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観測データ信号と外的信号の統計的な独立性を用いた重力異常データからのノイズ除去についての基礎的検討
Denoise of Severely Contaminated Gravity Anomaly Data Using Statistical Independence of Source and Perturbation Signals

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1.Introduction

Gravity anomaly, which is caused by the spatial distribution of stiff (heavy) layer, is used for the estimation of ground structure. For the improvement of usability and applicability, Morikawa et al.[1] has been working on the development of compact gravity observation system using force-balance (FB) accelerometer. It has a difficulty that the observed data is severely contaminated by various kinds of disturbances such as tilting motion of the carrier vessel. This report presents a scheme to extract the gravity anomaly signal from the noise-contaminated observed data, by exploiting the statistical independent property of gravity anomaly data and other perturbation signals. Although the final objective is to measure the gravity anomaly by using the air plane or some other aviation carrier, as a basic study of the research, this paper works on the results obtained by the ship in the Toyama Bay.

2.Methodology

As a scheme of considering independence of signals of source and other signals, blind source separation (BSS) techniques are used. Second Order Blind Identification method (SOBI)[2] separates signals from different sources by exploiting the statistical property of data. It separates the target source by assuming that source and unwanted data are un-correlated at various time-lags. Similar scheme is also implemented with the Independent Component Analysis (ICA), which separates the sources by maximizing the independence of linearly transformed observed signals. The method is referred to as ThinICA[3].

3.Data Observation

The presented schemes are applied to the data obtained by the field survey which was conducted at The Toyama Bay area, Japan. The carrier vessel was a middle size ship of 55 long. As the reference for comparison, we use the data generated based on the reliable data measured by AIST (National Organization of Advanced Industrial Science and Technology) by considering the Eotvos effect due to the location of the carrier and the free air anomaly, etc.

4. Results

It was found that application of low pass filtering (LPF) is efficient as a pre-process of observed data. Both SOBI and ICA worked well after the data is processed by low pass filter (LPF). As for the applicability of devices, combination of VSE data and vertical component of accelerometer Titan (Taurus-Z) were found to be suitable for our data set. It was also discussed that the motion of the carrier vessel influences the performance of noise removing algorithm. Under certain conditions, the proposed method was not able to salvage the gravity anomaly data from the observed data with the accuracy sufficient for the purpose of identification of gravity anomaly distribution. It was difficult, for example, to salvage the gravity data from the data obtained during the ship is stopped. Comparison of the LPFed observed data and the data extracted by the presented method using SOBI and ThinICA show that they are at acceptable level for the purpose of subsurface modeling. It would require, however, improvement for the application for the data obtained by the aviation carrier devices such as unmanned helicopter.

5. Conclusion

The noise removal method for the highly contaminated data to salvage the target data is discussed. The method is applied to the observed data from Toyama. It requires the condition for the mobility of carrier vessel. For the purpose of data obtained using the aviation device, considerable improvement of performance is required.

REFERENCES

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