

Tutorial introduction to Synthetic Aperture Radar

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The foundations of electromagnetics in Maxwell's equations will be explored and developed into basic radar principles, including propagation, echo ranging, and scattering. This will be followed by an examination of the mathematical foundations for processing radar signals, including common signal processing functions of mixing, multiplying, modulation, demodulation, filtering, and correlation. The widely employed Linear-FM Chirp waveform will be presented, as well as salient characteristics of desirable waveforms more generally. We will next examine basic airborne pulse-Doppler Synthetic Aperture Radar (SAR) systems. Basic data models will be developed, and several image processing algorithms will be illustrated and compared. These include a simple 2D-DFT algorithm, the Polar-Format Algorithm (PFA), and Backprojection. The radar equation for SAR will then be developed and explored in some detail to illustrate how SAR operating parameters can be traded for performance as measured by the Signal-to-Noise Ratio (SNR) for a target, and equivalently the Noise-Equivalent Reflectivity (NER).