GrabCut
Interactive Foreground Extraction
using Iterated Graph Cuts

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Problem

Fast & Accurate?
What GrabCut does

GrabCut

User Input

Result

Magic Wand (198?)

Intelligent Scissors
Mortensen and Barrett (1995)

Regions & Boundary

Regions

Boundary
Framework

Input: Image $x \in \{R, G, B\}^n$

Output: Segmentation $S \in \{0, 1\}^n$

Parameters: Colour $\Theta$, Coherence $\lambda$

Energy: $E(\Theta, S, x, \lambda) = E_{\text{Col}} + E_{\text{Coh}}$

Optimization: arg min $E(S, \Theta, x, \lambda)$

GrabCut – Interactive Foreground Extraction
Graph Cuts

Boykov and Jolly (2001)

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

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

![Diagram of Graph Cuts with Image, Foreground, Background, and Min Cut](image)
Iterated Graph Cut

User Initialisation

\[ \text{arg min}_\Theta E(S, \Theta, x, \lambda) \]

K-means for learning colour distributions

\[ \text{arg min}_S E(S, \Theta, x, \lambda) \]

Graph cuts to infer the segmentation
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:

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

\( \lambda = 0 \)

\( \lambda = 50 \)

\( \lambda = 1000 \)

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/

GrabCut – Interactive Foreground Extraction
Comparison

Boykov and Jolly (2001)

Error Rate: 0.72%

GrabCut

Error Rate: 0.72%
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)