Matting and compositing

Digital Visual Effects, Spring 2005

Yung-Yu Chuang

2005/4/27

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

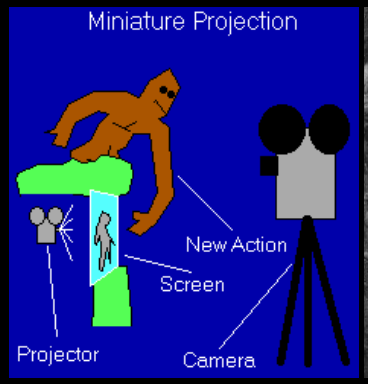
Use of mattes for compositing

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)

Miniature, stop-motion

The lost world (1997)

Computer-generated images

Digital matting and composting

King Kong (1933)

Optical compositing

Jurassic Park III (2001)

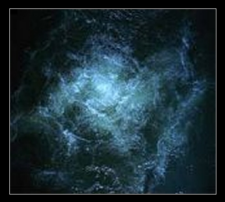
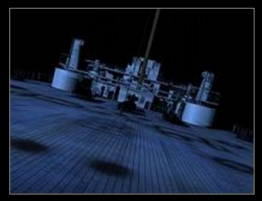
Blue-screen matting,
digital composition,
digital matte painting

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


background replacement

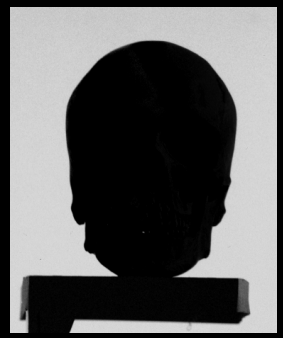

background editing

Matting and Compositing

Color difference method (Ultimatte)

$C=F+\bar{\alpha}B$ F $\bar{\alpha}$



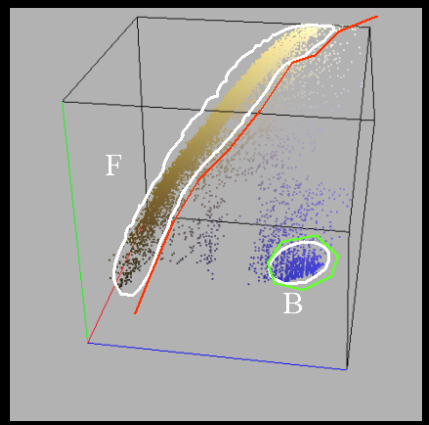


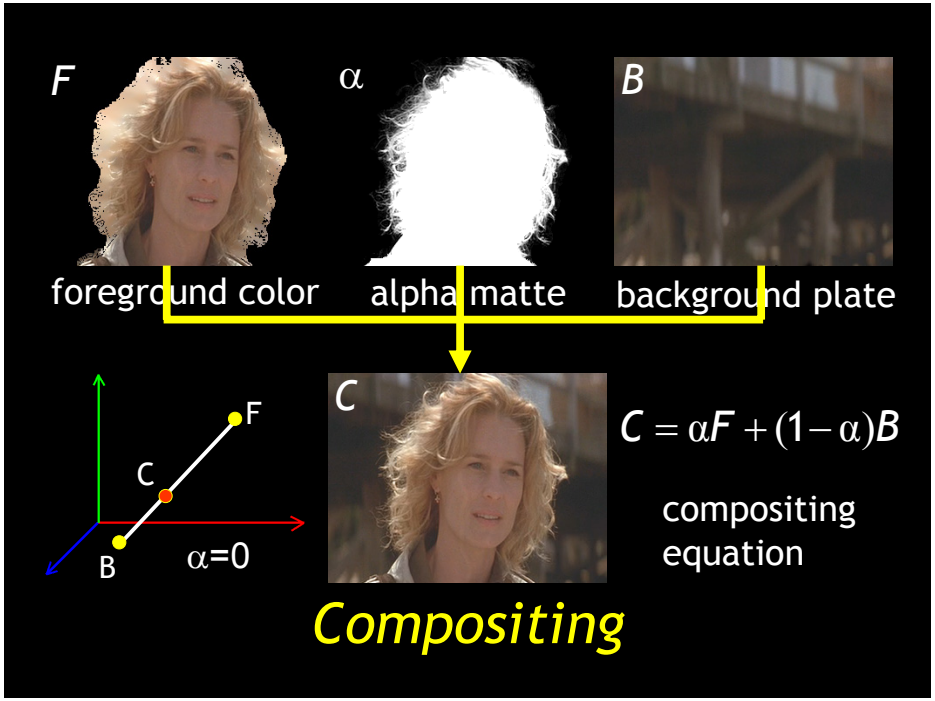
Blue-screen photograph

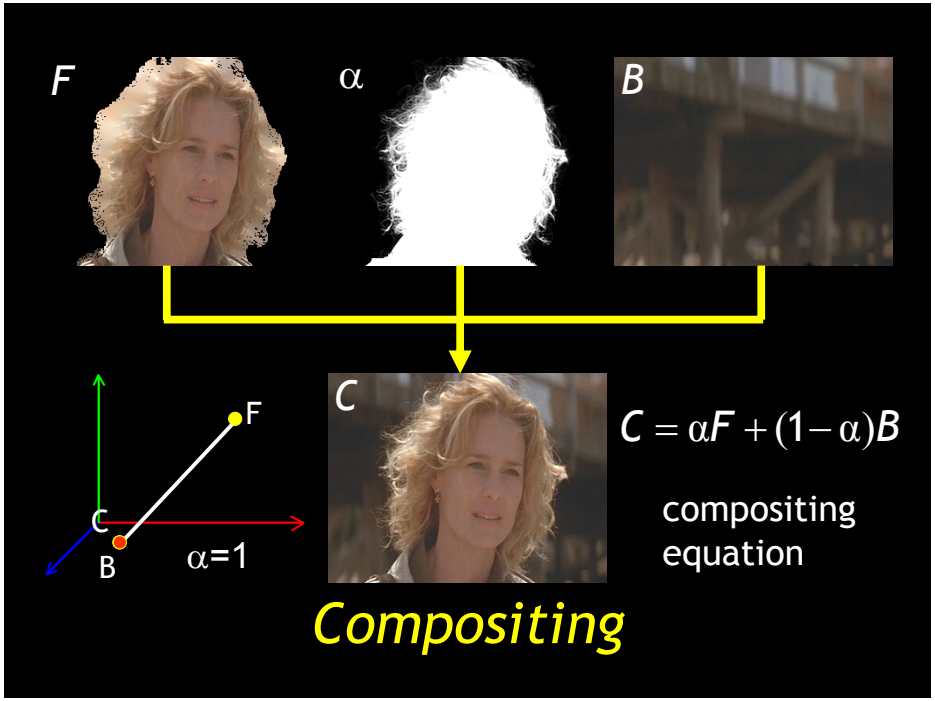
Spill suppression if B>G then B=G

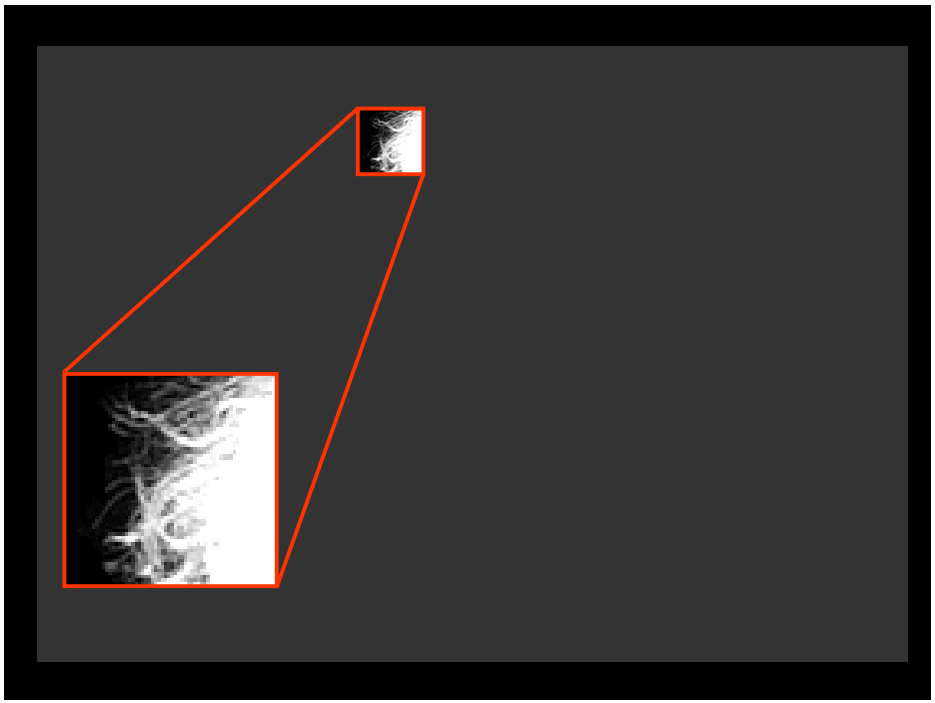
Matte creation $\bar{\alpha}$=B-max(G,R)

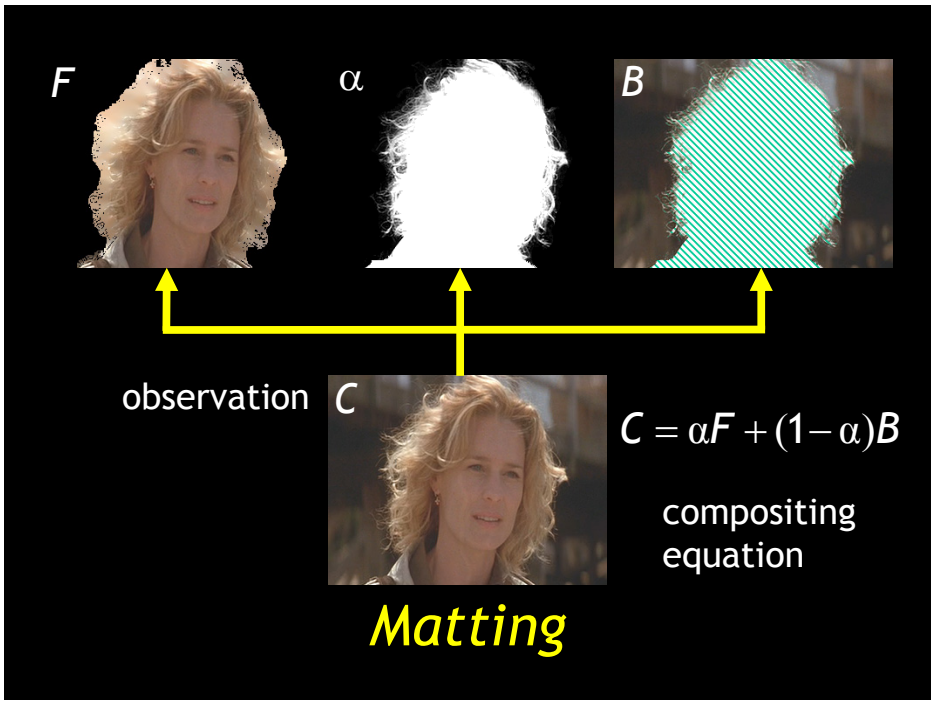
Chroma-keying (Primatte)

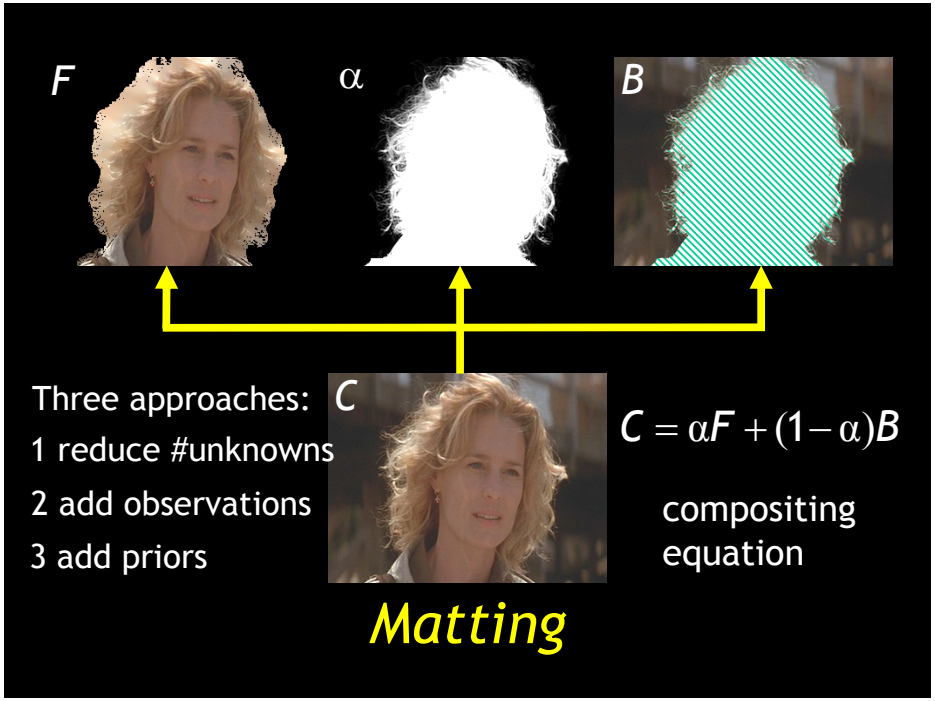



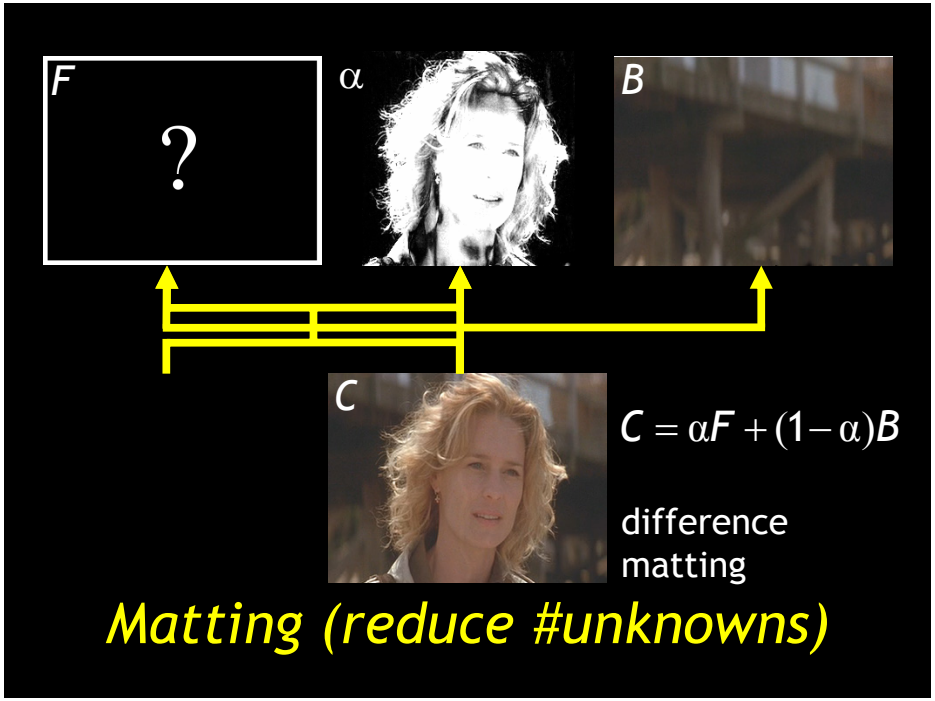

F
α
B
foreground color
alpha matte
background plate
C
F
C
B
α=0
$C = \alpha F + (1-\alpha)B$
compositing equation
Compositing

