Revisiting Component Tree Based Segmentation Using Meaningful Photometric Information

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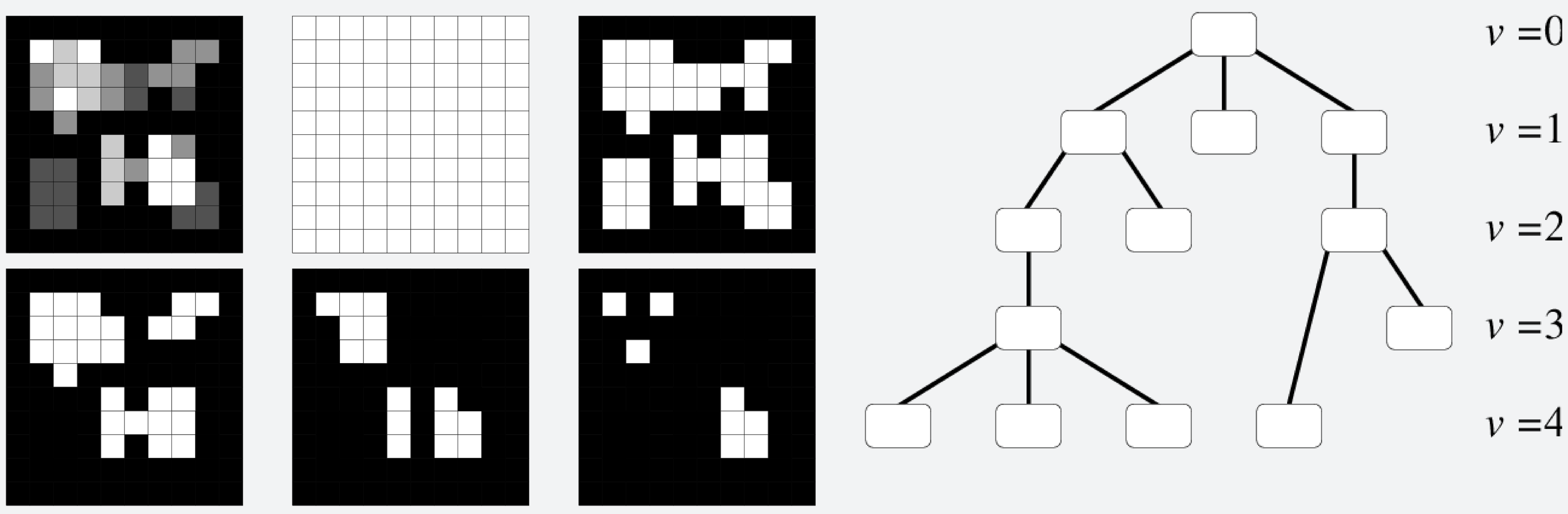
Context

Limitations of segmentation algorithm based on Component-Trees [2]**:**
- The algorithm works well only for objects that are lighter than its background.
- The algorithm is devoted to grey-scale images.
- Needs α parameter.

Our main ideas:
- Exploiting meaningful photometric information to deal with all possible local contrast configurations.
- Using information of colour image channels.
- Using the gradient and noise detection method to adjust α value automatically.

Component-Tree based Segmentation [2]

- Interactive segmentation algorithm (based on marker given by the user).
- Extract connected-components for each possible threshold value.
- Create a tree ordered structure (component-tree) containing all connected-components.
- Find a subset of nodes of Component-Tree that is relevant to given marker.
- α parameter sets relation between **false positives** and **false negatives** of marker and subset of nodes.



