Information Statistics II
Part II – Image filtering
Lecture 8. Image filtering, nonlinear image processing filters

Image filtering

Image filtering is a projection of an image to another image. Each pixel is transformed to a pixel at the corresponding position in the resultant image by a neighborhood operation with the pixel and pixels in its neighborhood. It is assumed that the same algorithm is applied to transformation of every pixel (translantion-invariant).

NB. Filterings in frequency domain can be interpreted into the above translation-invariant pixelwise operations via the inverse Fourier transformation.

Nonlinear filtering

Linear filter has been naturally applied to image processing by an analogy of linear filters for time-series signals implemented by electronical circuits. However, the image filtering is usually performed by digital computers, so that not only circuit-implemented linear operations but also nonlinear operations can be applied with equal complexity.

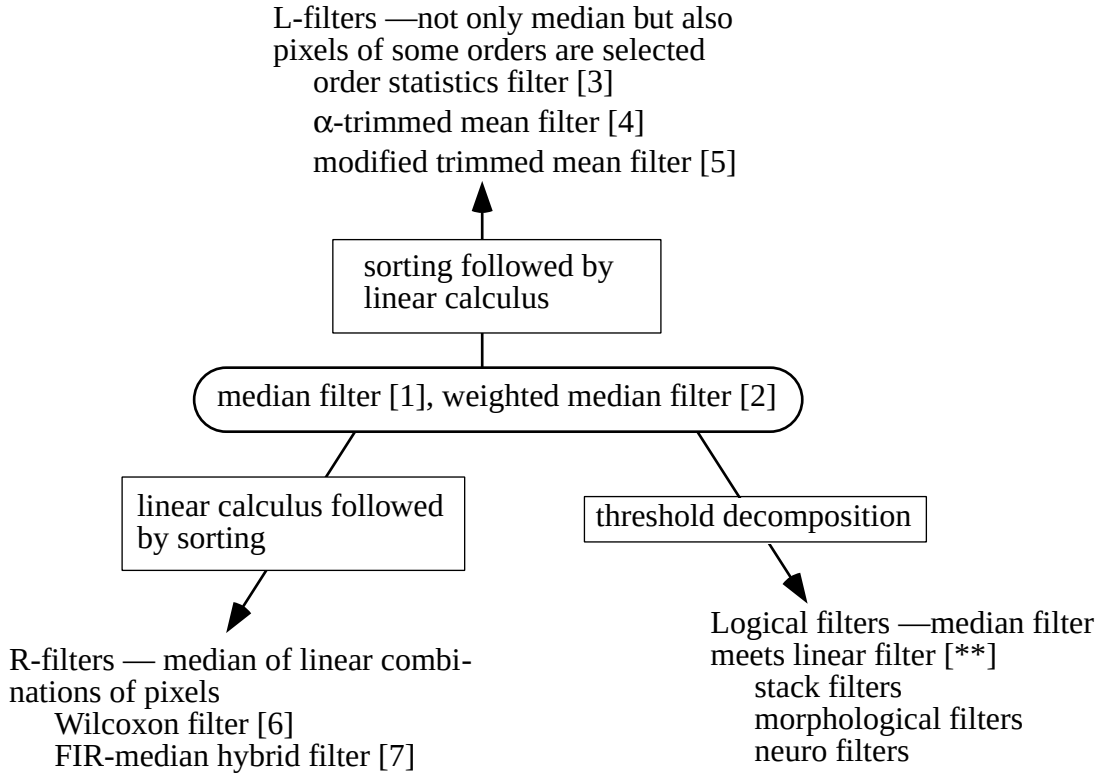
Categorization of nonlinear filters

Since all filters except linear filters are nonlinear ones, varios kinds of nonlinear filters have been proposed. They are briefly categorized as follows [*]:

1. Filters with higher-order calculus
   Volterra filter
2. Linear filters on nonlinearly transformed domain
   Linear filter with logarithmic domain
3. Adaptive linear filter whose coefficients are dynamically modified by local statistics
   "Edge preserving smoothing"
4. Transformation with partially linear functions
   ε–filter
5. Operations based on order statistics in the neighborhood

Categories 1–4 are extension of linear filters: category 5 is different, and its optimization is difficult.

Rank-order filter family



Refereces

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[7] P. Heinonen and Y. Neuvo, "FIR-Median Hybrid Filters," *IEEE Trans. Acoust., Speech, Signal Processing,* **ASSP-35,** 6, 832-838 (1987).

[*] 原島博，荒川薫，藤井竜也，”非線形ディジタルフィルタと信号処理，”*信学論A*，**J71-A,** 2, 143-154 (1988).

[*] 荒川薫，”非線形ディジタルフィルタとその応用，”*信学誌*，**77,** 8, 844-852 (1994).

[**] To be outlined in this lecture.