Remote Sensing

Image enhancement
Filters

Spatial enhancement: filters

- Digital filters operate by changing values according to the character of neighboring values

- Visual enhancement

- Noise removal

- High-pass filters – enhance information of high frequencies (local extrems, lines and eges)

- Low-pass filters – smoothing of image (post-classification correction)

Filters principle

- Filter window moves along the image. Filter window is squared matrix, which has uneven number of rows and columns (3x3, 5x5..61x61..)
- Every field of filter window contains a weight, which is than used on the DN values of the original image
- Resulting value of the whole filter window is then assigned to the central pixel of the window
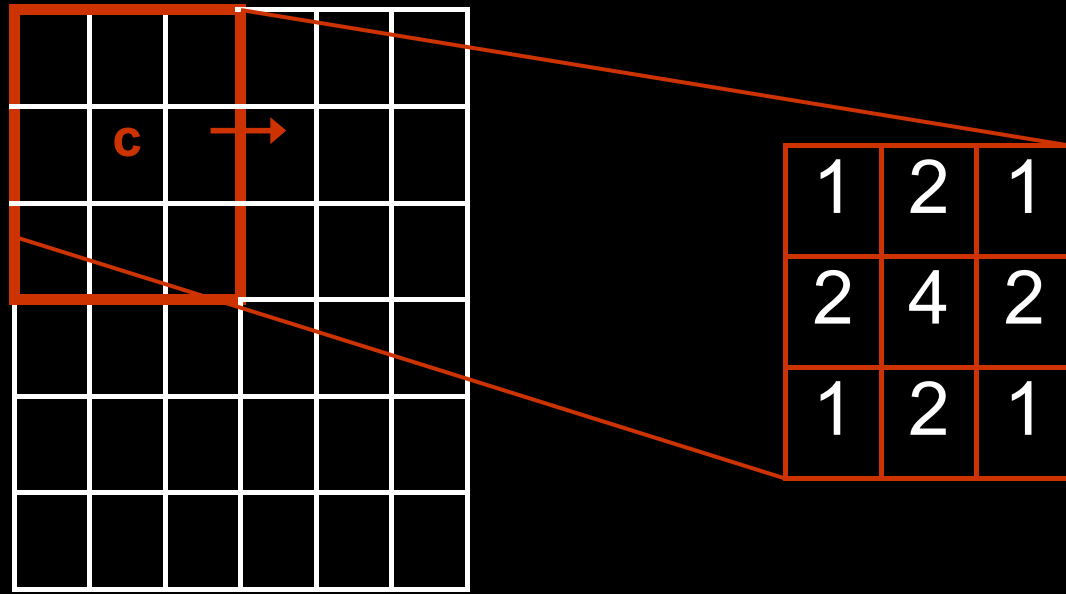
Low-pass filters

- Rate of smoothing depends on the size of filter window
- Denoising, post-class correccion

- Mean filter – the same weight within all filter window fields. Resulting value for the central pixel is sum of DN values of the original image divided by number of fields of the filter window

1	1	1
1	1	1
1	1	1

- Median filter – median can be found by arranging all the DN from lowest value to highest value and picking the middle one as the walue of the central pixel

- **Filter with weighted distance** – importance of surroundings pixels is reduced by the distance from the central pixel

1	2	1
2	4	2
1	2	1

- **Gaussian filter** – uses coefficients of normal distribution

- **Filter with weighted central pixel**
  - the window with high value of central pixel produce less smoothed results
  - the window with low value of central pixel is used for denoising

1	1	1
1	5	1
1	1	1

8	8	8
8	1	8
8	8	8

- **Sieve filter** – the image is sieved on basis of defined threshold

- **Mode filter** – central pixel obtains value which is the most appeared value of the window, it is used for post-classification

3	3	7
3	7	7
7	7	7

=> 7

High-pass filters

- Enhance differences between values of neighboring pixels, these changes in values are represented by edges and lines

