Colour Covering Blanket

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Overview

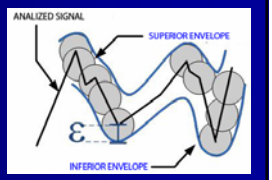
- Context
  - Characterization of the complexity of a colour texture
- Covering Blanket
  - For estimating the fractal dimension
- Colour Probabilistic Morphology
- Experimental Results
- Conclusions

Context

- Colour texture characterization
  - 3D histograms
  - Co-occurrence matrices
  - Colour fractal dimension
    - HyperBox-counting
    - Colour Covering Blanket

Covering Blanket

- Compute the volume *V(ε)* between the *superior* and *inferior* envelopes (morphological covers) of the analyzed image for different sizes of the structuring element *ε*
- Estimate the fractal dimension based on the slope of the regression line through the points:



$$\langle \log V(\varepsilon), \log \varepsilon \rangle$$

Morphological Covers

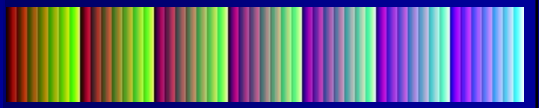
- Dilation and erosion for grey-scale images [Serra] with flat structuring elements (SE)

$$f \oplus g = \max_{y \in Supp(g)} \{f(x-y)\}$$
$$f \ominus g = \min_{y \in Supp(g)} \{f(x-y)\}$$

- Issue – for colour images – the definition of a total order in a 3D space
  - Hanbury & Lopez define lexicographical i.e. partial orders

Drawback of the Lexicographical Order

- Not "natural" order of colours
- Superior and inferior cover intersect
  - The volume has negative values!
- Example: RGB lexicographical order:



Probabilistic Extrema

- Chebysev's inequality

$$P\{|\xi - \overline{\xi}| \geq k\sigma_\xi\} \leq \frac{1}{k^2}$$

- Extrema by definition:

$$\begin{aligned} max\{\xi\} &\stackrel{\text{def}}{=} \overline{\xi} + k\sigma_\xi \\ min\{\xi\} &\stackrel{\text{def}}{=} \overline{\xi} - k\sigma_\xi \end{aligned}$$

Colour Morphology

- The Dilation and Erosion

$$\begin{aligned} f \oplus g &= \overline{f(x-y)}_{|y \in Supp(g)} + k\sigma_{f(x-y)|y \in Supp(g)} \\ f \ominus g &= \overline{f(x-y)}_{|y \in Supp(g)} - k\sigma_{f(x-y)|y \in Supp(g)} \end{aligned}$$

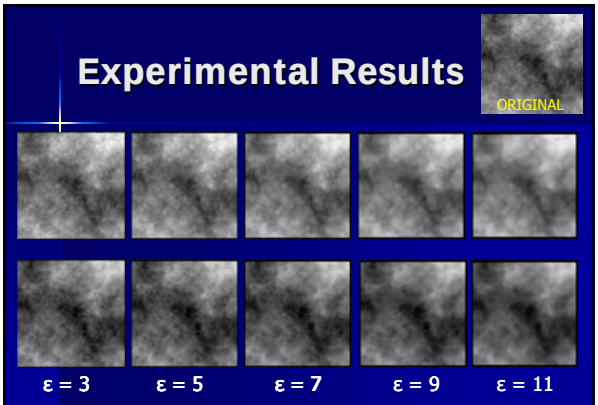
$$\begin{aligned} \overline{f(x-y)}_{|y \in Supp(g)} &= (\overline{r}, \overline{g}, \overline{b}) \\ \sigma_{f(x-y)|y \in Supp(g)} &= (\sigma_r, \sigma_g, \sigma_b) \end{aligned}$$

Volume Definition

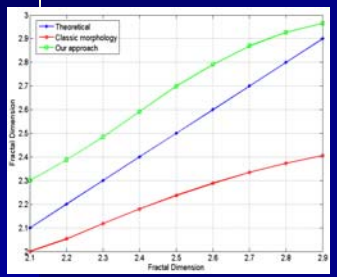
$$V(\varepsilon) = \sum_{i=1}^{M} \sum_{j=1}^{N} \underbrace{[Sup_\varepsilon\{x(i,j)\} - Inf_\varepsilon\{x(i,j)\}]}_{v(i,j)}$$

$$v(i,j) = \Delta r \times \Delta g \times \Delta b$$

Experimental Results

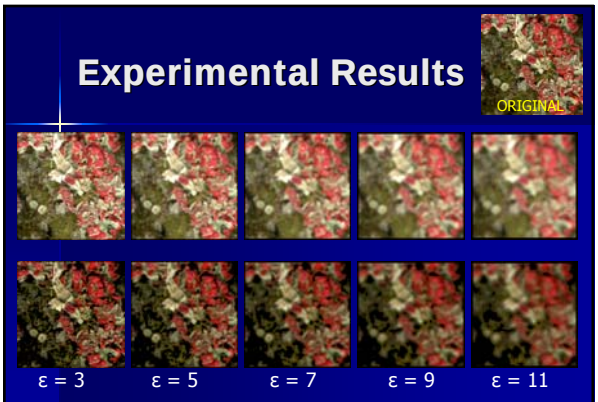


Gray-scale Covering Blanket

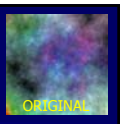


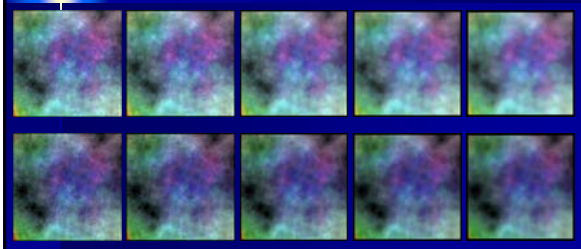
- Better estimation of the fractal dimension
- The fractal dimension is under-estimated using the classical morphology

Experimental Results



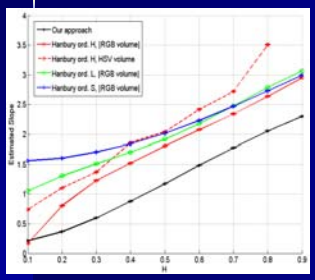
Experimental Results





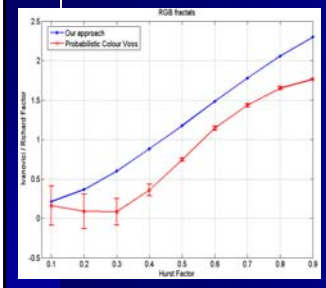
ε = 3 ε = 5 ε = 7 ε = 9 ε = 11

Color Covering Blanket



- Our approach provides more stable results
- Hanbury morphology → under-estimation of the fractal complexity

Comparison (2)



- More linear and stable behaviour compared to the colour Voss approach (box-counting like approach)
- CCB – under-estimation of the fractal complexity

Issues

- Marginal approach
- The statistically-estimated extrema
  - may not belong to the original set (new / false colours)
  - may not belong to the colour space (impossible to render or print)

Conclusions

- We don't define a partial order
- Extrema of a set – computed based on the mean and standard deviation
- The approach
  - colour extension of the covering blanket
  - suitable for metrological purposes
  - image complexity assessment performed in RGB