PEAK TO AVERAGE POWER REDUCTION FOR MULTICARRIER MODULATION

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I certify that I have read this dissertation and that in my opinion it is fully adequate, in scope and in quality, as a dissertation for the degree of Doctor of Philosophy.

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Abstract

THE DATA RATE AND RELIABILITY REQUIRED to support the new information age has increased the demand for high speed communication systems. Multicarrier modulation has recently gained great popularity due to its rohustness in mitigating various impairments in such systems.

A major drawback of multicarrier signals is their high Peak to Average Power Ratio (PAR). Since most practical transmission systems are peak-power limited, the average transmit power must be reduced for linear operation over the full dynamic range, which degrades the received signal power.

This dissertation formulates the PAR problem for multicarrier modulation and proposes three new methods for PAR reduction. The first two structures prevent distortions by reducing the PAR on the discrete-time signal prior to any nonlinear device such as a DAC or a power amplifier. The third structure corrects for transmitter nonlinear distortion at the receiver when the nonlinear function is known. Most methods reduce the PAR of the discrete-time signal although the PAR of the continuous-time signal is of more interest in practice. We derive new absolute and statistical bounds for the continuous-time PAR based on discrete-time samples.

The first distortionless structure, called Tone Reservation, reserves a small set of subcarriers for reducing the PAR. For this method, the exact solution and several low complexity suboptimal algorithms are presented.

The second distortionless structure is called Tone Injection. For this method, the constellation size is increased to allow multiple symbol representations for each information sequence. PAR rednction is achieved by selecting the appropriate symbol mappings. The exact solution to this PAR minimization problem has non-polynomial

complexity. Bounds on maximum PAR reduction are derived and efficient algorithms that achieve near optimal performance are proposed. Similar to the Tone Reservation method, most of the complexity is introduced at the transmitter. The additional complexity at the receiver is a simple modulo operation on the demodulated complex vectors.

The third structure reduces the PAR by applying a saturating nonlinearity at the transmitter and correcting for nonlinear distortion at the receiver. This simplifies the transmitter at the expense of adding complexity at the receiver. Mutual Information expressions are derived for multicarrier transmission in the presence of nonlinear distortion. The optimum maximum likelihood receiver and an efficient demodulator based on the maximum likelihood receiver are also described.

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