ESTIMATION OF FREQUENCY SELECTIVE WIRELESS CHANNELS FOR LAYERED SPACE-TIME SYSTEMS

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Abstract:
Space-time techniques for multiple-input multiple-output (MIMO) channels potentially provide vast increases in capacity compared to traditional wireless communication systems. A number of MIMO approaches have been proposed for both narrowband and wideband channels. In order to achieve the quoted capacity gains in the MIMO systems, the multiple channel impulse response and its fading coefficients must be known or estimated. Thus far, existing MIMO channel estimation schemes have been limited to either the narrowband case or cater specifically for coded space-time systems e.g. space-time block codes system or MIMO-OFDM system.

In this paper, we extend the layered space-time receiver architecture described in (*A. Lazono, C. Papadias, IEEE Trans. On Communication, Vol.50, 65-73, No.1 2002*) and present a novel MIMO channel estimation scheme for an uncoded layered space-time system operating in a wideband frequency selective fading environment. The proposed MIMO channel estimation scheme uses the orthogonal pilot sequences obtained from the Paley's construction of the Hadamard matrix and combines the following concepts to perform channel estimation in the MIMO frequency selective channel:

1) A pilot matrix transmitted as a sequence of pilot symbols is used to jointly estimate the fading coefficients of the individual channel impulse responses between the multiple transmit and receive antennas, as opposed to using a series of individual pilot symbols by an adaptive algorithm (*M. F. Siyau, P. Nobles, R. F. Ormondroyd, WPCM'01, Vol.3, 1451-1456, 2001*).

2) The Hadamard's property is utilised where the pilot sequences are made to be orthogonal and assigned to individual transmit antenna in order to resolve the multiple transmitted/received signals and the inter-symbol interference for each transmitted signals.

3) The Toeplitz structure of the Paley-Hadamard matrix is exploited to allow the length of the pilot sequence to be minimised for a given length of channel impulse response and thus maximise the effective data throughput.

The pilot sequences are periodically transmitted in block within frames of data that enable the channel estimation process to reconstruct the complete MIMO channel matrix. The key to the proposed MIMO channel estimation scheme is the ability to extract the orthogonal information carried by the received signals corresponding to the pilot sequences sent by the transmitter where the MIMO channel matrix can be obtained by applying a simple matrix operation to these pre-arranged received signals matrix at the receiver. We will also demonstrate how to design these pilot sequences. Results will be presented to demonstrate the accuracy of the proposed channel estimation scheme and its performance in layered space-time system with different system configurations.