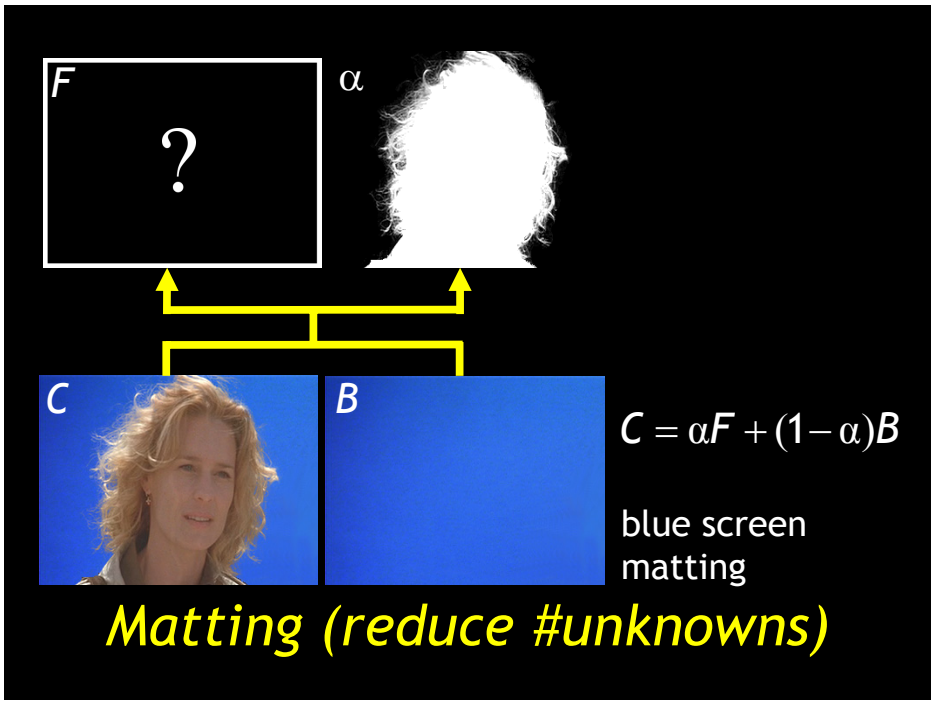

F
α
B
C
F
C
B
α=1
$C = \alpha F + (1-\alpha)B$
compositing equation
Compositing

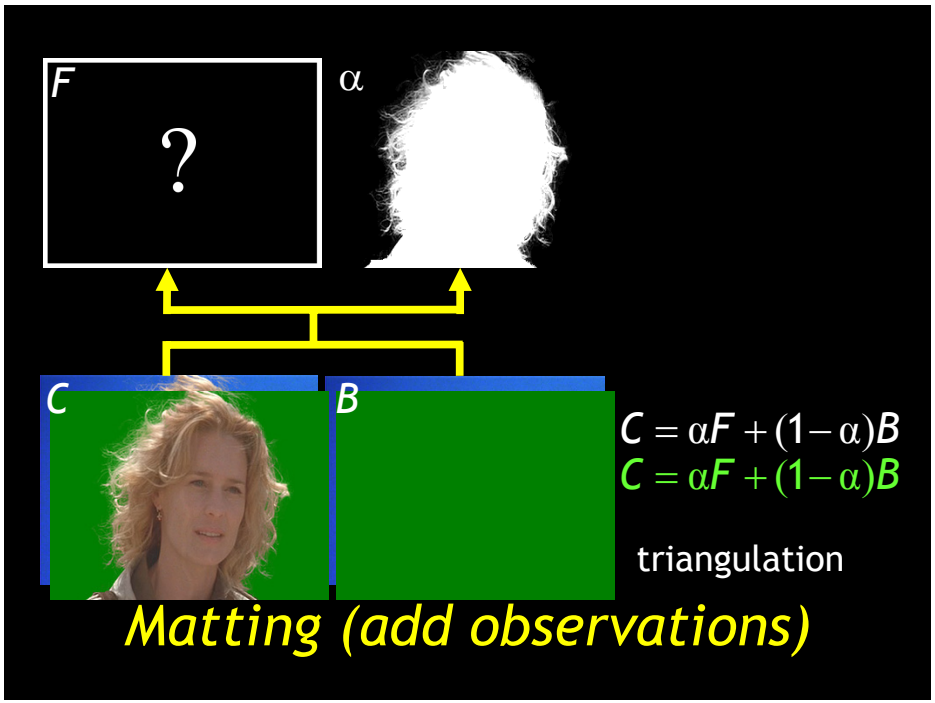


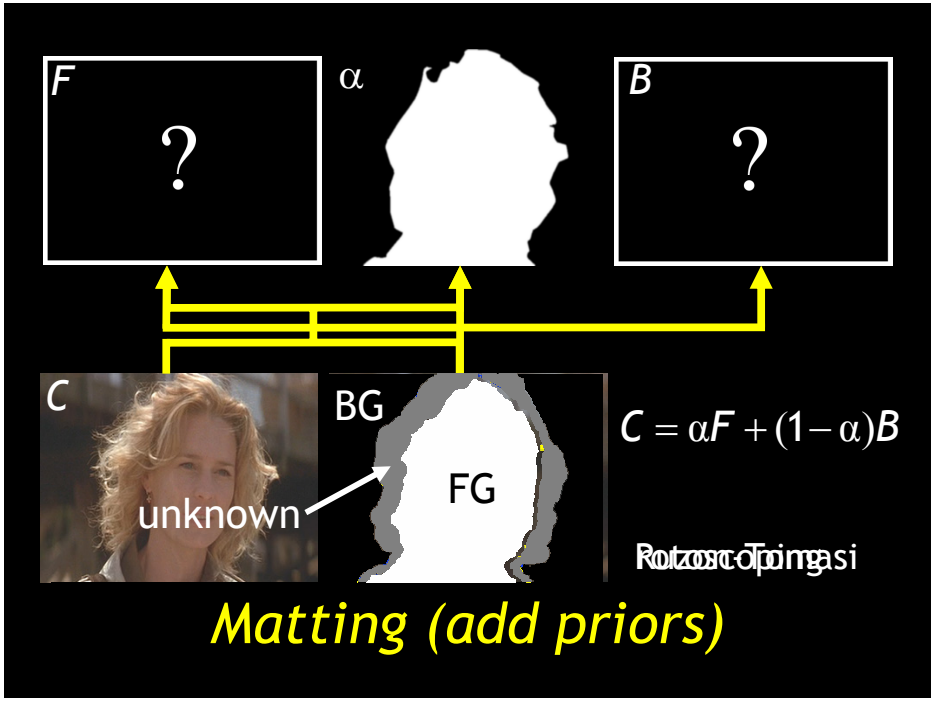

F
α
B
observation
C
$C = \alpha F + (1-\alpha)B$
compositing equation
Matting


F
α
B
C
$C = \alpha F + (1-\alpha)B$
compositing equation
Three approaches:
1 reduce #unknowns
2 add observations
3 add priors
Matting


F
?
α
B
C
$C = \alpha F + (1-\alpha)B$
difference matting
Matting (reduce #unknowns)


F
?
α
C
B
$C = \alpha F + (1-\alpha)B$
blue screen matting
Matting (reduce #unknowns)


F
?
α
C
B
$C = \alpha F + (1-\alpha)B$
$C = \alpha F + (1-\alpha)B$
triangulation
Matting (add observations)



Matting (add priors)

Bayesian image matting

posterior probability

likelihood

priors

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

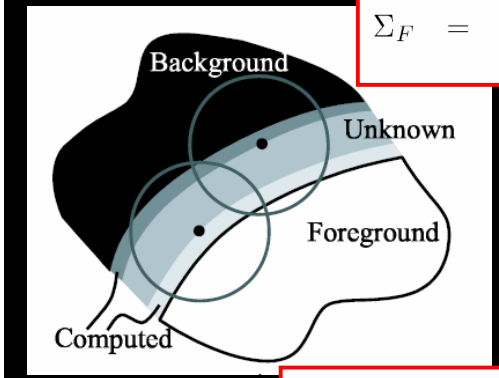
$$= \arg\max_{F,B,\alpha} P(C \mid F,B,\alpha)\, P(F)\, P(B)\, P(\alpha) / P(C)$$

