Image Denoising with Estimation Theory

Laboratory 6, DEDP

Objective

Implement and use a non-trivial use of estimation theory for image processing: given a noisy image, estimate the original with Total Variation ℓ_1 minimization.

Theoretical aspects

Consider an image that has been affected by noise. We only have the noisy image I_z.

Our job: estimate the true original image I^* from the noisy version. How? We know *a priori* that the true image is rather *smooth* (like all images, really).

The denoising problem can be formulated as follows:

$$\hat{I} = \arg\min_I \|I_z - I\| + \lambda \cdot TV(I)$$

Here, $TV(I)$ is "the Total Variation" of I and is defined as:

$$TV(I) = \sum_{i,j} |x[i+1,j] - x[i,j]| + |x[i,j+1] - x[i,j]|$$

Exercises

1. Load the noisy image 'noisy.jpg'. Convert to `double`, bring values to range $[0, 1]$, and convert to grayscale. Display the image.
2. Download and install the `cvx` Matlab package from http://cvxr.com/cvx/
3. Make a script which calls the `cvx` package as follows:

```
...
lambda = 0.1;
[height width] = size(Iz);
cvx_begin
    variable I(height,width)
    minimize( norm( I_z - I, 2 ) + lambda * TV(I) )
    % Replace TV(I) with its actual definition!
cvx_end
...
```

Plot the resulting image I. Repeat for various values of λ and compare.

Final questions

1. TBD