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Implementation of a Flexible Wide-band On-Board Radio Frequency Interference Mitigating Digital Back-end Radiometer System

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Recent passive space-borne microwave observing systems operating below 40GHz have shown an increase in the amount of man-made interference corrupting incoming natural thermal emissions (McKague et al., 2010 IGARSS). Many radiometer systems operate in bands (e.g. 18.7GHz) that are shared with space to ground-transmissions. Other space-borne systems (e.g. Aquarius, Soil Moisture Ocean Salinity – SMOS) operate in protected radio bands to avoid Radio Frequency Interference (RFI). Measurements from these missions have shown that RFI still persists even in protected bands. The RFI environment has forced many radiometer systems to operate in narrower bands than usual. This directly impacts the radiometric noise and instrument design, which in turn impacts the necessary fidelity required for retrieving the EDRs.

Based on these issues, there is a need for developing wideband microwave radiometer systems that can co-exist with a harsh RFI environment. The following talk will present the work undertaken by the Jet Propulsion Laboratory, to develop an agile wideband digital backend system that can operate in and adapt to any RFI environment. The digital backend system needs to be capable of implementing a flexible digital signal processing system that can detect and mitigate RFI contaminated spectrum regions. The goal of the digital backend is to incorporate all necessary processing in the backend to take a corrupted spectrum and produce a single RFI mitigated output value with a minimal data rate.

The first portion of the talk will focus on the intermediate RFI detection algorithms that were compared and contrasted with each other in terms of algorithm performance and backend implementability. The algorithms are compared with respect to various RFI parameters such as duty-cycle, power, spectral width, number of sources etc. We utilize innovative evaluation techniques and performance metrics to compare the different algorithms. The algorithms are also tested using real airborne data measured during the Soil Moisture Active/Passive Validation Experiment (SMAPVEX) field campaign of 2012. An optimal version of the kurtosis detection algorithm and an innovative "squrtosis" algorithm with cross-frequency is implemented. A brief description of these algorithms will be presented.

The final aspect of the talk will focus on the firmware implementation of the above algorithms. The algorithms are implemented on a Reconfigurable Open Architecture Computing Hardware (ROACH) -2, a Xilinx Virtex 6 stand-alone FPGA board. We will present results on the initial implementation as well as initial results based on lab-generated RFI signals. Further work based on the obtained results will also be discussed.