$$L(C \mid F,B,\alpha) = -\|C - \alpha F - (1-\alpha)B\|^2 / \sigma_C^2$$

Bayesian framework

$$\overline{F} = \frac{1}{W}\sum_{i \in N} w_i F_i$$

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



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

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

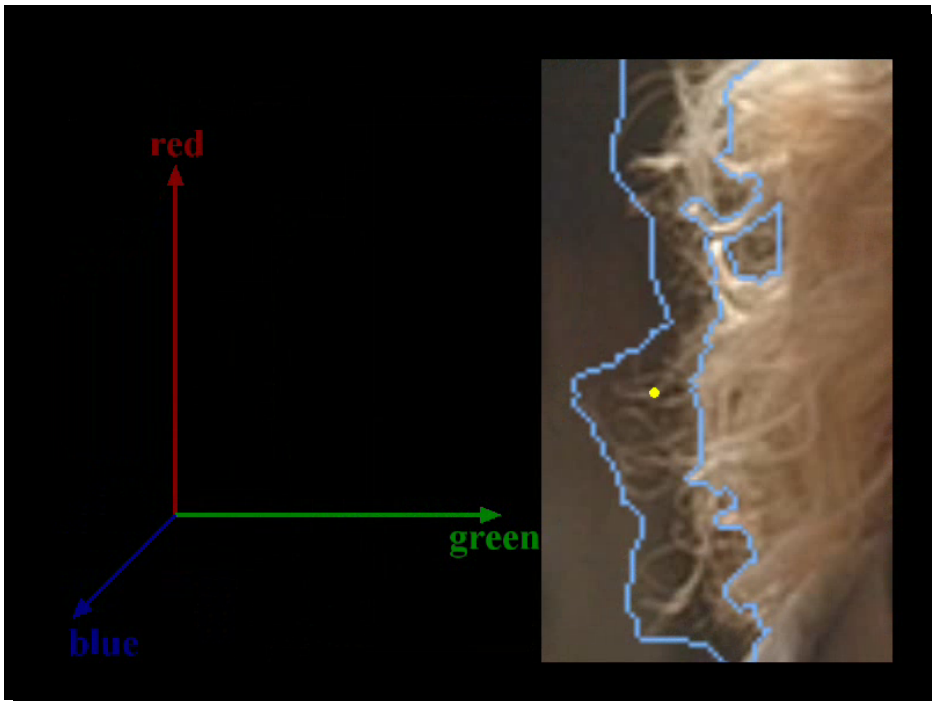
Bayesian image matting

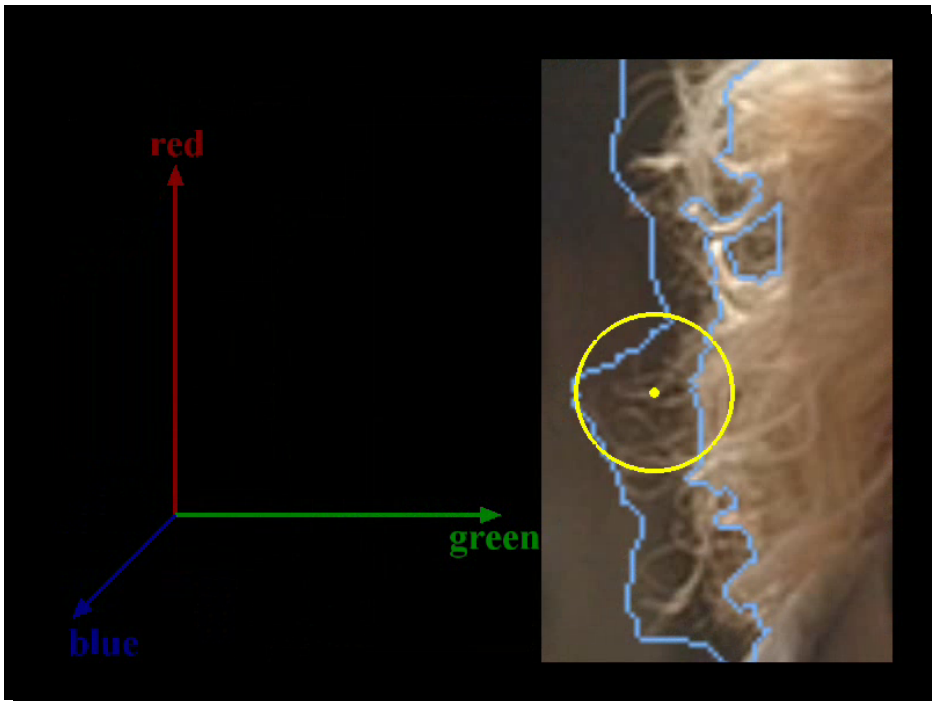
Bayesian image matting

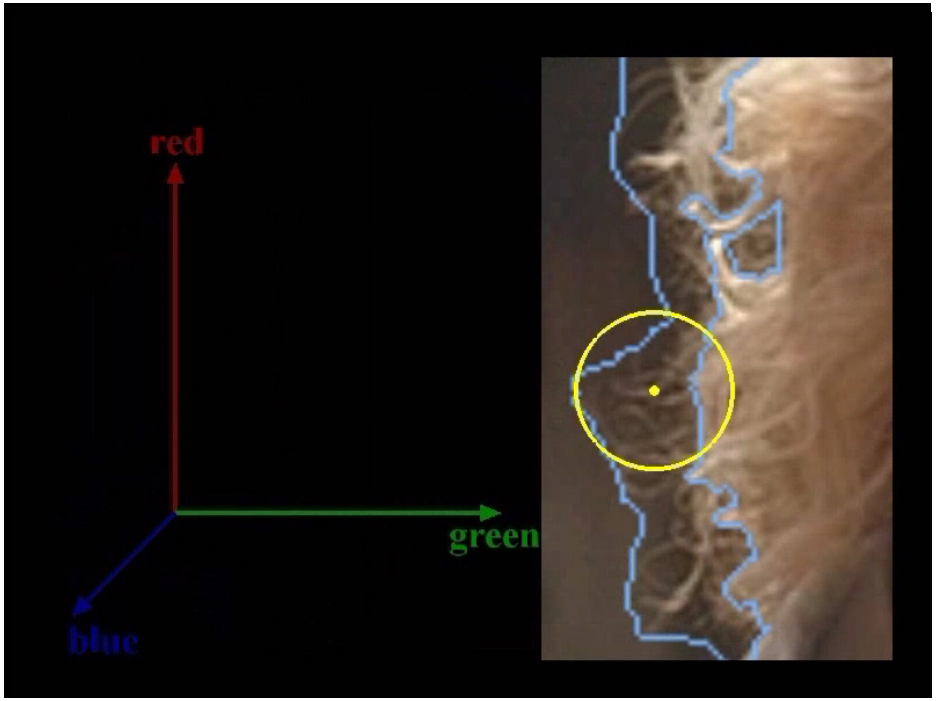
Bayesian image matting

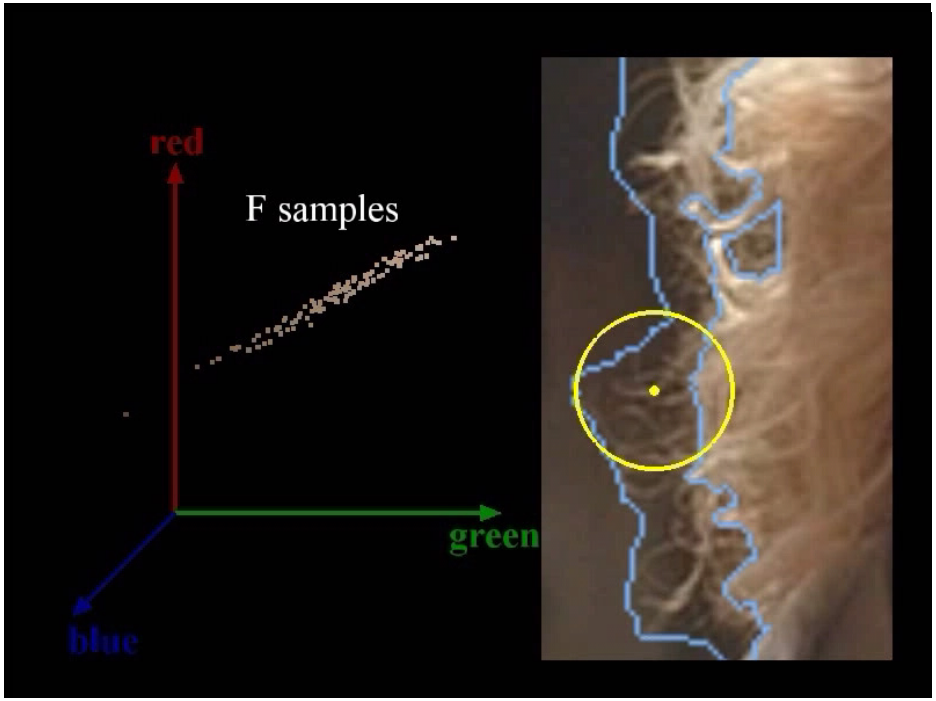

Bayesian image matting

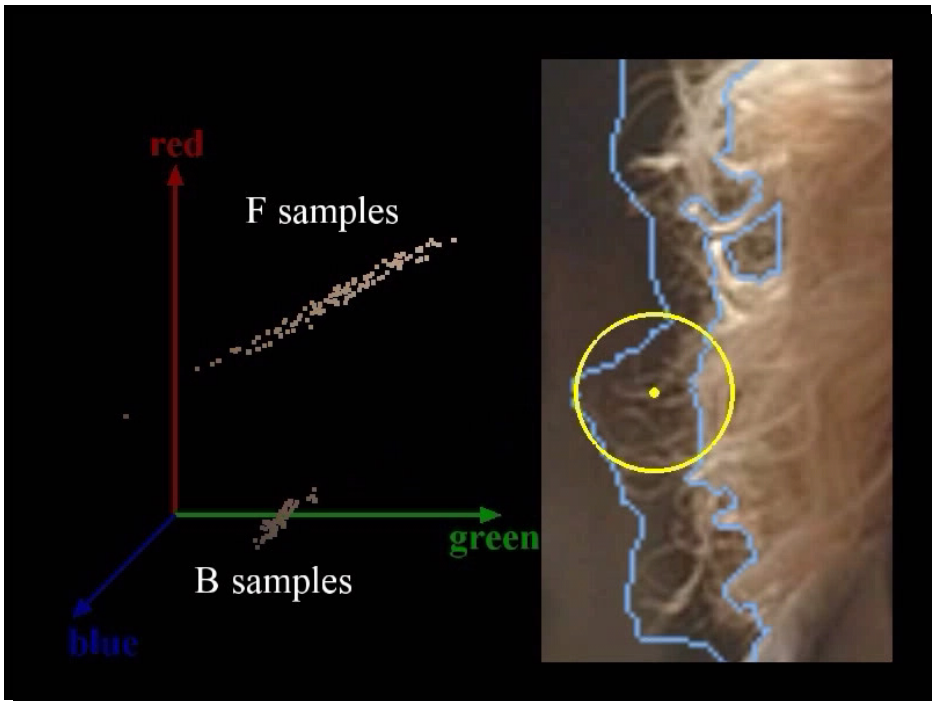

Bayesian image matting

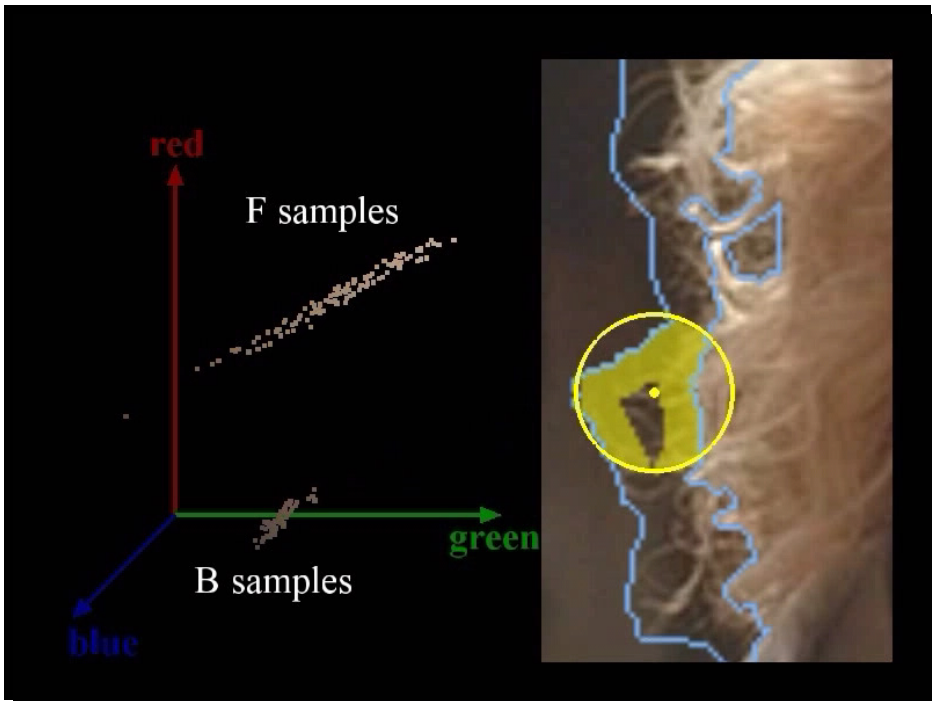

red
green
blue

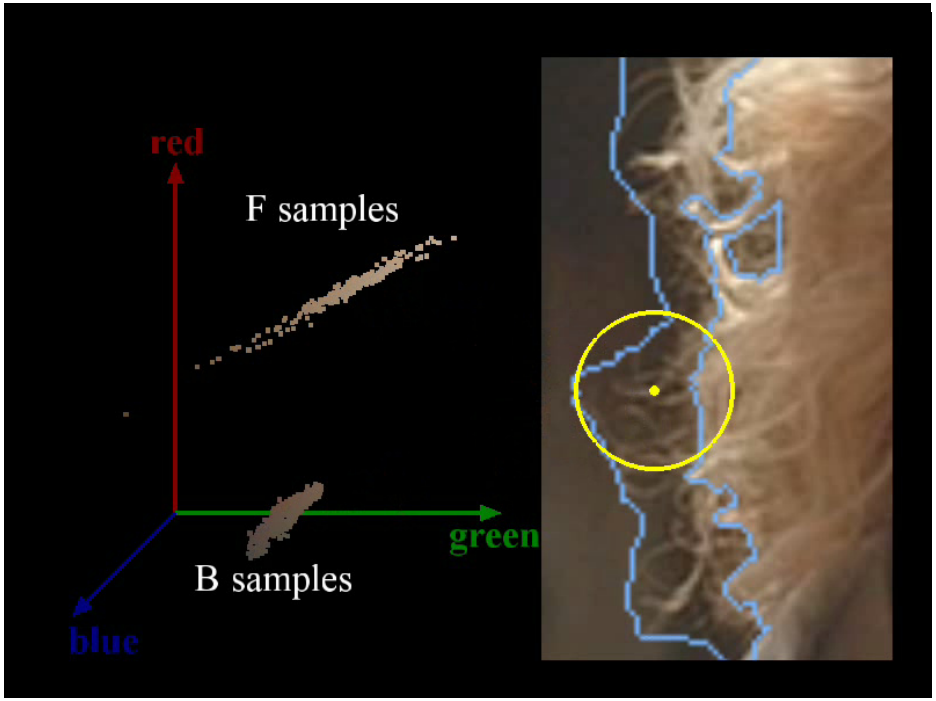

red
green
blue

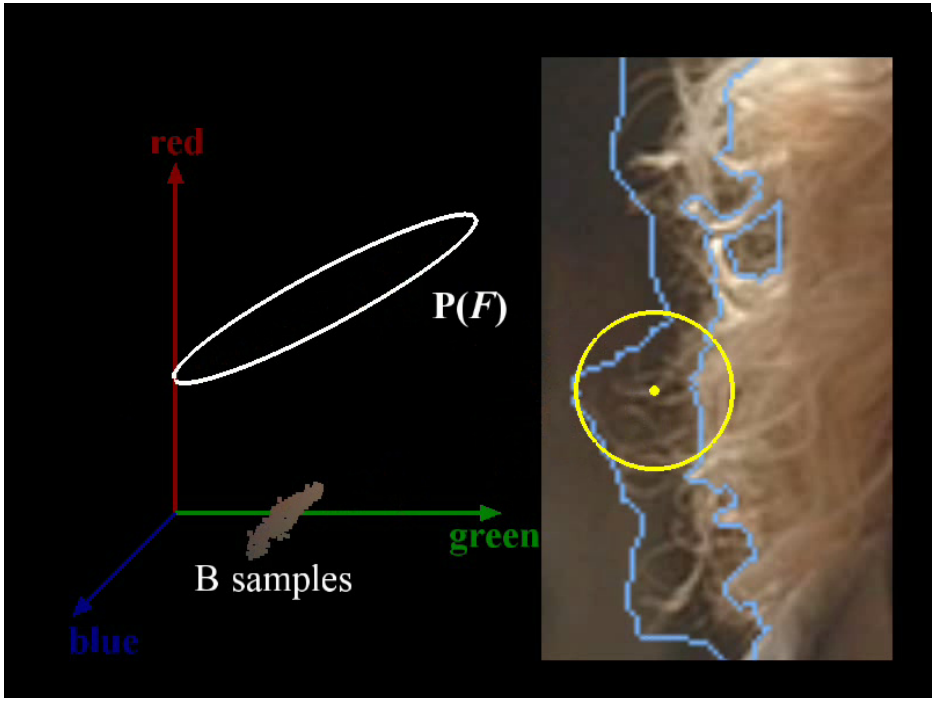

red
green
blue

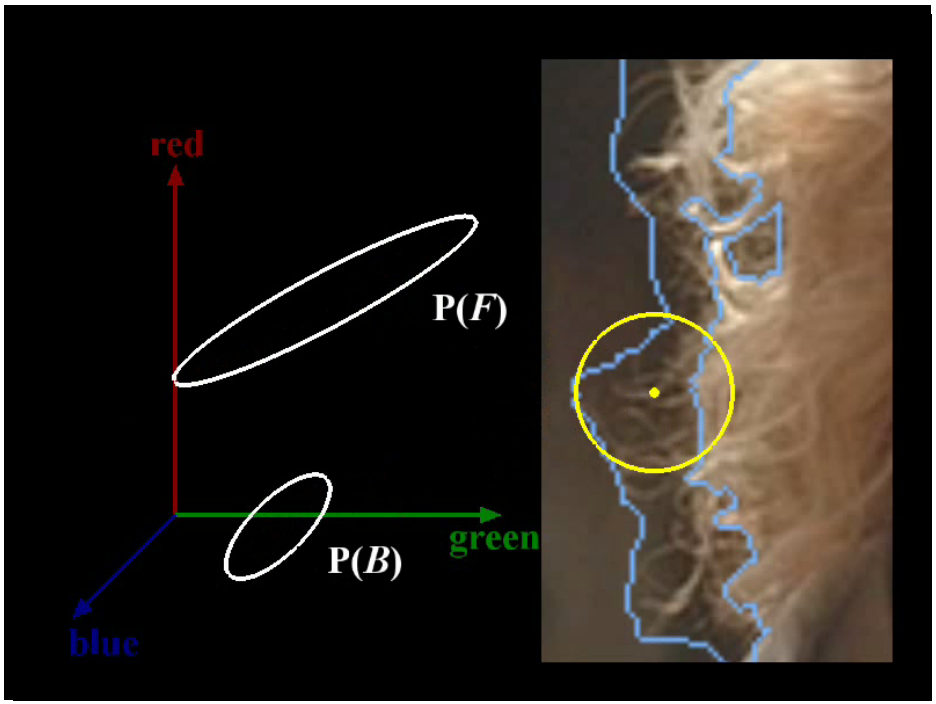

red
F samples
green
blue

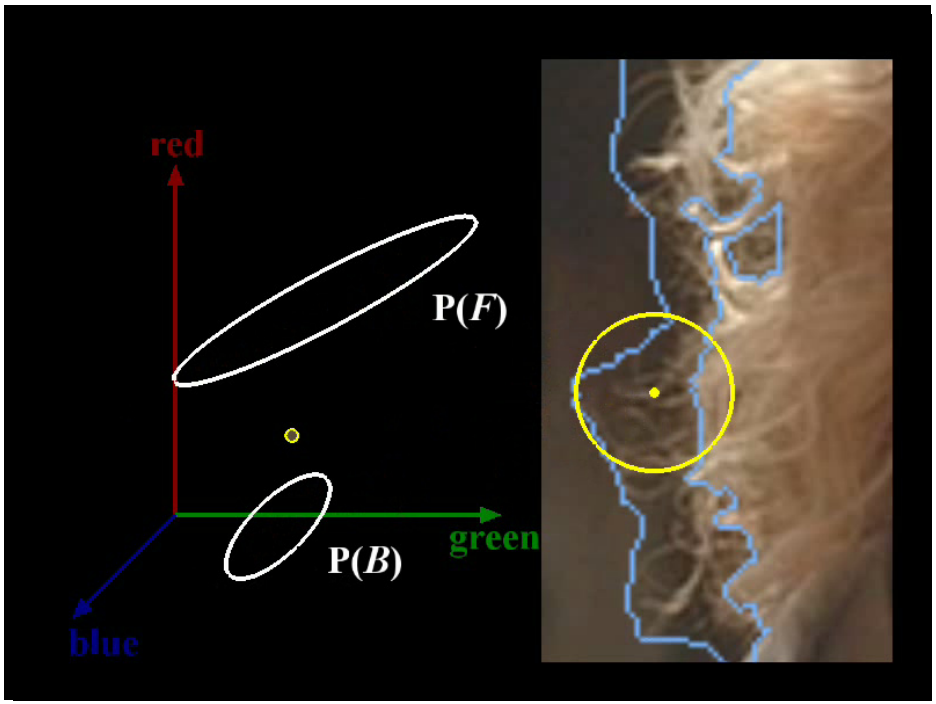

red
F samples
green
B samples
blue

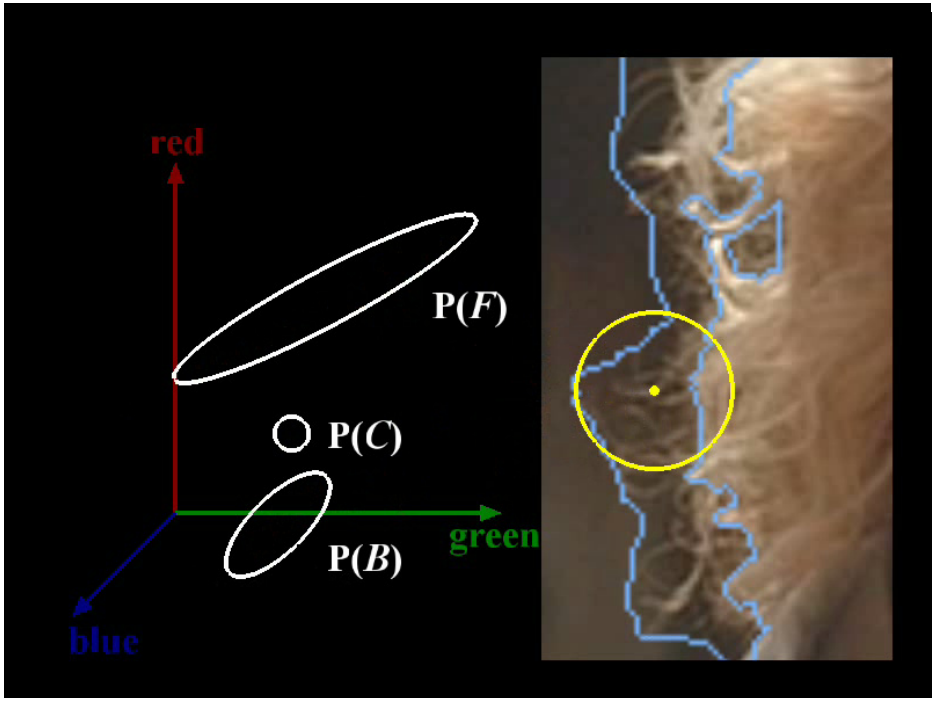

red
F samples
green
B samples
blue

