Exploiting Cyclic Features for Jammer Detection in Wide-band Cognitive Radios

Tassadaq Nawaz, Muhammad O. Mughal, Lucio Marcenaro and Carlo S. Regazzoni

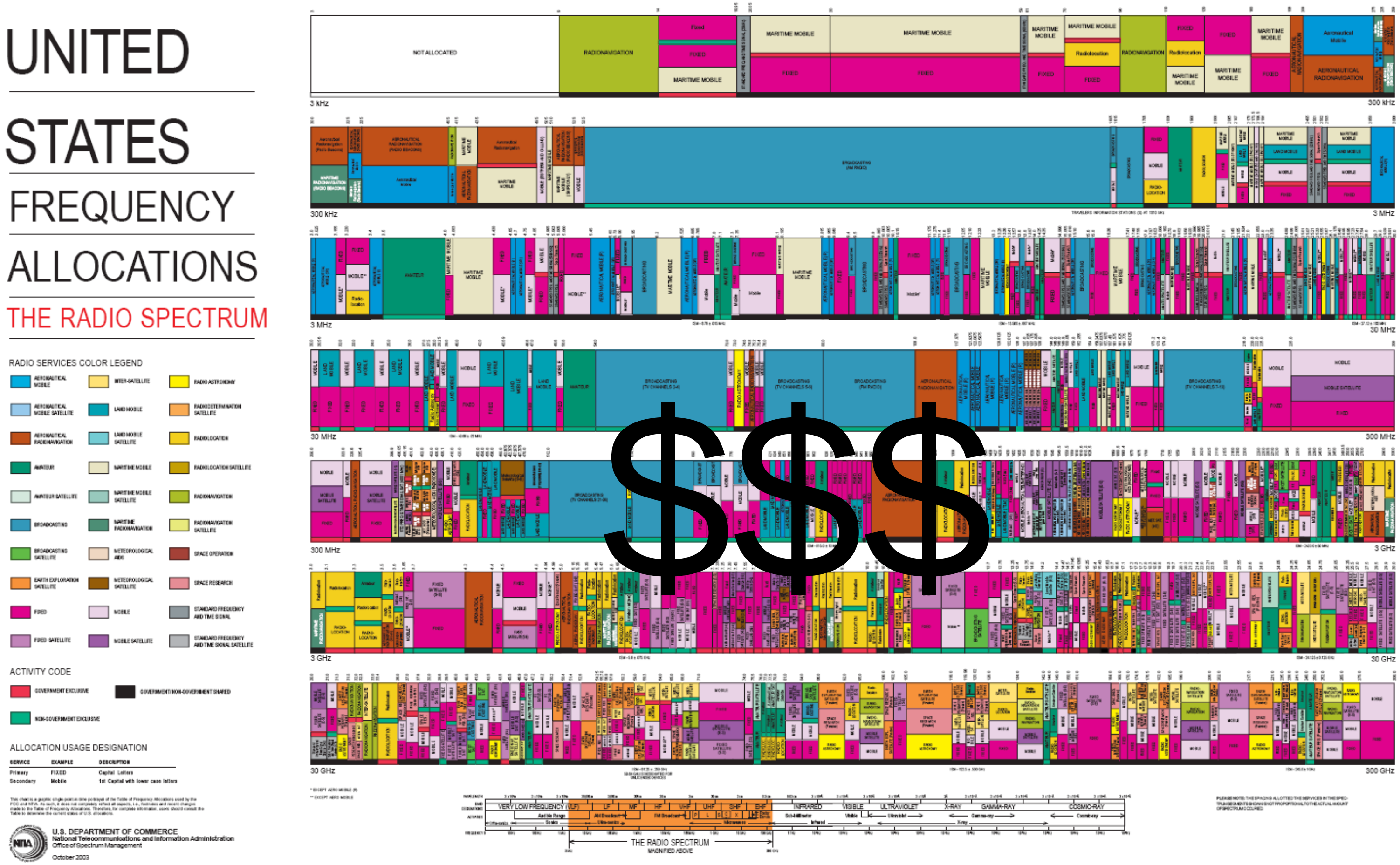
Department of Electrical, Electronic, Telecommunications Engineering and Naval Architecture-DITEN, University of Genova, Italy

Presentation Outline

- Introduction
- Jammer Detection in Wideband Cognitive Radios
- Conclusion

1 Introduction

Why cognitive radio?
Scarce Wireless Spectrum



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http://www.ntia.doc.gov/files/ntia/publications/2003-allochrt.pdf

Expensive

Why cognitive radio?

- Current wireless networks are regulated by fixed spectrum assignment policy.
- According to Federal Communication Commission, temporal and geographical variations in the utilization of the assigned spectrum ranges from 15% to 85%.

Why cognitive radio

Fixed Spectrum Assignment policy → spectrum white spaces

Inefficient spectrum utilization

- Cognitive radio network (CRN) is :
  - A new paradigm that provides the capability to share or use the spectrum in an opportunistic manner.

Cognitive radio

- Cognitive radio is a wireless communication system which is aware of the environment and its changes and can adapt its transmission parameters accordingly.
  - Cognitive Capability: The ability to sense the unused spectrum at a specific time and location (spectrum hole)
  - Reconfigurability: The ability to receive and transmit at different frequency band enables the cognitive radio to reconfigure its parameters and select the best band.

