Multi-scale k-means clustering of multispectral images

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Unsupervised image segmentation, image pyramid, large multispectral image

Recent equipments allow the acquisition of high resolution multispectral fluorescence images in a simple, quick and efficient way. Multiple images can be merged to form large mosaics, which can easily include millions of pixels. Analyzing together sets of multispectral mosaic images, i.e. to compare samples and take into account statistical variability, is not manageable with usual methods due to the large volume of data. We propose to combine a multi-scale representation of images using image pyramids [1] with clustering methods for multispectral image segmentation.

Mean pyramids and k-means clustering were combined as follows:
1) Compute the mean pyramid image at the lowest resolution level r
2) K-means clustering of the resulting image
3) Select n representative pixels in each cluster
4) Expand the selected pixels in the pyramid image level r-1
5) Repeat from 2 to 4 with the expanded pixels until initial resolution is recovered

The method is demonstrated on a fluorescence multispectral image of maize stem cross-section (5209x4338 pixels x12 fluorescence values). The sixth level of the pyramid was selected as starting level. The k-means was applied using the Euclidian distance and 2000 pixels maximum per groups were randomly selected at each step (Figure 2).

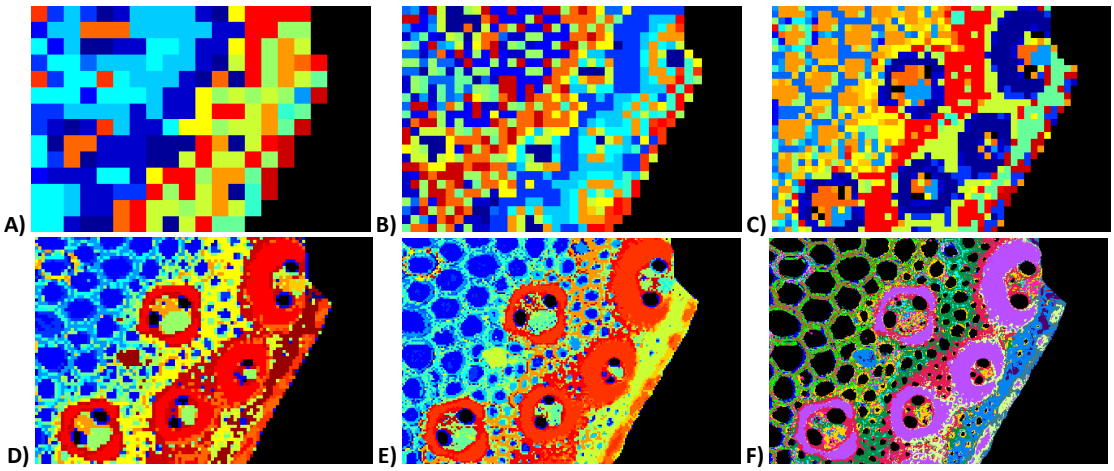

Figure 1: Segmented multipsectral image. Pyramid levels : A: 1/32; B: 1/16; C: 1/8; D: 1/4; E: 1/2; F: initial resolution. Filed of view: 1.1 x 0.8 mm² = 430 x 280 pixels at initial resolution

The multispectral segmentation method proposed, based on pyramid representation of multispectral images and k-means clustering, tackles with the problem of large volume of data. At each step, groups are downsized by deleting the most redundant data. The method is un-supervised and can be applied to the analysis of collections of images.

References:

[1] E.H. Adelson, C. H. Anderson, J. R. Bergen, P. J. Burt, J. M. Ogden. *Pyramid methods in image processing.* RCA engineer, 29(6), 33-41 (1984).