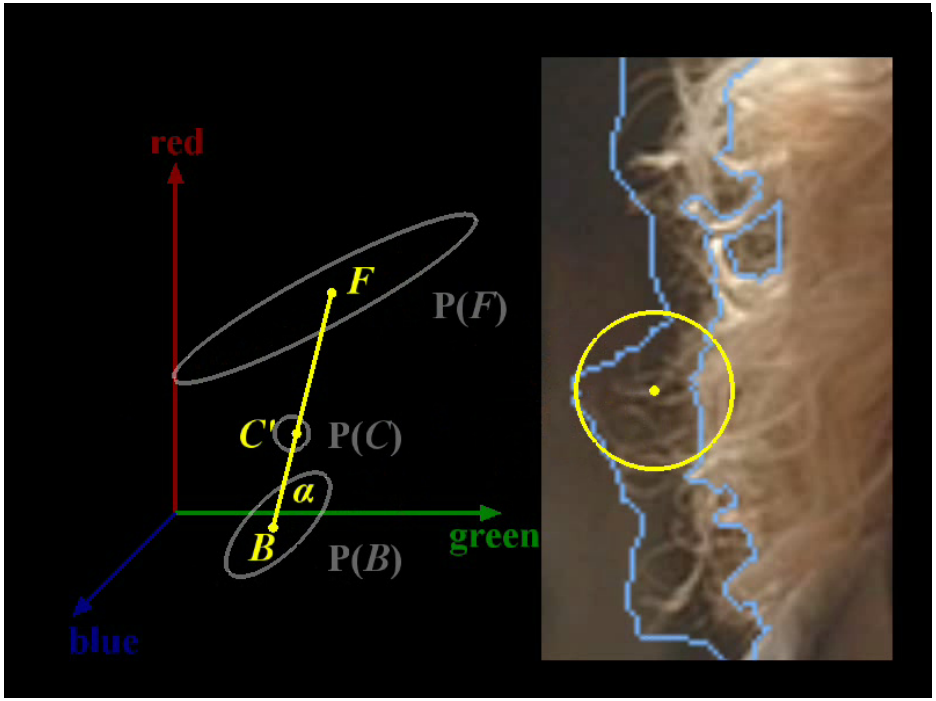

red
F samples
green
B samples
blue


red
P(F)
green
B samples
blue


red
P(F)
P(B)
green
blue


red
P(F)
P(B)
green
blue





alpha

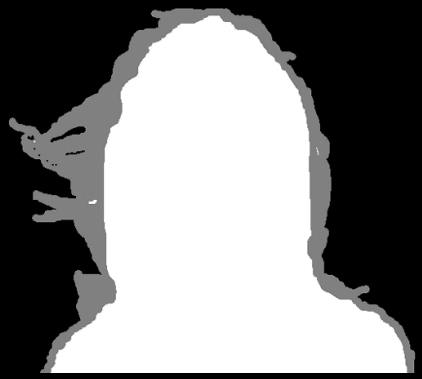
Results

input

composite

Results

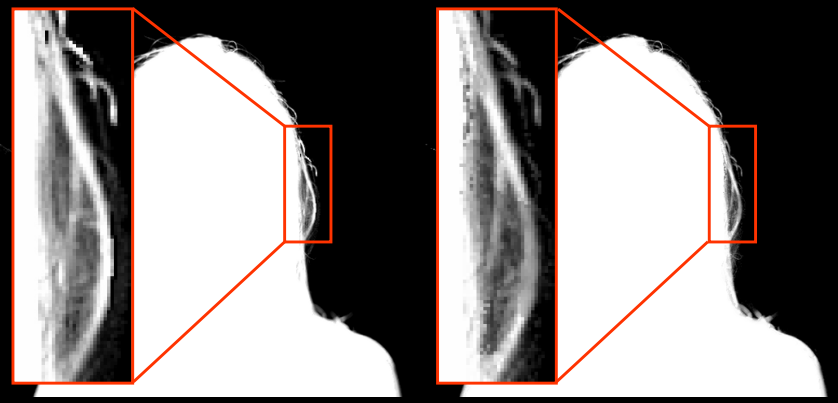
trimap



Comparisons

Bayesian

Ruzon-Tomasi



Comparisons

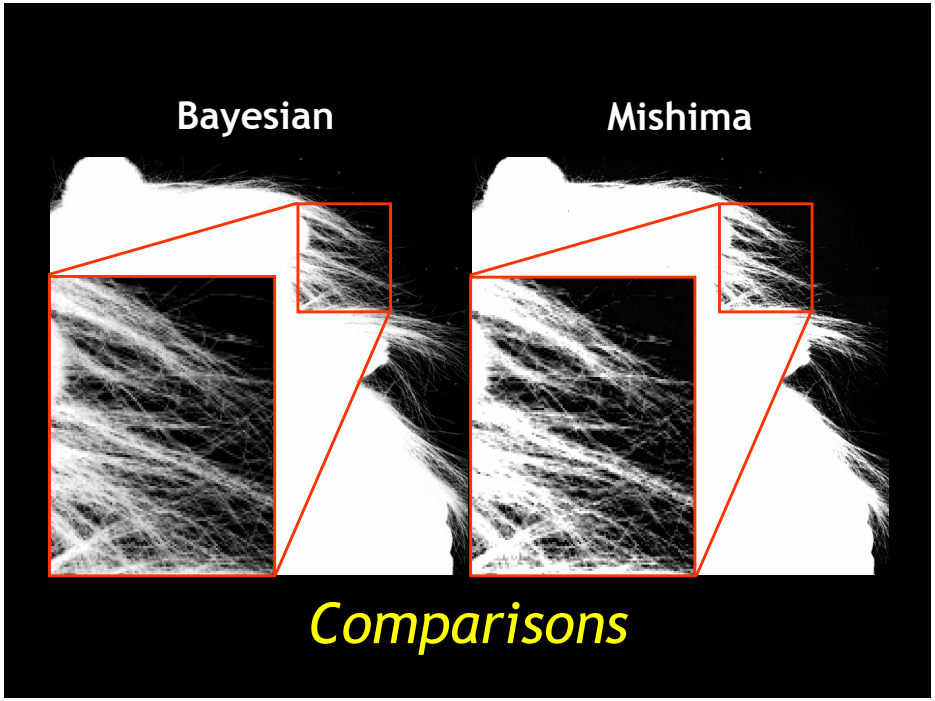
Bayesian

Ruzon-Tomasi

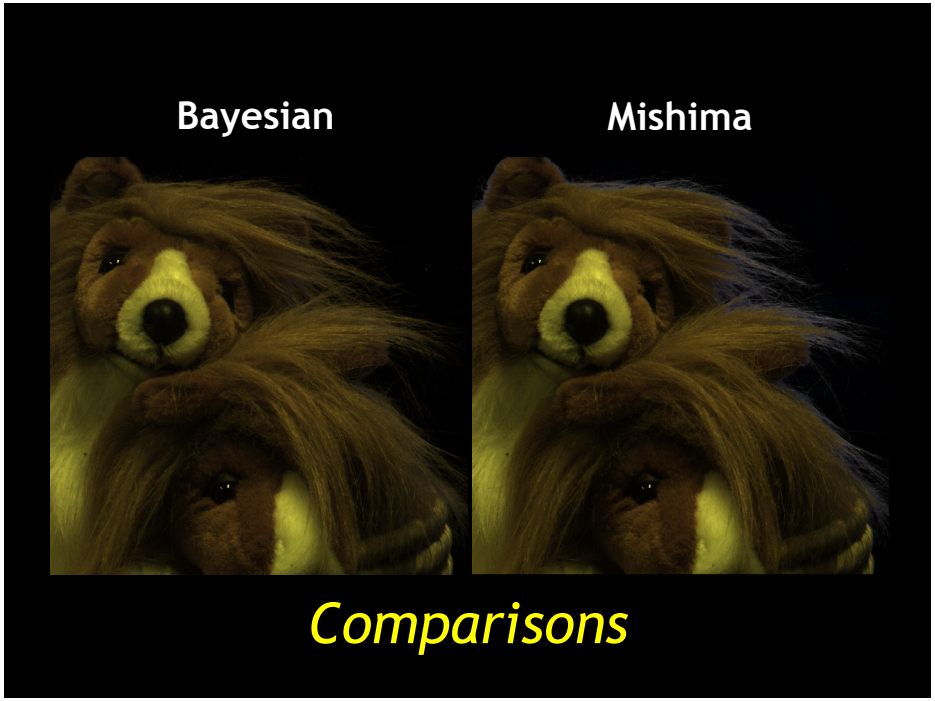
Comparisons

input image

Comparisons



Comparisons

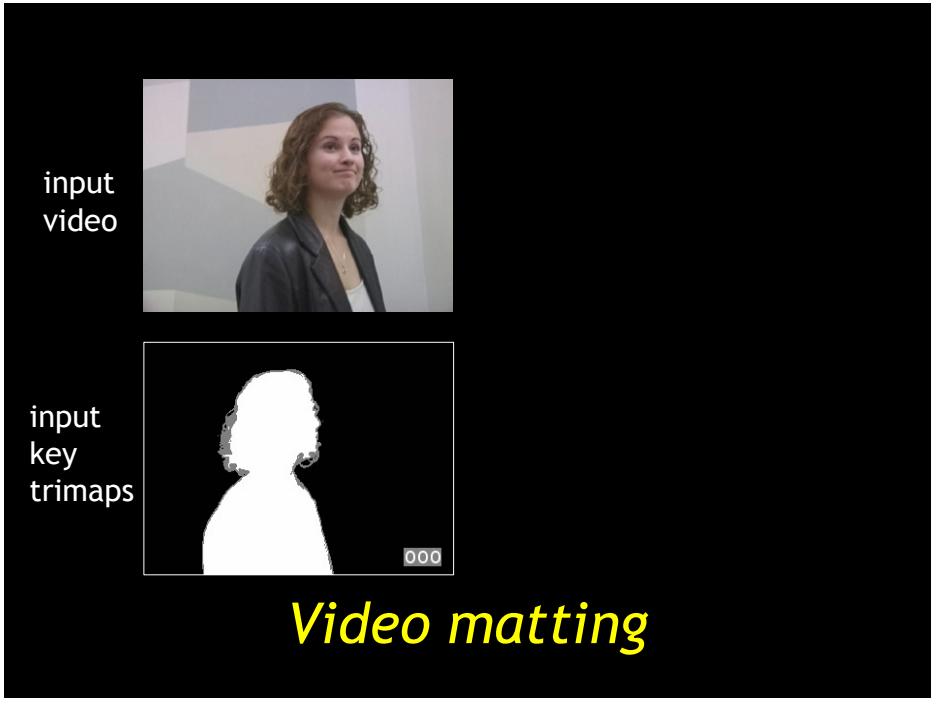


Comparisons

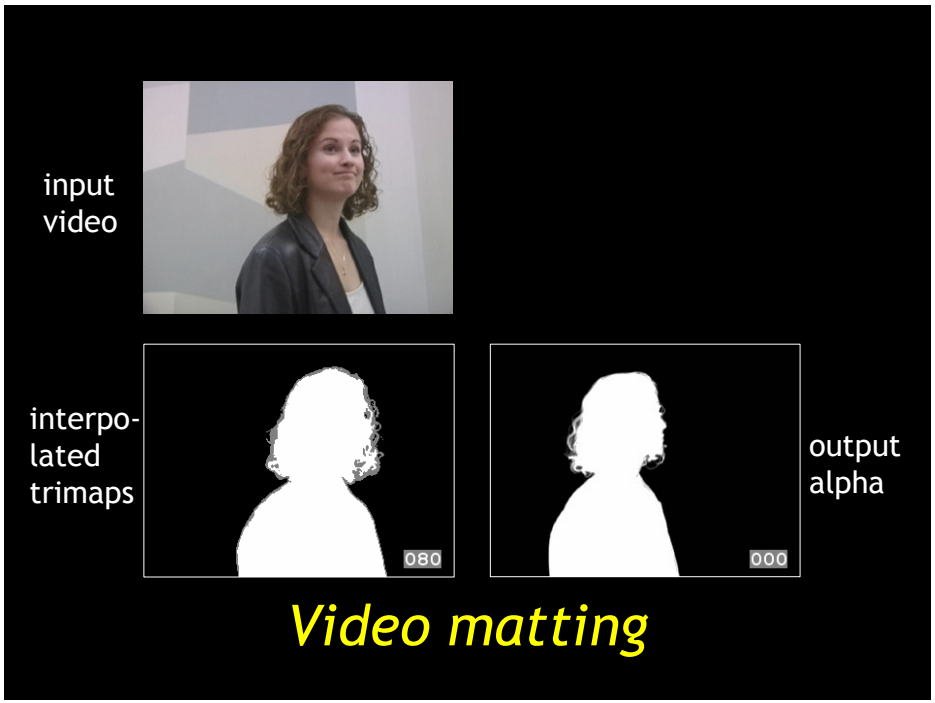
Video matting

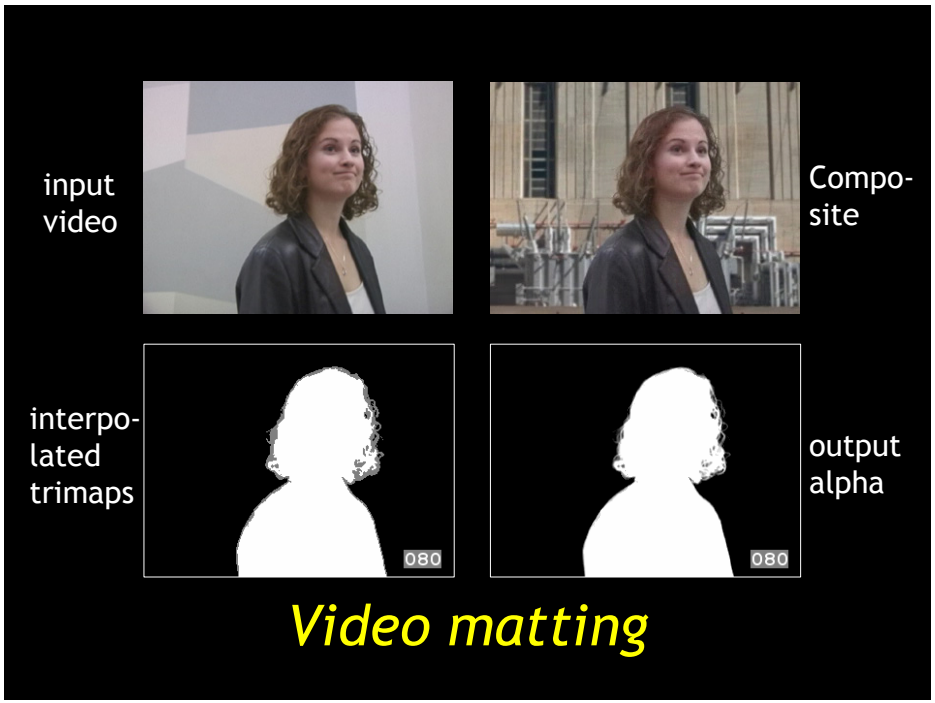
input video

Video matting


input
video
input
key
trimaps
000
Video matting


input
video
interpo-
lated
trimaps
000
Video matting


input
video
interpo-
lated
trimaps
080
000
output
alpha
Video matting


input
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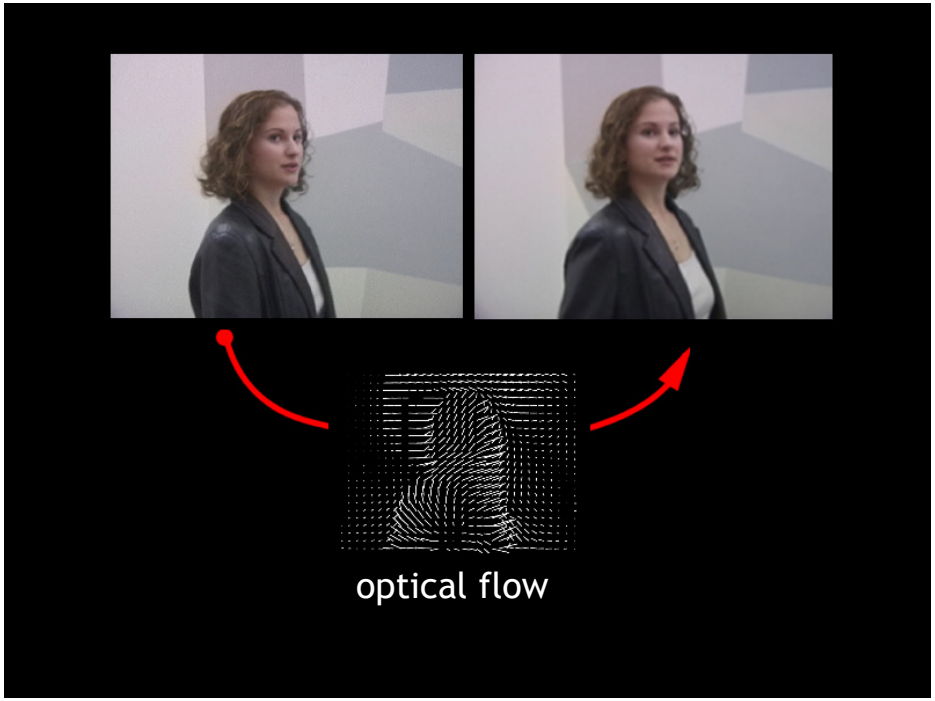
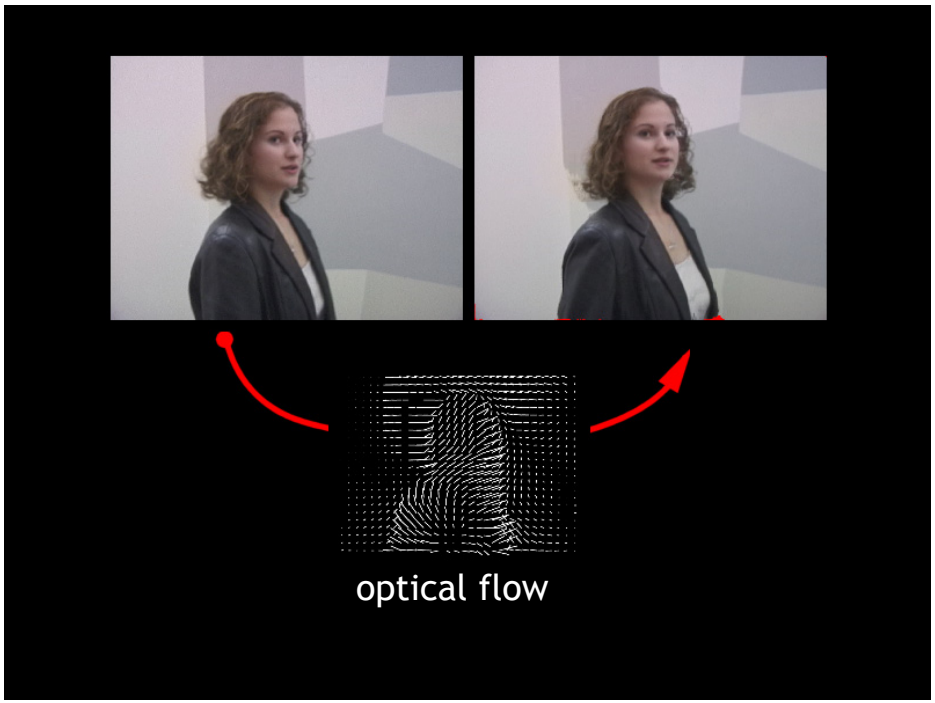
080
output
alpha
Video matting