Spectrum hole

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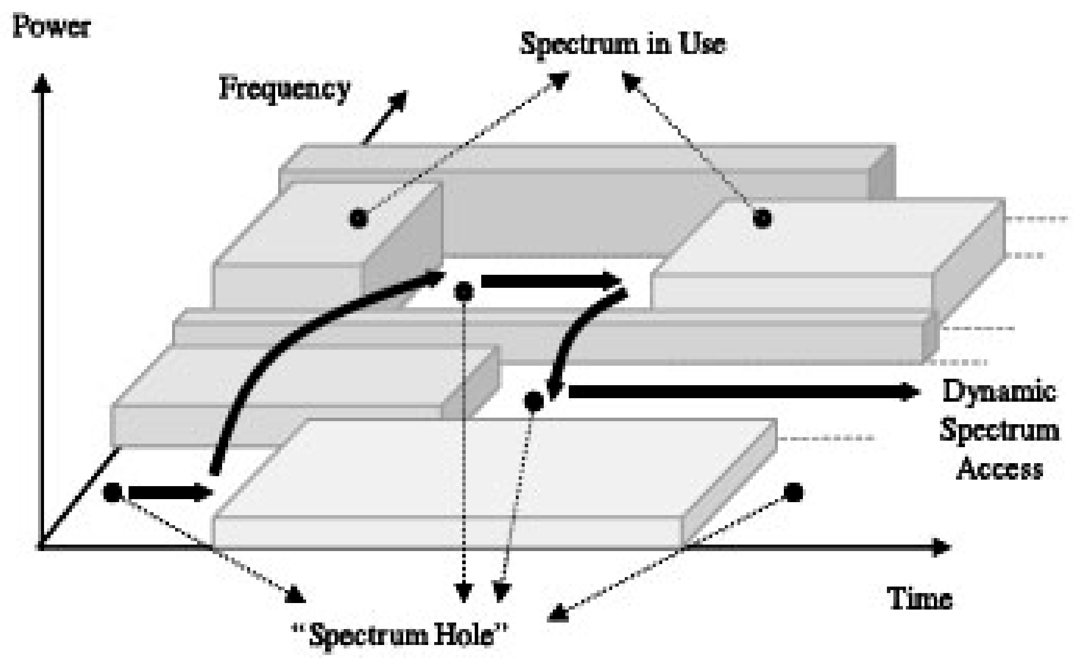


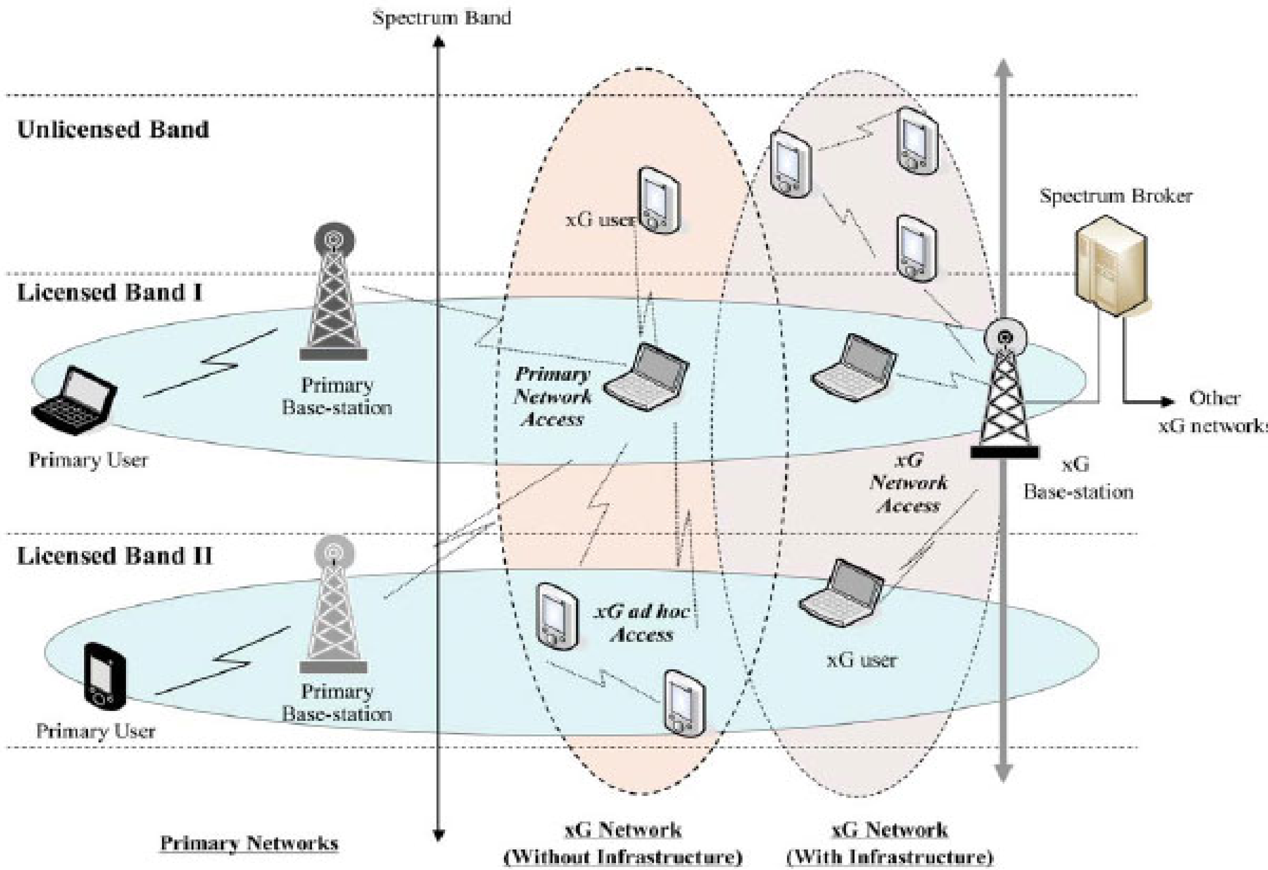
Illustration of Spectrum holes [1]

Components of CRN

- Primary network
  - Primary users:
    - Primary users have the license to operate in certain spectrum bands
  - Primary base station:
    - Controls the access of primary users to spectrum

- Secondary network
  - Secondary users:
    - Secondary users have no licensed bands assigned to them.
  - Secondary base-station:
    - A fixed infrastructure component with cognitive radio capabilities and provides single hop connection to secondary users.
  - Spectrum broker :
    - Scheduling server shares the spectrum resources between different cognitive radio networks.

