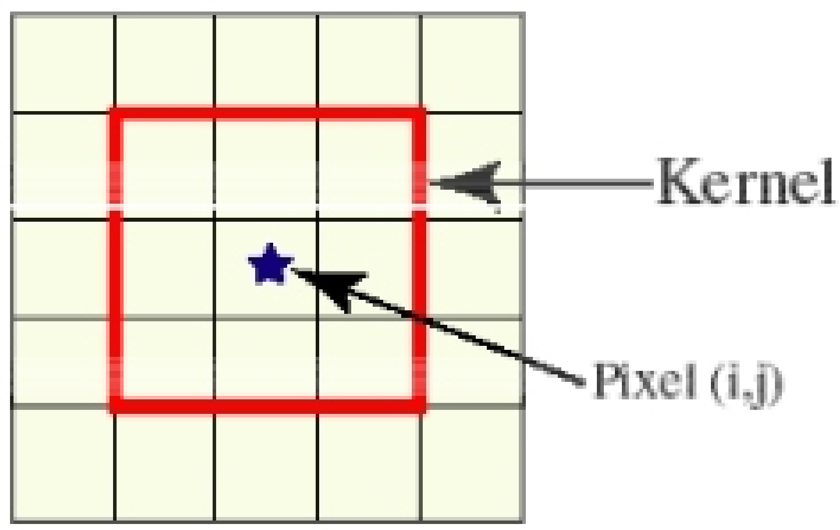
Geometric Enhancement Using Image Domain Techniques

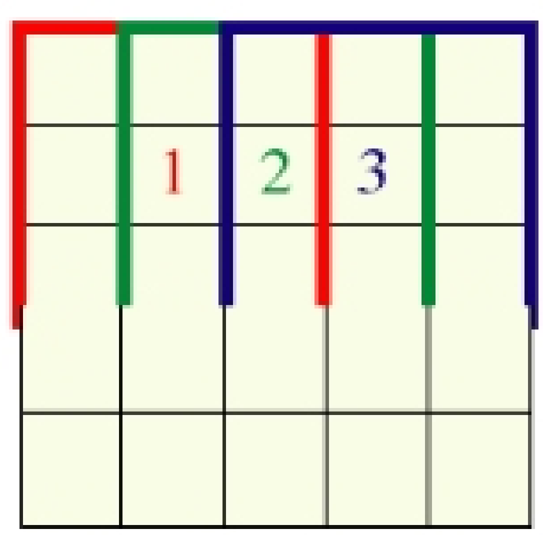
Introduction

This lecture deals with enhancing the geometric information in remotely sensed images. These geometric enhancements are most commonly aimed at (1) smoothing, (2) edge detection, (3) line detection and (4) sharpening. All the techniques presented here operate in the image domain. A *template, convolution filter or mask* or *kernel* is moved over the original image and an output image is produced that is some function of the values in the orginal image falling within the kernel.

Here is an example of a 3 x 3 filter



A kernel is moved over the entire image as is shown below. You should realize that the output image will be smaller than the original image by the two times number of pixels between the edge of the kernel the center pixel in both x and y directions. Usually, rows and columns of null cell values are added to the edges to make the output image the same size as the input.



Kernels can be any size in the x and y directions and various shapes. The output value is simply some convolution of the input values and for an M by N kernel can be described mathematically as follows:

$$\text{output}(i, j) = \sum_{m=1}^{M} \sum_{n=1}^{N} \text{input}(m, n) \times \text{template}(m, n)$$

In the equation above the template simply refers to the weight of each pixel in the template. An example of such weights for a low pass filters might be as follows.

1	1	1
1	1	1
1	1	1

Smoothing Operations (Low Pass Filters)

Images will contain random noise that is superimposed on the DN values in an image. In some instances it might be quite useful to damp out this random component and this is done using low pass filters. You should be aware that using low pass filters carries a penalty - some frequency information will be lost.

