Chapter 10

Adaptive Multicarrier Frequency Hopping Spread Spectrum Combined with Channel Coding

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ABSTRACT

This chapter presents an adaptive Multicarrier Frequency Hopping Spread Spectrum (MCFH-SS) system employing proposed Quasi Cyclic Low Density Parity Check (QC-LDPC) codes instead of the conventional LDPC codes. A new technique for constructing the QC-LDPC codes based on row division method is proposed. The new codes offer more flexibility in terms of girth, code rates and codeword length. Moreover, a new scheme for channel prediction in MCFH-SS system is also proposed. The technique adaptively estimates the channel conditions and eliminates the need for the system to transmit a request message prior to transmitting the packet data. The proposed adaptive MCFH-SS system uses PN sequences to spread out frequency spectrum, reduce the power spectral density and minimize the jammer effects.

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INTRODUCTION

The frequency hopping spread spectrum (FHSS) system with partial band interference requires appropriate combination of spread spectrum modulation, error correcting codes, diversity technique and decoding method in order to enhance the signal transmission (Berlekamp, 1980). The combination of a diversity technique and forward error correction codes for FHSS communications system offers the most reliable means of crossing the partial-band noise jammer (Berlekamp, 1980).

In FHSS technique the transmission bandwidth *W* Hertz is divided into *q* non-overlapping frequency slots. After the signal is modulated to an intermediate frequency, the carrier frequency is hopped periodically according to some predesignated code (a pseudo-random sequence) (Don, 2005; Simon et al., 1995). A patent Hedy Lamarr and music composer George Antheil (Don, 2005) for a "Secret Communication System," in 1942, is based on the frequency hopping concept, with the keys on a piano representing the different frequencies and frequency shifts used in music. In that year, the technology could not be realized for a practical implementation. Lemarr and Antheil incurred a patent for their idea soon after the expiry of the original patent. Then the U.S applied the FHSS technique for military communication systems onboard ships (Hoffman, 2002).The use of FHSS systems has then increased dramatically since 1962.

The benefit of a frequency hopping signal is that it intercepts resistant. This feature is extensively used in military communications where the risk of signal jamming or intercept is higher. Nowadays, it is used in the mobile communication industry as a multiple access technique. The frequency hopping communication systems are utilized to handle high capacity data in an urban setting (Don, 2005; Simon et al., 1995). Frequency hopping communication systems play an important role in military communications strategy. FH communication systems offer an enhancement in the performance when subjected by hostile interference. FH communication systems also reduce the ability of a hostile observer to receive and demodulate the communications signal. FH communication systems are susceptible to a number of jamming threats, such as noise jammers and narrowband, single or multitone jammers.

If all frequency hops are to be jammed, the jammer has to divide its power over the entire hop band. Thus, it needs to lower the amount of the received jamming power at each hop frequency. Unfortunately, if the tone jamming signal has a significant power advantage, reliable communications will not be possible, even when the jamming tones experience fading (Robertson and Sheltry, 1996; Katsoulis and Robertson, 1997). If the FH signal has an ample hop range, received jamming power will be negligible. If a tone jammer is concentrated on a particular portion of the FH bandwidth, its power may adversely impact communications. A likely anti-jamming strategy is used as a narrow bandstop filter to remove the tone from the received signal spectrum (Don, 2005). Another method based on the undecimated wavelet packet transform (UWPT) isolates the narrowband interference using frequency shifts to confine it to one transform subband (Perez et al., 2002). This technique is a robust to avoid interference and is suitable for FHSS systems.

Frequency Hopping Over Direct Spread Spectrum

The fundamental difference between direct spread Pseudonoise (PN) and frequency hop is that the instantaneous bandwidth and the spread bandwidth are identical for a direct spread PN system. While for a frequency hop system the spread bandwidth can be and is typically far greater than the instantaneous bandwidth. For the frequency hop system, all the anti-jamming (AJ) systems processing gain depends upon the number of available frequency slots. The spread bandwidth is generally equal to the frequency excursion from the lowest available

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