Cognitive radio architecture



Cognitive radio architecture [2]

Functionalities of a CRN

- **Spectrum sensing:** Cognitive radio user has the ability to sense the unused spectrum at any time and location.
- **Spectrum management:** Based on the availability of the spectrum and other policies, CR user allocates the best available spectrum band.
- **Spectrum mobility:** CR user shall vacate the spectrum in the presence of any primary user and move to next best available spectrum band
- **Spectrum sharing**: CR network has to provide a fair and optimal spectrum allocation method among multiple CR users.

Spectrum Sensing Methods

Three possible approaches:

- Matched Filter
- Energy detector
- Cyclostationary Feature detector
- **Local Spectrum Sensing**

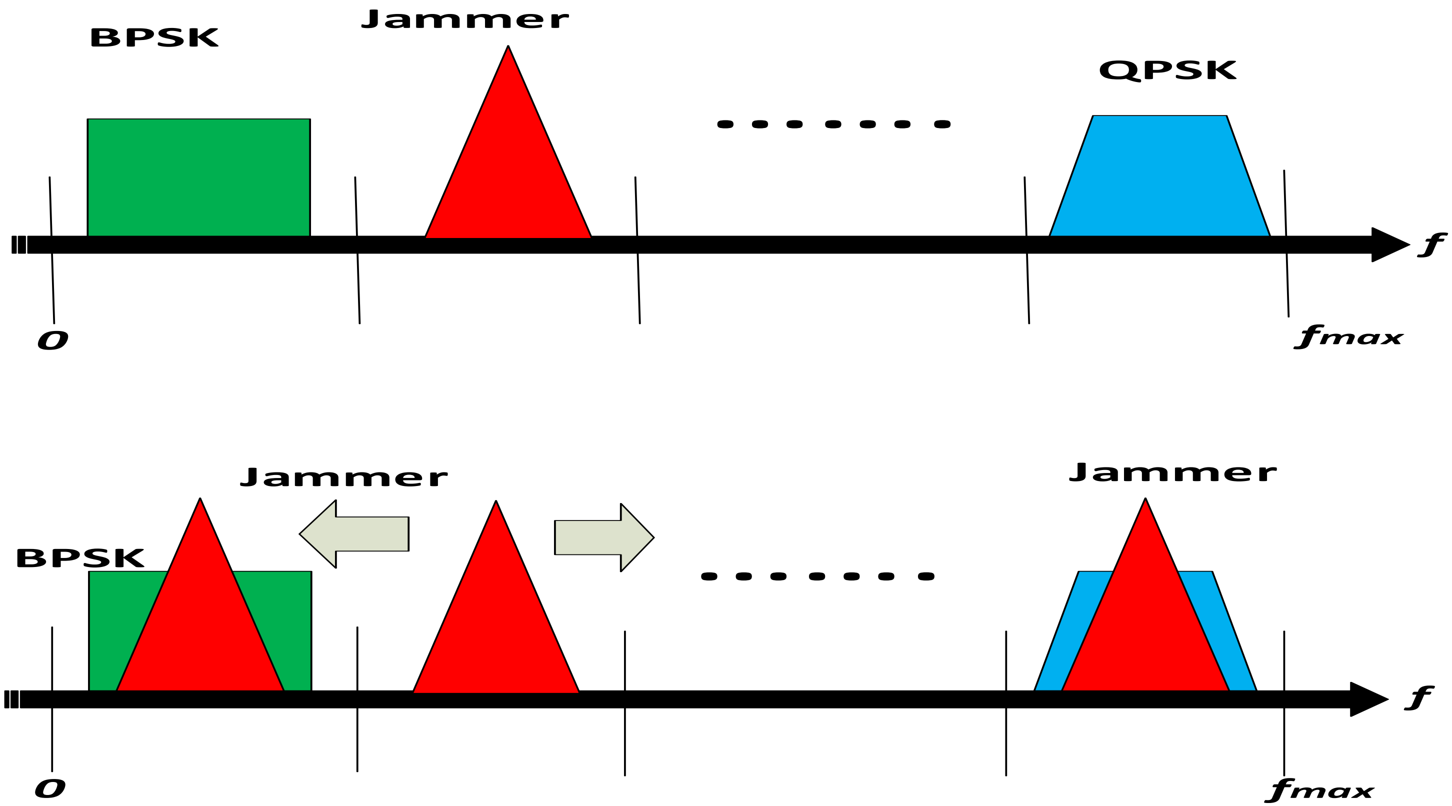
– Each user makes decision on a Primary User presence based on its local sensing measurements

- **Cooperative Spectrum Sensing**

– Collaborative spectrum sensing is most effective when collaborating cognitive radios observe independent fading or shadowing.

