REGION-BASED THRESHOLDING USING COMPONENT TREE

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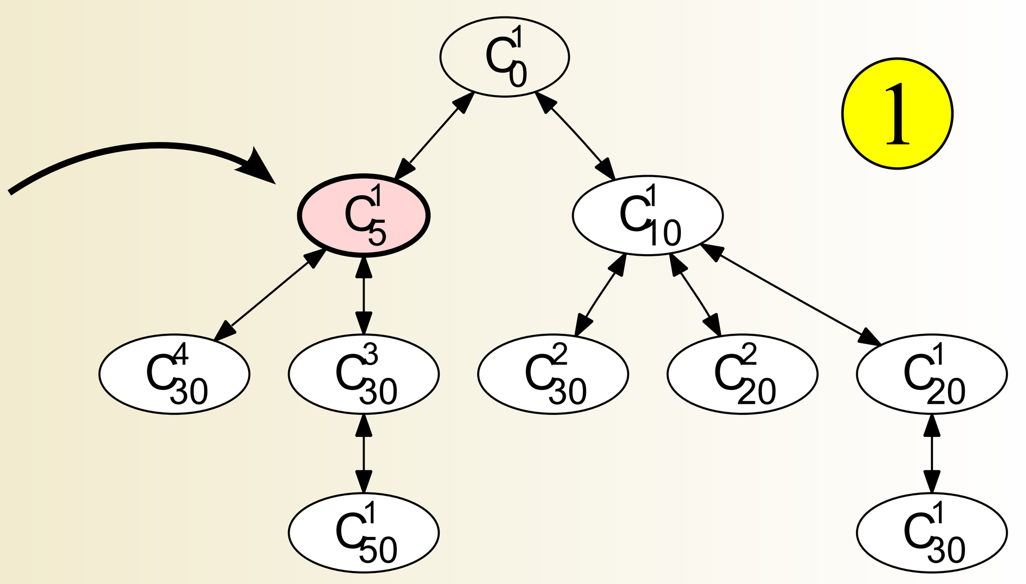
Abstract

A gray-level image can be represented by a component tree, based on the inclusion relation of connected regions obtained by threshold decomposition. The great advantage of this structure is the efficient determination of a set of attributes for each component of the image, being widely used in morphological filtering (for instance, *area* as attribute to the *area opening*). This paper describes the computation of new statistical attributes determined incrementally from this tree construction in quasi-linear time, defining variations of anti-extensive operators as region-based contrast restriction and region-based adaptive thresholding.

Statistical component tree

20	10	10	0	50	50
10	20	30	0	5	30
30	0	0	30	30	5



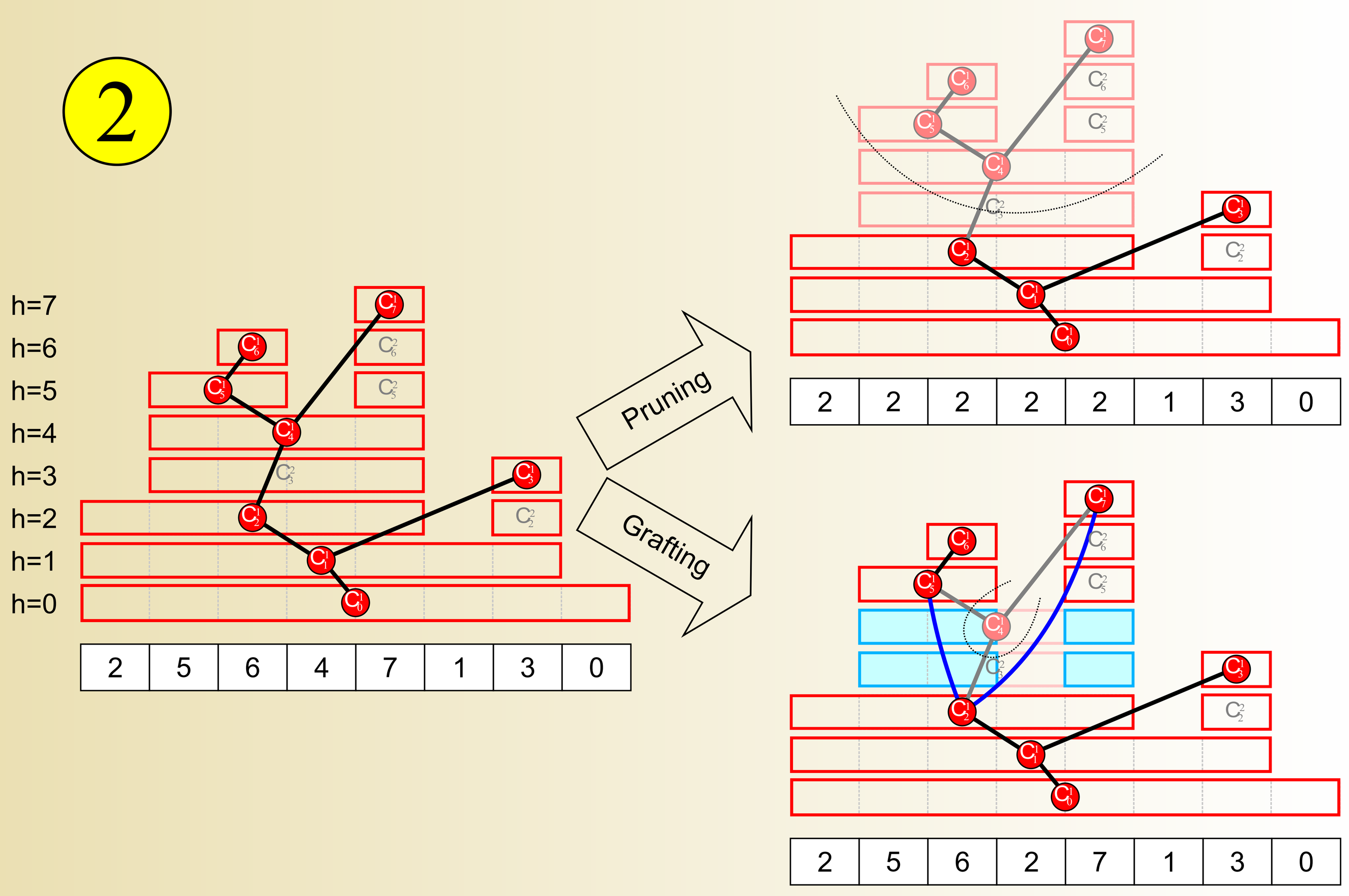
Area refers to the number of pixels belonging to the component.

