High Speed Computation for New Digital VHF and UHF Passive Radar Receiver

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We describe a new digital receiver for passive radar observation at HF, VHF, and UHF frequencies, which is free of Nyquist aliasing through 800 MHz. It follows the development of the digital receivers used in the Manastash Ridge Radar, which uses moderate undersampling at 100 MHz, and an analog downconverter for higher frequencies.

We were motivated to build this receiver by a desire to observe more stations in the FM broadcast band, and to begin observations using UHF digital TV transmissions, for which the existing receivers had some limitations.

The new receiver that samples the antennas is capable of simultaneously selecting VHF and UHF stations from a single antenna with a single RF signal path; and it is capable of much more aggregate bandwidth than the current receivers. That capability carries with it a challenge to reduce the 1.6 GSa/s data streams to more manageable rates.

In this report we will briefly summarize the "front end" of the receiver consisting of the samplers and the field programmable gate array (FPGA) which provides the channel selectivity and rate reduction. We will spend more time describing the implementation of the cross-ambiguity estimation in a graphical processing unit (GPU) that provides some direct-path suppression and all the cross-ambiguity computations needed to estimate range-Doppler profiles with low-latency in real time. Although the computational power needed is several hundred gigaflops, GPUs can perform this level of computation quite easily.

We will show examples of simultaneous VHF and UHF data from the same antenna, and offer some conclusions about performance, cost, complexity, and ease of use.

We hope that this study will prove useful to the radar community as it contemplates the next generation of high performance, low cost digital receivers for aerospace and geophysics applications.