Polynomial matrix decompositions

The interest and dramatic increase in demand for high-speed data transmission has exploded since the introduction of triple play multimedia services. One of the pioneering contributions is the increasingly higher data rates achievable through the use of multiple-input multiple output (MIMO) channels. A further increase in data rates is possible through a well-coordinated multiple channels.

Precoding and equalization transmission blocks represent a typical coordinated strategy that enhance the channel capacity of a deterministic narrowband MIMO channel. This strategy can be derived by performing a singular value decomposition (SVD) of a channel matrix.

These blocks allow a MIMO channel matrix to solve a host of special multicarrier problems using the orthogonal property of the system. It can also be exploited to approximate low-rank channel matrix by reducing the dimensionality of high-dimensional data sets. The technique referred to here as an orthogonal spatial multiplexing (OSM) method.

OSM allows multiple users to use a given bandwidth simultaneously by dividing the available channel into multiple narrow orthogonal bands that are spectrally spaced. Each band is then divided into numerous subcarriers, which are structures so as not to interfere with one another. The transmit signal is then modulated onto these subcarriers.

The technique exploits physical separation methods that permit the sharing of channel resources simultaneously. Every users becomes spatially spaced far enough from each other to counteract interference. In addition to spacing, dual polarizations are introduced to further avoid interference.

When signalling over MIMO channels using an orthogonal spatial multiplexing, an SVD can be used to derive every sub-carrier/tone. In the traditional method, an increase in the number of tones also increase the complex computational load. It is therefore the focus of this study to investigate an alternative means for obtaining an efficient decomposition.

A MIMO channel can be modelled as a weighted sum of the past and present samples of transmit data. The channel considers a finite impulse response (FIR) filters that can be represented by a covariance matrix whose elements are polynomials. This study focuses on investigating algorithms that decompose the covariance matrix directly.

Approximation factors can then be introduced to obtain the Precoding and equalization transmission blocks. Existing polynomial singular value decomposition algorithm is used and studied in the context of channel quality and computational complexity settings. The decomposition algorithms were shown to give decompositions of good channel quality, but if the goal is to obtain Precoding and equalization transmission blocks, the computational load is restricted with higher multidimensional channels.

An algorithm for approximating direct decomposition of covariance matrices is investigated. Although we discuss simple cases resulted in excellent decompositions but analyse with numerical stability of a spectral factorization steps for large-case decompositions.

For high frequency selective MIMO channels, the performance achieved by utilizing the polynomial SVD algorithm were compared to the channel capacity.

It was shown that if the transmit sequences are approximated individually at the receiver, as done in the traditional approach, the performance more likely to be sensitive to errors in the decomposition. An equalizer with a spatially joint detector seems promising to achieve a better performance close to the single-user transmission. With such an equalizer, the low complexity property of the traditional approach is compromised with performance.

Summarizing, this study has shown that a MIMO channel can be diagonalized in space and frequency using spatial multiplexing method in conjunction with a polynomial SVD algorithm. In order to reach better performance close to the achivable of a single-user, the computational load becomes restraining compared to the traditional approach, for channels with higher multidirectional channels.