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Modeling the earth magnetic temporal variant based on Gauss-Markov process and estimating the magnetic anomaly of the terrains by the UAV.

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Extended Abstract

Summary

In this paper, an online method is presented to estimate the magnetic anomaly of the earth by the sensor mounted on the unmanned aerial vehicle (UAV) without relying on the ground stations data. At first, the influential factors and important components in the magnetic field of the regions have been introduced. Then, using the data of a magnetic observatory, the temporal variation component is modeled. By removing the core field (namely, IGRF or international geomagnetic reference field) and the temporal variation from the magnetic field measured by the mobile sensor, the magnetic anomaly can be determined at any location. Finally, the method is validated with Iznik Geomagnetic Observatory station data.

Introduction

Today, with growth of earth magnetic anomaly application in deferent fields such as navigation, mineral and oil exploration, and production of geological and topographical maps to identify the subsurface structures as accurately as possible, the magnetic anomaly determination has become particularly important. One of the appropriate methods to determine the magnetic anomaly values of different areas is airborne geophysics. In this method, using unmanned aircraft vehicle (UAV), the data acquisition time for large areas becomes shorter than that of other geophysical survey methods such as ground and marine geophysics.

According to geophysical studies, the magnitude of the earth magnetic vector at any point includes the main static component caused by the Earth's core with low spatial frequency characteristics, as well as the high frequency component caused by the surface and subsurface structures of the regions. In addition to these factors, it also includes a time-variant component caused by external sources. Therefore, in a mobile sensor on a UAV, the determination of the magnetic anomaly value for an area depends on the proper separation of these temporal and spatial components of the magnetic field. On the other hand, the magnetic sensor has inherently noise related to the used technology that must be compensated to increase the accuracy and precision of the measurement.

Methodology and Approaches

In this paper, a novel method has been developed to estimate the magnetic field anomaly for the installed magnetic sensor on the AUV. In this regard, after data acquisition, the Hilbert transformation is used to reduce the noise from the data, and to increase the quality of the data. Then, the temporal variation of the magnetic field is modeled using the recorded data obtained from a local observatory at different periods. For this purpose, the temporal variation of the field is modeled based on the sum of the non-stochastic component for annual, monthly and daily periods and a Gauss-Markov process as the daily stochastic component. Then, subtracting the components of the time variant of the field and the main field value according to the IGRF model from the online measurement values, we estimate the magnetic anomaly value of the sensor.

Results and Conclusions

The effectiveness of the proposed method is validated by real and simulated acquisition data based on Iznik Geomagnetic Observatory recorded data. In this case study, the magnetic anomalies of AUV path with a length of 700 km have been estimated. It is shown that using this method, the path anomaly of a mobile sensor can be obtained in different conditions with an accuracy of better than 5 nano Tesla.