Group 5-2

# ICALAB for Signal Processing

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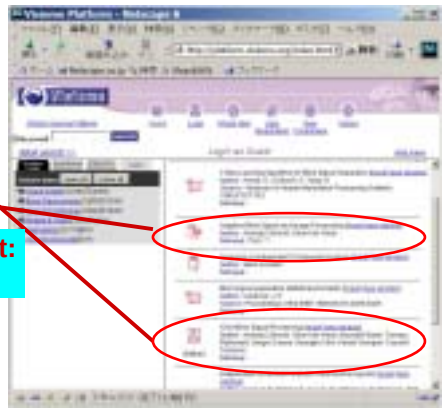
Reference: Adaptive blind signal and image processing, A Cichocki, S Amari. John Wiley & Sons, Ltd, Chichester, 2002.



**Submitted content: tools for analysis**

## *ICALAB Toolboxes – A software for analysis with GUI*

**ICALAB for Signal Processing** is a demo package for MATLAB that implements a number of efficient algorithms for **ICA** (*independent component analysis*) employing **HOS** (*higher order statistics*), **BSS** (*blind source separation*) employing **SOS** (*second order statistics*) and **LP** (*linear prediction*), and **BSE** (*blind signal extraction*) employing various **SOS** and **HOS** methods.

The main features of the package are an **easy-to-use graphical user interface**, **and implementation of computationally powerful and efficient algorithms**.

### The general concept of ICALAB

The important and unique features of our ICALAB toolboxes are **preprocessing** and **postprocessing** tools.

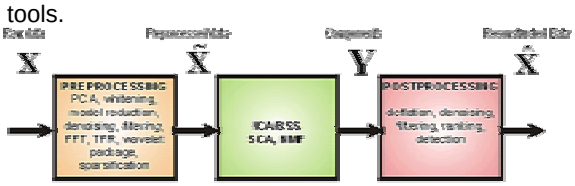



Fig. 1. Conceptual model of ICALAB Toolbox.

Actual optional **PREPROCESSING** tools include: Principal Component Analysis (**PCA**), prewhitening, filtering: High Pass Filtering (**HPF**), Low Pass Filtering (**LPF**), Subband filters (Butterworth, Chebyshev, Elliptic) with adjustable order of filters, frequency subbands and the number of subbands.

**POSTPROCESSING** tools actually includes: Deflation and Reconstruction ("cleaning") of original raw data by removing undesirable components, noise or artifacts.

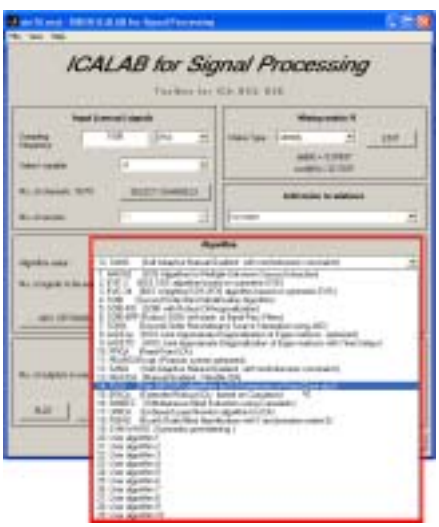



Fig.2. The main window of ICALAB. This figure illustrates how to select an algorithm from the list of available algorithms for ICA, BSS, BSE. Users can add their own algorithms or algorithms available on the internet using available user_algk.m files.

## *A preprocessing - subband decomposition*

In the Multiresolution Subband Decomposition Independent Component Analysis(MSD-ICA), we assume that only certain set of sub-components are independent.

Basic concept here is to divide the signal spectrum into its subspectra or subbands, and then to treat those subspectra individually for the purpose at hand. The subband signals can be ranked and processed independently by ICA/BSS algorithm. Provided that for some of the frequency subbands (at least one) are mutually independent or temporally decorrelated, we can easily estimate the separating system.

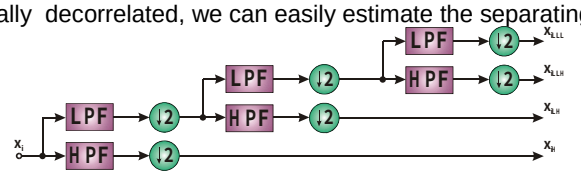



Fig. 3. Multiresolution Subbband Decomposition of observed signals

In practice, the high-frequency sub-components are often found to be mutually independent. We have implemented these concepts in our ICALAB software and extensively tested these concepts for some experimental data.

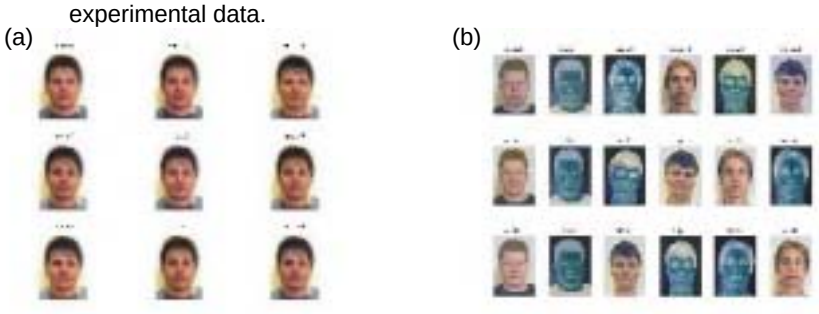



Fig. 4. Blind separation of heavily correlated and statistically dependent images: (a) Mixture of 9 human faces, (b) Reconstruction of original faces using MSD-ICA.

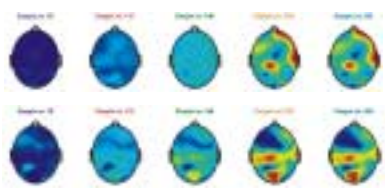


Fig. 5. Result showing of EEG patterns for 32-channel recordings (P300 response). The upper row: The original recording had a significant distortion from the facial muscle. The lower row: After separation the auditory response and visual activation were visible.