Time-Reversal and MUSIC imaging of objects near rough surface based on surface flattening transform

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Imaging and detection of objects located near rough ocean surface from transmitters to receivers which are also located on ocean surface are important practical problem. This problem is different from usual rough surface scattering including LGA (Low Grazing Angle) scattering, because the incident wave on the surface is neither a beam wave nor a spherical wave, but it is a mixture of the coherent and incoherent waves. Therefore, this needs to be studied on the basis of stochastic rough surface Green Function. Rough Surface Green Function has been obtained for perturbation solution, but it has been difficult for large rough surface heights. We have been considering this problem using the surface flattening transform. Using this transform, Green's function for rough surface is transformed to Green's function for flat surfaces with inhomogeneous random medium. Solutions for the transformed functions have been obtained using path integral and other method for several cases. We made use of the modified Rytov Method, which conserves the power, and obtained rough surface MCF (Mutual Coherence Function). The transformed equation contains the rough surface slope, the RMS height, and the correlation distances. The integral representations in the Rytov solution have been evaluated using asymptotic form and include the surface spectrum.

Next, we consider imaging problem. We use transmitter-receiver array and time-space signal processing of returned signal. Time-reversal method has been effective. We also use time-reversal MUSIC (multiple-signal-classification) , the modified beam former and SAR. Their signal processing are based on the use of multi-static data matrix, eigenvectors and the steering matrix. Numerical examples are given to illustrate the basic formulations, examples of images and comparisons among various signal processing techniques.