Abstract

In modern day research and studies, utilization of Blind Source Separation (BSS) techniques to extract and interpret data from various types of multi-sensory systems is recognized as a highly demanding area. The significance is that, those techniques do not rely on the information related to the source signals which are totally unknown and yet to be extracted. Further, the sensor measurements are always noisy in practice making this a noise reduction problem coupled with a source separation problem. And also, most source signals in a noisy mixture have overlapping bandwidths making it impossible to use standard filtering techniques to separate the sources. In my project, I tried to show that the Independent Component Analysis (ICA) based adaptive method can be used to overcome this problem to extract source signals effectively from a given over-determined noisy mix.
Due to the fact that ICA utilizes higher order statistics such as mutual independence, kurtosis, negentropy etc., it has the capacity to extract sources with overlapping spectral contents as well.

This blind source separation (BSS) technique that I propose, can be applicable to a wide array of applications including but not limited to acoustics, communication, context aware networks, computer vision, defense and security systems and bio-medicine.

I have analyzed a brute force approach for source separation through the identification of local maxima points for the mixtures that comprise super Gaussian source signals. Due to its limitations in higher dimensions, a gradient based adaptive approach was proposed. The adaptation process attempts to converge to a local maximum (in the super Gaussian case) through a gradient ascent approach.

In my project I conducted a detailed analysis of the kurtosis based gradient ascent ICA algorithm in the weight vector normalized subspace and the adaptation path and the variation of the direction of the kurtosis gradient is depicted. This enabled us to understand the behavior of the kurtosis surface gradient in the reduced space and realize its limitations as a convergence criterion. Thus it was proposed to utilize kurtosis difference as the convergence criteria for the adaptation process. The proposed method was extended for sub Gaussian and super-sub Gaussian mixtures as well.