Pre-conference Tutorial 1

Advanced Target Detection Techniques of Low Observables

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Background:

One of the recent challenges to the radar detection performance is to detect low RCS (Radar Cross Section) targets (e.g small boats, submarine, periscope etc) in a heavy sea clutter environment and high sea states. There is also a critical requirement for early detection and warning of the intruders (slow moving small boats) entering into the territorial waters, UAVs (Unmanned Aviation Vehicles) over land and sea involved in hostile EA assignments, detection of submarine periscopes exposed intermittently just above the water surface and so on. Furthermore, birds flying low at critical heights above the ground, have become potential aviation safety hazards, during approach and take off. With these threats on the increase, extracting such weaker, unpredictable and unstable target returns require fast, efficient, reliable and robust target detection methods and techniques. This tutorial will discuss the challenges and advanced techniques and fixes in detail.

Outline:

The small slow moving targets exhibit low Doppler frequencies and conventional Doppler processing used in surveillance system may not always be useful due to dwell length limitations to extract sufficient Doppler information with sea clutter returns exhibiting a similar Doppler spectrum as that of the targets of interest. To alleviate such hurdles in doppler processing we have other options open to us like various Track-before-detect methods viz Particle Filters, MHT (Multi-hypothesis Tracking) , pulse-to-pulse and scan-to-scan integration techniques etc Recent research exploited and refined scan-to-scan integration combined with sliding window CFAR process and binary integration with remarkable success. The other recent detection techniques that will also be covered are the Radon transform, cross correlation techniques etc. This paper will discuss various such techniques supported by case studies and evaluation trials and data analysis.

This tutorial will discuss the sea clutter distribution functions at low grazing angles as viewed from surface platforms and also at high grazing angle viewed from airborne platforms, like KK and Weibull distribution along with their characterisation and applicable integration, correlation and CFAR methods.

Also several recent research outcomes have demonstrated considerable improvements in the detectability of weak targets in a severe sea clutter background with netted (distributed) radars configuration, featuring data capture of the same target returns at various aspect angles, thanks to the availability of low cost surveillance radar systems in the market. The netted radar architecture improves system sensitivity multifold, as compared to single sensor detection. This tutorial will also discuss the sensitivity models of netted radars

Extraction of low observable targets also relies on the noise performance of the Receive RF front. Hence modification/tuning up of the RF front end circuitry helps to pre-process the target returns for enhanced SNR of targets of interest fed into the subsequent signal/data processing chain for optimising target detection performance. Discussions on the RF processing like Tracking STALO techniques to optimise SNR at the pre-processing stages.

This tutorial will start with an overview of the radar detection theory combined with detailed discussions on various CFAR processing techniques. It will elaborate the various algorithms/techniques employed for small target detection for ground based, sea borne and airborne platforms with illustrations, models and case studies with captured data in trials.

It will also elaborate further studies and research work undertaken among the radar community including the potential applications in this area. The delivery of the tutorial is aimed for about 2.5 hours through Power Point presentation and brief interactive sessions.

A broad and tentative list of topics that is proposed to be covered is as under:

- Introduction
- Target detection theory and CFAR processing
- Small Target Detection (STD) Techniques - overview
- Advanced STD techniques (TkBD, Scan-to-Scan Integration)
- Distributed/Netted radar sensing
- RF front end optimisation
- Simulation, Modelling and algorithm development with case studies and trials
- Summary/Conclusion
- References

Authors Bio Data

Krishna Venkataraman is a Radar Systems Engineer/Radar Specialist in DST Group, Department of Defence, Australia and Project S&T Advisor to the DoD, supporting various defence radar acquisition projects.

His current research interests include low observable target detection (intruder/non-cooperative), detection of biological targets, netted radar sensing, phase noise in radar systems, radar performance modelling/ assessment, analysis and mitigation of intentional/non-intentional RF interferences (Wind farms) on surveillance (ATC) radar performance etc.

He has more than 40 years of radar experience and his past activities in defence industries include, leading research and development of signal processing algorithms for naval surveillance (S and L band) radars, Doppler tracker for instrumentation (C band) radars for space surveillance, AEW radar signal processor, critical measurements of (Aeolian) phase noise in OTH radars, ATC radars etc

He has presented/published several technical papers/ reports in International conferences, symposiums and journals. He delivered several tutorials/workshops/planery talks in various international radar conferences worldwide and workshops for military personnel. He chaired Tutorial committees in RADAR2008 and RADAR2013 conferences.

Krishna Venkataraman is a **FELLOW** - **FIE(Aust)** and Chartered Professional Engineer (**CPEng**) of the Institution of Engineers (Australia). He is also a **SENIOR MEMBER** of the IEEE, USA. (**SMEEE**)

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