ICA APPROACH TO IMAGE NOISE REMOVAL

Abstract: Independent component analysis (ICA) is a method allowing finding of underlying components from multivariate statistical data. It is a recently developed technique that in many cases characterizes the data in a natural way. ICA, factor analysis (FA), principal component analysis (PCA), Kalman filter models, vector quantization (VQ), hidden Markov models, mixtures of Gaussian clusters can all be unified as variations of unsupervised learning under a single basic generative model with different nonlinearities. PCA is a widely used technique in data analysis. A PCA neural network is a one-layer feedforward neural network, which is able to extract the principal components of the stream of input vectors. The learning rules are Hebbian type.

A recent trend in neural networks research is to study various forms of unsupervised learning beyond standard PCA. Several neural approaches have been proposed for ICA, respective source separation problems, image segmentation and noise removal. Generally they require higher than second-order statistics, which specifically means information is not contained in the covariance matrix and therefore it is not provided by the PCA. Such higher order statistics can be incorporated into the computations either explicitly or by using suitable nonlinearities.

ICA (Independent Component Analysis), ISA (Independent Subspace Analysis) and TICA (Topographic Independent Component Analysis) are computational and statistical techniques for revealing hidden factors that underlie sets of random variables, measurements, or signals. Applications of these algorithms can be found in many different areas.

The goal of this research is to eliminate the noise from color images of different formats by using ICA, ISA or TICA. We compare and analyze the features of these three algorithms by using different sets of parameters.

We use different natural scenes and convert them to grayscale values between 0 and 255. A training set is generated by taking samples from the images. The mean and different whitening filters are implemented in order to sphere the training set. By prewhitening the original image in this way we can ensure that the subsequent transformation to be learnt should approximate an orthonormal matrix rotation without scaling.

We use preprocessing techniques in order to facilitate the operation of ICA algorithms and to enhance the features we are interested in. It should also be noted that working with different preprocessing methods might give valuable information about the algorithms.

Preprocessing stages can be divided into two different categories:

- **General preprocessing for ICA.** ICA algorithms require certain properties from the data to function correctly. Usually they require that the data be zero mean and whitened.
- **Image data preprocessing.** This phase is application dependent and is directed towards bringing out the properties of image data we are interested in and removing peculiarities of natural image data that might interfere with ICA algorithms.

**Keywords:** independent component analysis, image processing, noise removal