A NOVEL EFFICIENT NORMALIZATION TECHNIQUE FOR SONAR DETECTION

Timo Suojoki[1], *Ioan Tăbuş*

Abstract

In practical sonar signal processing the background normalization is one of the key operations to ensure steady detection performance. In this paper we propose a novel efficient normalization technique for narrowband detection in passive multibeam sonar. Proposed multistage normalization is demonstrated to be not only efficient but also fast which makes it very attractive for practical sonar systems. Alternative normalization techniques are also considered and compared to the suggested one using simulated and real data.

Introduction

The common problem of joint DOA and frequency estimation of multiple signals arriving at an antenna array is considered. Traditionally it has been applied to radar and sonar systems for target detection and parameter estimation. In this paper we will concentrate mainly on detection problem in passive multibeam sonar system.

The detection is realized via hypothesis testing where there are two or more hypotheses. The detection itself can be either automatic or operator based.

Regardless of the detection mechanism used, display images are always provided to the operator. In passive sonar systems these displays are usually gray-scale images known as LOFARs. In narrowband detection they are presented as a function of frequency, time and bearing. Traditional way to ensure uniform detection performance in a non-stationary noise background is normalization which is accomplished in the frequency domain, separately at each beam direction.

The system diagram used in this paper is depicted in the figure below. Difference to earlier studies is the addition of the spatial filter which enables the DOA estimation.

Multistage Normalization Technique

Multistage normalization is based on multistage filtering techniques used in image processing. It has some similarities but also some differences in relation to the slow 2D-normalization. Where the 2D-normalization techniques just used 2D-bin neighborhoods or approximations of these, multistage filtering is based on completely different philosophy, which takes advantage of diverse data features via subwindows. This enables powerful performance, and what is particularly interesting, at low computational costs.

[1]timo.suojoki@patria.fi

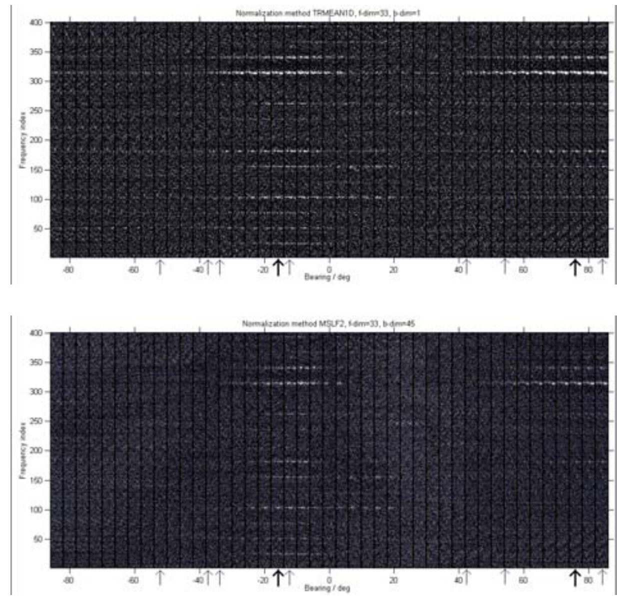

Figure 1: Multibeam LOFAR of multitarget situation, normalized by 1D-TrMean(upper fig) and MSLF2(lower fig) method

Experimental Tests

We run several tests with the uniform linear antenna with the following parameters: 24 antenna elements and 45 beam directions which span the entire spatial space (in 2D world). In our simulations we calculated detection statistics separately for each beam direction, but with the same threshold. Bearing ability was estimated via detection probabilities of existent signal as a function of bearing. With real data detection probabilities were not able to define. Instead of that the rough bearings of the detected tones were able to estimate from LOFARs and compare results to the a priori information of the targets.

The superior performance of the proposed multistage normalization technique with respect to the traditional one-dimensional normalization techniques is illustrated in the presented figures.