PERFORMANCE ANALYSIS OF A CROSS-FREQUENCY DETECTOR OF PULSED SINUSOIDAL RFI IN MICROWAVE RADIOMETRY

*Barış Güner, Joel T. Johnson, and Ninoslav Majurec**

The Ohio State University
Dept. of Electrical and Computer Engineering
1320 Kinnear Road
Columbus, OH 43212, USA
Phone: (614) 292-7981, Fax: (614) 292-7297
e-mail: guner.2@osu.edu

Recent surveys have shown that radio frequency interference (RFI) can limit the accuracy obtained by passive remote sensing systems in the measurement of environmental parameters. To eliminate this concern, several methods have been developed for the detection and mitigation of RFI. Radiometer systems with RFI detection capabilities have been implemented and successfully demonstrated as a result of this research. Many future remote sensing campaigns plan to incorporate these RFI detection methods.

Techniques used for RFI detection in the literature can be divided into three main classes: pulse detection, cross-frequency detection, and tests for Gaussianity. Both pulse and cross-frequency detection methods rely on finding "outliers" that are unlikely to be caused by thermal noise among the samples of the received field. Pulse detectors search for outliers in the time-domain, and, as a result, are more effective against pulsed rather than continuous RFI sources. Cross-frequency detectors are used to detect outliers in the frequency domain and are therefore most effective against narrowband sources. Since thermal radiation has a Gaussian distribution and anthropogenic emissions disrupt normality, it is also possible to detect RFI by testing measured fields for normality. Although numerous tests for Gaussianity exist, to date only the kurtosis test has been implemented. The kurtosis method has been shown to be sensitive to a wide variety of RFI types, however a blind spot has also been reported for interferers having a fifty percent duty cycle. Later studies have shown that it is possible to remove this blind spot and improve performance by subsampling in time and frequency.

In this presentation, a theoretical study of the performance of a cross-frequency detector in detecting pulsed sinusoidal RFI is performed. This RFI type is chosen as a representative of pulsed radars and continuous sinusoidal sources. Effects of varying RFI strength and pulse duty cycle are analyzed. Performance results are compared with those of the pulse and sub-sampled kurtosis algorithms as well. The cross-frequency detector looks for brightness values that exceed an expected value by a specified threshold; because the brightness expected value changes when different scenes are being observed, estimation of this expected value is an important issue in designing the detector. Examples that quantify the effect of inaccuracies in the system temperature estimation on the detection performance will be presented.

Results show that the cross-frequency detector has good performance against pulsed sinusoidal RFI even when a small number of frequency channels is utilized. It is also possible to improve performance by increasing the number of frequency channels. In comparisons with the other detectors, the pulse and subsampled kurtosis detectors perform better than the cross-frequency detector at lower duty cycles, but these algorithms become insensitive to higher duty cycle, and in particular continuous, RFI while the cross-frequency detector retains sensitivity. Studies of system temperature estimation effects also prove that errors in the estimation procedure cause only a modest degradation in detector performance. Given that multiple frequency channels may be included for RFI mitigation purposes in several future radiometer system, incorporation of a cross-frequency detection algorithm into such systems appears likely to provide benefit for RFI detection applications.