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The simple procedure for the fluxgate magnetometers calibration

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The fluxgate magnetometers are widely used in geophysics investigations including the geomagnetic field monitoring at the global network of geomagnetic observatories as well as for electromagnetic sounding of the Earth's crust conductivity. For solving these tasks the magnetometers have to be calibrated with an appropriate level of accuracy. As a particular case, the ways to satisfy the recent requirements to the scaling and orientation errors of 1-second INTERNAGNET magnetometers are considered in the work.
The goal of the present study was to choose a simple and reliable calibration method for estimation of scale factors and angular errors of the three-axis magnetometers in the field. There are a large number of the scalar calibration methods, which use a free rotation of the sensor in the calibration field followed by complicated data processing procedures for numerical solution of the high-order equations set.
The chosen approach also exploits the Earth's magnetic field as a calibrating signal, but, in contrast to other methods, the sensor has to be oriented in some particular positions in respect to the total field vector, instead of the sensor free rotation. This allows to use very simple and straightforward linear computation formulas and, as a result, to achieve more reliable estimations of the calibrated parameters. The estimation of the scale factors is performed by the sequential aligning of each component of the sensor in two positions: parallel and anti-parallel to the Earth's magnetic field vector. The estimation of non-orthogonality angles between each pair of components is performed after sequential aligning of the components at the angles +/- 45 and +/- 135 degrees of arc in respect to the total field vector. Due to such four positions approach the estimations of the non-orthogonality angles are invariant to the zero offsets and non-linearity of transfer functions of the components.
The experimental justifying of the proposed method by means of the Coil Calibration system reveals, that the achieved accuracy (<0.04 % for scale factors and 0.03 degrees of arc for angle errors) is sufficient for many applications, particularly for satisfying the INTERMAGNET requirements to 1-second instruments.