- Edge – border between two types of surface (forest – field), it has no width

- Lines – rivers, streams, roads

- High-pass filters enhance such objects which are smaller than a half of filter window. Wider objects are suppressed.
- These filters are used for sharpening of images, edge and line detection, to increase the difference between pixels
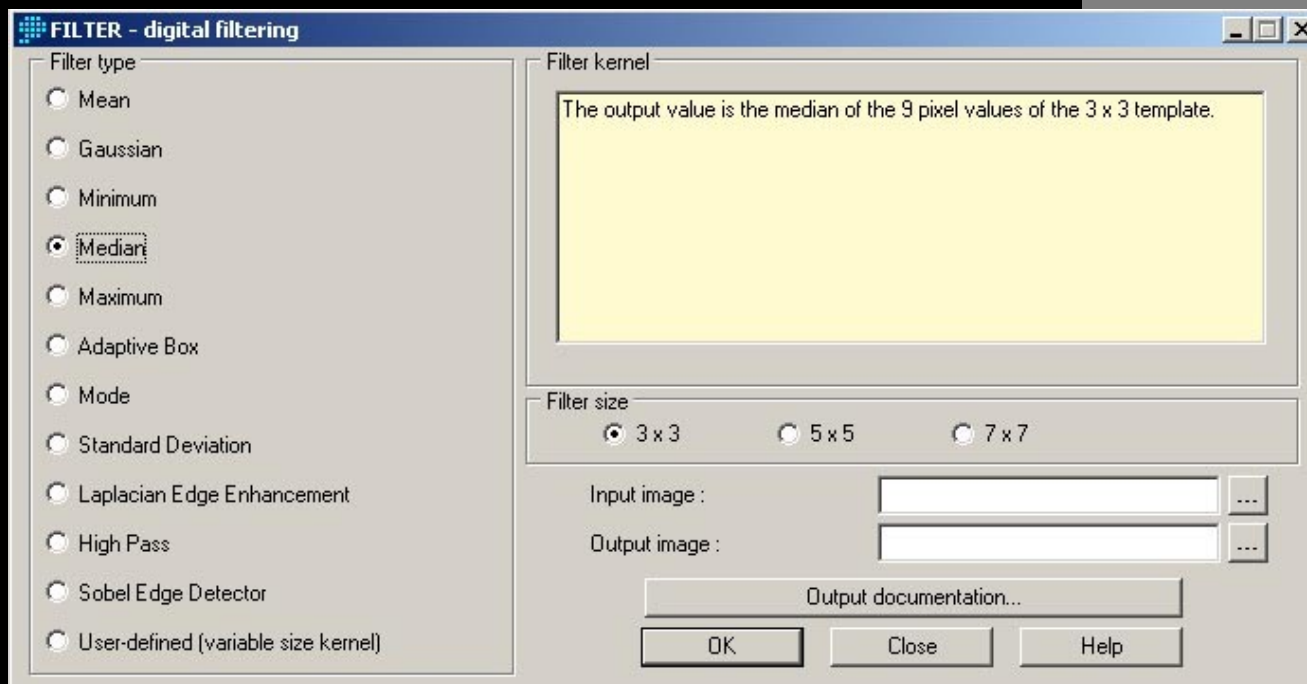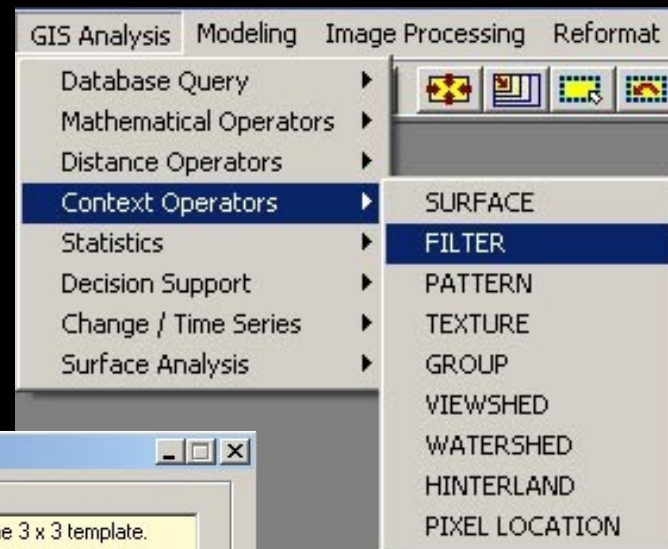
- **Laplacian edge enhancement** – weights within the filter window are distributed in such way: sum of the central pixel and all other pixels is equal to zero

-1	-1	-1
-1	8	-1
-1	-1	-1

- **Sobel edge detector** – enhance edges of horizontal or vertical direction

- **Difference filtration:**
  1. the image is filtered by mean filter, so the high frequencies are suppressed
  2. This filtered image is then subtracted from original image
  3. The result of step 2 is added to original image

