Digital Compositing

CS5245 Vision & Graphics for Special Effects

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Digital Compositing

Digital compositing means:

“digitally manipulated integration of at least two source images to produce a new image.”

- The new image must appear realistic.
- It must be completely and seamlessly integrated, as if it were actually photographed by a single camera.
Digital Compositing

- A scene in *Spartacus* shot with green-screen.

- The scene composited with real elements and CGI elements.

Main topics

- **Alpha Blending**: blending foreground and background
- **Keying**: separating foreground and background
  - Luma, chroma, difference keying
- **Rig Removal**: removing unwanted elements,

Other topics:

- Read [Kel00].
Alpha Blending

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

- $F$: foreground image
- $B$: background image
- $C$: composition
- $\alpha$: opacity or transparency
  An image of $\alpha$ values is called a **matte**.
- The above operation is performed on each corresponding pixel.
Alpha Blending

- If $\alpha = 1$, then $C = F$, foreground is shown, i.e., foreground is opaque.
- If $\alpha = 0$, then $C = B$, background is shown, i.e., foreground is transparent.
- $0 < \alpha < 1$: semi-transparent, e.g., shadow, smoke, etc.
Alpha Blending

Example: No background $B$

$F$ (transparent) \rightarrow $\alpha$ (matte) \rightarrow $C$ (opaque)
Alpha Blending

Example: With background $B$

Semi-transparent
$\alpha F + (1 - \alpha) B$

translucent
$B$

opaque
$F$

$C$
Alpha Blending

Example:

\[ F \]

\[ B \]

\[ \alpha \]

\[ \text{shadow} \]

\[ C \]
Alpha Blending

Notes:

- For shadow, $\alpha$ must take fractional value ($0 < \alpha < 1$). Otherwise, shadow looks unreal.

a bad matte results in a bad comp
Alpha Blending

\[ \alpha \] at boundary area should also be fractional. Otherwise, have **dark fringes**; unrealistic.

a bad comp  
a better comp
Alpha Blending

- A good matte has fractional $\alpha$ in shadow, and along object boundaries and shadow boundaries.
Alpha Blending

- Real images have smooth boundaries, no fringe.
Alpha Blending

Method 1: Using a foreground image with alpha channel.
- Import **object layer of foreground image**.
- Import background image.
- Composite the foreground layer over background image.
Alpha Blending

Method 2: Using foreground image without alpha channel.

- Import **foreground image** and **matte**.
- Import background image.
- Composite using **luminance-based track matte**.

![Alpha Blending with After Effects](image)
Keying

- Separating foreground from background, creating a matte of foreground.
- Also called *pulling a matte* (of foreground), or *keying out* (i.e., making transparent) *background*.
- Recall:
  A good matte has fractional $\alpha$ in shadow, and along object boundaries and shadow boundaries.
Keying

Basic methods:

- **Luma keying:**
  based on luminance (i.e., intensity)

- **Chroma keying:**
  based on color (i.e., bluescreen, greenscreen)

- **Difference keying:**
  requires a clean plate, i.e., a background image without the foreground element.
Keying

Basic idea:

- Compute difference between foreground and background (based on luma, chroma, or color)
- Very small diff $\Rightarrow \alpha = 0$.
- Very large diff $\Rightarrow \alpha = 1$
- Intermediate diff $\Rightarrow$ intermediate $\alpha$
Luma Keying

- Key out the background based on luminance.
- Useful when background has a uniform luminance that is very different from foreground luminance.
- Example:
Luma Keying with After Effects

- Select layer, choose “Effect > Keying > Luma Key”.
- Has several options:
  - Key out brighter, key out darker
  - Key out similar, key out dissimilar

Caution:
After Effects standard version supports only binary matte:
- keyed foreground is opaque ($\alpha = 255$)
- keyed out region is transparent ($\alpha = 0$)
- cannot have semi-transparent regions (other $\alpha$)
Luma Keying with After Effects

Example: Key out black background with threshold.

white background inserted for easy inspection only
Luma Keying with After Effects

- Reduce fringe thickness and soften edges.
Luma Keying with After Effects

- Keyed foreground is opaque ($\alpha = 255$).

Comp by alpha matte looks odd. Fire should not be opaque.
Luma Keying with After Effects

- With gray-scale matte, fire becomes transparent.
Chroma Keying

- Key out the background based on color.
- Useful when background has a uniform color that is very different from foreground color.
- Example: Image shot with blue screen.
Chroma Keying

Some characteristics of blue screen image:

- **Blue spill:** Light reflected from blue screen; must be removed.
- **Partial transparency:** Also looks bluish; must retain partial transparency.
- **Rig:** Used to support actor/prop; Must be removed.
Chroma Keying

- Another example of blue spill:

- To reduce blue spill, move foreground object far away from blue screen.
Chroma Keying

- If binary matte is pulled, get bad results.
- Clothe is semi-transparent. Now, it contains background color.
Chroma Keying with Ultimatte AdvantEdge

- Ultimatte AdvantEdge is a plug-in to After Effects.
- Select layer, choose “Effect > Ultimatte > AdvantEdge”.

