CCIT REPORT #553
August 2005

Efficient Blind Separation of Convolutive Image Mixtures

Sarit Shwartz, Yoav Y. Schechner and Michael Zibulevsky
Department of Electrical Engineering
Technion - Israel Institute of Technology.
Haifa 32000, Israel
psarit@tx.technion.ac.il , yoav@ee.technion.ac.il,
mzib@ee.technion.ac.il

Abstract

Convolutive mixtures of images are common in photography of semi-reflections. They also occur in microscopy and tomography. Their formation process involves focusing on an object layer, over which defocused layers are superimposed. It is possible to remove the mixture crosstalk (separate the layers) based on several images taken with different focus settings, if the defocus point spread function (PSF) is known. However, in general the PSF is unknown, hence there is need for a blind source separation (BSS) approach. We deal with cases in which the layers are independent, hence we seek to minimize the mutual information (MI) of the blindly estimated layers. However, direct MI optimization of convolutive image mixtures is very complex and suffers from local minima. In this paper we devise an efficient approach to solve these problems. Our method is convex, hence having a unique solution which is derived fast. It combines a parametric model of the PSF with factorization of convolution to multiplicative mixtures. Convolutive mixtures are factored into several small and simple problems by short time Fourier transform, where signal separation is efficiently done in each frequency channel by standard BSS tools. These tools, however, suffer from fundamental ambiguities. We overcome these ambiguities by exploiting the PSF parametric model. We apply our algorithm to semi-reflections, and demonstrate its performance in experiments.

Keywords: Blind source separation, Transparent layers, Independent Component Analysis, Sparsity.