Radar Clutter Modelling and Exploitation

Technical Summary:

Clutter and the need to detect targets in clutter is a significant part of radar design. The development of methods to model clutter and CFAR detection schemes for targets in clutter are still at the forefront of radar research, as evidenced by the numbers of papers on these topics in the radar journals and at the radar conferences. Models of clutter are only of value if they can be used in practice for the development of real radar systems. The tutorial will help attendees to understand the impact of clutter on radar design and performance, and how to use clutter models to develop better designs. This insight is relevant not only to radar systems engineers but also to those responsible for specifying and procuring new radar systems for operational use. Much of the tutorial will be based on sea clutter modelling but the general concepts that will be introduced have broader application to all clutter types.

Brief tutorial overview:

1. **Introduction to Radar Clutter**
   - An introduction to the characteristics used to describe clutter: reflectivity, polarisation, amplitude statistics, Doppler spectrum, and spatial correlation.
2. **The use of clutter models in the radar life cycle**
   - Practical insight into the use of clutter models at the various stages of the marketing, specification, design and development, testing and acceptance into service of radar systems.
3. **Clutter model overview**
   - Models for describing the behaviour of the reflectivity, amplitude, Doppler spectrum and spatial correlation.
4. **Parametric modelling**
   - Models that relate the clutter model parameters to environmental conditions, radar parameters and viewing geometry.
5. **The simulation of radar clutter**
   - Mathematical methods for the realistic simulation of coherent radar sea clutter returns over range and time.
6. **Performance prediction in radar clutter**
   - Analytic performance prediction in clutter under different environmental conditions, radar parameters and viewing geometries using the radar range equation.
   - Performance of CA CFAR detectors in spatially correlated clutter.
   - Monte Carlo simulation of performance where analytic methods cannot be used.

Intended Audience:

The tutorial is aimed at researchers and engineers working in the field of maritime radar or with a wider interest in clutter modelling. It will provide a basic introduction for those new to this topic and lead into a description of the more advanced modelling methods. This will require some understanding of signal processing, probability and statistics.

Instructors:

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Prof. Simon Watts was a deputy Scientific Director and Technical Fellow in Thales UK until 2013 and is a Visiting Professor in the department of Electronic and Electrical Engineering at University College London. He received an MA from the University of Oxford in 1971, an MSc from the University of Birmingham in 1972, a PhD from the CNAA in 1987 and a DSc from the University of Birmingham in 2013. He joined Thales (then EMI Electronics) in 1967 and worked on a wide range of radar and EW projects, with a particular research interest in airborne maritime radar and sea clutter. He is author and co-author of over 80 journal and conference papers, two books on sea clutter, various book chapters on clutter and several patents. He has also published two books on the history of airborne maritime surveillance radar. He received the IEEE AES Warren White Award in 2020. He was appointed a Member of the Order of the British Empire (MBE) by HM the Queen in 1996 for services to the UK defence industry and holds Fellowships of the Royal Academy of Engineering, the IET, the IMA and the IEEE.

Dr. Luke Rosenberg received a Bachelor's degree in electrical and electronic engineering, a Master's degree in signal and information processing, and a Ph.D. from the University of Adelaide, Australia. He is currently an adjunct Associate Professor with the University of Adelaide and a Senior Research Engineer at STELaRLab, Lockheed Martin Australia. Prior to this, he worked at the Defence Science and Technology Group Australia as a research specialist in maritime radar, and in 2014, he spent 12 months with the U.S. Naval Research Laboratory (NRL) working on algorithms for focusing moving scatterers in synthetic aperture radar imagery. Dr. Rosenberg has received a number of best paper awards, the prestigious Defence Science and Technology Achievement Award for Science and Engineering Excellence in 2016 and the IEEE AESS Fred Nathanson award in 2018 for 'Fundamental Experimental and Theoretical Work in Characterizing Radar Sea Clutter'. He is the vice president for publications on the AESS board of governors, a member of the radar systems panel, a distinguished lecturer for the AESS, senior editor for the Transactions of Aerospace and Electronic Systems, and past chair of the IEEE South Australian Section. He has over 180 publications including a recent book: Radar Sea Clutter: Modelling and Detection. He is an IEEE Fellow for contributions to maritime radars.