(1) Polarimetric Scattering, Imaging, Inversion and Recognition in Space-Borne Microwave Remote Sensing

Ya-Qiu Jin

Abstract

Remote sensing physics is essentially the interaction of electromagnetic waves with terrain surface media. Fully understanding this interaction and developing both simulation and inversion approaches are of great importance for retrieving quantitative information from microwave remote sensing.

This lecture presents some research progress on theoretical modeling and computational electromagnetics of complex random media (environment) and 3D volumetric object (target) in natural scene for polarimetric (POL) scattering simulation, imaging simulation and information analysis of multi-modes SAR, e.g. mono-static and bistatic SAR, InSAR, ISAR etc. Some issues on multi-temporal and multi-aspect SAR are also studied.

As an inverse study, some characteristic functions of high resolution POL-SAR in both spatial and polarimetric domains for automatic target recognition (ATR), based on simulation and real SAR image, are studied, and applied to novel ATR technique. These studies first establish an information chain of forward/backward, i.e. simulation/inversion, intelligent information retrieval of target/environment in POL-SAR technology.

Also, radiative transfer of multi-layered natural scatter media for modeling of natural media, e.g. vegetation canopy, snowpack etc., is also further studied for data Cal/Val and applications of natural events in microwave remote sensing.

(2) Electromagnetic Scattering/Emission Modeling for Moon, Mars and Extra-planetary Missions, and Chinese Deep-Space Exploration Program

Ya-Qiu Jin

Abstract

In this lecture, the multi-layered model of Moon/Mars rough surface/subsurface media is presented for scattering, emission and imaging of Moon, Mars and Extra-planetary missions. In China's first lunar exploration project, Chang'E-1,2 (CE-1,2), a multi-channel microwave radiometer in passive microwave remote sensing, was first aboard the satellite, with the purpose of measuring microwave brightness temperature (Tb) from lunar surface and surveying the global distribution of lunar regolith layer thickness. It is the first time to retrieve the regolith thickness using microwave remote sensing technology. Numerical simulation and data analysis of multi-channel Tb from global lunar regolith are obtained, and applied to retrievals of the temperature and dielectric properties, layer thickness of regolith media, and evaluation of global distribution of 3He content in regolith media.

Based on the DEM (digital elevation model) of Moon/Mars rough surface, the terrain feature of cratered rough surface is numerically generated. Electromagnetic scattering is calculated, and polarimetric (POL)-SAR image is then numerically simulated. Polarimetric scattering matrix of POL-SAR imaging is analyzed and compared with cross-POL ratio (CPR) analysis of Chandrayaan-1 SAR and Selene SAR of lunar missions.

Utilizing the nadir echoes time delay and intensity difference from the surface and subsurface, high frequency (HF) radar sounder has been an effective tool for investigation of Moon/Mars surface/subsurface media. Making use of rough surface scattering and ray tracing of geometric optics, a numerical simulation of radar echoes from Moon/Mars layering structures with surface feature, the topography of mare and highland surfaces is developed. Radar echoes and its range images are numerically simulated, and their dependence on the parameters of layering interfaces are described. Inversions of the surface/subsurface parameters, e.g. layer thickness, dielectric properties etc., are developed. Some examples using the data, e.g. SHARAD/MARSIS HF radar sounders of Mars missions, are presented.

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Ya-Qiu Jin (SM'89-F'04) received the B.S. degree in Atmospheric Physics from Peking University, Beijing, China in 1970, and received the M.S., E.E., and Ph.D. degrees from the Massachusetts Institute of Technology, Cambridge, USA in 1982, 1983 and 1985, respectively. All these degrees were from Electrical Engineering and Computer Science. He was the Research Scientist of AER (Atmospheric Environmental Research, Inc., Cambridge) (1985), Research Associate Fellow of City University of New York (1986-1987), and Visiting Professor in University of York, UK sponsored by the UK Royal Society (1993). He was awarded by the Senior Research Associateship in NOAA/NESDIS by USA National Research Council (1996). He was also a visiting Professor in City University of Hong Kong (2000), and Tohoku University, Japan (2004). Since 1988, he is the Te-Pin Professor, and Director of Key laboratory for Information Science of Electromagnetic Waves (MoE), Fudan University, Shanghai, China. Dr. Jin is the Academician of CAS (Chinese Academy of Sciences), and the Fellow of TWAS (the Developing Countries Academy of Sciences), IAA (International Academy of Astronautics), and Electromagnetic Academy. He is a IEEE Fellow, IEEE GRSS Distinguished Speaker (2010-), and Associate Editor of IEEE Access (2010-). He will be General co-Chair for IGARSS2016 in Beijing, China. He was the Associate Editor of IEEE Transactions on Geoscience and Remote Sensing (2005-2012), the member of IEEE GRSS AdCom and Chair for IEEE Fellow Evaluation of GRSS (2009-2011).

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He has published more than 700 papers in refereed journals and conference proceedings and 14 books, including the most recent book of *Polarimetric Scattering and SAR Information Retrieval* (Wiley and IEEE, 2013), *Theory and Approach of Information Retrievals from Electromagnetic Scattering and Remote Sensing* (Springer, 2005), *Electromagnetic Scattering Modelling for Quantitative Remote Sensing* (World Scientific, 1994). He was appointed as the Principal Scientist (2001) for the China State Major Basic Research Project by the MOST (State Ministry of Science and Technology) of China to lead the remote sensing program in China.
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