Mean intensity is the sum of the original image levels for the pixels belonging to the component divided by its area.

Standard deviation to measure the dispersion of the mean value on the component.

Minimum and maximum intensity of the image on the component.

Connected operators



Pruning is the preservation of components not contained in C^R or removal of a sub-tree rooted in node N^R.

Grafting consists on the removal of any single component that is not a regional maximum, or preservation of all nodes, except N^X if it is not a leaf.

```
ATTRIBUTE_FILTER()
1    for each L_x of N ∈ CT
2        if L_x satisfies the condition:
3            CT.remove(N)    //pruning or grafting
```

Operators proposed

Component contrast restriction consists in the reduction of the local scale range by attribute tree filtering. In this case, the condition is the contrast lesser/greater than a predefined constant. Figure 3 ilustrates this restriction for some examples.

$$L_C = L_{max} - L_{min}$$

Component adaptive thresholding consists in the definition of a threshold based on the component statistical attributes. Versions of Niblack and Bernsen methods (Sezgin and Sankur, 2004) are defined for the level components instead of pixel neighborhood analysis. Figure 4 compares with Otsu threshold. Yarn segmentation has similar visual quality to the best result of specific literature (Fabijanska, 2010).

$$L_N = L_\mu + \alpha \cdot L_\sigma \quad (\alpha \in \mathbb{R} \text{ must be choice}) \quad \text{or} \quad L_B = \frac{L_{max} - L_{min}}{2}$$

Results

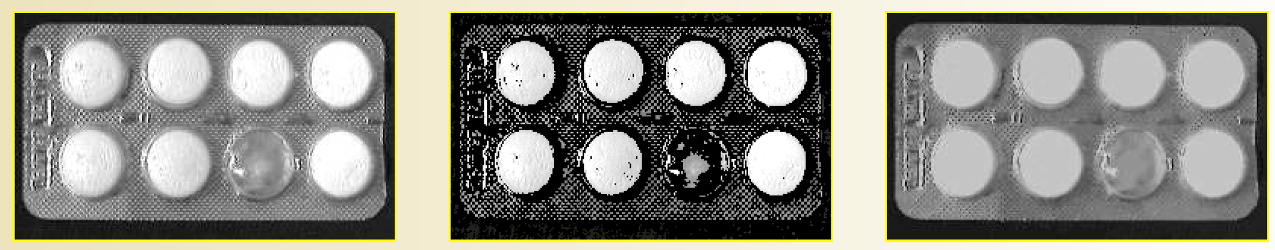
20	10	10	0	50	50
10	20	30	0	5	30
30	0	0	30	30	5

