Fast Graph Segmentation Based On Statistical Aggregation Phenomena

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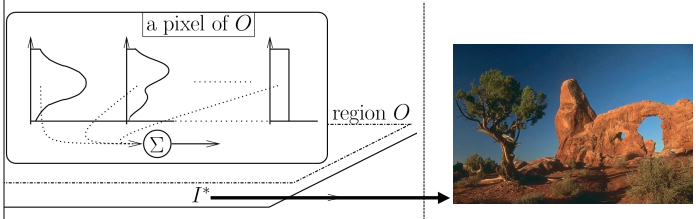
Principle :

Observed image sampled from a theoretical image



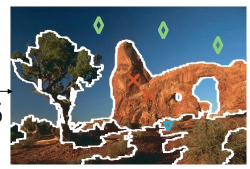
True regions
= connex sets of statistical pixels
*Sampled independently
*With identical **R** (resp. **G**, **B**) expectation
(**at least one** expectation is different between two **adjacent** true regions)

Objective :

Find the statistical regions of the theoretical image on the basis of the sole observed image…

…fully automatic
IEEE TPAMI 2004

…or semi-supervised
Elsevier Pattern Recognition 2005



Online

Applets at **http://www.sonycsl.co.jp/person/nielsen/SRM/**
http://www.sonycsl.co.jp/person/nielsen/SRMb/
(you can test on your own images)

Starting material (unsupervised grouping) :

IEEE TPAMI 2004 Statistical Region Merging

Algorithm 1: `SRM(`I`)`

Input: an image I

S'_I=`sort_increasing_values` (couples of adjacent pixels of I, function $f : \{\text{pixels}\}^2 \to I\!R$):

for $i = 0$ ***to*** $|S'_I| - 1$ **do**

  /*(p_i, p'_i) is the i^{th} couple of S'_I*/

  if

$$\texttt{region}(p_i) \neq \texttt{region}(p'_i)$$
$$\mathcal{P}(\texttt{region}(p_i), \texttt{region}(p'_i)) = \texttt{true}$$

  then `Union(`$\texttt{region}(p_i)$,$\texttt{region}(p'_i)$`)`;

Preordering: **[1.]**

$$f(p, p') = \max_{\mathbf{c} \in \{\mathbf{R},\mathbf{G},\mathbf{B}\}} |\mathbf{c}(p) - \mathbf{c}(p')|$$

Single-pass mergings:

$$\mathcal{P}(R, R') = \begin{cases} \texttt{true} & \text{if} \quad \forall \mathbf{c} \in \{\mathbf{R}, \mathbf{G}, \mathbf{B}\}, \\ & |\overline{\mathbf{c}}(R') - \overline{\mathbf{c}}(R)| \leq b(R) + b(R') \\ \texttt{false} & \textit{otherwise} \end{cases}$$

$$\max_{c \in \{R,G,B\}} \left(\bar{I}_c(i,j) - \bar{I}_c(i',j')\right)^2 \leq b(n_{i,j}) + b(n_{i',j'})$$

[2.]

$$b(x) = \frac{256^2}{2Qx}(\min(256, x)\log x + 2\log 6wh)$$

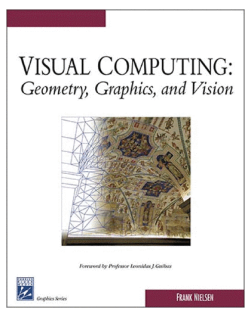
$$|\mathcal{R}_{|R|}| = (|R|+1)^g \ ,$$
$$b(R) = g\sqrt{\frac{1}{2Q|R|}\left(\ln\frac{2}{\delta'} + \ln|\mathcal{R}_{|R|}|\right)}$$

Graph segmentation: A Generic approach for segmentation.

