Advanced Radar Detection and Applications
Tutorial for 2024 International Radar Conference, Rennes - France

Tutorial Abstract:
We teach advanced radar detection from first principles and develop the concepts behind Space-Time Adaptive Processing (STAP) and advanced, yet practical, adaptive algorithms for realistic data environments. Detection theory is reviewed to provide the student with both the understanding of how STAP is derived, as well as to gain an appreciation for how the assumptions can be modified based on different signal and clutter models. Radar received data components are explained in detail and the mathematical models are derived so that the student can program their own MATLAB or other simulation code to represent target, jammer and clutter from a statistical framework and construct optimal and suboptimal radar detector structures. The course covers state-of-the-art STAP techniques that address many of the limitations of traditional STAP solutions, offering insight into future research trends.

Instructors:
Dr. Scott Goldstein, Parsons Corp., scott.goldstein@parsons.com
Dr. Michael Picciolo, Anduril Industries, picciolo@ieee.org

Bio-sketches:

Dr. Scott Goldstein is a Senior Vice President at Parsons Corporation and has served at executive levels in government, industry and academia. He achieved the rank of Major General in the United States Air Force and has led organizations in industry as well as served as a Chief Technology Officer, Chief Strategy Officer and Chief Scientist. He has performed fundamental research and development in radar detection and estimation theory, Space Time Adaptive Processing and advanced systems concepts. He is a Fellow of the IEEE and a member of the IEEE Radar Systems Panel. He received the 2002 IEEE Fred Nathanson Radar Engineer of the Year Award and the 2019 IEEE Warren D. White Award for Excellence in Radar Engineering.

Dr. Mike Picciolo is Senior Radar and EW Architect at Anduril Industries, in the Electronic Warfare organization. Previously, he was Director of Mission Engineering in the Engineering, Integration and Logistics Division at SAIC. Previously he served as Chief Technology Officer, NSS Division, at ENSCO. Prior, he was the Associate Chief Technologist for Dynetics and Chief Engineer of the Advanced Missions Solutions Group in Chantilly, VA. He has in-depth expertise in Radar, ISR systems, Space Time Adaptive Processing and conducts research in advanced technology development programs. Has deep domain expertise in SAR/GMTI radar, communications theory, waveform diversity, wireless
communications, hyperspectral imagery, IMINT, SIGINT, and MASINT intelligence disciplines. He is a member of the IEEE Radar Systems Panel, received the 2007 IEEE Fred Nathanson Radar Engineer of the Year Award, the 2018 IEEE AESS Outstanding Organizational Leadership Award, and founded the IEEE Radar Summer School series.

**Intended Audience:**

This tutorial is for anyone interested in learning advanced concepts and practical solutions to modern radar detection and estimation problems with emphasis on statistical adaptive signal processing. The students will also be able to use the course notes to simulate the radar target, clutter, jamming and processing algorithms using programming languages such as MATLAB.

**Suggested Prerequisites:**

Students should have some basic background in areas of radar, signal processing and linear algebra to get the most benefit.

**Learning Outcomes:**

This tutorial is very important to bridge the gap between radar detection theory and practice; the concepts behind adaptive detectors; constant false alarm rate (CFAR) detectors; STAP; and practical algorithms to implement viable processing approaches in real systems. Many examples are presented that illustrate how the core processing algorithms can be applied to all aspects of radar.

**Topics (over 4 hours):**

Part 1 – Introduction, Classic Radar Detection cases.


Part 3 – Adaptive algorithms, Reduced rank algorithms, Multistage Wiener Filter.

Part 4 – Real world data environments, robust STAP algorithms, Summary.

**Prior Presentations:**

This tutorial has evolved at the IEEE Radar and International Radar Conferences almost every year since 1997. As the more relevant material becomes available over time the content has been modified to ensure students are presented with timely, useful and currently relevant information and practical examples. Typical attendance has been strong throughout the ~27 years with excellent reviews (about 25-40 students per event), even from students who took it more than once as the content evolved.

**Appendix: Selected papers, All Presenters**