$\alpha = 0.1$ $\alpha = 0.3$ $\alpha = 0.5$ $\alpha = 0.7$

Including Meaningful Image Information in Component Tree

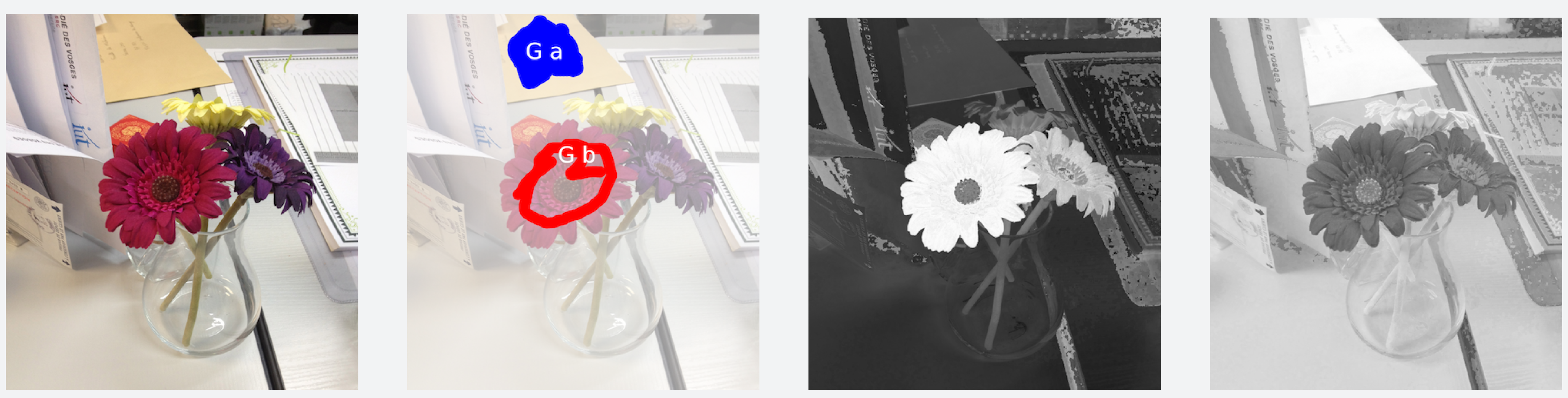
Let $c_I(X,Y) = \mu_I(X) - \mu_I(Y)$ with $X \cap Y = \emptyset$ where $\mu_I(X)$ is average lightness of region X. Let G be marked region and N_G its neighbourhood. If $c_I(G, N_G) < 0$, it means that the marked object is possibly darker than its neighbourhood so we perform negation.

Let $s_o(I)$ be the function: $s_o(I)(p) = V_{max} - |(I(p) - o)|$, where p is a point of an image, V is a set of all thresholding possible values and $o \in V$ is a reference colour defined by the marker G. (*i.e.* $o = \mu_I(G)$). After this transformation marked object is moved to leaves of Component Tree.

Let m be the ponderation function defined for each p by:

$$m(I)(p) = \frac{w_1 * I_1(p) + w_2 * I_2(p) + \ldots + w_n * I_k(p)}{w_1 + w_2 + \ldots + w_k},$$

where the $I_{i=0}^k$ represent the k colour channels of I and the $w_{i=0}^k$ are the weights associated to each channels. Let r_i be the function giving, for each channel I_i, a contrast measure between the marker and its neighbourhood: $r_i(G) = c_{I_i}(G, N_G)^2$. Let $w_i = r_i(G)$ in order to favour the channels in which the marker has a high local contrast.



Meaningful Scale [1]

- **Unsupervised** method for estimation an amount of noise based on digital segments.
- Noise is defined as meaningful scale for each pixel of a contour.

