Matting and compositing

Digital Visual Effects, Spring 2005

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Announcements

- Project #2 was due yesterday.
- Project #3 will be assigned next Wednesday.
- Grading proportion change. (15%, 20%, 20%, 30%)
Outline

- Traditional matting and compositing
- Natural image matting
- Video matting
- Shadow matting
- Environment matting
Traditional matting and composting
Photomontage

The Two Ways of Life, 1857, Oscar Gustav Rejlander
Printed from the original 32 wet collodion negatives.
Photographic compositions

Lang Ching-shan
Use of mattes for compositing

The Great Train Robbery (1903) matte shot
Use of mattes for compositing

The Great Train Robbery (1903) matte shot
Optical compositing

King Kong (1933) Stop-motion + optical compositing
Digital matting and compositing

The lost world (1925)  The lost world (1997)

Miniature, stop-motion  Computer-generated images
**Digital matting and composting**

King Kong (1933)  
Optical compositing

Jurassic Park III (2001)  
Blue-screen matting, digital composition, digital matte painting
Digital matting: bluescreen matting

Forrest Gump (1994)

- The most common approach for films.
- Expensive, studio setup.
- Not a simple one-step process.
Titanic

Matting and compositing
Matting and Compositing

background replacement

background editing

Matting and Compositing
Color difference method (Ultimatte)

\[ C = F + \alpha B \]

\[ F \]

\[ \bar{\alpha} \]

Blue-screen photograph

Spill suppression if \( B > G \) then \( B = G \)

Matte creation \( \bar{\alpha} = B - \max(G, R) \)
Compositing

$C = \alpha F + (1 - \alpha)B$

foreground color

alpha matte

background plate

Compositing
Compositing

The compositing equation is given by:

\[ C = \alpha F + (1 - \alpha)B \]
Compositing equation:

\[ \alpha F + BFC = 0.6 \]
Matting

observation

$C = \alpha F + (1 - \alpha)B$

compositing equation

Matting
Matting

Three approaches:
1. reduce #unknowns
2. add observations
3. add priors

\[ C = \alpha F + (1 - \alpha)B \]

compositing equation
Matting (reduce unknowns)

\[ C = \alpha F + (1 - \alpha)B \]

difference matting
Matting (reduce unknowns)

\[
C = \alpha F + (1 - \alpha)B
\]

blue screen matting

Matting (reduce unknowns)
Matting (add observations)

\[ \alpha (\alpha - 1 + \beta) = 1 \]

\[ C = \alpha F + (1 - \alpha)B \]

triangulation

Matting (add observations)
Matting (add priors)
Bayesian image matting
Bayesian framework

\[ \arg \max_{F, B, \alpha} P(F, B, \alpha \mid C) \]

\[ = \arg \max_{F, B, \alpha} P(C \mid F, B, \alpha) \frac{P(F) P(B) P(\alpha)}{P(C)} \]

\[ L(C \mid F, B, \alpha) = -\|C - \alpha F - (1 - \alpha) B\|^2 / \sigma_C^2 \]
\[ \overline{F} = \frac{1}{W} \sum_{i \in N} w_i F_i \]

\[ \Sigma_F = \frac{1}{W} \sum_{i \in N} w_i (F_i - \overline{F}) (F_i - \overline{F})^T \]

\[ L(F) = -(F - \overline{F})^T \Sigma_F^{-1} (F - \overline{F}) / 2 \]

**Priors**
repeat

1. fix alpha

\[
\begin{bmatrix}
\Sigma_F^{-1} + I \alpha^2 / \sigma_C^2 & I \alpha (1 - \alpha) / \sigma_C^2 \\
I \alpha (1 - \alpha) / \sigma_C^2 & \Sigma_B^{-1} + I (1 - \alpha)^2 / \sigma_C^2
\end{bmatrix}
\begin{bmatrix}
F \\
B
\end{bmatrix}
= 
\begin{bmatrix}
\Sigma_F^{-1} \overline{F} + C \alpha / \sigma_C^2 \\
\Sigma_B^{-1} \overline{B} + C (1 - \alpha) / \sigma_C^2
\end{bmatrix}
\]

2. fix F and B

\[
\alpha = \frac{(C - B) \cdot (F - B)}{\|F - B\|^2}
\]

until converge

Optimization
Bayesian image matting
Bayesian image matting
Bayesian image matting
Bayesian image matting
Bayesian image matting
Results
input

composite

Results
Comparisons

trimap
Comparisons

Bayesian

Ruzon-Tomasi

Comparisons
Comparisons

Bayesian

Ruzon-Tomasi

Comparisons
Comparisons
Comparisons
Bayesian
Mishima
Comparisons

Bayesian

Mishima
Video matting
input video

Video matting
Video matting
Video matting
Video matting

input video

interpolated trimaps

output alpha
Composited interpolated trimaps

input video

Video matting

Composited

interpolated trimaps

output alpha
optical flow
optical flow
Sample composite
Garbage mattes
Garbage mattes
Background estimation
Background estimation
Comparison without background

Comparison with background
Shadow matting and composting
blue screen composite  target background
blue screen composite

photograph
blue screen composite

photograph

Geometric errors
blue screen composite  photograph

Photometric errors
Shadow compositing equation

$$C = \beta L + (1 - \beta) S$$
Shadow matting

\[ C = \beta L + (1-\beta)S \]

shadow compositing equation
Shadow matting

\[ C = \beta L + (1 - \beta) S \]

shadow compositing equation
Shadow matting

\[ C = \beta L + (1 - \beta)S \]

Shadow compositing equation
Shadow compositing

\[ C = \beta L + (1 - \beta)S \]
Geometric errors
source scene  target background

Requirement #1
source scene  target background

Requirement #2
Reference