optical flow


optical flow


t
t+1
t+2
t+3


t
t+1
t+2
t+3

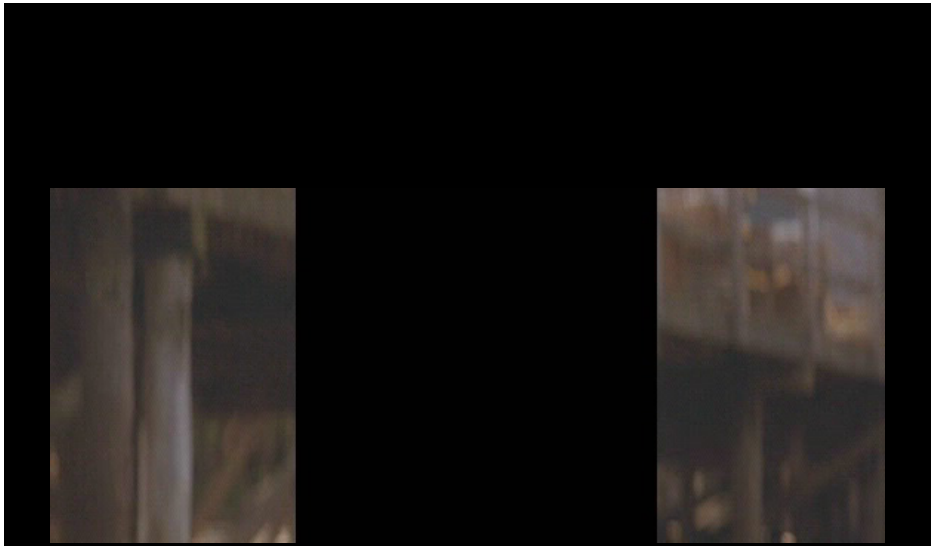

t
t+1
t+2
t+3


t
t+1
t+2
t+3

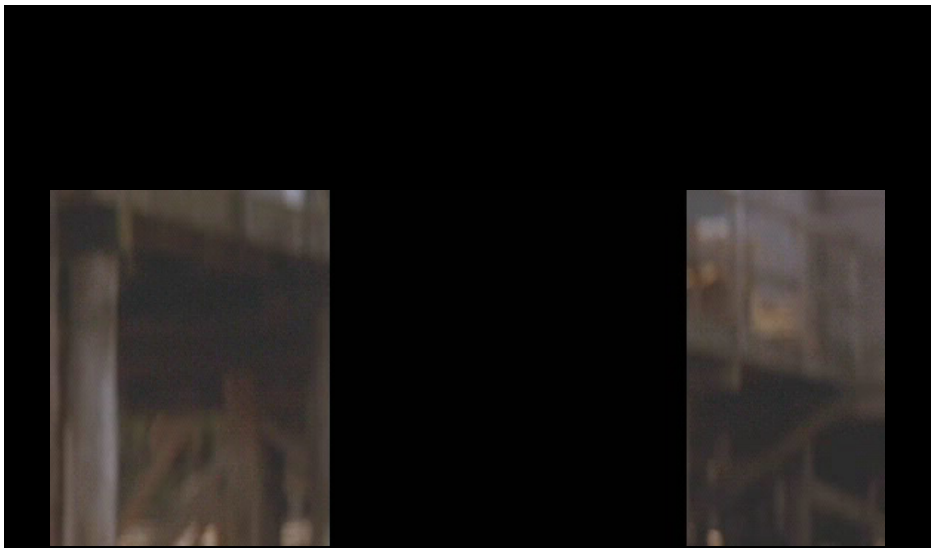

t
t+1
t+2
t+3


Sample composite

Garbage mattes



Garbage mattes



Background estimation

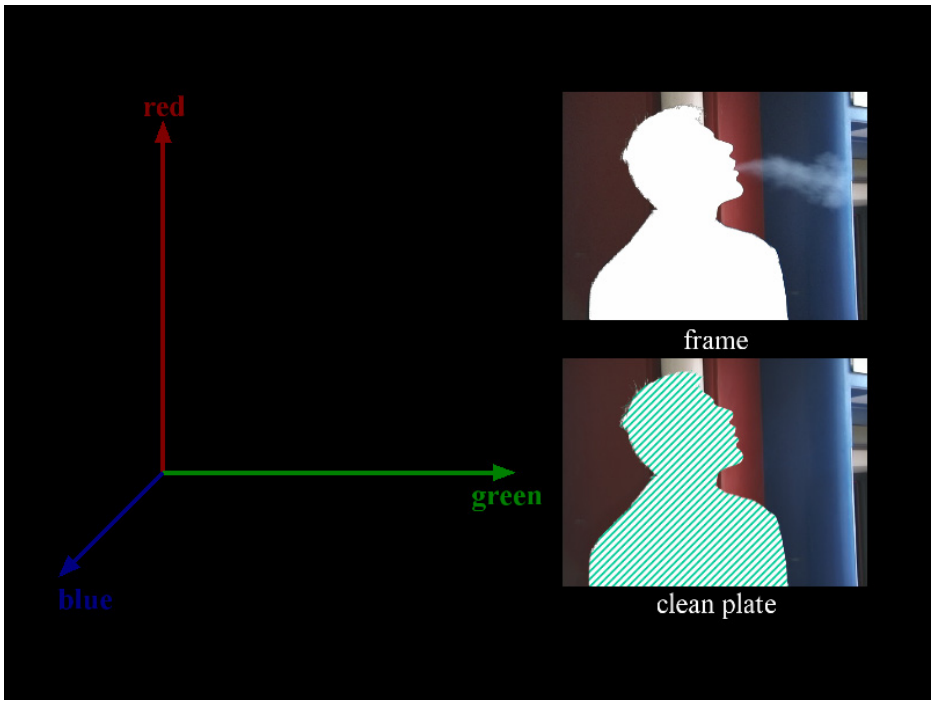
Background estimation

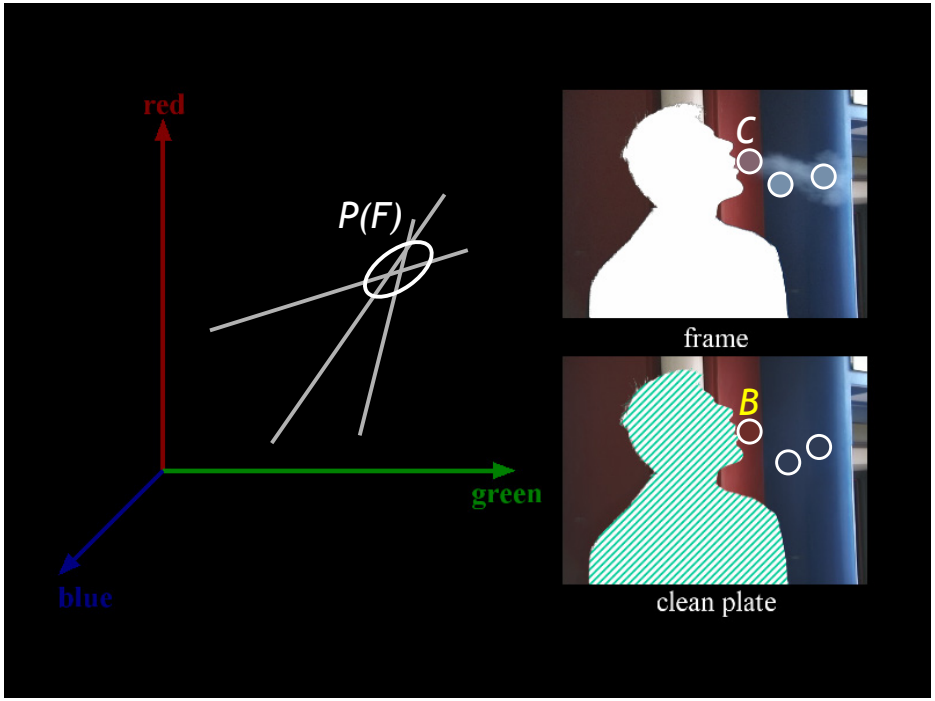
Alpha matte

without background

with background

Comparison


red
green
blue
frame
clean plate


red
P(F)
green
blue
C
frame
B
clean plate

Shadow matting
and compositing

source scene

target background

blue screen image

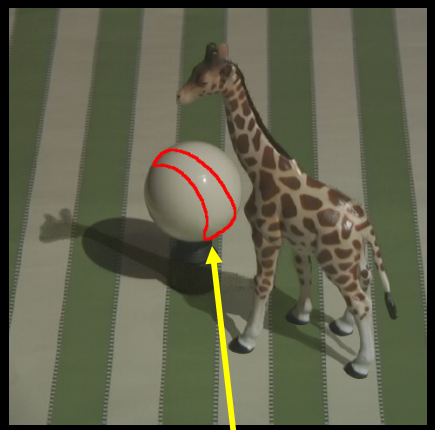
target background

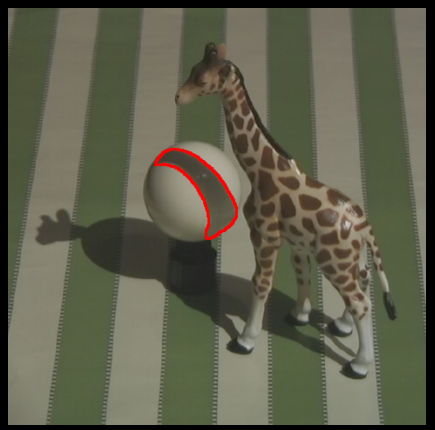
blue screen composite

target background

blue screen composite photograph

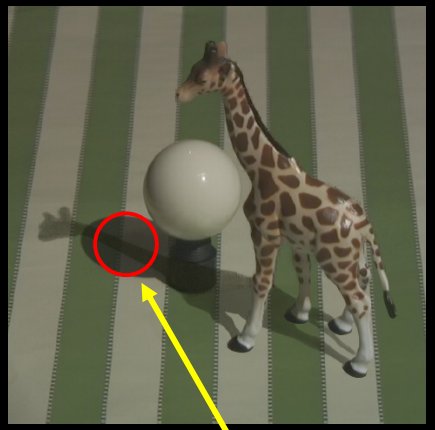
blue screen composite photograph



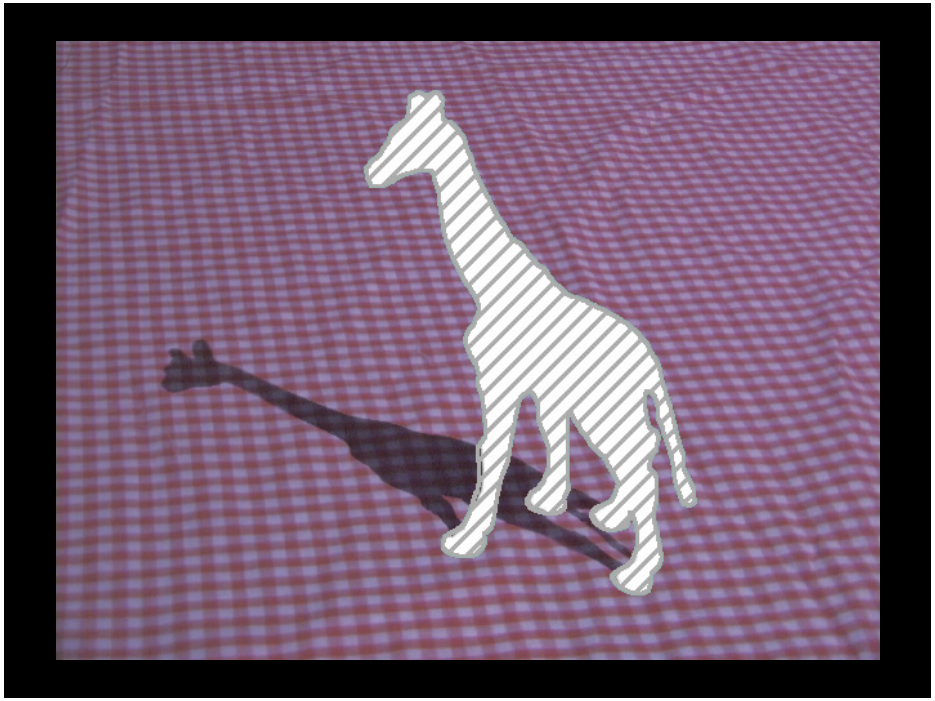


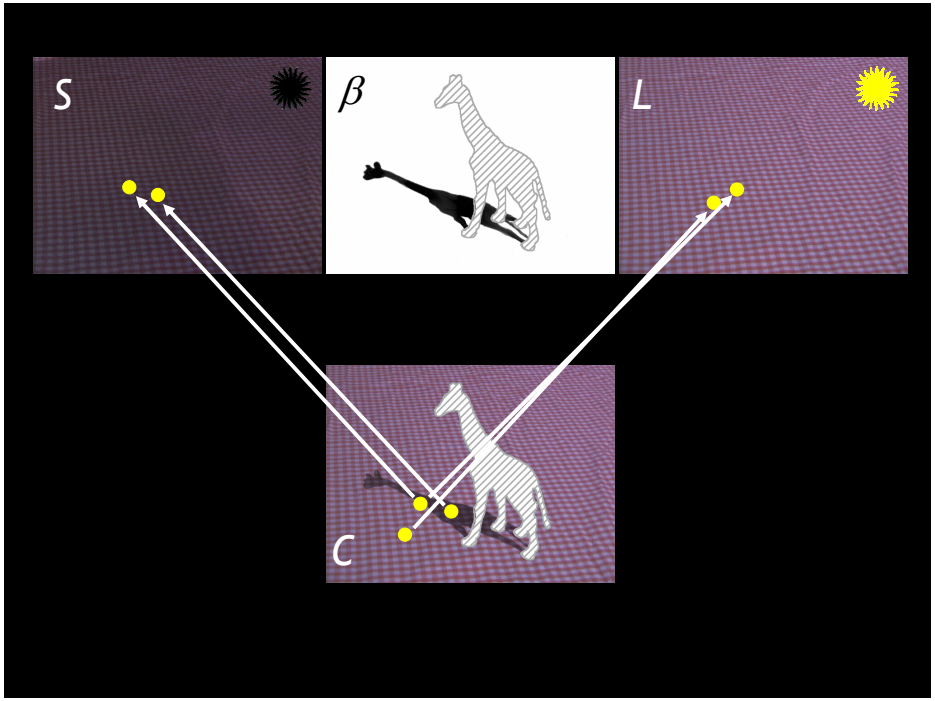
