# Denoising with Non-Local Means

## The Non-Local Means Algorithm

Non-local means is an image denoising algorithm based on a simple principal – taking the average of similar pixels to that being denoised, this method is a relatively recent development in Image Processing algorithms and techniques, especially in comparison to more traditional local image denoising using kernels (taking weighted averages of directly neighbouring pixels).

On a continuous image, the non-local means algorithm filter is defined as

where is the Euclidian distance between the image patches and centred at points and respectively, is a decreasing function and is the normalizing factor (to prevent a change in brightness).

Sample space, patch and neighbourhood

## Implementations of Non-Local Means

Non-local means has two main implementations which yield slightly different denoising characteristics: pixel-wise and patch-wise.

### Pixelwise N-L Means

The pixelwise implementation runs on each pixel of the image. Given image at pixel location , the discrete algorithm is

such that

where and is the weight applied between pixel and each pixel that is an element of the neighbourhood being scanned.

### Patchwise N-L Means

The patchwise implementation of non-local means differs in that instead of just looking at a single pixel, the area (patch) around the pixel is taken also into account, this effectively applies a standard kernel filter to each patch fir further reduction in noise.

## Algorithm Parameters

Size of sample space (or window of similarity)

H-value

Neighbourhood size

## Strengths and Limitations

Introduces its own noise, but has net removal, does not affect frequency space

Many images contain

## Modifications of the Main Algorithm

## Applications of Non-Local Means

# References

Buades, Antoni, Bartomeu Coll, and Bartomeu Morel. 2011. “Non-Local Means Denoising.” *Image Processing On Line.*