

Estimation of dielectric constant of lunar material by HF sounder observation

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Space borne radio sounding observation has been one of indispensable items in planetary missions. An HF sounder, Lunar Radar Sounder (LRS), will be onboard SELENE, a lunar exploration program of Japan, in 2007. Its primary objective is subsurface geologic structure of the Moon. Especially mare regions are of strong interest of investigators because of its relatively smooth surface: it is thought that smooth surface allows us to see subsurface feature with less difficulty. However, even if a clear subsurface image is obtained, the data does not provide us with quantitative information unless the dielectric constant of the lunar subsurface material.

We propose a technique to estimate the dielectric constant of lunar material that utilizes HF sounder data of closely located multiple orbits.

The technique is applied to SAR images that are produced from HF sounder data and stands on the fact that the apparent position of subsurface object varies as a function of the dielectric constant of subsurface material. Assuming a uniform subsurface material, the displacement of images of a subsurface target should be consistent with that of observation orbits if the correct dielectric constant of the subsurface material is assumed.

A numerical model on geometrical optics estimates that the proposed technique requires a synthetic aperture larger than about 50km, provided that the orbit altitude is 100km, subsurface target depth is a few km and that the observation frequency is 5MHz with 2MHz bandwidth.

Some laboratory experiments were conducted to demonstrate validity of the proposed technique. A stepped frequency radar was used with diffraction stacking migration in place of SAR algorithm for imaging. Observation frequency range was from 1GHz to 6GHz. A metal can, whose diameter was 8cm, was buried in dry sandy soil at the depth of 10cm. The estimated dielectric constant of the soil was consistent with the value obtained by an alternative laboratory measurement.