- Can include background image.
Chroma Keying with Ultimatte AdvantEdge

In AdvantEdge

- Use “Screen / Sample Backing” to sample a set of backing colors, i.e., colors of blue screen.
Chroma Keying with Ultimatte AdvantEdge

- Sample backing colors.
Chroma Keying with Ultimatte AdvantEdge

- Produce gray matte: with transparent parts.
- Performs default spill suppression.
Chroma Keying with Ultimatte AdvantEdge

- Need to remove fine rig, screen non-uniformity, fringe effect.
- Need to remove leg transparency.

Keying
AdvantEdge
Chroma Keying with Ultimatte AdvantEdge

- Problems appear clearly in matte.

fine rig has large $\alpha$

fringe has large $\alpha$
Chroma Keying with Ultimatte AdvantEdge

- Problems appear clearly in matte.

leg $\alpha < 1$
Chroma Keying with Ultimatte AdvantEdge

- Adjust matte density ($\alpha$) of foreground to make leg opaque.
- Shrink matte to remove fine rig, fringe effect, screen non-uniformity.
Chroma Keying with Ultimatte AdvantEdge

- Adjusting matte density is equivalent to adjusting matte thresholds.

![Matte Density Control Panel](image)

![Graph showing alpha vs diff](graph)
Chroma Keying with Ultimatte AdvantEdge

- After matte refinement:
Chroma Keying with Ultimatte AdvantEdge

Final comp:

Demo
Difference Keying

- More general than luma and chroma keying.
- Key out background based on pixel-wise color difference between foreground and background footage.

- Can be used when:
  - Blue screen is not perfect, e.g., many shades of blue.
  - Background is not blue screen.
Difference Keying

- Requires clean plates of background footage.
Difference Keying with Ultimatte AdvantEdge

- Include clean plate.
- Then, do it in a similar way as chroma keying.
- AdvantEdge can use clean plate to do screen correction, i.e., handle imperfect blue screen.
Difference Keying with Ultimatte AdvantEdge

- If screen correction is imperfect, can use guide lines to limit area to be blended.
Difference Keying with Ultimatte AdvantEdge

- Final comp:

Demo
Rig Removal

- Rigs are equipment that support the actors or props.
- Sometimes, rigs cannot be removed by keying alone.
- So, have to apply masking technique to remove rigs.
- Need clean plate of background footage.
- If camera moves, then need **motion-controlled camera**:
  - Computer controls camera to move the same way twice:
    - Without foreground objects; get clean plate.
    - With foreground objects.
Rig Removal

Basic Idea:

- Apply a mask to mask out the rig.
- Then, replace pixels in masked area by corresponding pixels in clean plate background.
- If rig moves in footage, then have to animate the mask accordingly.
Example: Let's assume that this chess piece is a rig.

Foreground

Clean Plate
Rig Removal

1. **Align Clean Plates:**
   - Check misalignment between foreground and clean plate. Motion-controlled camera can't be perfect.
   - Comp difference of foreground and clean plate. It can reveal misalignment as prominent edges.
Toggling visibility setting can also reveal misalignment.
For this example, translation of clean plate is sufficient to align it with foreground image.

Note: To use real number coordinates, have to set layer quality to “Best”.
Rig Removal

- Difference comp after alignment:
2. **Mask Out Rig:**

- Put a mask over rig.
- Include rig shadow.
- Set mask mode to “subtract”.

Or

Note: Can lock layer to avoid accidental changes
Rig Removal

- Result for first frame:
Rig Removal

- Oval shaped mask may not work in general.
- Example: An oval mask will also mask out part of another foreground element.
Rig Removal

- Need to manually set the mask shape.
- Manually setting the outline of mask, matte, or foreground element is called **rotooscoping**.
- A rotoscoped matte is called a **roto-matte** for short.
- Adjust matte outline to mask out rig and shadow but keep other required foreground elements.
3. **Animate Roto-Matte:**
   - Move matte to cover rig in subsequent frames.
   - Make large matte to minimize the number of keyframes that need rotoscoping.

Rig is close to foreground elements. Need to adjust matte frequently.

**Demo**
Summary

Topics covered:
- alpha blending
- keying: luma, chroma, difference keying
- rig removal

There are many other topics relevant to compositing. For details, read [Kel00].
References