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*"**Contribution to WG1**: Definition of cognitive algorithms for adaptation and configuration of a single link according to the status of external environment"*

Sparsity-Based Primary User Detection for Cognitive Radio

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Abstract

Spectrum sharing has gained a special attention in the research community for its promising results in improving the spectral efficiency [1]. CR [2] resolves the problem of limited spectral resources by enabling unlicensed systems to opportunistically utilize the unused licensed bands. The task of accurately detecting the presence of licensed user is encompassed in spectrum sensing. Among the challenges related to spectrum sensing implementation, the most critical is the need to process very wide bandwidth, which involves sampling many points on the radio spectrum [3].

Compressive Sensing (CS) [4] is a powerful technique for accurately detect the existence of primary users from a reduced number of measurements by exploiting the sparsity described by active primary users. In the spectrum sensing problem, the spectral support of the signals of interest is significantly smaller compared to the bandwidth under scrutiny. Furthermore, the sparsity can also be leveraged to increase the accuracy of the detections by using sparsity-based recovery methods.

In practical settings, primary signals must be detected even with the presence of low-regulated transmissions from secondary systems. The existence of interferences emanating from low-regulated transmissions, which cannot be taken into account in the CS model because of their non-regulated nature, greatly degrade the identification of licensed activity.

This paper presents a feature-based technique for primary user's spectrum identification with interference immunity which works with a reduced amount of data. The proposed method detects which channels are occupied by primary users' and also identify the primary users' transmission powers. The spectrum characteristics of the primary signals, which can be obtained by identifying its transmission technologies, are used as features. The basic strategy is to compare the a priori known spectral shape of the primary user with the power spectral density of the received signal. This comparison can be made in terms of autocorrelation by means of a correlation matching. Thus, the occupied channels are directly detected from the sample autocorrelation matrix avoiding the complete signal reconstruction. An overcomplete dictionary that contains tuned spectral shapes of the primary user allow sparse representation of the primary user

spectral support, thus allowing the different matched-filters to be applied simultaneously to the compressive data. Note that the use of overcomplete dictionaries increases the sparseness of the conventional frequency-domain sparse basis. Extraction of the primary user frequency locations is performed based on sparse signal recovery algorithms.

The essence of the proposed interference rejection mechanism lies in preserving the positive semidefinite character of the difference between the reference and the sample autocorrelation matrices. The interference rejection is achieved by introducing weights to the l1-norm and supplying a new stopping criterion for the Weighted Orthogonal Matching Pursuit (WOMP) [5].

Simulation results support this paper. The following scenario is used in the simulations: two primary users using BPSK modulation (rectangular pulse shape) with SNR=10dB and SNR=7dB, the first located at 2.5MHz and the second located at 12.5MHz. A 10dB carrier is included at 7.5MHz as interference.
Fig. 1 shows the periodogram of the scenario for different compression rates (ρ), where ρ=1 is equivalent to sampling at the Nyquist sampling rate. Fig. 1(b) shows the performance of the proposed technique (in blue). The true primary users' power and frequency are indicated with black crosses and the interferent user location is indicated with a red line. The results obtained with the proposed technique provide accurate frequency locations of the primary users as well as an estimate of its transmitted power.

References

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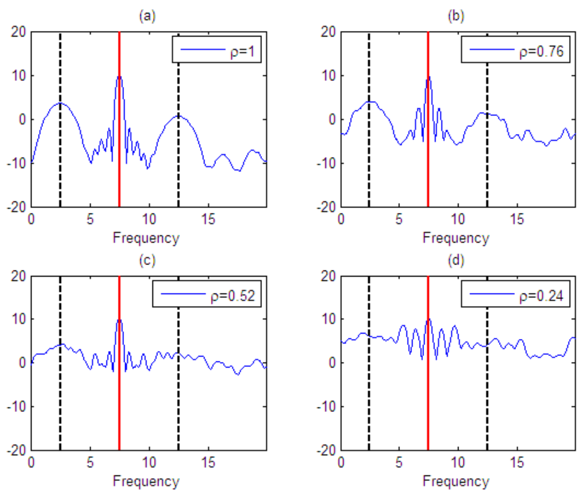

Fig. 1: Periodograms for different compression rates

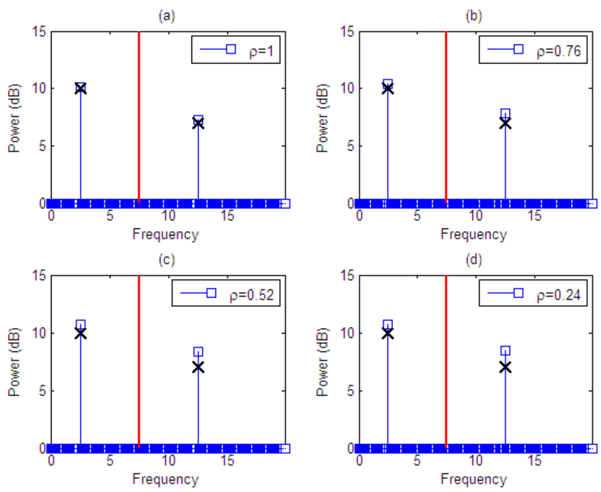

Fig. 2: Proposed Technique for different compression rates (in blue).