Keyword-based image re-coloring

Fayez Lahoud
Bin Jin
Sabine Süsstrunk
At the start

But

Sky

Strawberry

Red
Can we do better with deep learning?
Recoloring a strawberry
Recoloring a strawberry

• Where is it?
Recoloring a strawberry

• Where is it?

• What colors should it be?

Strawberry
Recoloring a strawberry

- Where is it?

- What colors should it be?

Strawberry
Where is the keyword?
Keyword-based segmentation

Semantic Segmentation

• Learning segmentation from annotations
Semantic Segmentation

• Learning segmentation without human annotations
Goal

- Learning segmentation without human annotations

- Using image tags instead!
Web image sets

\[ W_{\text{car}} \]

\[ W_{\text{airplane}} \]
Web image sets

$W_{\text{car}}$

$W_{\text{airplane}}$

Automatic masks

Saliency and Conditional Random Fields [1]

Web image sets

$W_{car}$

$W_{airplane}$

$C$
Web image sets

$W_{\text{car}}$

$W_{\text{airplane}}$

$C$

$R_{\text{car}}$

$R_{\text{airplane}}$
Method

- Stage 1: Learning to differentiate concept/background
- Stage 2: Refinement on natural images
Stage 1

$W_{\text{car}}$

hypercolumn features

VGG16

$C$

SNN

positive

negative
Stage 2

Hypercolumn features

SNN

VGG16

R_{car}

CRF
Stage 2

Hypercolumn features

SNN

VGG16

$R_{car}$

CRF
Stage 2

Hypercolumn features

SNN

VGG16

iterate

CRF

$R_{car}$
Stage 2

Hypercolumn features

SNN

VGG16

R_{car}

Iterate
• Optimize CRF
• Update SNN

Two iterations enough for a large boost
## Labels evolution

<table>
<thead>
<tr>
<th>Images</th>
<th>Initial</th>
<th>Iteration 1</th>
<th>Iteration 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Boat Image" /></td>
<td><img src="image2.png" alt="Initial Boat" /></td>
<td><img src="image3.png" alt="Iteration 1 Boat" /></td>
<td><img src="image4.png" alt="Iteration 2 Boat" /></td>
</tr>
<tr>
<td><img src="image5.png" alt="Cat Image" /></td>
<td><img src="image6.png" alt="Initial Cat" /></td>
<td><img src="image7.png" alt="Iteration 1 Cat" /></td>
<td><img src="image8.png" alt="Iteration 2 Cat" /></td>
</tr>
<tr>
<td><img src="image9.png" alt="Dog Image" /></td>
<td><img src="image10.png" alt="Initial Dog" /></td>
<td><img src="image11.png" alt="Iteration 1 Dog" /></td>
<td><img src="image12.png" alt="Iteration 2 Dog" /></td>
</tr>
</tbody>
</table>
Keyword-SNN pairs

- **Car**: \( SNN_{\text{car}} \)
- **Airplane**: \( SNN_{\text{airplane}} \)
- **Horse**: \( SNN_{\text{horse}} \)
- **Strawberry**: \( SNN_{\text{strawberry}} \)
What colors to assign/modify?

Strawberry
Keyword-based re-coloring

Strawberry

Banana

Method

input image

semantic segmentation

Strawberry
input keyword

compute color feature

color feature

keyword-feature DB

segmentation

re-coloring

significance values

result
Method

Input image → semantic segmentation

Input keyword: Strawberry → keyword-feature DB

Compute color feature → segmentation

Color feature → re-coloring

Result
Method

input image

compute color feature

semantic segmentation

Strawberry

input keyword

keyword-feature DB

segmentation

color feature

result

re-coloring

significance values

DB
Color Features

Graylevel Histogram

Lightness Layout
Local Color Features

Sunflower

![Sunflower Image]

![Hue angle characteristic graph]

- full
- segmented
Method

input image → compute color feature

semantic segmentation → segmentation

Strawberry → keyword-feature DB

input keyword → significance values

result → re-coloring
Significance values

Significance values

Significance values

Positive

Night

Negative

Significance values

Night

Positive

Color Features

Relevance [1]

Negative

25% Quantile $Q_{25}$

75% Quantile $Q_{75}$

$z$-values

Significance values

Concept **Sunflower**

Concept **Orchid**
Method

1. Input image
2. Semantic segmentation
3. Compute color feature
4. Keyword-feature DB
5. Result

- Input keyword: Strawberry
- Re-coloring
- Color feature
- Significance values
- Segmentation

Flowchart:
- Input image → Semantic segmentation → Compute color feature → Keyword-feature DB → Re-coloring → Result
Local color enhancement

$\mathbf{I}_i$

Strawberry
Local color enhancement

$I_i$

Strawberry

$(Q_{25}; Q_{75})$
Local color enhancement

Strawberry

\( I_i \)

\( (Q_{25}; Q_{75}) \)
Local color enhancement

\( I_i \) → ? → \((Q_{25}; Q_{75})\) → \( I_G \)

Strawberry
Local color enhancement

\(I_i\)

Strawberry

\((Q_{25}; Q_{75})\)

\(I_G\)

\(I_L\)
Local color enhancement

\[ I_L = M \times I_G + (1 - M) \times I_I \]
Local color enhancement

Tulip

Banana

Ferrari

Strawberry

Lily

Strawberry

Orchid

Strawberry

https://github.com/GrimReaperSam/SILE
Conclusion

- Deep Learning
  - Keyword <-> Concept

- Color
  - Keyword <-> Properties

Strawberry