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The CubeRRT Mission: Space-borne Demonstration for On-board Wide-bandwidth RFI Filtering

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The impact of Radio Frequency Interference (RFI) from man-made RF sources on passive microwave remote sensing has been increasing over the past couple of decades. The result of RFI corruption within passive radiometry measurements have resulted in biased or lost geophysical measurements necessary for understanding several immediate climate and weather phenomenon on Earth.

RFI is only expected to increase with continuously shrinking spectrum allocations for remote sensing and the need for commercial wireless industries for more spectrum. As a result, current and upcoming Earth science missions have to develop and implement several RFI filtering strategies. It should be noted that RFI filtering does not recover RF corrupted data, but filters out RFI and preserve non-corrupted data. If 100% of the data is corrupted, all the data is lost.

Traditional space-borne RFI filtering technologies involve analog filter banks or narrow bandwidth digital filtering schemes. Though effective, these strategies have very little flexibility to discard most of the RFI sources and an inability to deal with wider bandwidths (above 500 MHz) for microwave radiometry in the 6 to 40 GHz range.

We will present an advanced digital back-end technology capable of on-board RFI filtering over wider bandwidths. The digital back-end and RFI filtering algorithm has already been successfully demonstrated by the CubeSat Radiometer RFI Technology Validation (CubeRRT) mission deployed from the ISS on July 13, 2018. The CubeRRT mission operated a 6 to 40 GHz tunable radiometer swept in 1 GHz steps. The brightness temperature measured by the radiometer are digitized by a wide-band digital back-end and then processed using an on-board Zynq 7100 FPGA with two on-chip ARM processors.

The advanced FPGA and ADC enabled the CuebRRT system to apply real-time RFI filtering algorithms. The algorithms include a high spectral resolution poly-phase filter bank (128 channels) with a cross-frequency RFI detection filter applied, and a higher-order moment calculator to apply a statistical algorithm that distinguishes the normality of natural thermal emissions versus man-made signals. The on-board operation allows lower downlink data bandwidths. The digital backend also affords the flexibility to dynamically change detection thresholds and aggressiveness of the algorithms implemented. Successful CubeRRT demonstration allows future space-borne high frequency radiometers to deal with increasing RFI.