Photomontage

GrabCut – Interactive Foreground Extraction
Problem

Fast & Accurate?
What GrabCut does

- Magic Wand (198?)
  - Mortensen and Barrett (1995)

User Input

Result

Regions

Boundary

Regions & Boundary

GrabCut – Interactive Foreground Extraction
Framework

- **Input:** Image $x \in \{R, G, B\}^n$
- **Output:** Segmentation $S \in \{0, 1\}^n$
- **Parameters:** Colour $\Theta$, Coherence $\lambda$
- **Energy:** $E(\Theta, S, x, \lambda) = E_{Col} + E_{Coh}$
- **Optimization:** $\arg\min_{S, \Theta} E(S, \Theta, x, \lambda)$

GrabCut – Interactive Foreground Extraction
Graph Cuts

Boykov and Jolly (2001)

**Image**

**Cut:** separating source and sink; Energy: collection of edges

**Min Cut:** Global minimal energy in polynomial time

Min Cut

Foreground (source)

Background (sink)
Iterated Graph Cut

User Initialisation

$\arg\min\limits_{\Theta} E(S, \Theta, x, \lambda)$

Graph cuts to infer the segmentation

K-means for learning colour distributions
Iterated Graph Cuts

Result

Energy after each Iteration

Guaranteed to converge
Colour Model

Gaussian Mixture Model (typically 5-8 components)

\[ E_{Col}(\Theta, S, x) = \sum_n D(S_n, \Theta, x_n) \]
An object is a coherent set of pixels:

$$E_{coh}(S, x, \lambda) = \lambda \sum_{i,j \text{ adj.}} (S_i \neq S_j) \exp\left\{-\frac{1}{2\sigma^2} \|x_i - x_j\|^2\right\}$$

Blake et al. (2004): Learn $\Theta, \lambda$ jointly
Moderately straightforward examples

... GrabCut completes automatically
Difficult Examples

Camouflage & Low Contrast

Fine structure

No telepathy

Initial Rectangle

Initial Result

GrabCut – Interactive Foreground Extraction
Evaluation – Labelled Database

Available online:  http://research.microsoft.com/vision/cambridge/segmentation/
Comparison

Boykov and Jolly (2001)

Error Rate: 0.72%

GrabCut

Error Rate: 0.72%

User Input

Result

GrabCut – Interactive Foreground Extraction
Summary

Magic Wand
(198?)
Intelligent Scissors
Mortensen and Barrett (1995)
Graph Cuts
Boykov and Jolly (2001)
LazySnapping
Li et al. (2004)
GrabCut
Rother et al. (2004)

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