Mean Filter

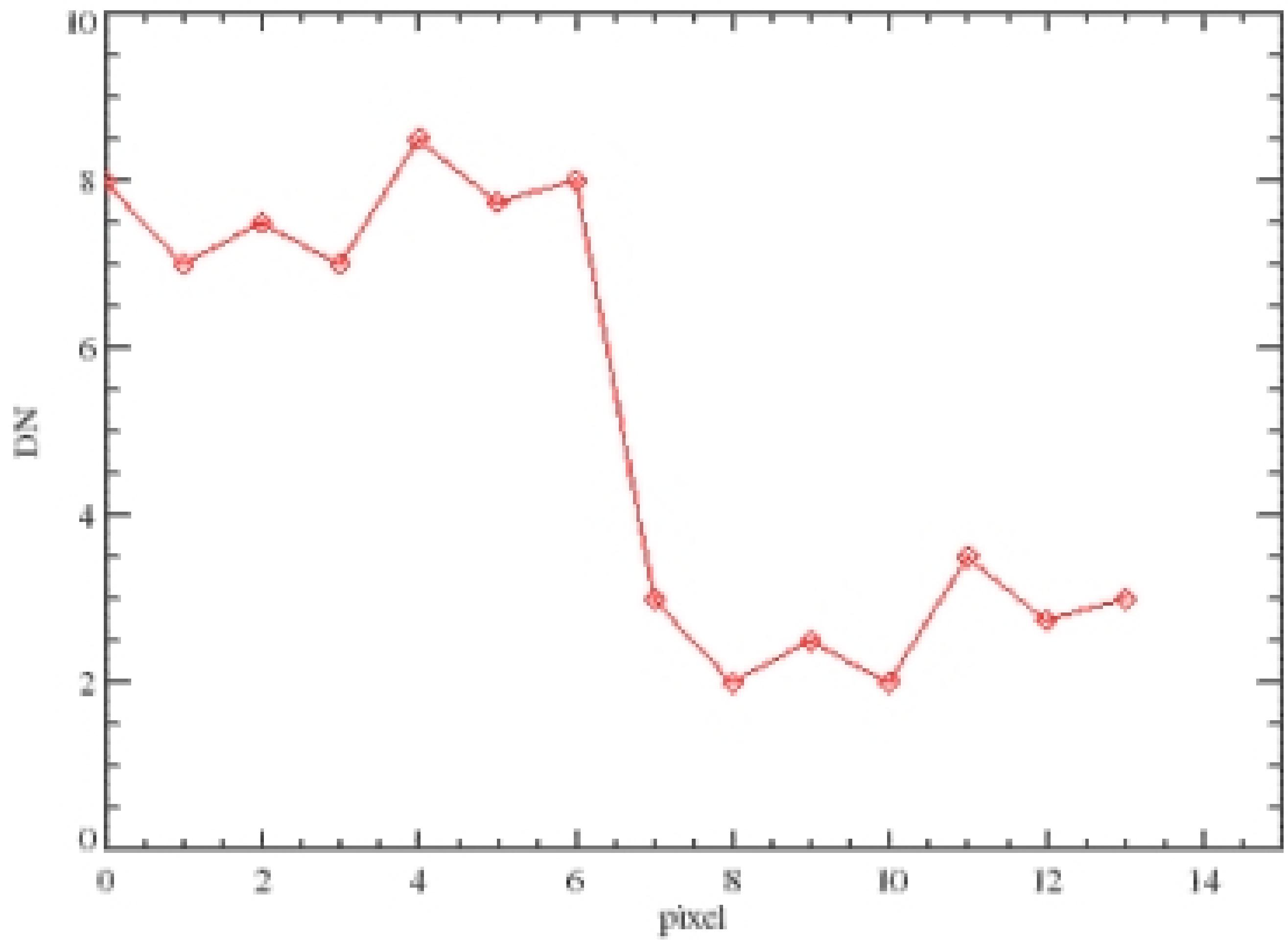
The most common low pass filter is the average filter and is mathematically:

$$\text{template}(m,n) = \frac{1}{M * N}$$

Which for our 3 x 3 template would simply be

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

Now let us look at a 1-D case to show the effect of the mean filter. Here is the original function (adapted from Richards and Jia, 1999).



Here is the function after smoothing with a 3 x 1 window (dashed blue line). The filter has two effects. The first is our intended smoothing of the high frequency variation, but the second is an unintentional degradation of the edge between the groups of DN values.