Geometric errors

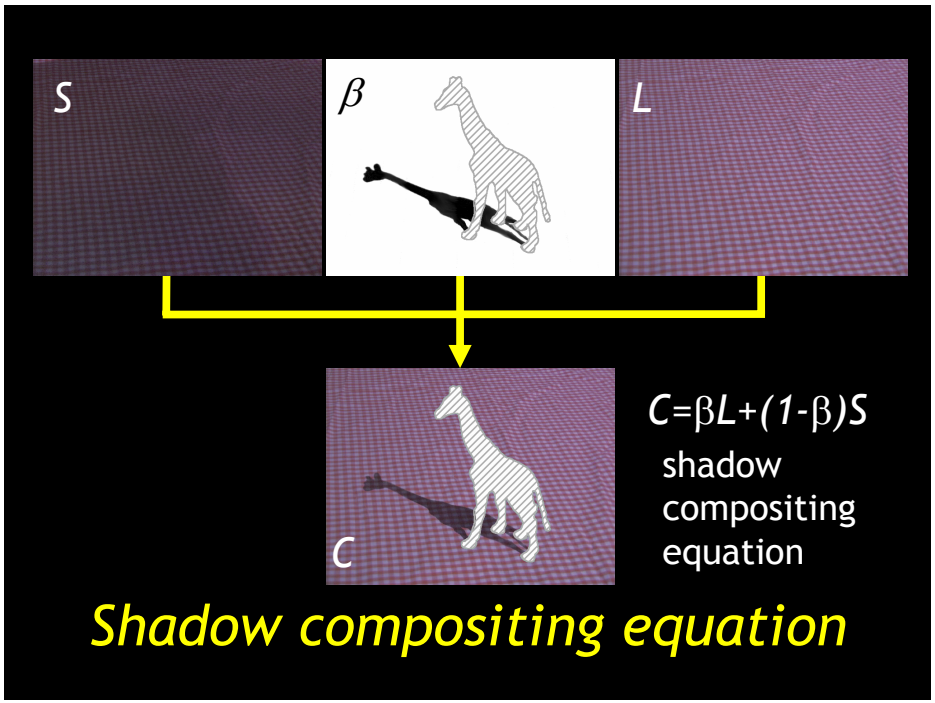
blue screen composite photograph

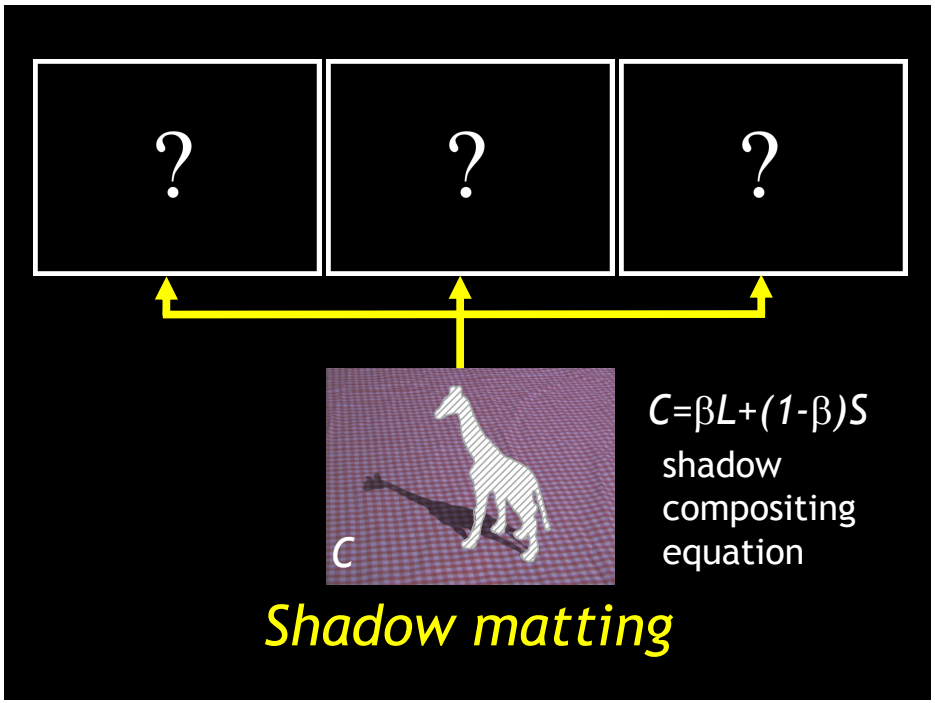


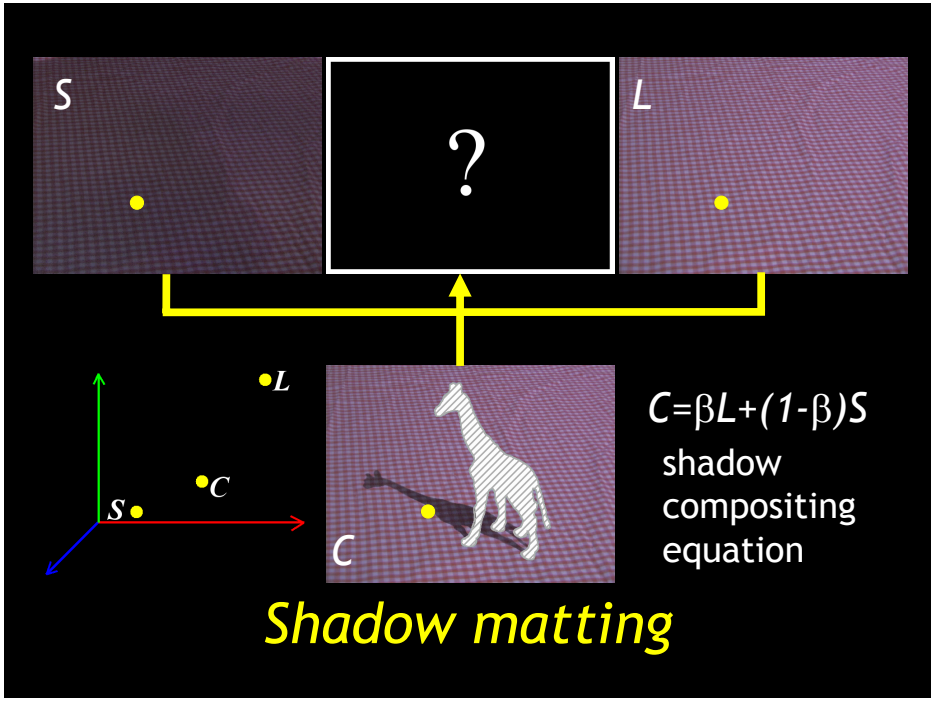
Photometric errors

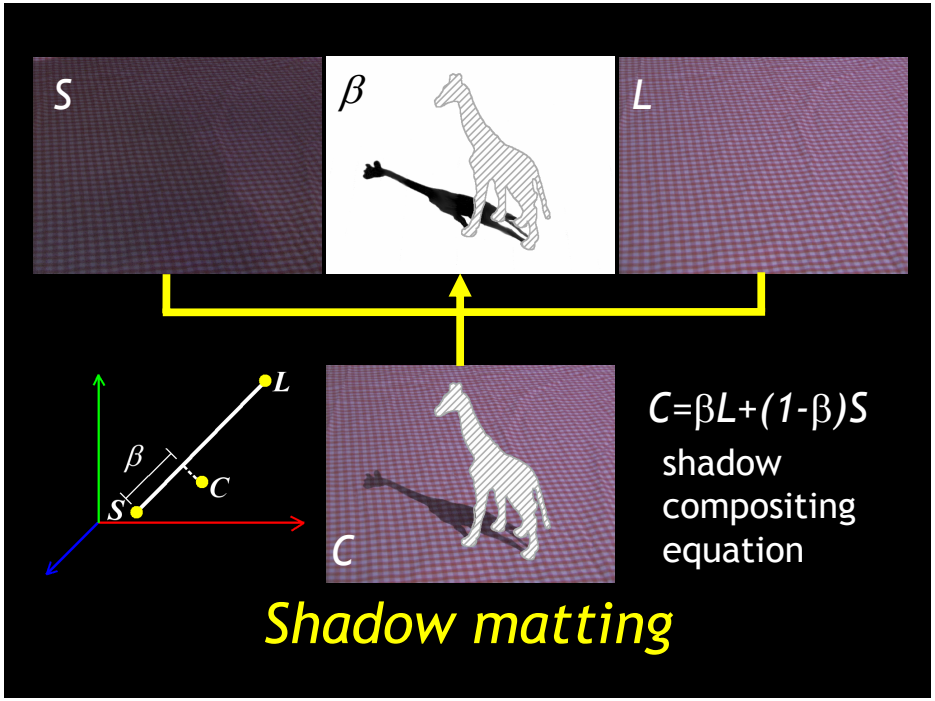



S
β
L
C


S
β
L
C
C=βL+(1-β)S
shadow
compositing
equation
Shadow compositing equation


?
?
?
C
C=βL+(1-β)S
shadow
compositing
equation
Shadow matting


S
?
L
L
C
S
C
C=βL+(1-β)S
shadow
compositing
equation
Shadow matting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compositing
equation
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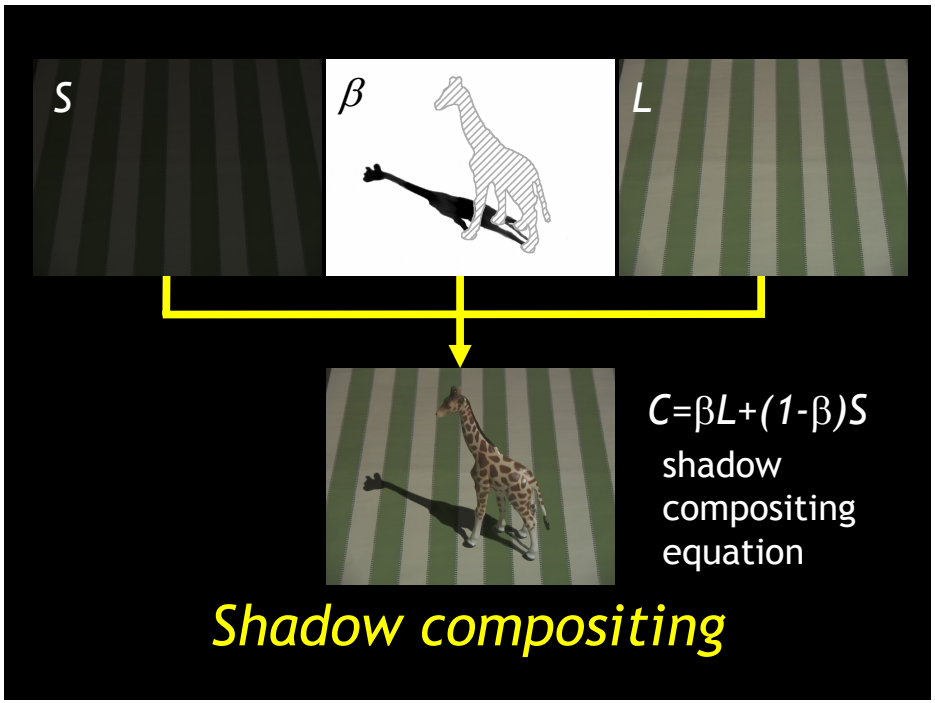
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L
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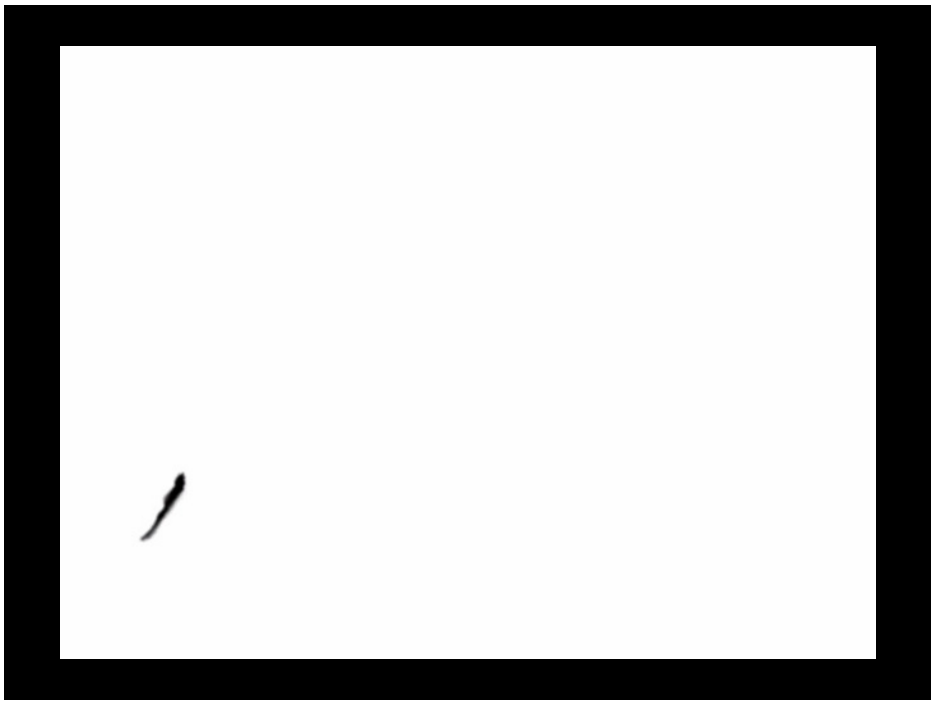
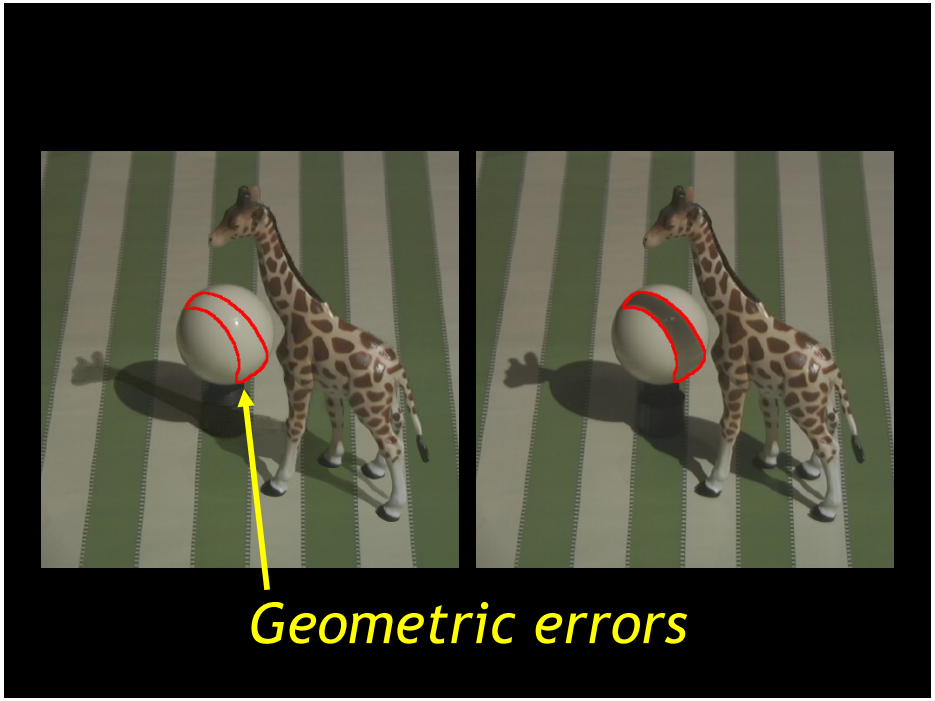
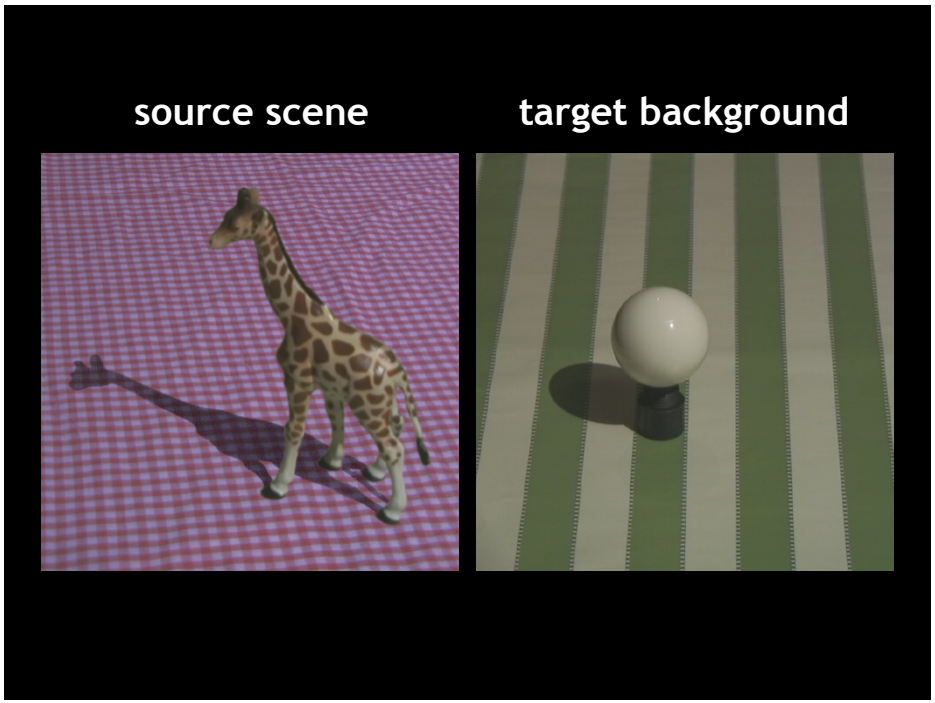
shadow
compositing
equation
Shadow compositing




