Sound-zoned - a multichannel separation of audio signals

Venkatesh Bharadwaj S

Spider, The Research and Development Club of NIT Trichy.

1. Introduction

Imagine a scenario where a filmmaker feels that live record would enhance the sound quality and the dubbing of a film thereby reducing the re-recording and post-production time. Assume that there are multiple people speaking and you would like to listen to one person at a time to catch hold of what exactly he or she is saying.

2. Independent Component Analysis

Independent component analysis (ICA) is a statistical method for transforming an observed multidimensional random vector into components that are as statistically independent as possible from each other, for revealing the hidden factors that are within the random signals.

Independent Component Analysis is used to decompose a multichannel signal into individual non Gaussian sources. The source signals must be independent of each other and the values in each source signal have non-Gaussian distributions.

1. Independence,
2. Normality and
3. Complexity are the 3 effects of Independent Component Analysis.

We are basically given two linear mixtures of two source signals which we know to be independent of each other, i.e. observing the value of one signal does not give any information about the value of the other. The problem statement boils down to determine the source signals with the mixtures of signals that we have.

Putting this into mathematical notation, we model the problem by $Y = AX$, where X is a two-dimensional random vector containing the independent source signals, A is the two-by-two mixing matrix, and Y contains the observed (mixed) signals, thereby relating it to the linear system.

3. Algorithm

The first step in ICA is to sphere the non-Gaussian data, i.e. to whiten the data. We are forcing the signals to become uncorrelated. The individual signals are then obtained by performing orthogonal transformation of whitened signals , which is basically a rotation of the joint density plot, which is got by maximizing the non- normality of marginal densities. It's a fact that the linear mix of 2 independent random parameters is more Gaussian than non linear signal.

We had adopted a fixed point algorithm technique called FASTICA which is the most efficient ICA algorithm that could be used. FastICA uses an orthogonal rotation of sphered data, through a fixed-point iteration scheme, that maximizes a measure of non-Gaussianity of the rotated components. Non-gaussianity serves as a very strong condition and requires infinite data to verify.

4. Applications

ICA is used for analyzing non-physical signals too. Of late, ICA has been used extensively to filter out the noises in

1. EEG signal processing,
2. Face recognition,
3. Modeling receptive fields of primary visual neurons,
4. Removing artifacts, such as eye blinks, from EEG data

5. Inputs and outputs

Input: