Blind Modulation based on Cyclostationary Feature Detection

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Abstract-An ideal detection scheme should be fast, accurate, and efficient. Cyclostationary feature detection is a detection scheme that satisfies all these criteria. The method also possesses the ability to distinguish between noise and the primary user signal. One major advantage of the cyclostationary feature detection method is that in addition to identifying the primary user signal, it also identifies the modulation scheme used by the primary user. This paper investigates the cyclostationary feature detection method under different modulation schemes. In this paper, cooperative spectrum sensing is performed, which involves cooperation among various cognitive relay nodes. Cooperative spectrum sensing is thus found to be an effective technique to improve the detection performance by exploring the spatial diversity of various relay nodes.

INTRODUCTION

Wireless communication becomes an essential part of daily human life. With new emerging technologies, many applications, such as smartphones and mobile computing, involve more bandwidth. All those developments become a constraint between the growing demand for wireless spectrum and the limited wireless resources. The Federal Communication Commission (FCC) in the U.S. is an independent agency that regulates the usage of spectrum internationally and domestically. For large geographical areas and long term usage, a licensee is assigned with the spectrum. It has been studied that a portion of the radio spectrum allocated to the licensed user remains underutilized. The underutilized section of the spectrum is called white space or spectrum holes [1]. To solve the inconsistency between the wireless resources and the demand of the wireless spectrum, the unused spectrum must be used fully. To make the feasible, the spectrum assignment should be dynamic instead of statistical or fixed. In the fixed spectrum assignment, an unlicensed user is not able to reuse the unconsumed frequency spectrum or bands properly. Whereas, dynamic or opportunistic spectrum access (OSA) allows an unlicensed user to access the available bands suitably without interrupting the primary users. Therefore, the unlicensed user must be familiar with the occupancy of a licensee in the available band. In order to make use of the free spectrum, the cognitive user must locale the spectrum holes and idle state of licensed users. The cognitive user must be capable of instantly quitting the band if a primary user is transmitting. This is accomplished by dynamically accessing the spectrum. Cognitive radio (CR) appears to be a technology, which makes use of dynamic spectrum assignment.

CYCLOSTATIONARY FEATURE DETECTION

A cyclostationary process has statistical properties that vary periodically over time. Cyclostationary feature detection method deals with the inherent cyclostationary properties or features of the signal. Such features have periodic statistics and spectral correlation that cannot be found in any interference signal or stationary noise. It exploits this periodicity in the received primary signal to identify the presence of primary users, and that is why the cyclostationary feature detection method possesses higher noise immunity than any other spectrum sensing method. In this method, the cyclic spectral correlation function (or SCF) is the parameter that is used for detecting the primary user signals.

Cyclostationary spectrum sensing method performs better than other detection schemes such as energy detection method in low SNR regions, because of its noise rejection capability. This occurs because noise is totally random and does not exhibit any periodic form of behavior. When we have no prior knowledge about the primary user’s waveform, which is the scenario in real life, then the best technique to be adopted is cyclostationary feature detection. As an advantage, the cyclostationary spectrum sensing method can be used to find out the type of modulation scheme used by the primary user signal.

At the same time, the cyclostationary method has some disadvantages too. These include spectral leakage of high amplitude signals, their non-linearity, etc. The method is computationally complex and hence requires significantly longer observation time and also costs high [1]. Also, when an insufficient number of samples are used, the detection performance will degrade due to the poor estimate of the cyclic spectral density. Two-dimensional spectral correlation is the way to extract the periodic features of the primary user signal. These signals are cyclostationary processes that are periodic in time t. They also possess a periodic autocorrelation function.