Geometric errors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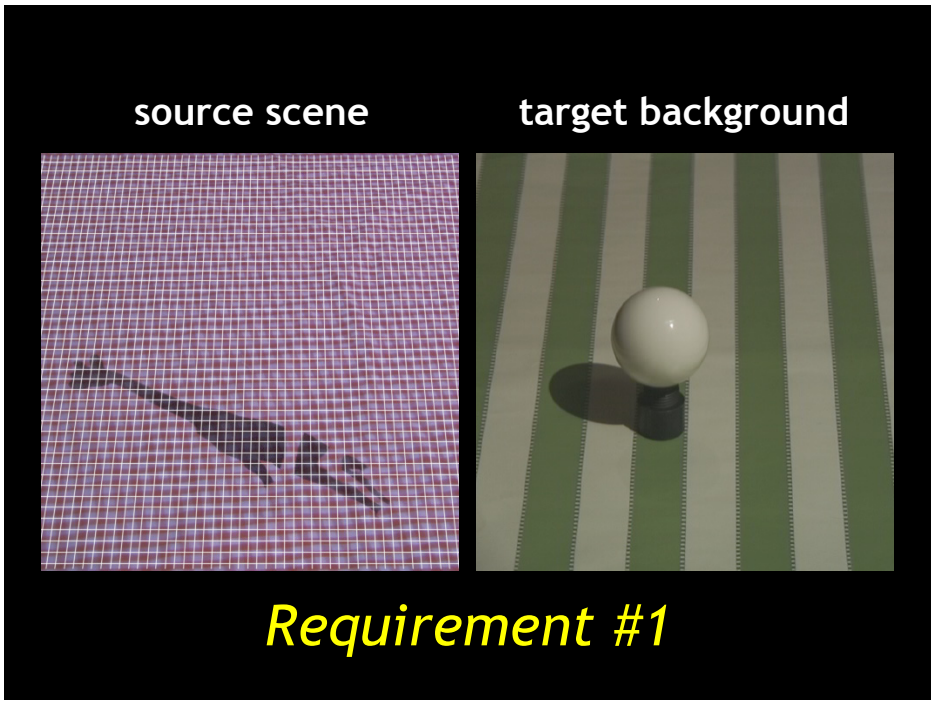
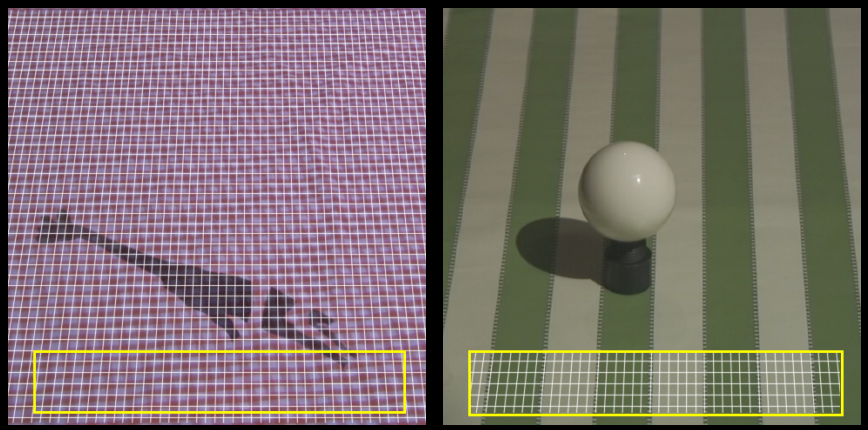
target background

