URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Robust Power-line RFI filtering for Radio Telescopes

Kaushal D. Buch*(1), Kishor D. Naik(1), Sanjay Kudale(1), Mekhala Muley(1), Ruta Kale(1), Ajithkumar B. (1), Yashwant Gupta. (1)

(1) National Centre for Radio Astrophysics, TIFR, Pune, India.

e-mail: kdbuch@gmrt.ncra.tifr.res.in, kishornaik33@gmail.com, ksanjay@gmrt.ncra.tifr.res.in, mekhala@gmrt.ncra.tifr.res.in, ruta@ncra.tifr.res.in, ajit@ncra.tifr.res.in, ygupta@ncra.tifr.res.in

Radio Frequency Interference (RFI) from high-voltage power lines and associated electrical equipments is one of the main sources of interference to the radio telescopes operating in the VHF and UHF bands. Power-line RFI impulses occur in bunches and repeats at multiples of power-line frequency [1]. The density of these impulses and the duty cycle depend on the nature of the power-line fault, wind and moisture [1]. Strong RFI leads to reduction in the dynamic range and signal-to-noise ratio (SNR) of a radio telescope receiver hence mitigation techniques are crucial to achieve desired sensitivity limits. Because of its broadband nature, power-line RFI cannot be removed by a frequency selective filter. Thus, the preferred approach involves the use of a robust non-linear digital filter which computes the detection threshold using statistics of the received signal. This paper describes latest developments in the techniques and results from real-time RFI filtering system implemented on GMRT Wideband Backend (GWB). We use Median-of-MAD (MoM) as the robust estimator for computing standard deviation over a ~2s time duration [2]. The RFI samples are replaced by digital noise samples. We describe the properties of power-line RFI observed in different uGMRT frequency bands which are necessary to fine-tune the parameters of the filtering algorithm.

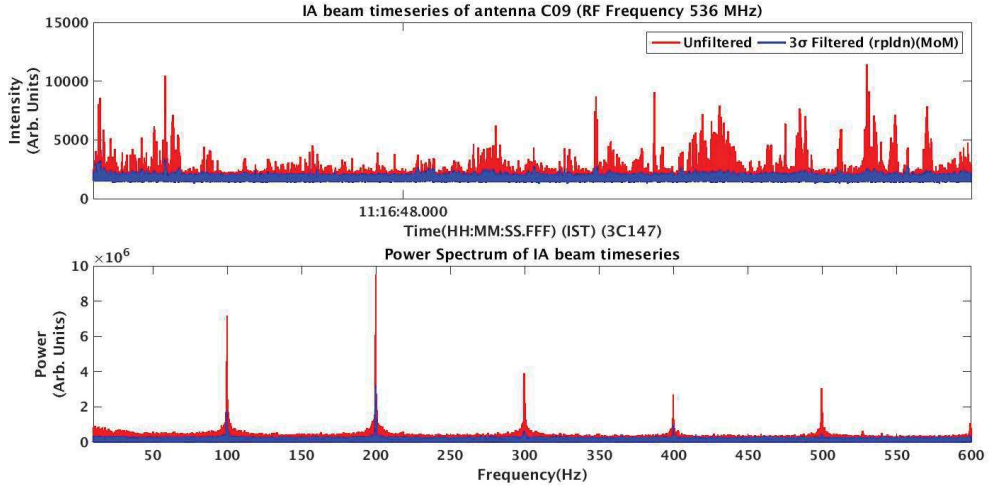

Figure 1: Intensity time series (1.3 ms averaging) of spectral channel (536 MHz) and its Fourier transform

A simultaneous comparison of filtered and unfiltered signal is carried out [2]. An improvement of up to 10 dB in the post-filtering SNR is observed. Figure 1 shows the Fourier transform (subplot 2) of intensity time-series (subplot 1) of a single spectral-channel. 100 Hz, 200 Hz and their harmonics (for 50 Hz power-line frequency) are observed (red) and are mitigated after filtering (blue). Further, we describe the test results for spatial cross-correlation function (visibilities) and closure phase. Results from astronomical imaging which show improvement up to 4 dB in the noise RMS are discussed.

1. Loftness, M., "Power Line RF Interference – Sounds, Patterns and Myths", IEEE Transactions on Power Delivery, Vol. 12, No. 2, April 1997.

2. Buch, K., Naik, K., Nalawade, S., Bhatporia, S., Gupta, Y. & Ajithkumar B., "Implementing and Characterizing Real-Time Broadband RFI Excision System for the GMRT Wideband Backend", IETE Technical Review, April 2018.