications, interference suppression techniques for CDMA systems, and channel coding and decoding methods. The motivations of this dissertation are also described, namely, problems in past works and contributions of the researches in the dissertation.

Chapter 2 presents proposals of TCM schemes that reduce the number of transmission signal points in the constellation by overlapping the particular signal points. One is called as TO-TCM in which all the signal points are totally overlapped, hence no signal constellation expansion is caused by coding. It is confirmed that the TO-TCM can extend the minimum free distance and achieves about up to 3.0dB of coding gain comparing to the conventional TCM scheme. In another method, the signal points are partially overlapped, but the occurrence probability of the signal points are unequal. This method can also reduce the signal constellation expansion and average transmission power, that contribute to achieve about 1.8 to 3.9dB of coding gain comparing with conventional and TO-TCM schemes.

Chapter 3 studies on digital matched filter (MF) for CDMA mobile communication systems, aiming low power consumption and small logic scale. New MF designs are proposed, in those the gate switching rate is minimised for reducing the consuming power. Moreover, an MF structure with reduced taps and inner cyclic accumulation of partial dispreading correlation contributes to the logic scale reduction. It is shown that the proposed MF design can reduce 10% of gate count and 50% of consuming power comparing with the conventional MF.

Chapter 4 evaluates the performance of multi-stage parallel interference cancellation (MSPIC) receiver using a channel estimation of forward-backward multiplication method (FBMM) filtering in WCDMA uplink. The FBMM filtering channel estimation has features of good tracking performance to slow and fast fading, as well as short processing delay and low complexity. It is confirmed that the FBMM filtering channel estimation can improve performance of both the MSPIC and ordinary Rake receivers comparing with the conventional 1-slot pilot averaging method.

Chapter 5 studies on Generalised Rake (G-Rake) receiver for CDMA uplink. The G-Rake was originally proposed to whiten interference signal in CDMA downlink. In this chapter, the usage of G-Rake is expanded for the uplink. Furthermore, a space-time processing for G-Rake with multiple antennas is proposed. From the performance evaluations in WCDMA uplink, it is shown that the space-time G-Rake achieves a good performance near MSPIC. Chapter 6 proposes a novel decoding algorithm for turbo codes, aiming to improve the coding gain. It is first pointed out that the errors of redundant information in the channel might be a major cause of decoder performance limits such as error floors. In order to improve the reliability of the redundant information, a new method is proposed, in that the likelihood values for redundant parts are updated based on the interim decoding outputs. It is shown that the proposed decoding method can improve the error correcting capabilities, i.e., the improvements of bit error rate (BER) and block error rate (BLER) performance and the achievable BER / BLER limit. Chapter 7 provides the overall conclusions of the dissertation.