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 compositing
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 composting

The lost world (1925) The lost world (1997)
Miniature, stop-motion Computer-generated images

Digital matting and composting

King Kong (1933) Jurassic Park III (2001)
Optical compositing 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**

**Color difference method (Ultimatte)**

\[ C = F + \alpha B \]

- **Blue-screen photograph**
- **Spill suppression** if \( B > G \) then \( B = G \)
- **Matte creation** \( \alpha = B - \text{max}(G,R) \)

**Chroma-keying (Primatte)**

**Matting and Compositing**

- **background replacement**
- **background editing**
Compositing

Foreground color \( F \)

Alpha matte \( \alpha \)

Background plate \( B \)

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

Compositing equation

Matting

Observation \( C \)

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

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

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

Matting (reduce #unknowns):
- Blue screen matting
- Triangulation

Matting (add observations):
- Difference matting
Natural image matting

Bayesian image matting

Matting (add priors)

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

Bayesian framework

\[
\begin{align*}
\arg\max_{F,B,\alpha} & \quad P(F,B,\alpha | C) \\
& = \arg\max_{F,B,\alpha} \frac{P(C | F,B,\alpha) P(F) P(B) P(\alpha)}{P(C)} \\
L(C | F,B,\alpha) & = -\|C - \alpha F - (1 - \alpha)B\|^2 / \sigma_C^2
\end{align*}
\]

Priors

\[
\begin{align*}
\bar{F} & = \frac{1}{W} \sum_{i \in N} w_i F_i \\
\Sigma_F & = \frac{1}{W} \sum_{i \in N} w_i (F_i - \bar{F})(F_i - \bar{F})^T
\end{align*}
\]

\[
L(F) = -(F - \bar{F})^T \Sigma_F^{-1} (F - \bar{F}) / 2
\]
repeat
1. fix alpha
\[
\begin{bmatrix}
\Sigma_F^{-1} + I\alpha^2/\sigma_C^2 & I\alpha(1-\alpha)/\sigma_C^2 \\
I\alpha(1-\alpha)/\sigma_C^2 & \Sigma_B^{-1} + I(1-\alpha)^2/\sigma_C^2
\end{bmatrix}
\begin{bmatrix}
F \\
B
\end{bmatrix}
= 
\begin{bmatrix}
\Sigma_F^{-1} F + C\alpha/\sigma_C^2 \\
\Sigma_B^{-1} B + C(1-\alpha)/\sigma_C^2
\end{bmatrix}
\]
2. fix F and B
\[
\alpha = \frac{(C - B) \cdot (F - B)}{\|F - B\|^2}
\]
until converge

Optimization

Bayesian image matting
Garbage mattes

Background estimation

Garbage mattes

Background estimation
Shadow matting and composting
Geometric errors

Photometric errors
Shadow compositing equation

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

Shadow matting
Shadow matting

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

Shadow compositing

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

source scene  target background

source scene  target background

Requirement #1
Requirement #2
Reference