Form 2

Dissertation Abstract

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Dissertation title	Spectrum Sensing of OFDM Signals in Highly Noisy Environments for Cognitive Radios (コグニティブ無線のための高雑音環境下でのOFDM信号のスペクトルセンシング)		

Abstract

※ The abstract should be in keeping with the structure of the dissertation (objective, statement of problem, investigation, conclusion) and should convey the substance of the dissertation.

The radio frequency spectrum is a precious and limited resource which is used for all forms of broadband wireless communication systems. The excessive use of the radio frequency spectrum has created a serious spectrum scarcity problem. Cognitive radio (CR) systems confer a novel solution for reducing the spectrum scarcity problem by solving the inefficient use of the radio frequency spectrum.

Spectrum sensing is an important requirement in CR systems to identify the radio spectrum status being either active or vacant. Orthogonal frequency division multiplexing (OFDM) is broadly used in modern broadband wireless communication standards such as digital audio broadcasting (DAB), terrestrial digital video broadcasting (DVB-T), long term evolution (LTE), Wi-Fi, WiMAX, and many other wireless systems. For this reason, the spectrum sensing for OFDM systems is one of the most important problems in CR systems. Much research has been carried out in the last two decades, however, there is no well-known method exists which provides the necessary preciseness, reliability, and robustness. The major limitation of the existing spectrum-sensing methods results for OFDM systems in their high computational complexity and unsatisfactory sensing capability in highly noisy environments. In addition, most techniques assume that the OFDM primary user information is known in prior which is impractical in the real world situation. Thus, spectrum sensing of OFDM transmitted systems for low signal-to-noise ratio (SNR) cases in the semiblind condition are foremost significant in the CR system. For this requirement, this thesis introduces three efficient spectrum-sensing methods of OFDM-transmitted signals for CR systems. The objective of this thesis is to propose an efficient spectrum-sensing approach to improve the OFDM signal detection performance over multipath fading channels in highly noisy environments of CR systems for modern and upcoming wireless communication systems.

The first method utilizes autocorrelation function for spectrum sensing to detect OFDM signals for low SNR cases. In the proposed method, a comb filter is combined with autocorrelation function, where an OFDM-transmitted signal is considered. In this method, the OFDM primary user information is not required for spectrum sensing. This method is a semiblind one. The detection performance is measured for different cyclic prefix (CP) sizes of OFDM signals over additive white Gaussian noise (AWGN) and multipath Rayleigh

fading channels for different digital modulations. The proposed method is a low-complexity semiblind spectrum-sensing method. The proposed spectrum-sensing method improves the SNR compared with that for the conventional spectrum-sensing methods over AWGN channel and multipath Rayleigh fading channels. This method comparatively enhances the OFDM detection performance, however, it is sensitive for low SNR cases.

In the second method, the combination of comb filter and time domain autocorrelation calculation is applied in a parallel form for sensing OFDM transmitted signals. Several comb filters to be prepared in a parallel form are used for reducing the loss of orthogonality of OFDM influenced by a multipath fading channel, while the autocorrelation functions in each parallel path are averaged and enhanced for spectrum sensing. This idea increases detection performance in spectrum sensing by improving effectively the SNR of the received signal in a merged fashion. The proposed method is an effective semiblind spectrum-sensing method. This method enhances the detection performance of OFDM signals than the conventional CP known and CP unknown autocorrelation based spectrum-sensing scheme in highly noisy environments.

For the multipath fading channel case, many signals cannot be detected adequately using second order statistics including autocorrelation. As a result, higher order statistics can be used for OFDM detection instead of second order statistics to overcome the low SNR detection problem. In this thesis, the third method proposes a spectrum sensing to obtain excellent detection performance of the OFDM transmitted signal. This method utilizes higher order statistics including skewness function and kurtosis function. The proposed method improves the detection performance by increasing its computational complexity, where an OFDM-transmitted signal over multipath fading channel is considered. The OFDM signal detection is possible for various symbol lengths and CP sizes over multipath fading channels under higher order digital modulations in highly noisy environments using the proposed method. The proposed method is compared with the conventional autocorrelation based spectrum-sensing methods over multipath Rayleigh fading channels. The use of skewness increases the OFDM detection performance than the conventional spectrum-sensing schemes dramatically for low SNR cases. Furthermore, the use of kurtosis function markedly increments the sensing capability of OFDM primary user signals in highly noisy environments.

The performance of the proposed spectrum-sensing methods for OFDM transmitted signals is compared with the well-known existing method in terms of probability of detection, probability of false alarm, probability of miss detection, receiver operating characteristic (ROC) curves, and complementary receiver operating characteristic (CROC) curves. A comprehensive evaluation of the spectrum sensing results for OFDM-transmitted signals under different channels of AWGN and multipath Rayleigh fading for different digital modulations in detection performance simulations. These results demonstrate that our proposed spectrum-sensing methods can be a suitable candidate of OFDM signals detection in CR for modern and next generation wireless communication systems.