

7.3 Reducing Noise in Natural Images

The third example deals with finding ICA filters for natural images and, based on the ICA decomposition, removing noise from images corrupted with additive Gaussian noise.

A set of digitized natural images were used. Denote the vector of pixel gray levels in an image window by \mathbf{x} . Note that, contrary to the other two applications in the previous sections, we are not this time considering multivalued time series or images changing with time; instead the elements of \mathbf{x} are indexed by the location in the image window or patch. The sample windows were taken at random locations. The 2-D structure of the windows is of no significance here: row by row scanning was used to turn a square image window into a vector of pixel values. The independent components of such image windows are represented in Fig. 4. Each window in this Figure corresponds to one of the columns \mathbf{a}_i of the mixing matrix \mathbf{A} . Thus an observed image window is a superposition of these windows as in (5), with independent coefficients (Bell and Sejnowski, 1997; Olshausen and Field, 1996).

Now, suppose a noisy image model holds:

$$\mathbf{z} = \mathbf{x} + \mathbf{n} \tag{49}$$