$$R_y(t+\tau) = R_y(t+T_0,\tau)$$

Figure 1. Periodic Auto-Correlation Function

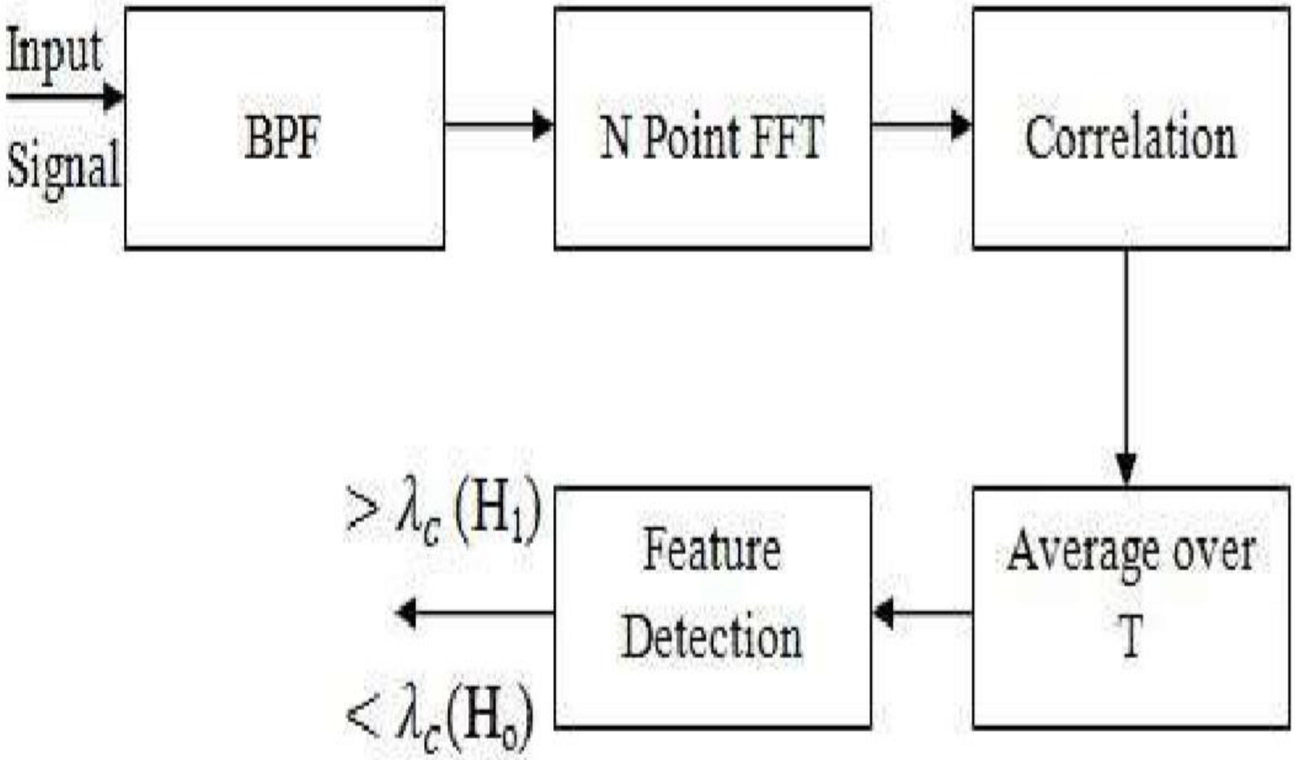

Figure 2. Block Diagram of cyclostationary feature detection

MODEL

Our baseline method leverages the list of higher-order features and other aggregate signal behavior statistics. Here we can compute each of these statistics over each of the keys present, and translate the example into feature space, a set of real values associated with each statistic for the example. For making the classification task much simpler but also discarding the vast majority of the data. We use an ensemble model of Decision Tree to classify modulations from these features, which outperforms a single support vector machine (SVM) significantly on the task.