2 Jammer Detection in Wideband CRN

SYSTEM MODEL

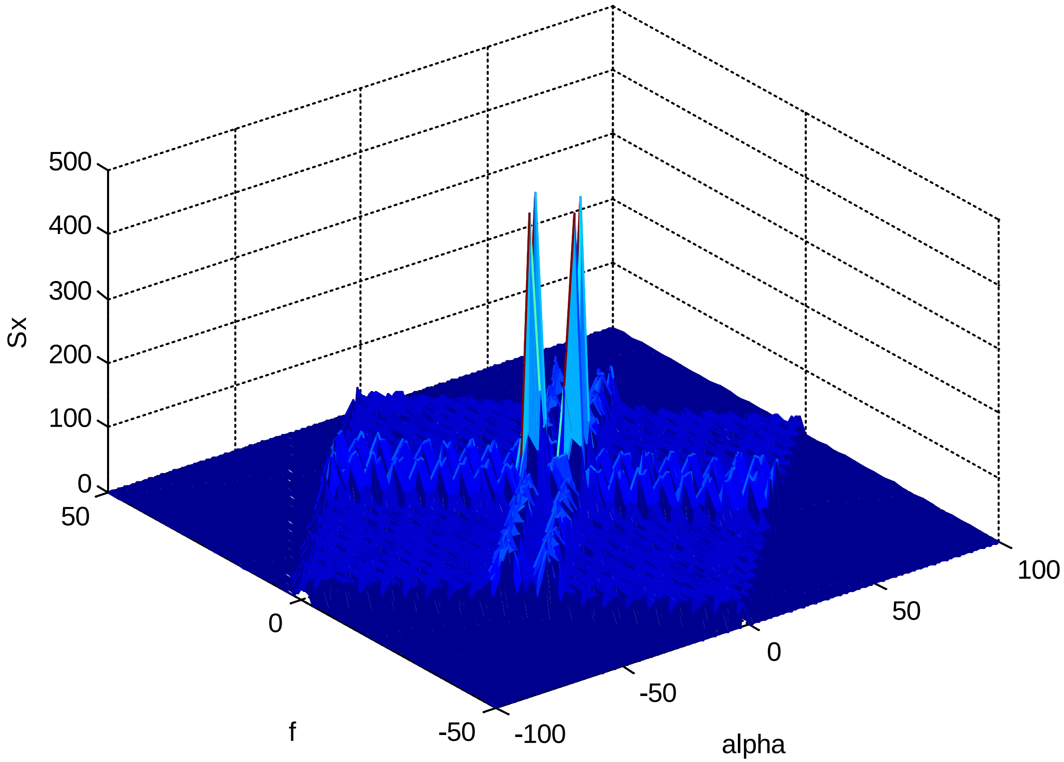


Wide-band spectrum divided into multiple sub-SBs and each SB is occupied by a narrow-band signal

Simulation Setup

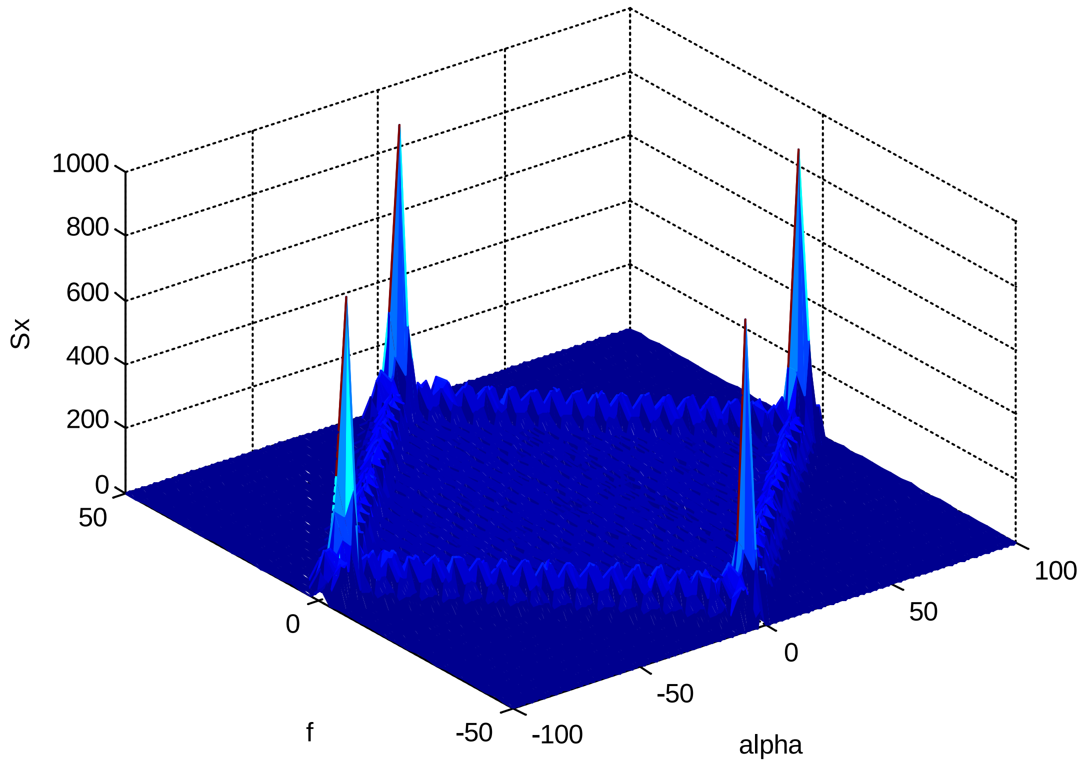
- A WB spectrum is considered of 50ΔHz. This WB is divided into 5 equal bandwidth SBs.
- Each SB is either occupied by narrow-band signal or free.
- BPSK and QPSK are considered as legitimate signals and sine wave as a jammer.
- The received signals are considered to be affected by AWGN. The Nyquist rate is set to $f_s = 100\Delta$ Hz.
- The Monte-Carlo simulation is run for 1000 runs to evaluate the performance of system.

