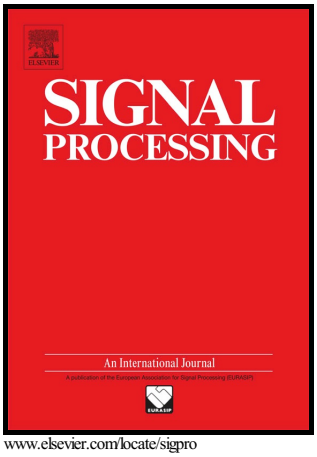

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Extreme direction analysis for blind separation of nonnegative signals

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Abstract

Blind signal separation consists in processing a set of observed mixed signals in order to separate them into a set of components without any *a priori* knowledge about the mixing process.

This paper deals with the blind separation of nonnegative signals. We show that, for such signals, the problem can be expressed as the identification of relevant extreme directions of a data defined polyhedral cone. Direction relevance is determined by means of a new criterion which integrates both sparseness and linear independence. In order to optimize this criterion with a low complexity, a suboptimal but efficient algorithm based on linear programming is proposed.

After a rigorous soundness proof, the steps of the proposed algorithm are detailed, its convergence is analyzed and its performance is evaluated via experiments involving two-dimensional signals.

Keywords: Blind signal separation, nonnegative signals, dual cone, extreme directions, l-simplicial cone, MRI images.

1. Introduction

Blind signal separation is one of the most studied problem in the field of signal processing. It consists in determining a set of unknown source signals from a set of mixtures of them despite the lack of information about the mixing process. The problem has many variations for different contexts. In this paper, we focus on the variation that involves signal mixtures obtained by means of a *linear* and *instantaneous* mixing process. Such mixtures can be expressed by the following matrix equation

$$\mathbf{X} = \mathbf{MS} \tag{1}$$

where $\mathbf{X}$ is a $d \times n$ real matrix holding in its rows the signal mixtures. $\mathbf{M}$ is a $d \times d$ mixing matrix whose entries are the unknown mixing coefficients and $\mathbf{S}$ is a $d \times n$ matrix holding in its rows the unknown source signals. The problem is then to estimate both $\mathbf{M}$ and $\mathbf{S}$ based on the mixture matrix $\mathbf{X}$ alone. Notice

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