15. Electromagnetic Wave Theory and Remote Sensing

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15.1 Electromagnetic Waves

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Electromagnetic waves are studied with applications to microstrip antennas,[1,2] microwave integrated circuit problems,[3-5] geophysical subsurface probing,[6,7] and scattering from helical structures.[8-10] Radiation and resonance characteristics of the annular-ring microstrip antennas and two coupled circular microstrip disk antennas are studied rigorously using numerical techniques, matched asympotic analysis, and newly developed Hankel transform analysis. The classical subject of dipole antenna radiation in the presence of stratified earth as applied to geophysical probing is studied. A new double-deformation technique has also been developed to analyze transient electromagnetic phenomena. Electromagnetic wave scattering from helical structures has been studied using physical optics and modal approaches. Also, the Smith-Purcell radiation problem is solved taking into account the penetrable properties of metallic gratings.[11]

15.2 Remote Sensing with Electromagnetic Waves

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Remote sensing with electromagnetic waves has been studied with the theoretical models of random media, discrete scatterers, and random distribution of discrete scatterers. These models are used to simulate snow-ice fields, forest, vegetation, and atmosphere.[12-16] Scattering and emission of electromagnetic waves by such media bounded by rough interfaces are investigated.[17-22] Multiple scattering effects of electromagnetic waves by a half space of densely distributed discrete scatterers are studied.[23-26] The quasi crystalline approximation is applied to truncate the hierarchy of multiple scattering equation and the Percus–Yevick result is used to represent the pair distribution function. The strong fluctuation theory is also applied to the study of electromagnatic wave scattering by a layer of random discrete scatterers.[27,28]

15.3 Acoustic Wave Propagation Studies

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Multiple scattering of acoustic waves by random distributions of discrete scatterers has been studied with the use of quasi crystalline–coherent potential approximation and Percus–Yevick equation.[23] The same technique is also used to study electromagnetic wave scattering by unbounded and half-space of densely distributed discrete scatterers.[25,29] In addition, the radiation and resonance of microstrip line structures,[1-3,5] geophysical subsurface probing by dipole antennas,[6,7] and scattering of waves from helical structures[8,10] have been studied.

15.4 Remote Sensing of Vegetation and Soil Moisture

National Aeronautics and Space Administration (Contract NAG 5-141)

Jin Au Kong, Robert T. Shin

In the remote sensing of vegetation and soil moisture, the scattering effects due to volume inhomogeneities and rough surfaces play a dominant role in the determination of radar backscattering coefficients and radiometric brightness temperatures.[15,22,30] The strong fluctuation theory for electromagnetic wave propagation in a random medium with large variance of permittivity function is developed.[27,28] This is particularly pertinent for vegetation canopy since the contrast of permittivity between vegetation, which is essentially water droplets, and air is very large. For row structures in plowed vegetation fields, we have developed a modal theory with the extended boundary condition approach to study electromagnetic wave scattering and emission.[17-20] These theoretical models have been used to interpret the experimental data collected from vegetation fields.[14,31]

15.5 Passive Microwave Snowpack Experiment

National Aeronautics and Space Administration (Contract NAS5-26861)

Jin Au Kong, Robert T. Shin

A multi–frequency microwave radiometer with wavelengths ranging from 8 mm to 4.6 cm was used to study the microwave thermal emission from snowpacks in the Sleepers River Valley of Northeastern

Vermont.[21,32] The radiometer used was an "Engineering Model" of the Scanning Multichannel Microwave Radiometer (SMMR), flown on the Seasat and Nimbus-7 satellites. Due to the weather cycles in the area, there were prominent ice layers embedded in the snowpacks. These ice layers cause the interference effects which modify the emission characteristics of the snowpack. Analysis of the preliminary results indicate that the incidence angle dependence of the brightness temperature of the snowpack containing the ice layers is quite different from that of more homogeneous snowpacks typical of Rocky Mountains.

15.6 Remote Sensing of Earth Terrain

National Aeronautics and Space Administration (Contract NAG5-270)
Jin Au Kong, Robert T. Shin

Extensive work has been accomplished in the development of theoretical models that account for absorption, scattering, layering, and rough surface effects of earth terrain.[15,22,30] Electromagnetic wave scattering and emission from periodic surfaces have been solved using a rigorous modal theory.[18,19] The results satisfy the principles of reciprocity and energy conservation and include shadowing and multiple scattering effects. Active and passive remote sensing of atmospheric precipitation is studied with the vector radiative transfer equations.[12,16] Electromagnetic wave scattering from a layer of random discrete scatterers has been studied with the strong fluctuation theory[28] and the quantum mechanical potential approach.[24-26]

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