Processing of a scalar magnetometer signal contaminated by 1/fα noise

Sheinker A., Shkalim A., Salomonski N., Ginzburg B., Frumkis L., Kaplan B.-Z.

R and D Integrated Systems Section, Propulsion Division, SOREQ NRC, Yavne, 81800, Israel; Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, P.O. Box 653, Beer-Sheva, 84105, Israel

Abstract: Magnetic anomaly detection (MAD) is a passive method for detection of a ferromagnetic target. A magnetic field generated by a ferromagnetic target is assumed as a dipole field, resulting in an anomaly in the ambient Earth magnetic field. Magnetic anomaly detection method using orthonormal basis functions (OBF) decomposition is a known approach. The method, which relies on matched filtering, should be optimal for detection of a known signal in the presence of Gaussian white noise. In this work, we expand the method to the more general case of magnetic noise with a power spectral density of 1/fα, where $0 < \alpha < 2$. We have designed a whitening filter, which improves magnetic anomaly detection using the basis functions decomposition approach. It turned out that the measured magnetic noise, comprising intrinsic sensor noise and geomagnetic noise, may be considered as an autoregressive (AR) process. Thus, by calculating the coefficients of the autoregressive model, we can build a whitening filter. Application of a whitening filter transforms the noise from 1/fα into a white noise, but also distorts the target signal. As a consequence, the original orthonormal basis functions should be modified in order to form a basis for the distorted target signal. The results in the present work demonstrate the advantage of the proposed method.

Author Keywords: Autoregressive (AR) process; Magnetic anomaly detection (MAD); Magnetic noise; Magnetometer; Orthonormal basis functions (OBFs); Whitening filter

Year: 2007
Source title: Sensors and Actuators, A: Physical
Volume: 138
Issue: 1
Page : 105-111
Cited by: 5
Link: Scorpus Link
Document Type: Article
Source: Scopus

Authors with affiliations:

1. Sheinker, A., R and D Integrated Systems Section, Propulsion Division, SOREQ NRC, Yavne, 81800, Israel
2. Shkalim, A., R and D Integrated Systems Section, Propulsion Division, SOREQ NRC, Yavne, 81800, Israel
3. Salomonski, N., R and D Integrated Systems Section, Propulsion Division, SOREQ NRC, Yavne, 81800, Israel
4. Ginzburg, B., R and D Integrated Systems Section, Propulsion Division, SOREQ NRC, Yavne, 81800, Israel

5. Frumkis, L., Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, P.O. Box 653, Beer-Sheva, 84105, Israel
6. Kaplan, B.-Z., Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, P.O. Box 653, Beer-Sheva, 84105, Israel