20	10	10	0	50	50
10	20	30	0	0	30
30	0	0	30	30	0

$L_C > 20$

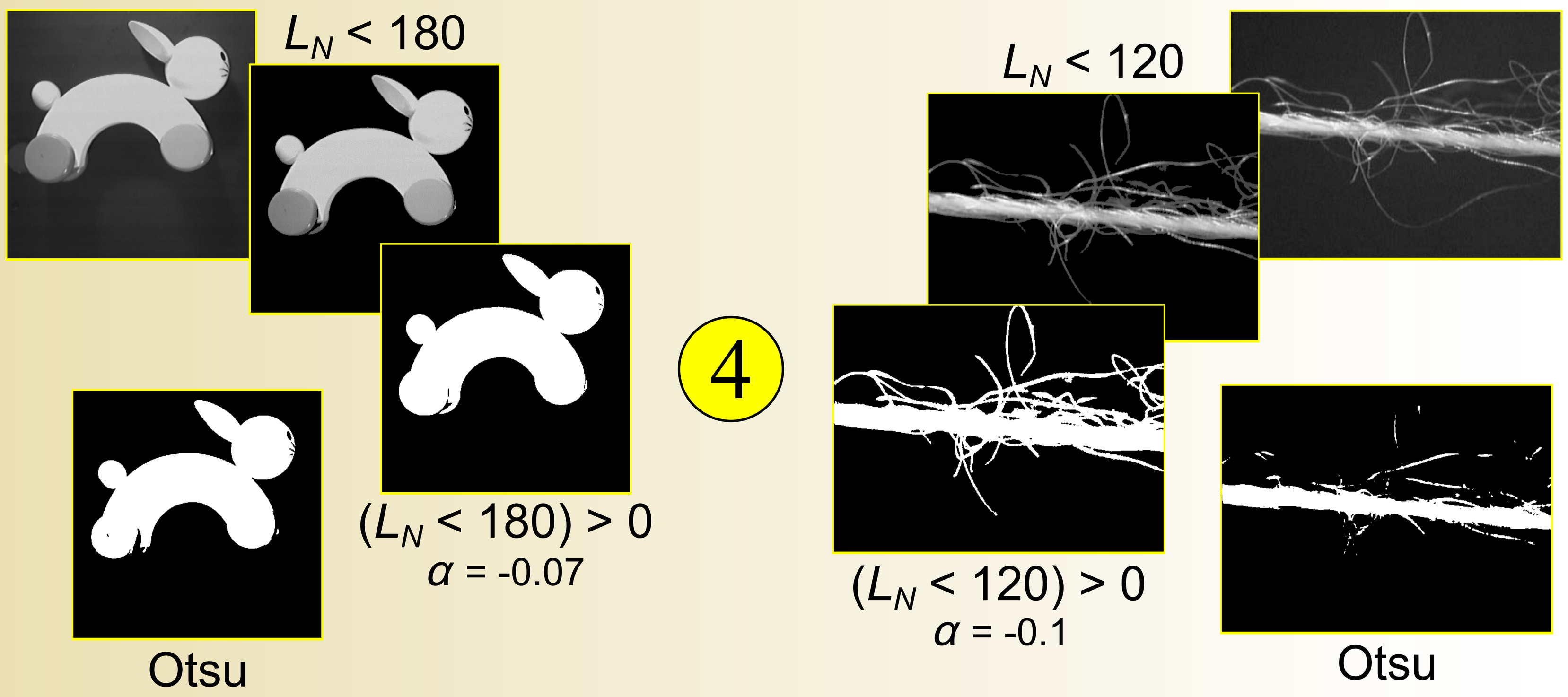
20	0	0	0	50	50
0	20	30	0	0	0
30	0	0	30	30	0

$L_C > 15$



$L_C > 50$ $L_C \leqslant 50$

3



Discussion

This work added statistical attributes to the component tree. Connected operators could be defined from the selection of these node attributes, efficiently determining region-based contrast and threshold on each level component of the image, which may be more effective (see, for instance, details of the segmentation in Figure 4) than point or even neighborhood pixel processing. Future work is expected to automate the choice of parameters. It would also be interesting to check the matching of images by the statistics of its components.

References

- L. Najman and M. Couprie, "Building the Component Tree in Quasi-Linear Time," *IEEE Transactions on Image Processing*, vol. 15, no. 11, pp. 3531–3539, 2006.
- M. Sezgin and B. Sankur, "Survey over image thresholding techniques and quantitative performance evaluation," *Journal of Electronic Imaging*, vol. 13, no. 1, pp. 146–168, 2004.
- A. Fabijanska, "A survey of thresholding algorithms on yarn images," in *VIth International Conference on Perspective Technologies and Methods in MEMS Design*, 2010, pp. 23–26.

ICIP 2011 BRUSSELS • IEEE INTERNATIONAL CONFERENCE ON IMAGE PROCESSING • September 11 - 14, 2011 • Belgium