Abstract of the Dissertation

System Architectures for Space-Time Communications over Frequency Selective Fading Channels

by

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Space-time MIMO communication is a powerful technique that provides a significant improvement in spectral efficiency. The application of MIMO communication systems to frequency selective fading channels is studied in this dissertation. The research is oriented toward communication systems with a complexity suitable for implementation. These systems exploit the multipaths and the multiple transmit/receive antennas to deliver high channel throughput to the user. The research presented in this dissertation covers the theoretical aspect, optimal implementation, and practical adaptive algorithm for wideband MIMO. It thus provides a solid basis for the designer of MIMO communication systems for frequency selective fading environments.

The theoretical capacity of wideband MIMO systems under colored noise is derived and used to demonstrate the multi-fold increase in capacity offered by these systems. The effect on the MIMO wideband capacity of frequency diversity, transmit/receive antennas configurations, multi-users and multi-devices environments, channel correlation, line-of-sight propagation, and channel knowl-
edge at the transmitter is characterized. Field measurements of indoor high speed wireless communications realized using a testbed featuring real-time equalization and smart antenna array technology are also presented. The field measurements demonstrate the improvement provided by a smart antenna array in realistic frequency selective fading channel conditions.

Different system architectures for wideband MIMO are studied. Equalization, multi-carrier and spread spectrum forms of MIMO receivers are considered in this dissertation. Novel receivers are introduced such as an optimal finite length MIMO DFE receiver with cancellation, a generalized MIMO RAKE receiver with cancellation, and low complexity combiner MIMO RAKE receivers. The performance of the wideband MIMO receivers is studied and compared for various system configurations and channel environments. Several simulation results show that their behavior is conformed to the theoretical wideband MIMO channel capacity.

Novel LMS and RLS adaptive algorithms are proposed for the MIMO DFE receiver with cancellation. A new MIMO inverse QR RLS algorithm with better stability properties and lower complexity than the RLS algorithm is also introduced. Extension of the adaptive algorithms to MIMO OFDM and the generalized MIMO RAKE receiver are finally derived.