Chapter 1

Blind Signal Detection Techniques for Spectrum Sensing in Satellite Communication:

Blind Signal Detection Techniques for Satellite Communication

Bilal Muhammad Khan
National University of Sciences and Technology Islamabad, Pakistan

Rabia Bilal
Usman Institute of Technology, Pakistan

ABSTRACT

Modulated signals used in communication systems exhibits cyclic periodicity. This is primarily due to sinusoidal product modulators, repeating preambles, coding and multiplexing in modern communication. This property of signals can be analyzed using cyclostationary analysis. SCF (Spectral correlation function) of cyclic autocorrelation (CAF) has unique features for different modulated signals and noise. Different techniques are applied to SCF for extracting features on the basis of which decision of detecting a signal or noise is made. In this chapter, study and analysis of different modulated signals used in satellite communication is presented using SCF. Also comparison of several signal detection techniques is provided on the basis of utilizing unique feature exhibit by a normalized vector calculated on SCF along frequency axis. Moreover a signal detection technique is also proposed which identifies the presence of a signal or noise in the analyzed data within the defined threshold limits.

DOI: 10.4018/978-1-5225-1785-6.ch001

INTRODUCTION

Motivation

Satellite cognitive radios have been proposed in recent years so that the static bandwidth of the satellite can be utilized by primary and secondary users. Cognitive radio needs spectrum sensing technique to sense the free radio channel for utilization. Cyclostationary analysis is a hot research topic in spectrum sensing because it is efficient than traditional energy detection analysis. Techniques based on this method are complex and computational hungry to be used in cognitive radios. This chapter focuses towards the modulated signals used in communication satellites since there is almost no or very little research present focusing this particular area. If computational complexity of the detection technique is minimized, the research will help in developing algorithms for spectrum sensing modules for satellite cognitive radios.

Cyclostationary and Cognitive Radios for Satellite

Cyclostationary analysis of modulated signals have been a vast topic of research for almost half a century, different aspects of this inherent property of modulated signals have been investigated in that period (Gardner, 1994). The main application of cyclostationarity of signals is in the domain of spectrum sensing as it has been a proven technique for this purpose than conventional energy detection (Yucek & Arsalan, 2009). After the advent of SDR (Software defined radio) based CR (Cognitive radios) to solve the problem of spectrum scarcity in the frequency bands (Mitola & Maguire, 1999), cyclostationary analysis have been adopted as a perfect choice for spectrum sensing (Sutton, Nolan, & Doyle, 2008; Paisana, N. Prasad, Rodrigues, & R. Prasad, 2012; Nafkha, Naoues, Cichon, & Kliks, 2014). The main focus in this context is in the terrestrial bands but their exploitation in satellite communication is still not explored (Tarchi et al., 2014). Particularly, very few initiatives at academic and industrial level have addressed the spectrum sensing aspects for CR of satellite communication (Tarchi et al., 2014). So application of cyclostationary analysis to the modulated carriers in the satellite band is an open research area. The CR for satellite needs to detect the modulated carriers while performing the spectrum sensing in order to provide opportunity spectrum holes to secondary users. There is a computational complexity associated with the cyclostationary based detection so detection technique devised for satellite CR should be low in complexity with shorter number of samples and low resolution analysis (Sutton, Nolan, & Doyle, 2008).

In satellite communication, modulated carriers are generated with modems, function generators meant for this purpose and travels at around 36000 km up to the satellite receiver. The band pipe nature of the satellite sends them back to the downlink. So this channel incorporated a lot of noisy effects in the communication signals and then intended CR should be working with these received signals having the effect of this long path channel. The importance of this scenario must be kept in mind while designing the signal detection technique for satellite CR. In this research, properties of such signals are exploited and a simpler technique incorporating all the complexity parameters discussed above is being proposed for satellite CR. The platform for the design of practical CR is of great importance. This is due to the fact that if the designed algorithm for detection is not compatible with the CR platform then the signal detection efficiency will be compromised. So USRP2 which has been a proven platform for practical SDR and CR development is used to capture the satellite signals and the lab generated satellite signals. This will enable the developed algorithm to work as a practical spectrum sensing engine for a prospective satellite CR on a real CR platform as in (Sutton, Nolan, & Doyle, 2008; Baldini, Guiliani, Capriglione, & Sithamparanathan, 2012; Aziz, & Nafkha, 2014; Nafkha, Naoues, Cichon, & Kliks, 2014).