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Validation of Adaptive Transmission for Realistic Single- and Multi-Carrier Mobile Radio Channels

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Reliable adaptive transmission for frequency selective mobile radio systems is addressed. In particular, we investigate adaptive channel loading for wireless Orthogonal Frequency Division Multiplexing (OFDM) systems and adaptive modulation aided by observations of another carrier (e.g, Frequency Division Duplex (FDD) channels). Adaptive transmission techniques, where the modulation size, coding rate, or other signal transmission parameters are dynamically adapted to the changing channel conditions, have recently emerged as powerful tools for increasing the data rate and spectral efficiency for wireless system. However, reliable adaptive transmission requires long-range prediction (LRP) of future channel state information (CSI) due to the variation of the wireless channel, which results in different channel conditions between the time of data transmission and the time of the channel estimation. We derive the minimum mean-square-error (MMSE) long range channel prediction method that utilizes the time and frequency domain correlation function of the Rayleigh fading channel. Since the channel statistics are usually unknown, reduced complexity robust prediction methods that can converge rapidly to the theoretical MMSE and do not require the knowledge of correlation functions are developed for OFDM channels and systems aided by observations of another carrier. Statistical model of the prediction error that depends on the frequency and time correlation is developed and is used in the design of reliable adaptive modulation methods.

A standard sum-of-sinusoids Rayleigh fading channel model (Jakes) and a novel physical model based on the method of images augmented with diffraction are employed to test the prediction algorithm. This physical model can generate non-stationary datasets to test both the LRP and its application in adaptive transmission schemes. It is demonstrated that this physical model generates realistic datasets that closely resemble measured data, and the results of the LRP for the physical model and measured data are similar, and differ significantly from those produced for the Jakes model. We use this model to produce different scenarios to classify typical and challenging cases to test the performance of the proposed prediction algorithm. These cases are more difficult to identify with the measured data. Moreover, we examine the dependency of the correlation between two different carrier frequencies on the variation of the root mean square (*rms*) delay spread and investigate the limits on the adaptation rate in adaptive transmission systems aided by observations of another carrier. Thus, the physical model allows to test robustness and to determine practical constraints of the proposed adaptive transmission methods.

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