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Adaptive IIR-notch filter for RFI suppression in a radio detection of cosmic rays

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Radio stations can observe radio signals caused by coherent emissions due to geomagnetic radiation and charge excess processes. Auger Engineering Radio Array (AERA) observes the frequency band from 30 to 80 MHz. This range is highly contaminated by human-made RFI. In order to improve the signal to noise ratio RFI filters are used in AERA to suppress this contamination.

The AERA uses the IIR notch filters operating with fixed parameters and suppressing four narrow bands. They are not sensitive on new source of RFI as walkie-talkie, mobile communicators and other human-made RFI.

In order to increase an efficiency of a self-trigger the signal should be cleaned from the RFI to improve a signal to noise ratio.

One of the source of RFI are narrow-band transmitters. This type of RFI can be significantly suppressed by digital filters after a signal digitization in the ADCs.

IIR filters are generally potentially unstable due to feedbacks, however than are much shorter and power efficient than FIR filters.

We implemented a NIOS virtual processor calculating new set of IIR filter coefficients, which are reloaded dynamically on the fly. The spectrum analysis of 30-80 MHz band is supported by the Altera FFT IP Core. The NIOS adjusts the new coefficients the poles of the filter to be inside the unique complex radius (a condition of stability) as well as it tunes a width of the notch filter.

Practical implementation was tested in the laboratory with signal and pattern generators as well as with the LPDA antenna with LNA - a set used in real AERA radio stations.

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