STAP Techniques and Applications

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Overview

Adaptive Processing is becoming an integral part of modern airborne and space-based radar (SBR) systems for Air/Ground/Surface Moving Target Indication (A/G/S MTI). Space-time adaptive processing (STAP) techniques combine spatial and temporal degrees of freedom to detect moving targets in strong background interference consisting of clutter and jamming. STAP uses the multiple spatial channels in a phased-array antenna and the multiple coherent pulses transmitted and received by the radar to form an adaptive weight vector that is applied to the received radar data. To calculate the adaptive STAP weight vector, the statistics of the interference environment are determined from the training or secondary data. The interference covariance matrix is not known a priori and must be estimated from independent and identically distributed (iid) data. However, experimental data obtained from several experiments have shown that this data is non- homogeneous, and hence violates the iid assumption. These facts are exacerbated when a bistatic, spaceborne, or a conformal radar configuration is employed. These issues and challenges will be identified, and adequate solutions will be provided in this tutorial. The tutorial begins with monostatic airborne radar, where the principles of STAP are formulated. These are then extended to a bistatic configuration, where the transmitter and receiver are not co-located and move independently of each other. For space-based radar, the earth's rotation around its axis adds another degree of difficulty and novel STAP techniques have been developed and will be discussed. Recently, there has been a strong interest in deploying smaller platforms, where three-dimensional (3D) conformal arrays are used. We will address this with different implementations of STAP. We will conclude the tutorial with extensions of STAP to other applications such as Hyperspectral Imaging (HSI) and multiple-input multiple-output (MIMO) radar. Concluding remarks and a bibliography are then provided.

Past Presentations

The tutorial and its variant have successfully been given at Radar2008 (Adelaide, AUS), Radar 2013 (Adelaide, AUS), and Radar2024 (Bordeaux, FR). Attendance varied between 15 – 30, and attendees came from academia, industry, and government.

Outline:

1. Overview
2. STAP for Monostatic Airborne Radar Systems
3. Extensions to Bistatic Airborne Radar Systems
4. Space-Based Radar (SBR) STAP Systems
5. Conformal Array STAP
6. Hyperspectral Imaging (HSI)

7. MIMO Radar
8. Concluding remarks
9. Bibliography

Biography

Dr. Braham Himed received the Engineer Degree in electrical engineering from Ecole Nationale Polytechnique of Algiers, Algeria in 1984, and his M.S. and Ph.D. degrees both in electrical engineering, from Syracuse University, Syracuse, NY, in 1987 and 1990, respectively. Dr. Himed is a Division Research Fellow with the Air Force Research Laboratory, Sensors Directorate, Multi-Spectral Sensing and Detection Division, Distributed RF Sensing Branch, in Dayton Ohio, where he is involved with several aspects of radar developments. His research includes detection and estimation, multichannel adaptive signal processing, array processing, adaptive processing, waveform diversity and design, distributed active/passive MIMO radar, and over the horizon radar. Dr. Himed is the recipient of the 2001 IEEE region 1 award for his work on bistatic radar systems, algorithm development, and phenomenology. He is a Fellow of IEEE (Class of 2007), a past-Chair of the IEEE AESS Radar Systems Panel, and a current IEEE AESS board of governors member, serving as VP of Conferences. He is the recipient of the 2012 IEEE Warren White award for excellence in radar engineering. Dr. Himed is also a Fellow of AFRL (Class of 2013).