  Result: edges will be enhanced in context to the surroundings

Idrisi Taiga: module FILTER

GIS Analysis | Modeling | Image Processing | Reformat

- Database Query ▶
- Mathematical Operators ▶
- Distance Operators ▶
- **Context Operators** ▶
  - SURFACE
  - **FILTER**
  - PATTERN
  - TEXTURE
  - GROUP
  - VIEWSHED
  - WATERSHED
  - HINTERLAND
  - PIXEL LOCATION
- Statistics ▶
- Decision Support ▶
- Change / Time Series ▶
- Surface Analysis ▶

FILTER – digital filtering

Filter type
- ○ Mean
- ○ Gaussian
- ○ Minimum
- ● Median
- ○ Maximum
- ○ Adaptive Box
- ○ Mode
- ○ Standard Deviation
- ○ Laplacian Edge Enhancement
- ○ High Pass
- ○ Sobel Edge Detector
- ○ User-defined (variable size kernel)

Filter kernel

The output value is the median of the 9 pixel values of the 3 x 3 template.

Filter size
- ● 3 x 3
- ○ 5 x 5
- ○ 7 x 7

Input image :

Output image :

Output documentation...

OK | Close | Help
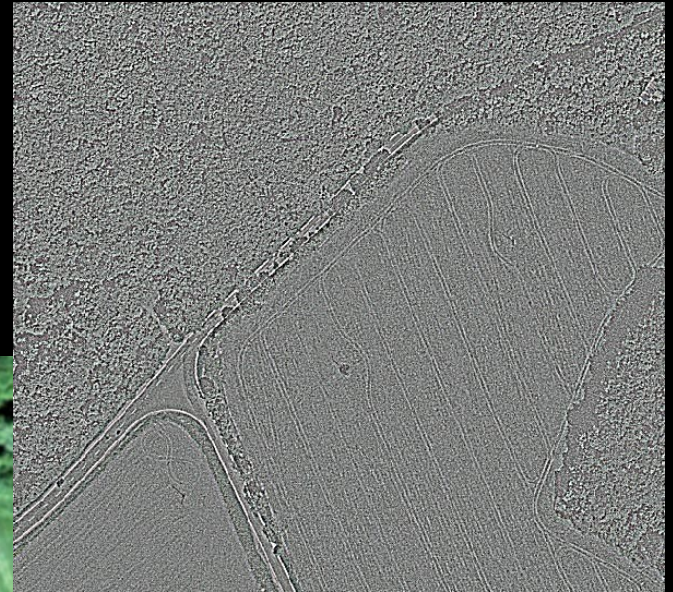
Some filtered images

High-pass filter (laplacian)

Original
image

Low-pass filter
(gaussian)

Texture

- Image texture is defined as a function of the spatial variation in pixel intensities (gray values). For example, the image of a wooden surface is not uniform but contains variations of intensities which form certain repeated patterns called visual texture.

- This filters are based on statistical calculation of homogeneity or variability of the filter window values

- Edge analysis – texture segmentation

Idrisi Andes: modul TEXTURE
(menu Image Processing / Transformation)
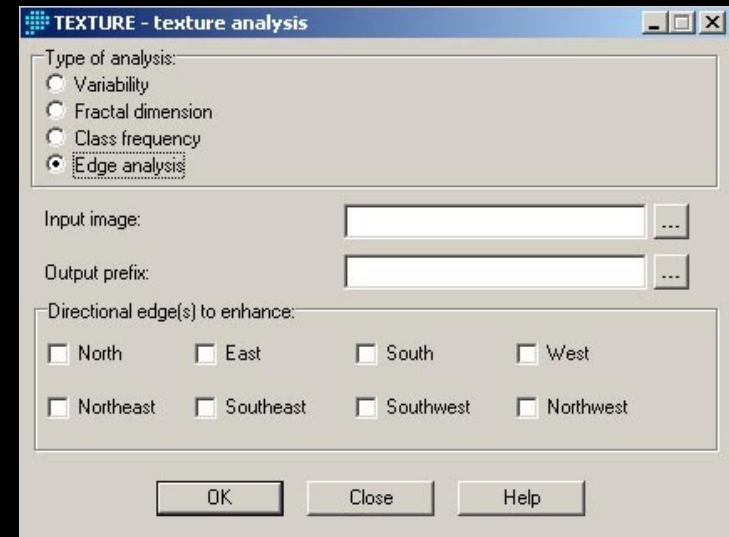
References

- Campbell, J.B. 1996: Introdution to Remote Sensing, Taylor and Francis, London
- Eastman, J.R. 2009: Idrisi TAIGA Guide to GIS and Image Processing, Clark Labs, Worcester, MA