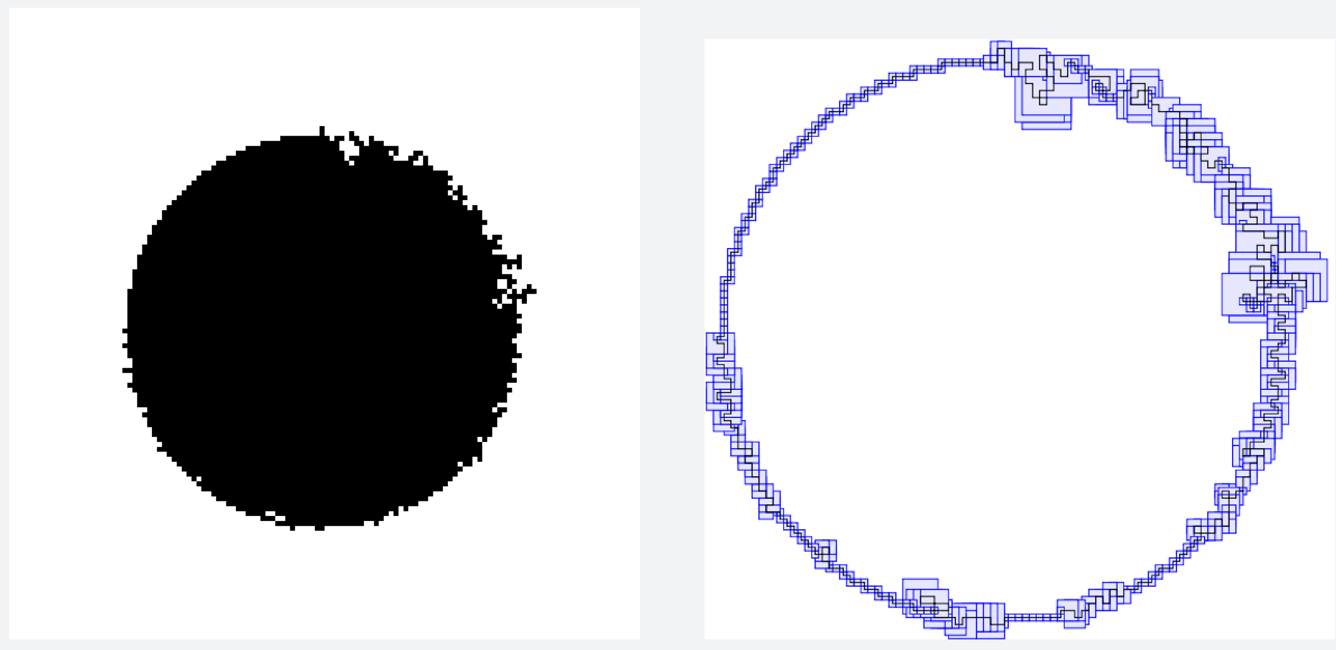


Image gradient intensity

Let W a segmentation result, and $O \subseteq W$ the set of contour pixels of W. Let $Y = \{O_1, O_2, \ldots, O_n\}$ the set of all connected contours of the result and D the longest contour of Y. Let $j(O_i)$ be weight function defined for a contour as follows:

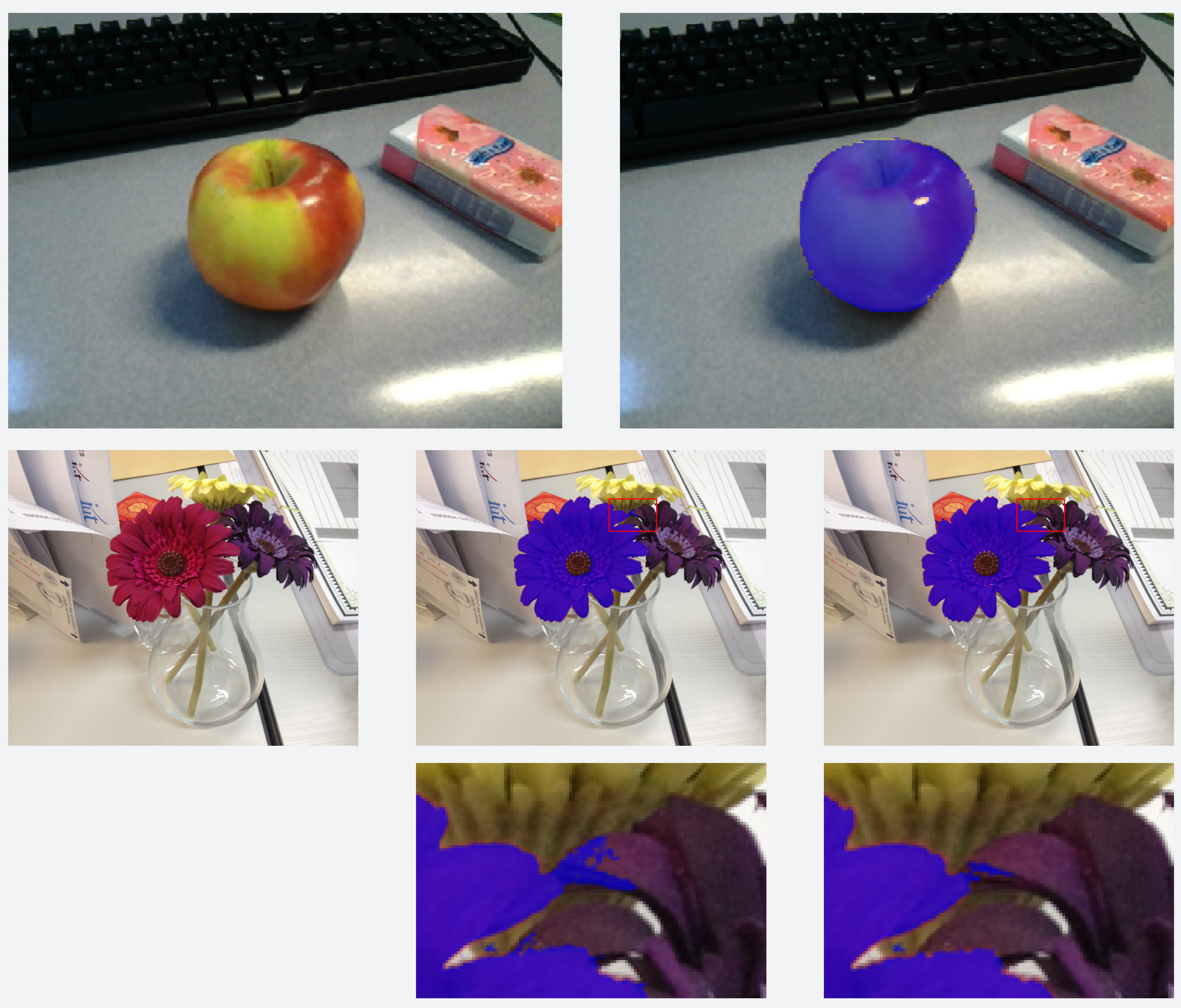
$$j(O_i) = \frac{|D|}{(|D| - |O_i| + 1) * N_{MP}(D)},$$

where $N_{MP}(D)$ is the number of meaningful pixels p of D (the number of pixels of D for which meaningful scale is 1). We propose as a criterion, to set α parameter automatically, a minimum of:

$$k = \frac{\sum_{O_i \in Y} |O_i|}{(\sum_{O_i \in Y} g_{max}(O_i) * j(O_i))}$$

where $g_{max}(O_i) = \sum_{p \in O_i} (\max\{g(p') | p \in O_i \ \wedge max(|x_p - x_{p'}|, |y_p - y_{p'}|) \leq 1\})$ and g is the image gradient.

Experiments and results



References

[1] B. Kerautret and J.-O. Lachaud. Meaningful scales detection along digital contours for unsupervised local noise estimation. *IEEE Transactions on PAMI*, 99(PrePrints), 2012.

[2] N. Passat and B. Naegel. Selection of relevant nodes from component-trees in linear time. DGCI'11, pages 453–464, Berlin, Heidelberg, 2011. Springer-Verlag.

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