

Extraction of subsurface structures from SELENE Lunar Radar Sounder data

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SELENE mission is a Japanese lunar exploration project planned jointly by ISAS and NASDA. The SELENE spacecraft is scheduled to be launched in 2005. The aim of the SELENE mission is to study the origin and evolution processes of the Moon.

Lunar Radar Sounder(LRS) is one of the observation instruments onboard the SELENE spacecraft. LRS investigates lunar subsurface structures by using an HF radar whose frequency is 4 to 6 MHz.

LRS data include surface nadir echo, subsurface nadir echo and surface off-nadir echo(Kobayashi T.,1999). Surface nadir echo is strong reflection from nadir surface. Surface off-nadir echo consists of two components. One is strong surface echo from reflection matters such as crater walls facing to the spacecraft. Another is scattering wave from the lunar surface, and is found in all ranges as noise. Subsurface nadir echo is reflection from the subsurface boundary, which we would like to pick up from LRS observation.

For the purpose to analyze the subsurface structures, we must extract only subsurface echoes from observation data. It is possible to distinguish surface off-nadir echo and subsurface nadir echo in the view of a geometric difference: Subsurface echo becomes a straight line and surface off-nadir echo becomes a hyperbola in B-scan format, in which data of pulses are arranged as a time series.

The author applied two methods to extract straight lines and hyperbolas in B-scan format, that is, Hough transform and template matching. Hough transform is often used to extract features expressed by parameters such as a line and circle. By Hough transform method, the coordinate system of a feature in an image is transformed from the image space to the parameter space, where a feature is extracted.

By Hough transform, it is possible to extract a subsurface boundary. But the result depends on threshold. If the threshold is too small, echoes different from a subsurface nadir echo may be extracted as a straight line. On the contrary, if the threshold is too large, it is impossible to extract a subsurface nadir echo. It is important to select an appropriate threshold value.

In the case of hyperbolas extraction by Hough transform, Clear hyperbolas are extracted exactly. But extracted hyperbolas up to the range of 10 km do not correspond to the original image well. Extraction of hyperbolas by template matching is better than one by Hough transform up to the depth of 10 km. Both of Hough transform and template matching did not work satisfactory at the moment, but the possibility of this method was shown.