BLIND FREQUENCY- OFFSET ESTIMATION FOR OFDM SYSTEMS OPERATING IN FREQUENCY SELECTIVE FADING CHANNELS

This thesis was submitted to the Department of Electronic and Telecommunication Engineering of the University of Moratuwa in partial fulfillment of the requirements for the degree of Master of Science.

Department of Electronic and Telecommunication Engineering
University of Moratuwa
Sri Lanka

University of Moratuwa

82428

November 2004

82428

ABSTRACT

Orthogonal frequency division multiplexing (OFDM) is successfully used in many wireless digital communications systems. [is used in Digital audio video broadcasting, Wireless Local Area Networks (LAN) and related discrete multi-tone (DMT) is use in wired digital communications.

Power of OFDM lies in dividing wideband channels into narrow band subcannels while keeping the bandwidth efficiency. When channels are narrow band, they can be considered as frequency flat even in harsh conditions such as mobile communications. It also possesses some disadvantages. Sensitivity of OFDM to carrier frequency offsets and the degradation due to that in performance is one of the main disadvantages.

This research work is focused on estimating unknown frequency offsets which cause intercarrier interference (ICI), while maintaining the bandwidth efficiency. There are numerous methods that have been proposed to overcome frequency offset problem in OFDM. Some adversely affect on the bandwidth efficiency by repeatedly transmitting data symbols or by overloading system with synchronization aided data. But there are methods which use inherent properties of OFDM signals to estimate the carrier offset while not lowering the bandwidth efficiency.

The technique proposed in this thesis uses a concept which has been published by Mounir Ghogho and Anantharam Swami. But their algorithm has been modified so that a relatively efficient combined quadrature amplitude modulation (QAM) scheme can be used for transmissions. This new combined modulation scheme, which is referred to as 'pseudo QAM' in this thesis, uses full QAM constellation for modulating part of the subcarriers in the OFDM symbol while other subcarriers are modulated using a subconstellation of the full QAM constellation. The subconstellation is selected so that all the symbols in the constellation have the same modulus. The estimation algorithm is based on virtual subcarrier property and the constant modulus property of the pseudo QAM subcarriers.

To compare the performance improvement of the proposed scheme, computer simulations have been carried out for multipath fading channel with additive white Gaussian noise (AWGN). Simulation results indicate very good improvement of the accuracy of the estimation relative to the estimation based on virtual subcarriers alone. Few bit error rate (BER) simulations have also been carried out and the results are included to verify performance in terms of BER. The bandwidth efficiency has been improved in proposed scheme since part of the subcarriers can be modulated with full QAM constellations. Hardware required for this new modulation scheme is the same as that for general QAM schemes. Required changes can be carried out in software. System can be made such that it goes for pseudo QAM scheme only when the estimation accuracy obtained with virtual carriers alone is not enough.