Robust statistical learning for adaptive processing in MIMO RADAR

Thesis subject (Oct. 2018-Sept. 2021)

Keywords : learning, robust statistics, non convex optimization, MIMO RADAR, real data

1. Scientific background

The increase of sensors number and the development of new technologies have led to large size of RADAR data. Since decades, statistical approaches have shown their good capacity to deal with RADAR data. In particular, the statistical learning methods are the most likely used in many applications. But they are based on a learning support which depends on the data size. Therefore, since this size is strongly increased with the new RADAR systems, most of classical algorithms become inefficient. Development of new approaches adapted to large data size is a current topic both in research and in application fields. More precisely for statistical methods, new algorithms have to correctly run with a limited learning support. For this purpose, the best solution is to take into account the mathematical and physical properties of the data in the new algorithms (integration of prior knowledge). From an application point of view, it is needed to develop new efficient and robust algorithms for data of large size from new RADAR systems.

The MIMO STAP (*Multiple-Input Multiple Output Space-Time Adaptive Processing*) RADAR for the detection of moving target (GMTI for *Ground Moving Target Indication*) deals with the large data dimension problematic. Indeed, the multi-sensor, the multi-Doppler and the multi-arrays characteristics of the MIMO STAP lead to large size of data. Moreover, most of classical approaches in MIMO-STAP assume that the different transmitted waveforms are orthogonal but this is no longer verified in practice. Therefore, we have to develop new algorithms for data of large size and without the assumption of orthogonality of the transmitted waveforms.

2. Objectives

The general objective of the thesis is the development of a GMTI algorithm for MIMO-STAP RADAR. The thesis is organized around three main focus areas. In the first one, new statistical learning strategies for adaptive processing [1] will be proposed for large dimension data. The low rank and the Kronecker structure properties of the covariance matrix of the disturbance will be exploited to strongly reduce the learning support size [2,3].

The second topic deals with the problematic of transmitted waveforms which are not orthogonal. The goal is to develop new algorithms whose performances are not degraded by considering realistic MIMO transmitted waveforms (not orthogonal). The sidelobes reduction has already been proposed with mismatched filters [3]. We propose to include such approaches in the adaptive processes developed in the previous step. If possible, we will derive the theoretical performances of the new developed algorithms by using asymptotic methods [4,5].

Real MIMO RADAR data have been recently acquired by ONERA for moving target detection. The final objective of the thesis will then be to apply the previous developed algorithms on these real data which will allow to evaluate their performance for the detection and the localization of moving targets in several conditions (small SNR, slow moving target, ...). New scenarii and transmitted waveforms could be considered if necessary.

3. Informations

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The thesis will take place at ONERA in Palaiseau (Paris area). The funding is assured by the DGA and the ONERA.

4. Candidate profile

The candidate must have the equivalent of a master degree in the field of signal and image processing, applied mathematics or data science. A solid background in statistical signal processing and/or numerical optimization is required as well as programming skills in Matlab and/or Python. Only applicants with E.U. nationality will be considered, due to funding constraints.

5. Contact

Applicants must send via e-mail to {guillaume.ginolhac@univ-smb.fr, frederic.brigui@onera.fr} a CV as well as a transcript of the last year study. Recommendation letters will be a plus. Do not hesitate to send an e-mail for more information

Références

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