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A Theoretical Study of Radar Backscatter from Distributed Targets with Emphasis on Polarization Dependence

Development of an unified mathematical framework for the electromagnetic scattering from random extended targets, such as terrain and sea surface, is reported. Both power scattering and signal depolarization are encompassed in the formalism. The concept of the scattering matrix is extended from point targets to distributed random targets. All polarization possibilities are dealt with in the results. An exact correspondence is shown with results derived for special cases by other workers in the field.

This theory links the work of other investigators with the phenomenological approach through the use of the scattering matrix and incorporates classical "acoustic" or specular (high-frequency) treatment of electromagnetic scattering as well as the electrical properties represented by surface impedance and polarization dependence.

Polarization effects are incorporated through a so-called "local scattering matrix", which includes amplitude (size) and phase (surface height) parameters as well as a "local orientation" of the surface element and local Fresnel reaction coefficients.

Total integrated surface scattering may be represented by a composite scattering matrix through which the distributed surface may be considered as a single composite scatterer. Character and orientation of the composite symmetric target may change with aspect angle and frequency.

Whether a target is more facet-like, dipole-like, trough-like, or a mixture of these can be determined by extending the ordinary definition and use of the Fresnel coefficients to include not only electrical surface properties but also geometrical properties (e.g., shape, symmetry, convexity, and regularity).

Polarization information is used to bring out novel features of terrain characteristics, for example, shape, convexity, radii of curvature ratio, and average orientation.

A method is described whereby the composite scattering matrix of the distributed target can be determined by either a direct (amplitude and phase) or an indirect (amplitude only) approach.

Specific means for estimating target conductivity and dielectric of extended random targets are developed. Possibilities for measuring certain statistical properties such as rms surface height, rms surface slope, and surface correlation length are identified.

Note:

Requests for further information may be directed to:

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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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