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An Optimization of the FPGA/NIOS Adaptive FIR Filter Using Linear Prediction to Reduce Narrow Band RFI for the Next Generation Ground-Based Ultra-High Energy Cosmic-Ray Experiment.

The electromagnetic part of an extensive air shower developing in the atmosphere provides significant information complementary to that obtained by water Cherenkov detectors which are predominantly sensitive to the muonic content of an air shower at ground. The emissions can be observed in the frequency band between 10 - 100 MHz. However, this frequency range is significantly contaminated by narrow-band RFI and other human-made distortions. Auger Engineering Radio Array suppresses an RFI by multiple time-to-frequency domain conversions using an FFT procedure. An alternative approach developed in this paper is an adaptive FIR filter based on a linear prediction (LP). The coefficients for the linear predictor are dynamically refreshed and calculated in the virtual NIOS® processor. The Levinson recursion, used to obtain the filter coefficients is also supported by a direct multiplication in the DSP blocks of the logic FPGA segment. The radio detector is an autonomous system installed on the Argentinean pampas and supplied from a solar panel. A power consumption vs. a powerful calculation capacity inside the FPGA is a factor. Results show that a LP approach is more power efficient than the FFT one for 64-point linear predictor. The LP method introduces also less digital distortion than FFT procedures based on streaming architecture and disentangling trick. The LP filter is being developed for the next generation of cosmic rays detector supported by the ASPERA-2 consortium.

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