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Finding a detection threshold for Fisher Detector applied to beamforming

Adrien Nouvellet (1), François Roueff (2), Maurice Charbit (2), and Alexis Le Pichon (1)
(1) CEA, DAM, DIF, F-91297 Arpajon, France, (2) CNRS/LTCI of Telecom ParisTech, France

The so called F-stat function of test (FoT) is a commonly used detector of signal of interest (SOI) received by sensors with additive white Gaussian noise [1], [3]. This FoT is related to the generalized likelihood ratio test based on the Gaussian assumption and on the parametrization of the planar propagation of the wave carrying the SOI by a slowness vector. The detection test is obtained by comparing the FoT to some threshold or by providing the p-value which is directly compared to the targeted type-I error. In both cases, we need to compute the distribution of the FoT under the null hypothesis i.e. in the absence of the SOI.
Unfortunately when the FoT is maximized over a set of various possible slowness vectors for the SOI propagation, the distribution under the null hypothesis is no longer the expected Fisher distribution [4]. In this study we present a new approach to approximate the null distribution when this maximization is performed over a finite set of slowness parameters, which corresponds to the most encountered practical setting. To this end, we derive the asymptotic (Gaussian) behavior of the finite dimensional distributions of the FoT seen as a process indexed by the set of delays that appear in its computation. This approach, although asymptotic, provides a practical way to tune the type-I error of the detection test in a consistent and efficient way, which performs quite well on simulations.