RESULT

1.Classification accuracy vs SNR

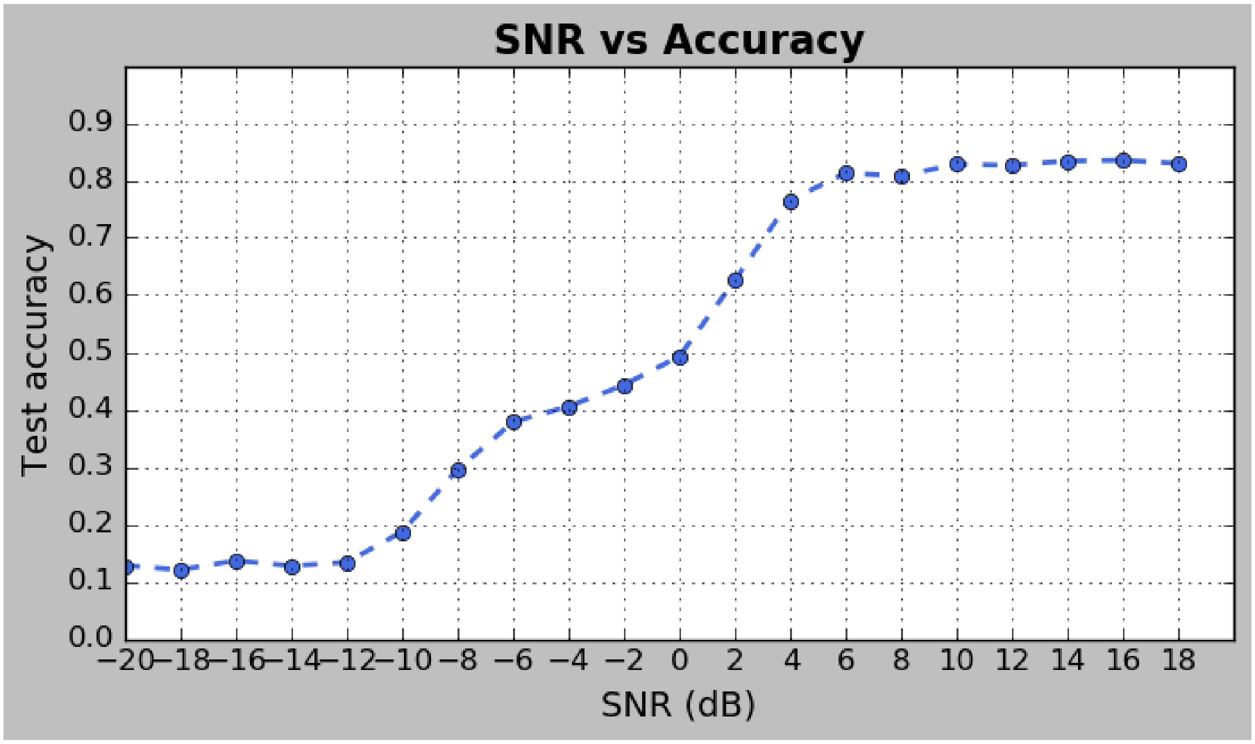

Figure 3. Decision Tree High SNR Confusion on RML2016.10a Dataset

2.Confusion Matrix

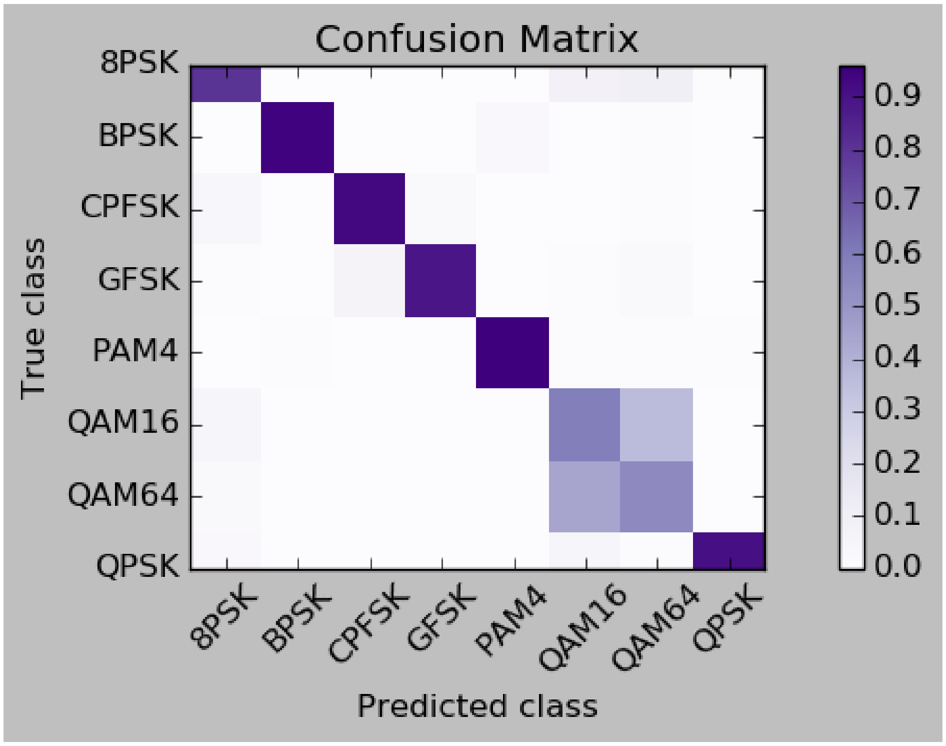

Figure 4. Decision Tree High SNR Confusion on RML2016.10a Dataset

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