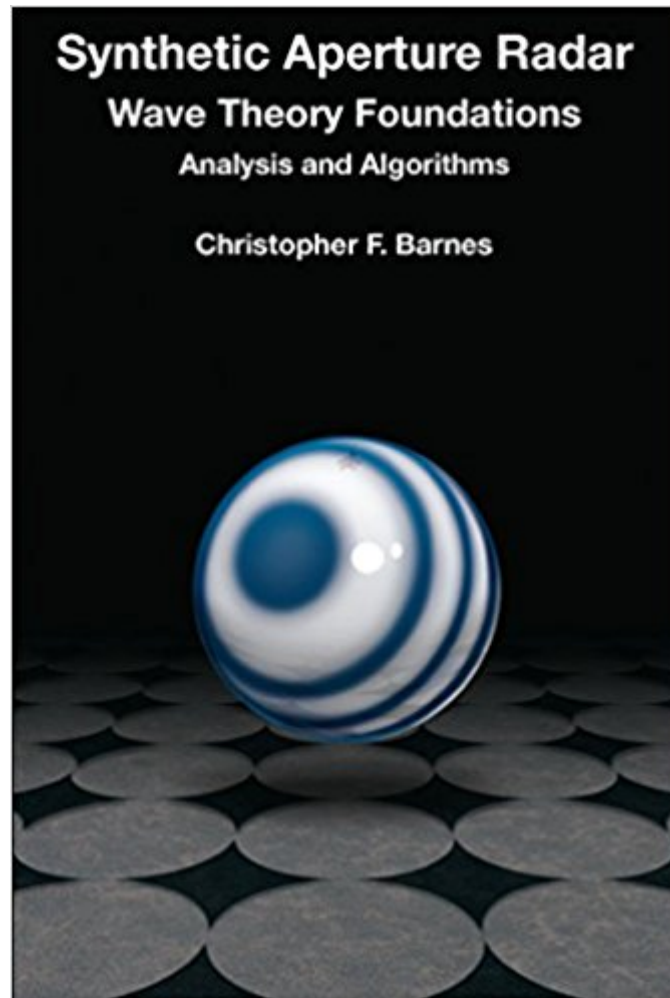




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Synthetic Aperture Radar



Synopsis

Synthetic Aperture Radar, Wave Theory Foundations, Analysis and Algorithms delivers a comprehensive and in-depth study of the subject. This book covers all major topics related to synthetic aperture radar (SAR) science, systems and software. SAR science is established on a foundation of wave theory. SAR systems for stripmap, spotlight, spotmap, volumetric, inverse, scan, swept, etc. modes are explained. SAR analysis techniques are presented at a detailed mathematical level, including analyses of chirp signals, and both stretch and chirp receiver systems. All SAR algorithm classes are presented: Stolt formatting, polar formatting (including direct and filtered back-projection methods), hyperbolic coherent summing, spherical coherent summing (including direct, filtered and factorized back-propagation versions), range stacking, range-Doppler and chirp scaling. Most SAR algorithms are described with sufficient detail to enable software implementations. Novel methods for volumetric SAR (VolSAR) imaging are presented. The empowerment of diffraction limited VolSAR imaging with swarms of SAR sensors and non-linear flight paths is demonstrated in simulation studies. Coherent fusion of multiband SAR is also demonstrated. Vector and scalar wave motion equations based on Maxwell's equations and acoustic wave dynamics are derived. Electromagnetic and acoustic wave theory principles are used to develop SAR signal models for both differential and integral descriptions of terrain scattering and received backscatter. SAR and computed imaging literature of the last sixty years is extensively surveyed and summarized. Relationships between SAR image formation algorithms and the computed imaging algorithms of holography, diffraction tomography, ray tomography and seismology are explained. Many variations of SAR algorithms that can be found in the literature are organized into a taxonomy that illuminates algorithm relationships. #SARWAVE

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Another excellent book from what should be called: "The Georgia Tech School of Radar". This book by Prof. Barnes attempts to provide a holistic foundation of modern synthetic aperture radar theory that is different from the popular classical works. The classical works I am familiar with are: 1) Digital Processing of Synthetic Aperture Radar Data by Cumming and Wong. 2) Spotlight-Mode Synthetic Aperture Radar by Jackowatz et al. 3) Spotlight Synthetic Aperture Radar by Carrara and Majewski. 4) Synthetic Aperture Radar Signal Processing by Soumekh. 5) Synthetic Aperture Radar: Systems

and Signal Processing by Curlander et al. Although these books have their strengths, what they lack is fundamental pedagogy in relating basic and advanced signal processing principles to basic and fundamental physics. I shall refer to these books as "legacy books". What strikingly distinguishes this book from the legacy books is that Barnes has harmoniously synthesized electromagnetic scattering theory and SAR signal processing in a unified framework. Without such a framework, one feels a definite confusion and lack of depth/intuition going through the legacy SAR books. The author in page 12 correctly alludes to the "Balkanization of the practicing SAR communities". Anyone going through even a modest number of the 1000+! references (side note: I do not think there exists too many people reading 1000+ references related to SAR theory) cited by the author notices that many papers and books are based upon a simplified geometric viewpoint that lead to basic equations based upon time-varying range. Subsequently, Taylor series approximations are used to derive basic design parameters of a SAR system. These basic parameters are often contradicted by other papers and books because of different approximations used. Also going from one algorithm to another using these basic geometric diagrams, PSP, hand-waving and Taylor series approximation can lead to vastly different fundamental parameters such as PRF with foreseeable negative consequences. Barnes on the other hand develops SAR from the wave theory of Huygen-Fresnel, and the approximations of Fraunhofer and Fresnel. This underlying mechanism provides a unity that is not seen in the aforementioned legacy books. What is extremely beautiful about this book is that no more than an undergraduate EMF course (if that!) is needed in order to understand how these wavefield concepts provide the fundamental foundation for the variety of SAR algorithms. This accessibility is rare when discussing such advanced concepts. Barnes book covers all the standard image formation algorithms such as Polar, Back-Projection, RDA, Omega-K, Range-Stacking etc., as well as providing information and his own innovations on new algorithms such as the three dimensional volumetric SAR (VolSAR). Another point I like about this book is that the author delves into the meat of the problem rather than use abstract notations of operator theory and unconventional mathematical notations which usually have little correlation to designing real world systems. I estimate that there are about 150-200 figures in the book and they also provide further intuition. The book should be useful to practicing engineer, researchers, advanced undergraduate and graduate students as well as the theoreticians. The author should rightfully be proud of this monumental and timely work. Two recommendations for the author are: 1) To provide toy Matlab examples for the various image formation algorithms discussed in the book. 2) To provide video lectures/notes based on his teaching of the courses at Georgia Tech. One side note for those who are new to radar. The POMR volumes (Principle of Modern Radar volumes 1-3 written mostly by the

Georgia Tech School), as well as "Fundamental of Radar Signal Processing" by Prof. Mark Richards are two excellent books to accompany this book. The price of all these books including this SAR book by Barnes are worth it in my opinion. They will provide a necessary foundation for a career that provides orders of magnitude in return.

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