Signal and Information Processing for Wireless Communication Systems

Srikrishna Bhashyam

Abstract

Next generation wireless communication systems need to support access to multimedia data available on the internet. This universal wireless access to multimedia data requires data rates and quality of service that are orders of magnitude better than those available in current wireless systems. The two major problems posed by the wireless channel, multipath fading and multiple access interference, are addressed here. The time-varying and shared nature of the wireless channel lead to multipath fading and multiple access interference (MAI) respectively. In this work, signal and information processing algorithms are developed to combat these problems and, consequently, increase data rates and improve performance.

First, multiuser signal processing algorithms that combat MAI are developed for code division multiple access (CDMA) systems. Although multiuser signal processing has been extensively studied in the past, very little attention has focused on the practically important case of CDMA with long spreading codes that forms the basis of next generation wireless cellular communications. This work proposes new multiuser channel estimation and tracking algorithms for long code CDMA and demonstrates the significant gains achievable in performance. We also propose new channel estimation algorithms for short code CDMA systems that support multi-

ple data rates to achieve multimedia communication. The new problems posed by the multirate nature of this system, key to support multimedia communication, are studied.

Then, in the rest of this work, the use of multiple antenna systems with channel feedback is studied to combat fading. Multiple antenna systems provide multiple independent channels for communication and can effectively combat fading. The following practical issues, ignored in most existing work, are considered in the analysis and design: (i) the channel information is imperfect both at the receiver and at the transmitter, and (ii) part of the total available resources for the system need to be used for channel estimation and feedback. Feedback and power control schemes are designed to achieve significant gains in performance (in terms of outage probability) and data rates. These gains, based on the information-theoretic analysis, are then translated into frame error rate improvements for practical systems that employ space-time codes.