A Curriculum for Modern Graduate Instruction in Electromagnetic Remote Sensing

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Modern graduate-level classroom instruction in remote sensing needs to cover a variety of topics that build upon and synthesize concepts in electromagnetics and wave propagation, signal processing and random process theory, and the physics of the environment or other observable processes of interest. Accordingly, the curriculum must necessarily be broad, covering relevant aspects of electronics, microwave engineering, optics, wave propagation and radiative transfer theory, interferometry, estimation theory (including spectral estimation), and meteorology, oceanography, hydrology, space plasmas, and aerospace engineering. Underlying this seemingly broad collection of material, however, is the need to understand the fundamental limitations of sensors, including the effects of integration time, bandwidth, range-velocity tradeoffs, beamwidth/aperture size, etc... for a sufficiently large class of elementary remote sensing systems.

We discuss in this presentation the curriculum within the CU Department of Electrical and Computer Engineering used in preparation for graduate studies in electromagnetic remote sensing. A two-course sequence includes the necessary background material from both the signals and systems and propagation standpoints. The first of these, "Remote Sensing Signals and Systems" (ECEN 5254), synthesizes concepts in thermal noise, radiometry, infrared detection, optical detection, real-aperture and synthetic aperture radar, lidar, and fundamental detection limits. The second, "Electromagnetic Absorption, Scattering, and Propagation" (ECEN 5264) covers topics in atmospheric spectroscopy from a quantum mechanical basis, ionospheric propagation, and propagation within and reflection from random media. These courses also provide background material useful for students focusing on sensors or sensing and communications systems, including satellite and cellular telecommunications.

Complementing the above classroom instruction at CU is an introductory laboratory program involving contact with major remote sensing hardware or system software that provides an important degree of practical experience, along with potential research challenges. The combination of the two experiences (classroom and laboratory) are complimentary and provide a sound basis for advanced graduate research in remote sensing and long-term career development.