Chapter 5

BER Improvement in OFDM Systems Using Wavelet Transform Based on Kalman Filter

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ABSTRACT

Orthogonal frequency division multiplexing (OFDM) is an efficient method of data transmission for high speed communication systems over multipath fading channels. However, the peak-to-average power ratio (PAPR) is a major drawback of multicarrier transmission systems such as OFDM is the high sensitivity of frequency offset. The bit error rate analysis (BER) of discrete wavelet transform (DWT)-OFDM system is compared with conventional fast Fourier transform (FFT)-OFDMA system in order to ensure that wavelet transform based OFDMA transmission gives better improvement to combat ICI than FFT-based OFDMA transmission and hence improvement in BER. Wavelet transform is applied together with OFDM technology in order to improve performance enhancement. In the proposed system, a Kalman filter has been used in order to improve BER by minimizing the effect of ICI and noise. The obtained results from the proposed system simulation showed acceptable BER performance at standard SNR.

INTRODUCTION

The FFT based systems are replaced by one of the wavelet transforms called the discrete wavelet transform (DWT). Since DWT based OFDM does not use cyclic prefix, so a better spectral control of channels can be achieved. Discrete wavelet transform employs a low pass filter (LPF) and a high pass filter (HPF) which operates as a quadrature mirror filters fulfilling perfect reconstruction and orthogonal properties. In order to transmit the modulated signal zero padding and vector transposing is done in DWT OFDM systems. The use of wavelet promises to reduce the inter symbol interference (ISI) and inter carrier interference (ICI). The wavelet transform offers a higher suppression of side lobes. First,

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gives the already existing self-cancellation scheme and adaptive modulation to decrease ICI in OFDM system have been explained. Kalman filter (KF) method, statistically estimate the frequency offset and correct the offset, using the estimated value at the receiver. It has been showed that using Kalman filter with DWT based OFDM systems; improvement in BER can be made Kalman filter has been discussed laterally. From discussion then observed that the proposed DWT-based OFDM system outperforms than other existing schemes.

Expansion of OFDM and OFDMA

A major restriction in the transmission of high bit rates over a wireless medium is the large delay spread come from multipath propagation. The delay spread causes inter-symbol interference (ISI) which restricts the maximum achievable data rate. To overcome this limit and others, orthogonal frequency division multiplexing (OFDM) has been successfully employed in wireless systems. The basic idea underlying this technique is to partition the entire bandwidth into several narrowband subcarriers and the amnesty to multipath propagation acquires from the fact that an OFDM system transmits information on multiple orthogonal frequency carriers, each operating at a low bit rate. Moreover, OFDM has the following three main advantages: (1) Spectral efficiency is high (2) Easy to implement and (3) robustness against multipath delay spread. Since OFDM system subcarriers can be shared among multiple users, orthogonal frequency division multiple accesses (OFDMA) has been expected. The subcarriers are common among users, each having a mutually displace set of subcarriers, by setting up the subcarriers to the users with the best channel status for the specific subcarrier over others. The procedure, of course, is not simple since the best subcarrier of one user may be also the best subcarrier of another user who may not have any alternative one. Arranging the subcarriers and bit constellations in an excellent manner is called adaptive resource allocation which will be discussed below in this chapter.

An uplink OFDMA system block diagram is shown in Figure 1. The QAM input symbols are delivered into an inverse fast Fourier transform (IFFT) block (Krishna et al., 2018). Using channel estimation information feedback, adaptive resource allocation assigns a set of subcarriers to every user and adapts bit constellations for the data mapped in the assigned subcarriers. After IFFT, a cyclic prefix (CP) is added to the front of an OFDM symbol. As long as the CP length is larger than the wireless channel delay spread, only 1- tap frequency domain equalization per subcarrier is required to recover the transmission data. The function of rest of the receiver blocks essentially to invert the operations at the transmitter (Sreekanth et al., 2018).

On the other hand, the OFDMA waveform shows very clear-cut envelope variations resulting in a high peak-to-average power ratio (PAPR). Signals with a high PAPR desire highly linear power amplifiers toward off exaggerated inter-modulation distortion. In order to attain this linearity, the amplifiers have to run with a large back-off from their peak power capacity (Pareyani et al., 2012). This results in low power efficiency measured by the ratio of transmitted power to dc power dissipated, places a significant load on portable wireless terminals. Another problem with OFDMA in cellular uplink transmissions derives from the unavoidable offset in frequency references among the different terminals that transmit together. Frequency offset damages the orthogonality of the transmissions, thus introducing multiple access interference (Sreekanth et al., 2018).

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