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TIME-BASED NOISE REMOVAL FROM MAGNETIC RESONANCE SOUNDING SIGNALS

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Abstract. *The Magnetic Resonance Sounding (MRS) is a new method for the groundwater exploration. In this method, an electromagnetic pulse with specific frequency equal to the Larmor frequency (the resonance frequency of the water molecules in the geomagnetic field) is sent to the underground from the surface. When the pulse is disconnected, after a few milliseconds, an electromagnetic field is returned from the water molecules and induces a voltage into the receiving antenna on the surface. As the inductive voltage generated by the protons is very small, the MRS method is very sensitive to the electromagnetic interferences and noise, which is the most important limitation for the practical application. Both the depth of investigation and precision of the MRS method depend on signal to noise ratio (SNR). In this paper, in order to improve the performance in the noisy environments, a time-based method is hereby proposed, so that the characteristics of the merely taken noise used to estimate the features of the interfered noise with the signal. By applying an optimization process, we can remove the noise from the signal to a high extent. Also, a frequency method is investigated for comparison. It will be observed that the proposed method is actually advantageous to the mentioned frequency method and the performance indexes, especially SNR, will increase significantly.*
Keywords: Magnetic resonance sounding, Noise, Standard deviation, Larmor frequency, Parameter estimation

1. **Introduction.** A non-invasive method to explore the underground water resources, which has recently been provided, is the Proton Magnetic Resonance (PMR). This method is recently known as the Magnetic Resonance Sounding (MRS). A major limitation of MRS is the sensitivity to the natural and man-made electromagnetic (EM) noise. Magnetic storms, telluric currents, thunderstorms and so on can create natural EM noise. It always occurs in the MRS measurements and usually has the random Gaussian distribution. Electrical generators, radio transmitters and the like generate man-made EM noise. An alternative magnetic field which is produced by the precession of the proton magnetic moments in groundwater always varies between 10^{-12} and 4×10^{-9} T. Therefore, the voltage created by the MRS signal varies between 10 nv and 4000 nv when using a wire loop of 100m diameter as a receiving antenna. In this method, contrary to many geophysical techniques, the signal cannot be amplified by increasing the transmitter power. Thus,