Spectral correlation Function (SCF)



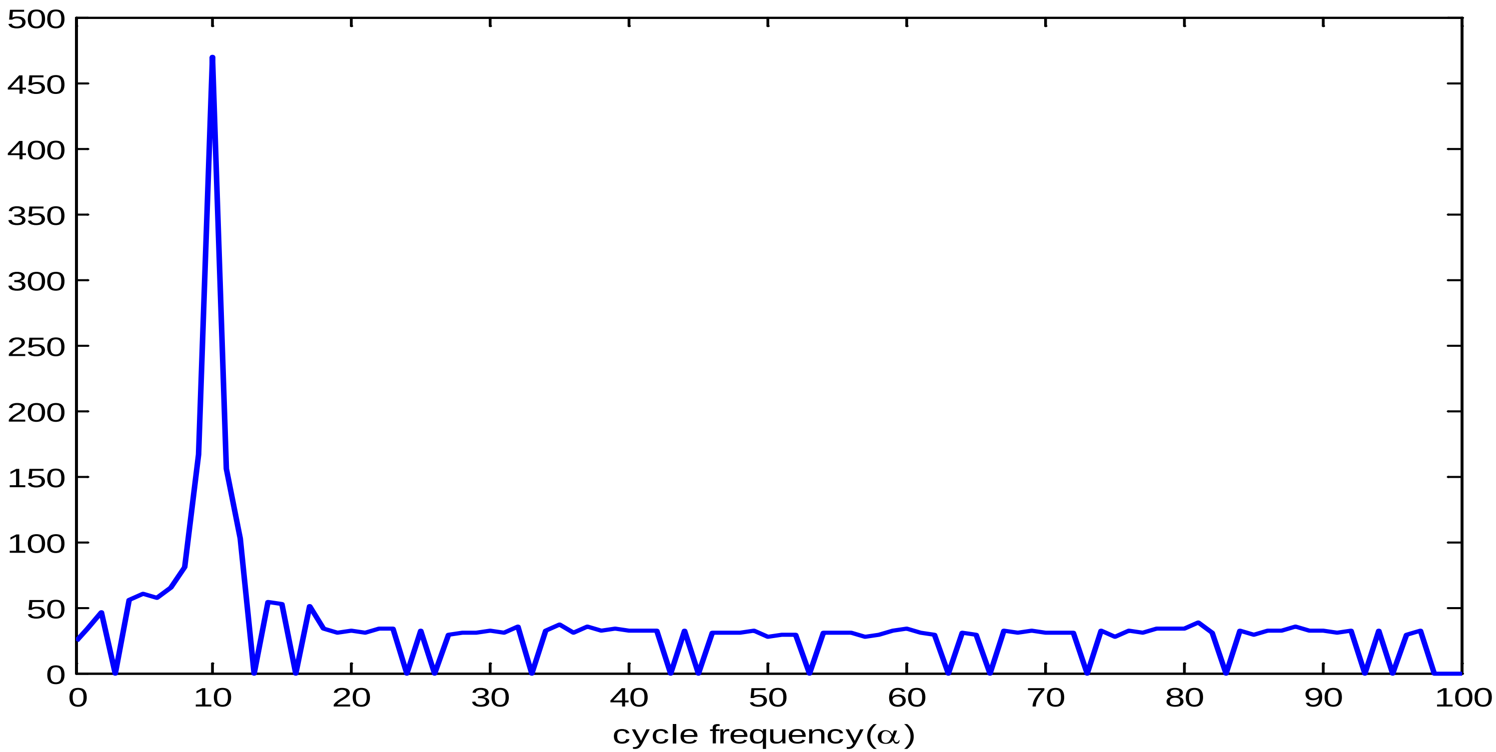
SCF of BPSK

Spectral correlation Function (SCF)