Allows to handle data generically:
- Images and videos
- 3D meshes
- 3D images

→ Speed graph construction for efficient real-time video segmentation

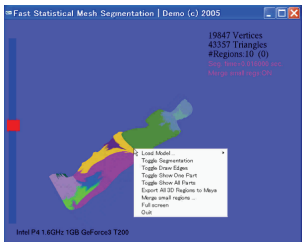
Basic source C++ source code in

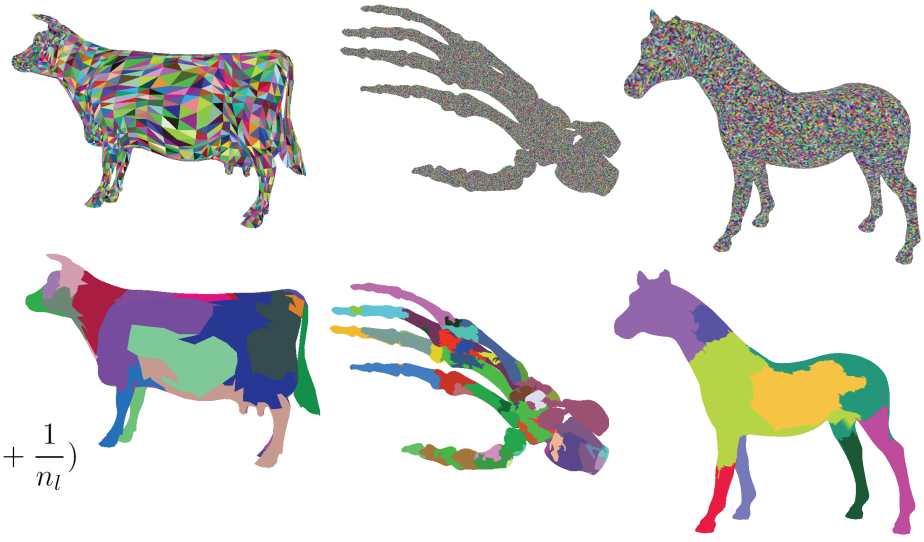


ISBN 1584504277
540 pp, 2005.
50+ C++ codes

3D MESH SEGMENTATION

- Several ways to build the RAG
- Interactive mesh segmentation

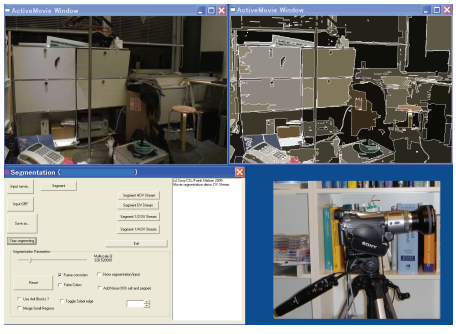


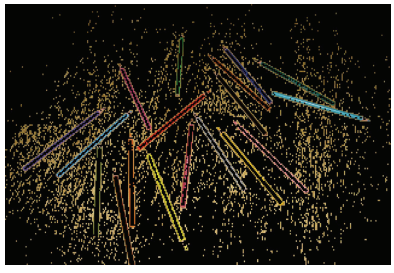


$$(\bar{V}_k - \bar{V}_l)^2 \leq \frac{(n_k \log n_k + n_l \log n_l)}{Q}(\frac{1}{n_k} + \frac{1}{n_l})$$

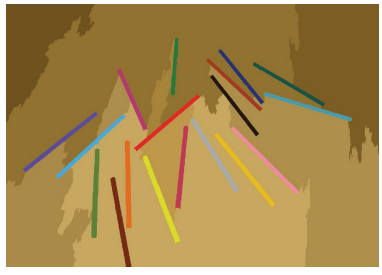
VIDEO-RATE IMAGE SEGMENTATION

- 30+ fps QVGA on Pentium IV
- Tag 4x4 blocks uniform or not
- Block node internal edges are not built





Blocks tagged uniform are shown in black

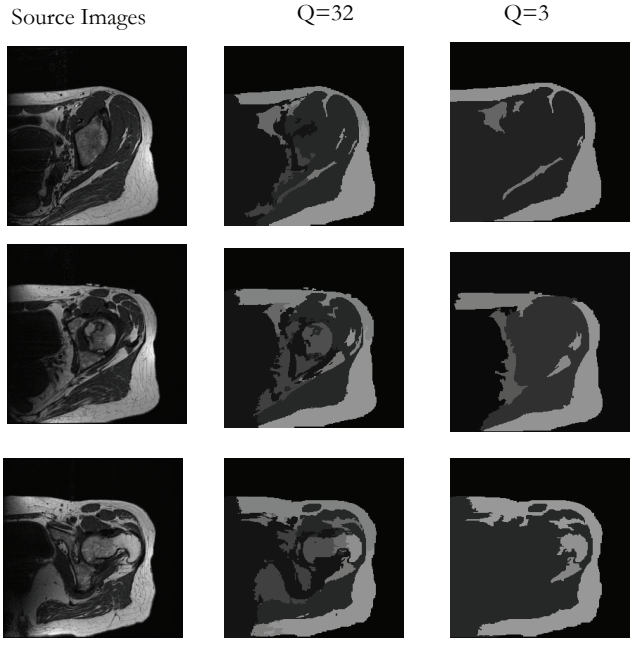


Segmentation results

Block size	#uniform/#total	#uniform%	seg. time (msec)
24×24	$331/600$	55%	20
16×16	$954/1350$	70%	16
4×4	$20251/21600$	93%	$14,7$
2×2	$85444/86400$	98%	$20,2$

3D VOLUME SEGMENTATION

C6 or C26 connectivity
Multiscale (parameter Q)



References:

- Volume catcher.
  ACM I3D 2005, pp. 111-116

- Semi-supervised statistical region refinement for color image segmentation.
  Pattern Recognition 38(6): pp. 835-846 (2005)