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Edge detection of subsurface structures in magnetic data in presence of remnant magnetization

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Extended Abstract

Summary

Edge detection of subsurface structures is an important goal of magnetic data interpretation. To achieve this goal, the reduction to the pole (RTP) is used to locate magnetic anomalies over the structures causing these magnetic anomalies. The RTP cannot be used in the presence of remnant magnetization. In this situation, amplitude of magnetic anomaly, analytic signal, E and R transforms are used. In this paper, we apply the Canny edge detector over amplitude of magnetic anomaly for edge detection in magnetic data. The results indicate that this edge detection method is suitable when the remnant magnetization exists in the magnetic data.

Introduction

Magnetic method is an important geophysical method, which is extensively used in mineral and petroleum exploration. One of the goals of magnetic data interpretation is to locate geological structures that cause anomalies in earth magnetic field. Reaching this goal is complex by the fact that both the lateral position and shape of the magnetic anomaly depend not just on the position and shape of the magnetic body causing the anomaly but also on the orientation of earth magnetic field and the body magnetization vectors. The reduction to the pole (RTP) can simplify interpretation by locating the magnetic anomalies over the bodies causing them. Unfortunately, the RTP needs information about the declination and inclination of both the geomagnetic field and of the source magnetization vectors. The source magnetization vector direction may be unknown when significant remnant magnetization exists in the source. In this situation, a new group of transforms such as amplitude of magnetic anomaly (T_a), analytic signal (AS), E and R transforms are designed to avoid these pitfalls. In this paper, we propose the Canny edge detector filter in image processing for finding the edges of subsurface structures by T_a .

Methodology and Approaches

T_a is computed by components of magnetic anomalies in x, y and z directions. E and R transforms are computed based on the components of the gradients of magnetic anomalies. The AS is the full gradient of the measured total magnetic field (T). The Canny operator has a multi-stage procedure. This method works based on the characteristic of intensity values of pixels in the image. The edge detector should have a good signal-to-noise ratio so that the edges can be found even if the quality of the amplitude of magnetic anomaly is poor. For implementation, the amplitude of magnetic anomaly (T_a) map is first smoothed by using a 2-D Gaussian filter. In the next step, the horizontal gradient of the smoothed map is computed, and then, we use the gradient and directions to estimate the strength and directions at every pixel. The Canny edge detection algorithm uses double thresholds for the edge enhancement in which the edges are found based on a procedure applied on the horizontal gradient.

Results and Conclusions

To verify the edge detection results using the proposed methods, we apply the proposed methods on magnetic data sets acquired from over a synthetic model and real case study in Allahabad iron deposit, Yazd Province, Iran. The results indicate that T_a has a centricity problem and AS, E, and R transforms show better centricity over the bodies when remnant magnetization exists, however, poor results are obtained in the presence of the noise. These methods can hardly find the edges of the deep subsurface structures. The Canny edge detection filter over the T_a produces wider edges but it has a better centricity rather than the T_a and it can find the edges of deep bodies better compared to gradient-based methods. This method is less sensitive to the noise.