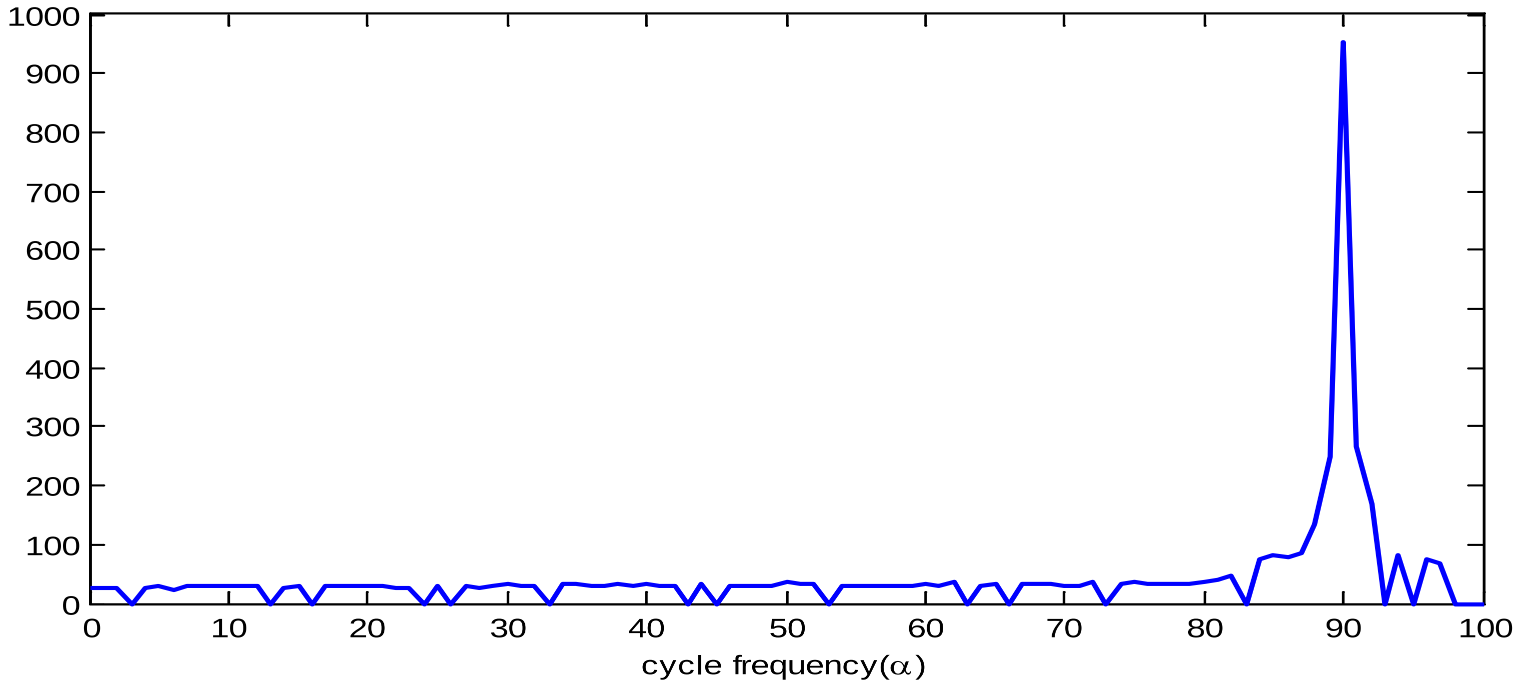
SCF of QPSK

Cyclic Frequency Profile (α−Profile)



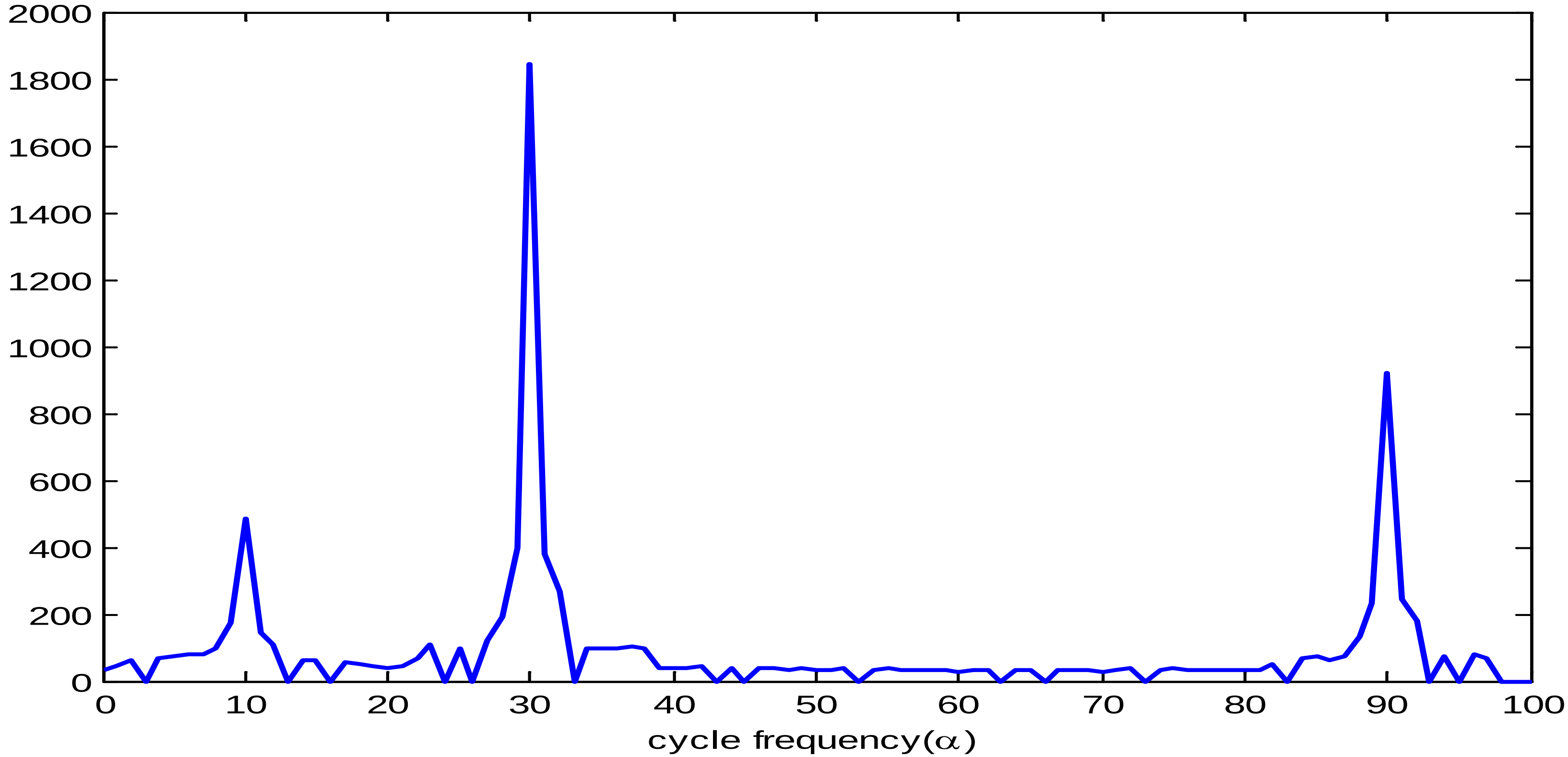
α profile of BPSK

Cyclic Frequency Profile (α–Profile)



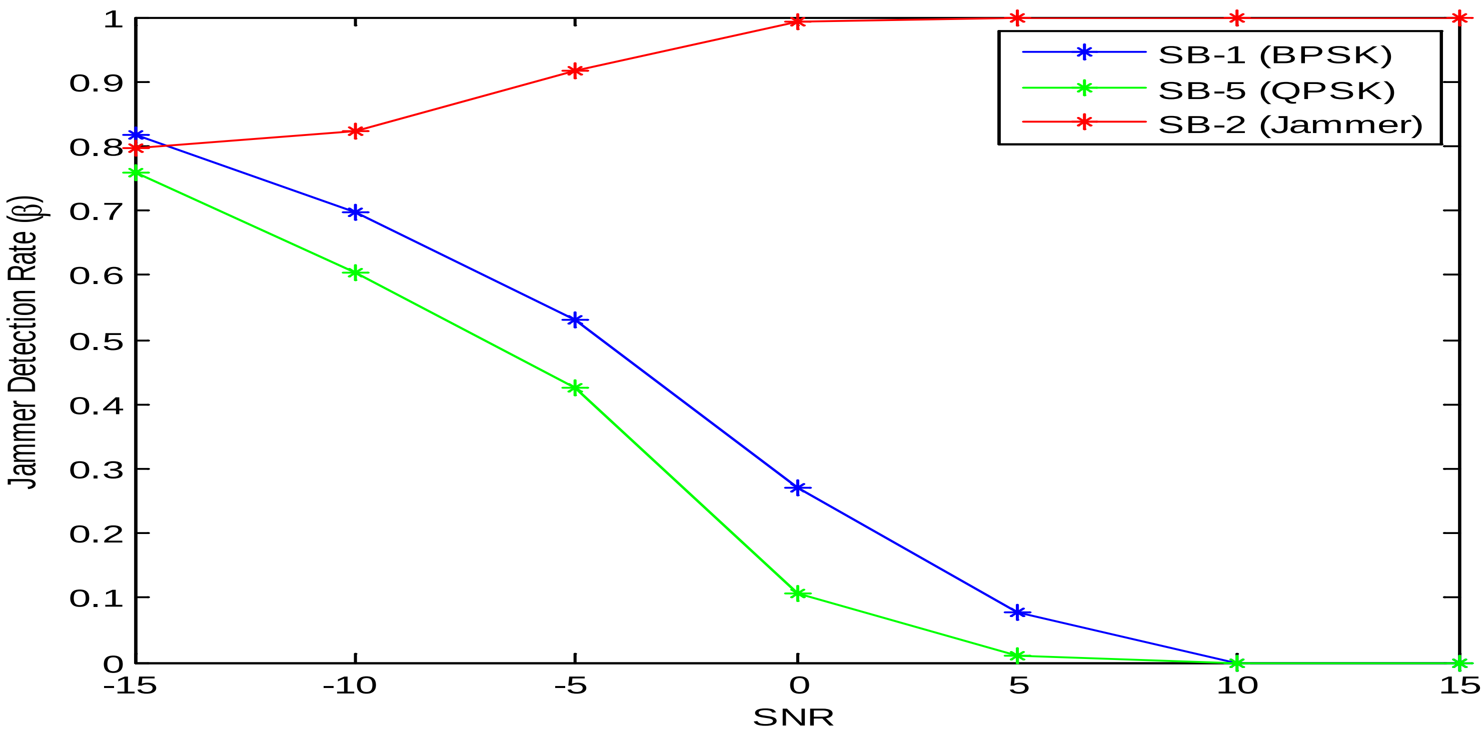
α profile of QPSK

Cyclic Frequency Profile (α−Profile)



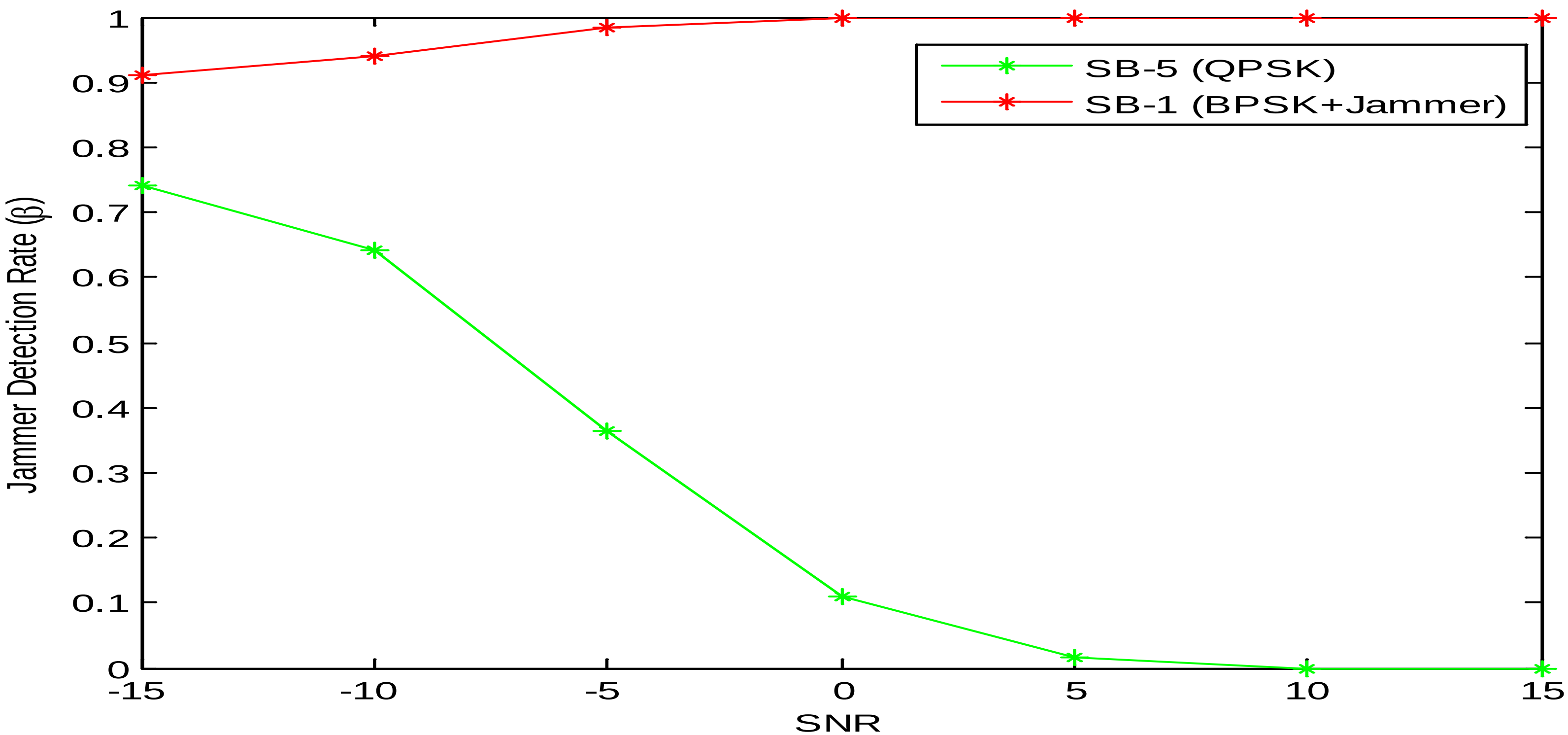
α profile of Wide band Signal

Simulation Results



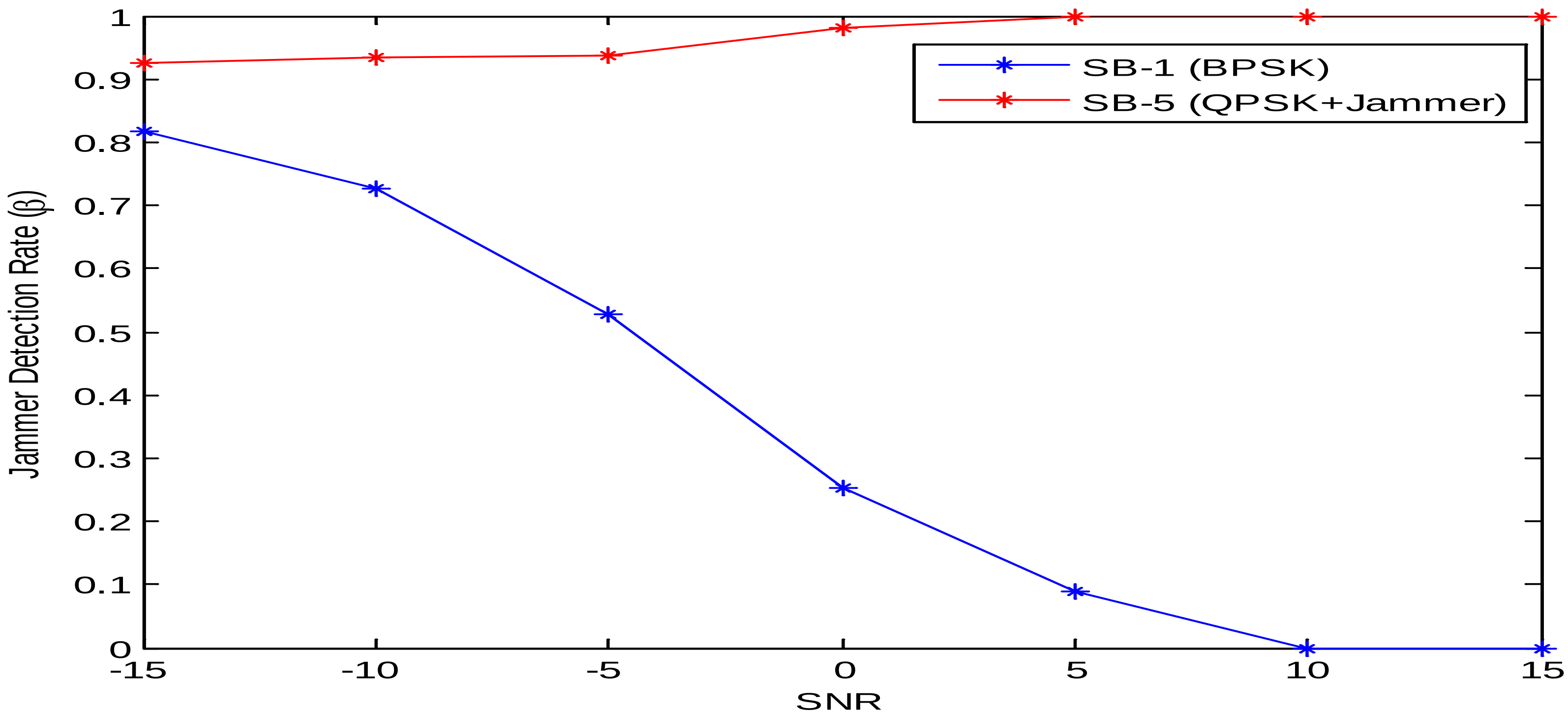
Jammer Detection Rate (β) vs. SNR

Simulation Results



Jammer Detection Rate (β) vs. SNR

Simulation Results



Jammer Detection Rate (β) vs. SNR

3

Conclusion

Conclusion

- In this paper, a cyclostationary-based jammer detection algorithm is proposed to be used for WB cognitive radios.
- The cyclic features of received WB signal are extracted by spectral correlation function.
- The technique is shown to perform well at low SNR value.
- In future, more sophisticated classification schemes such as neural network or support vector machine (SVM) can be used to improve the performance of this technique.

References

1. Simon Haykin, David J. Thomson, and Jeffrey H. Reed (2009), “Spectrum Sensing for Cognitive Radio’’, IEEE Proceeding, Vol. 97, No.5, pp: 849-877
2. I.F. Akyildiz, W.Y. Lee, M.C. Vuran, S. Mohanty, “NeXt Generation/Dynamic Spectrum Access/CognitiveRadio Wireless Networks: A Survey”, Computer Networks Journal, 2006