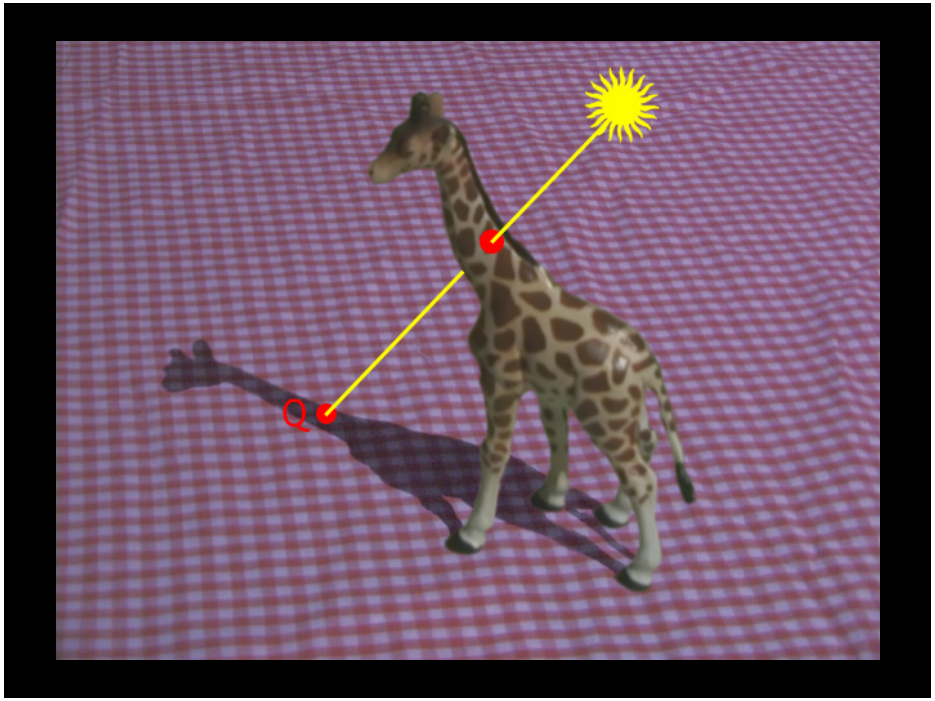

source scene
target background
Requirement #1

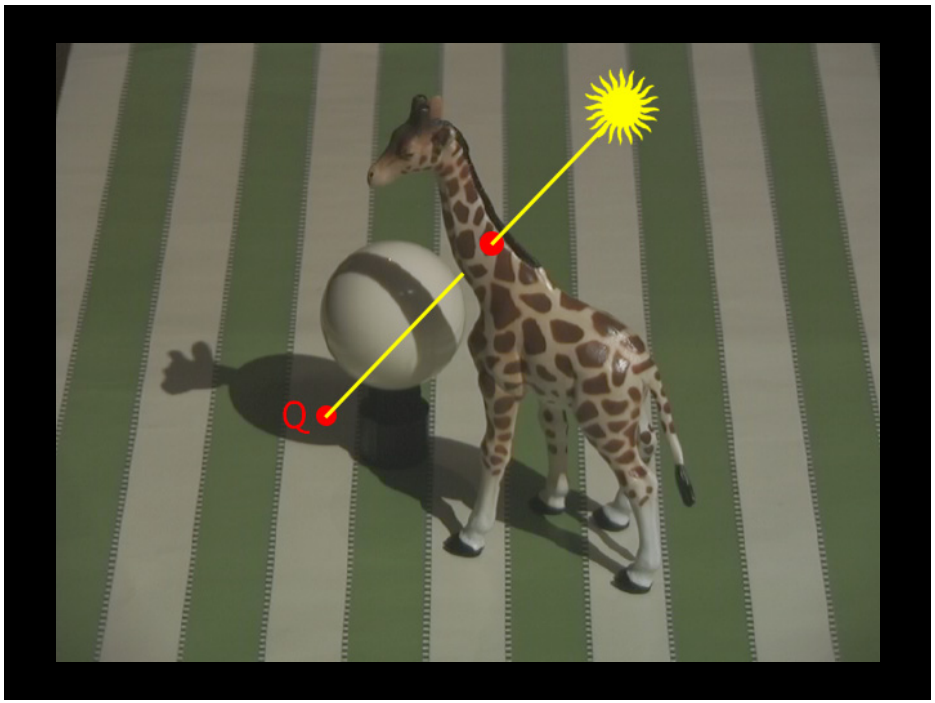
source scene

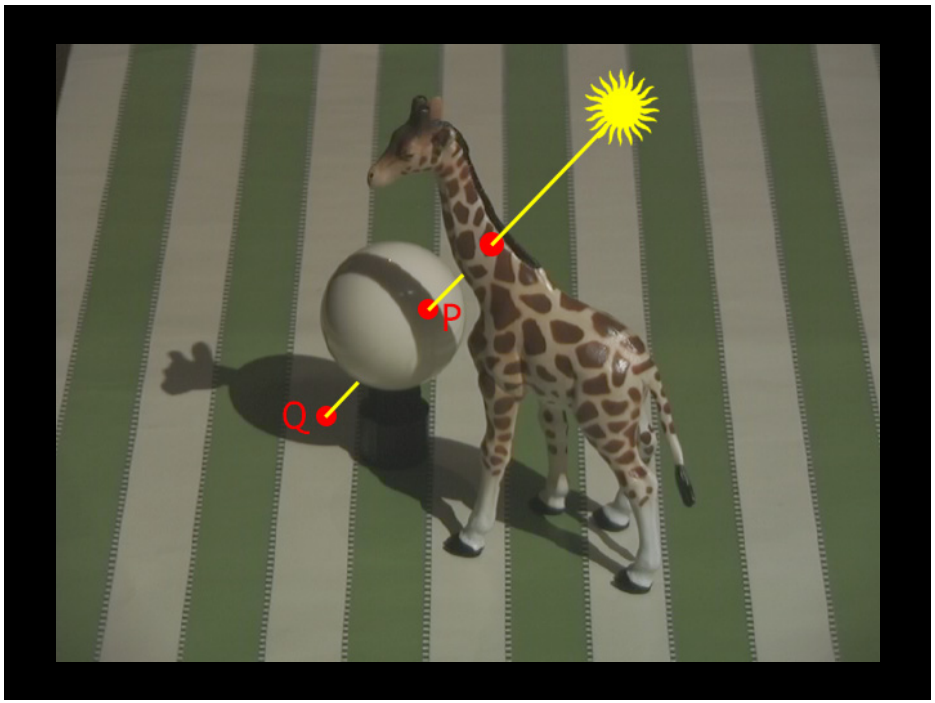
target background

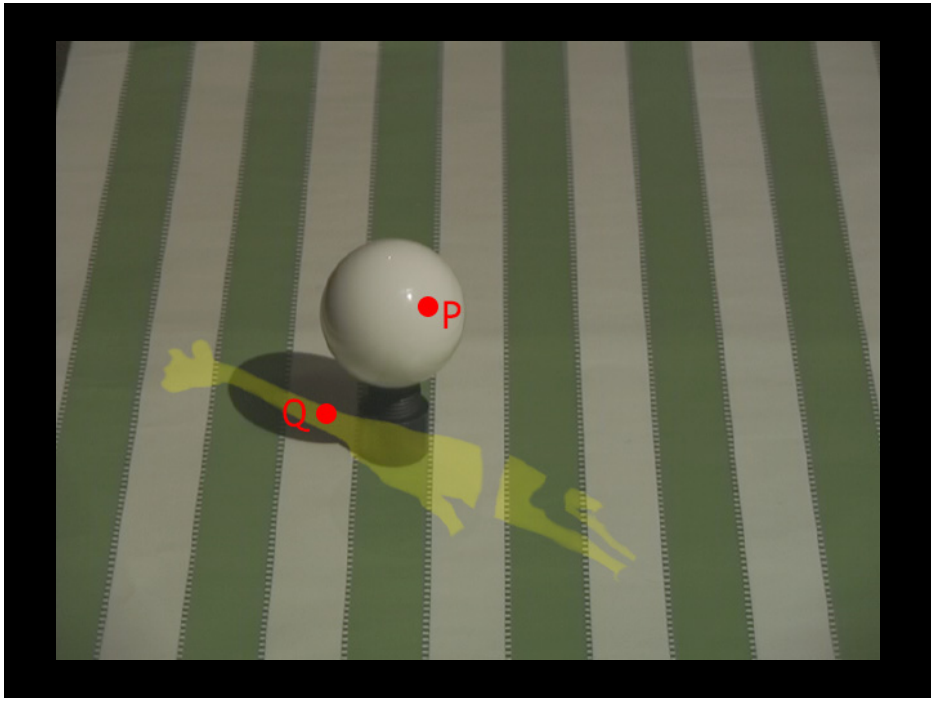


Requirement #2





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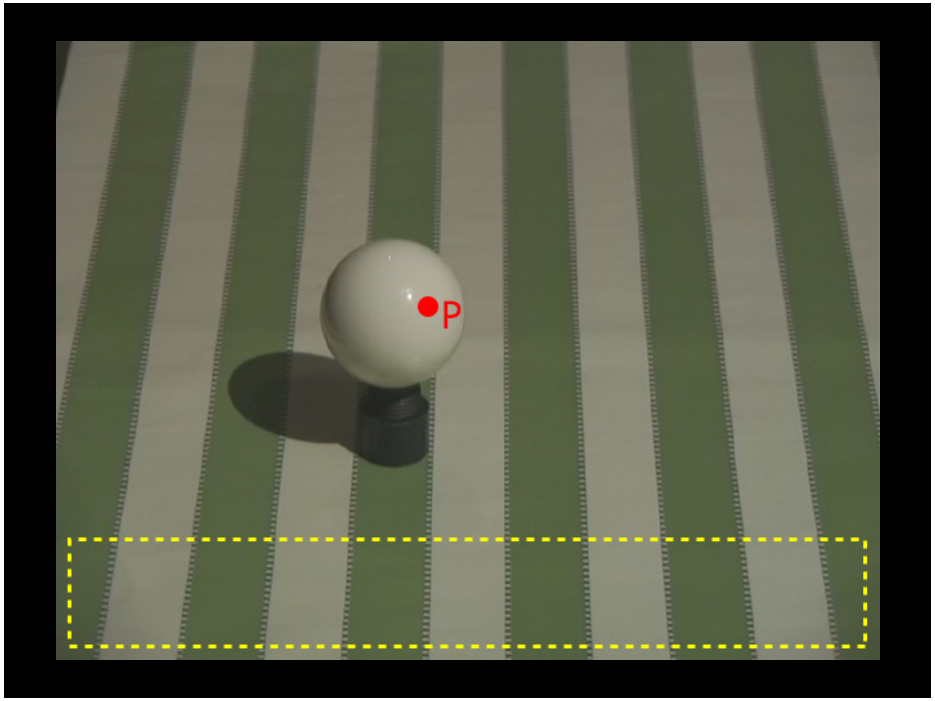
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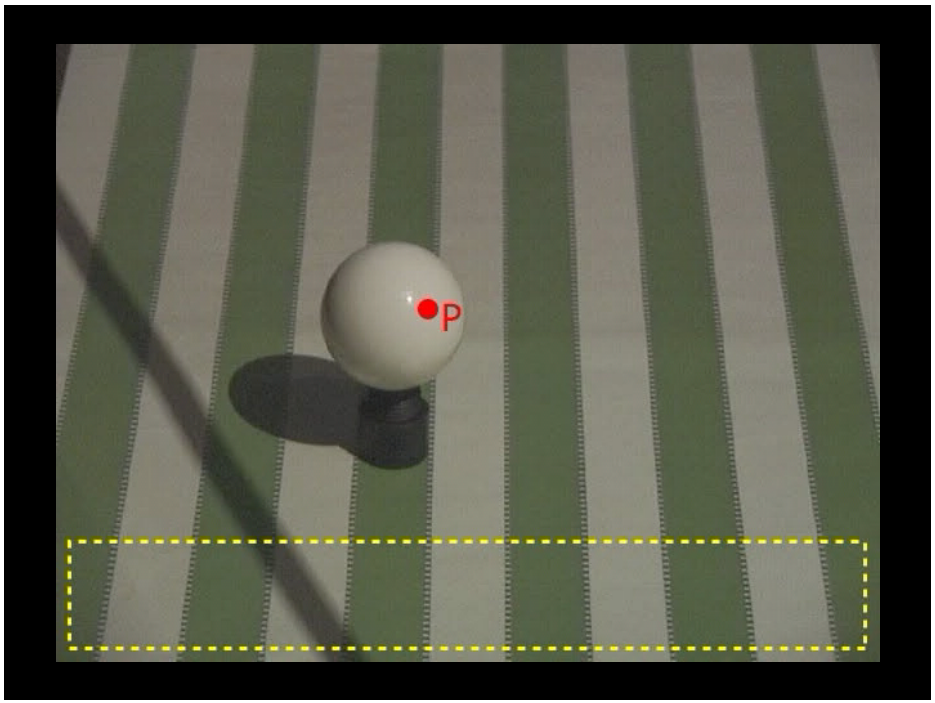
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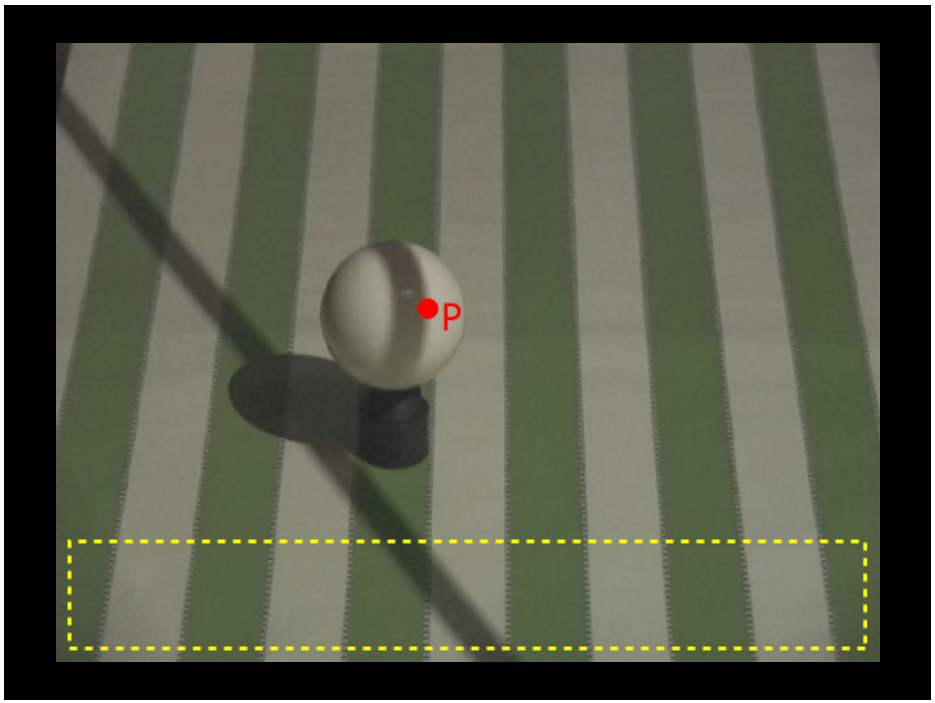
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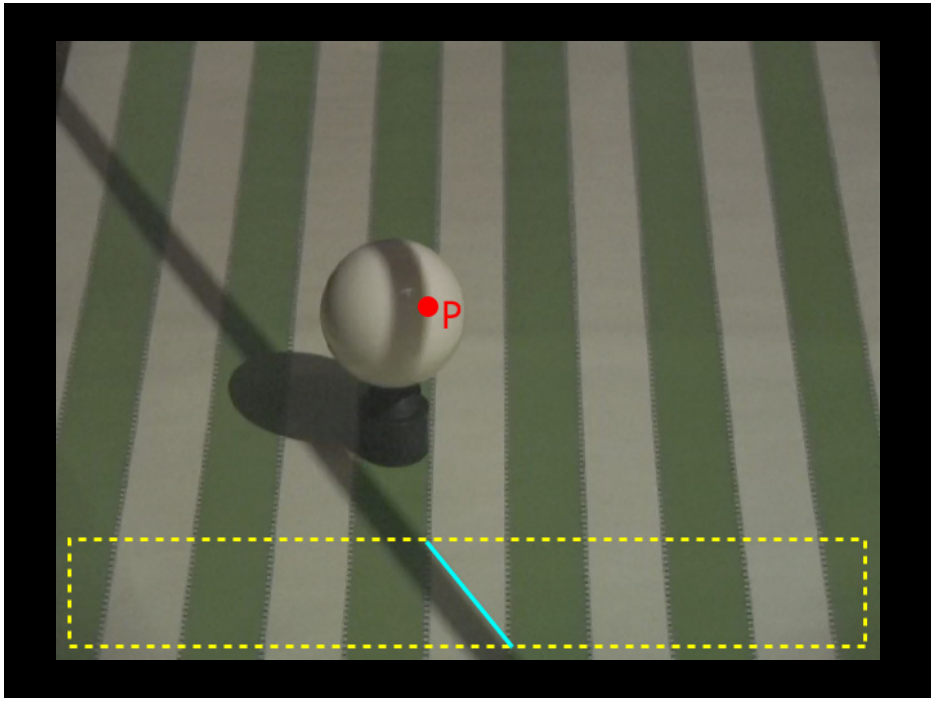
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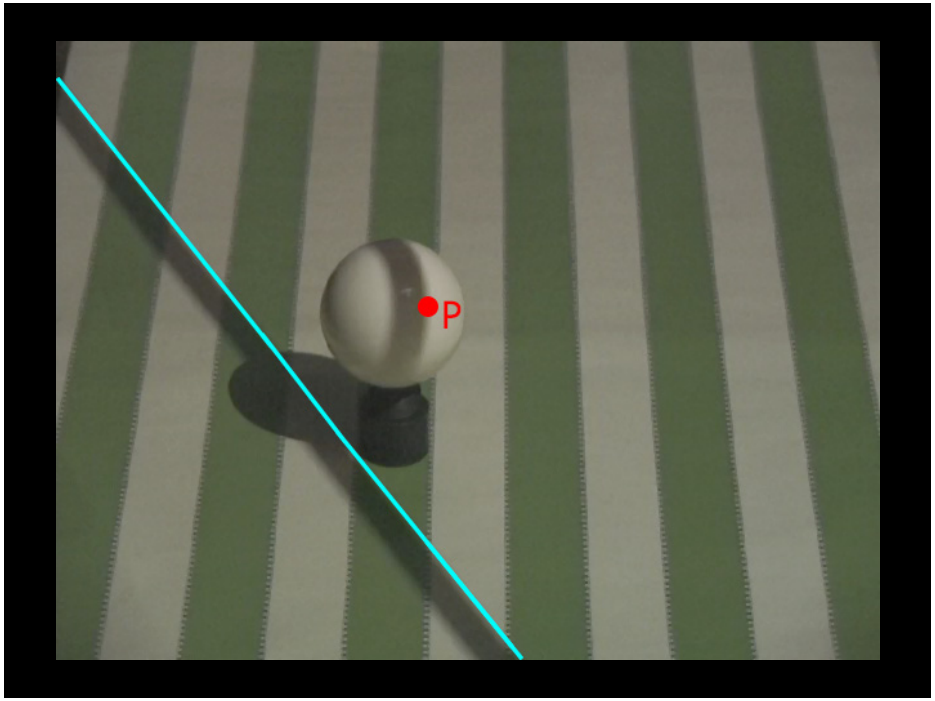
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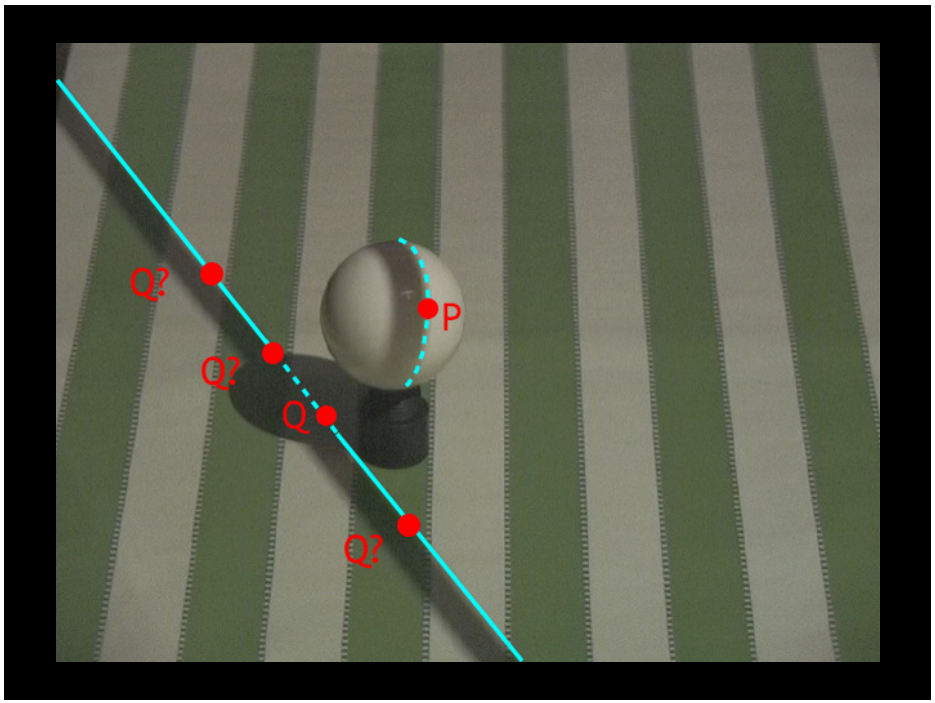
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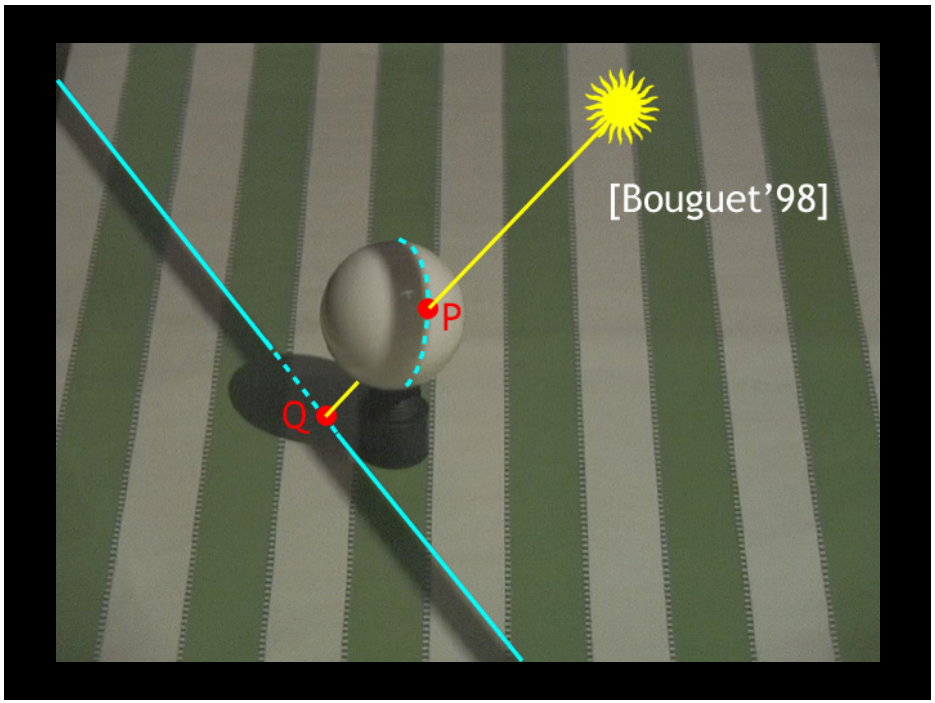
Q?
Q?
Q?
Q?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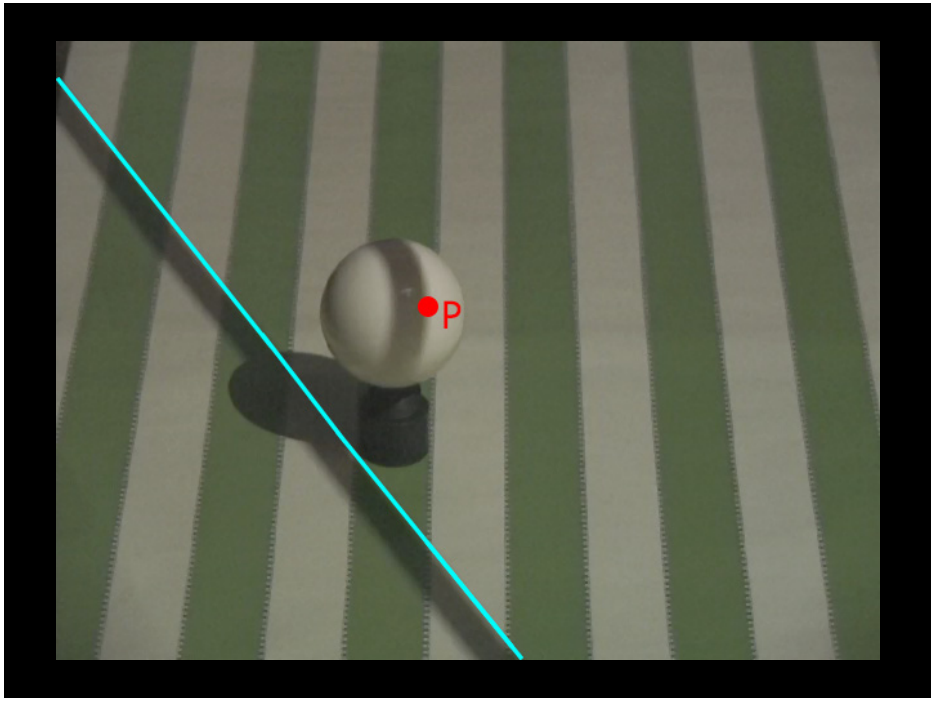
[Bouguet'98]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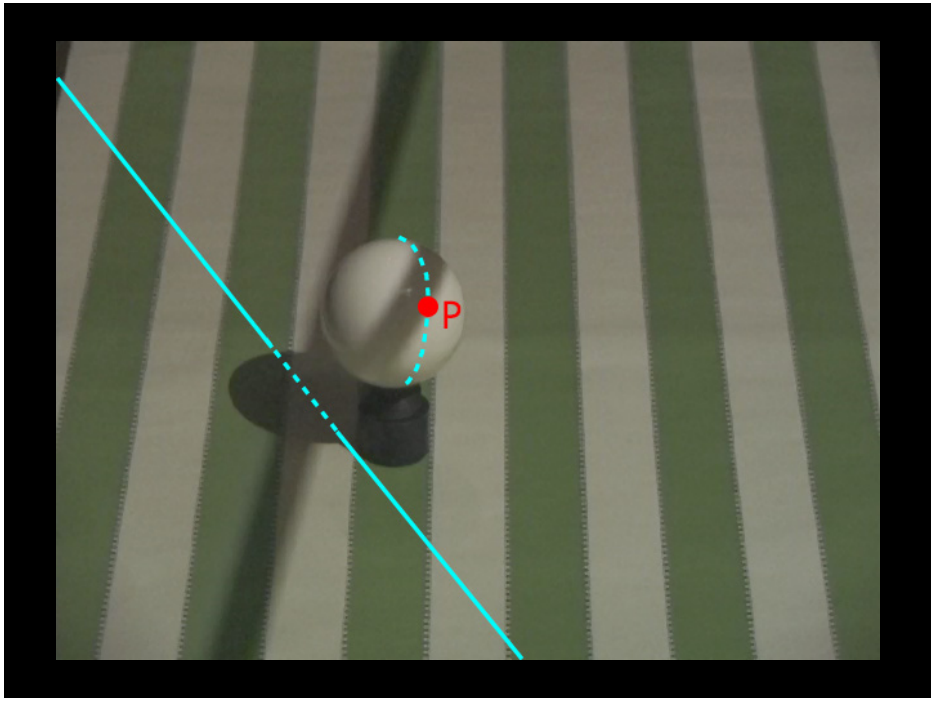
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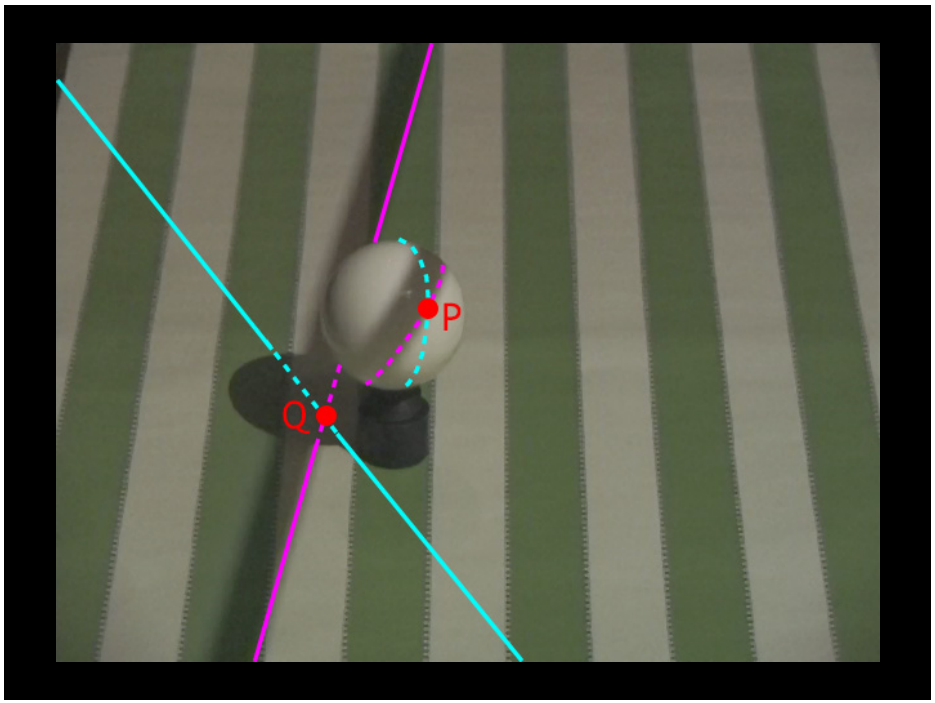
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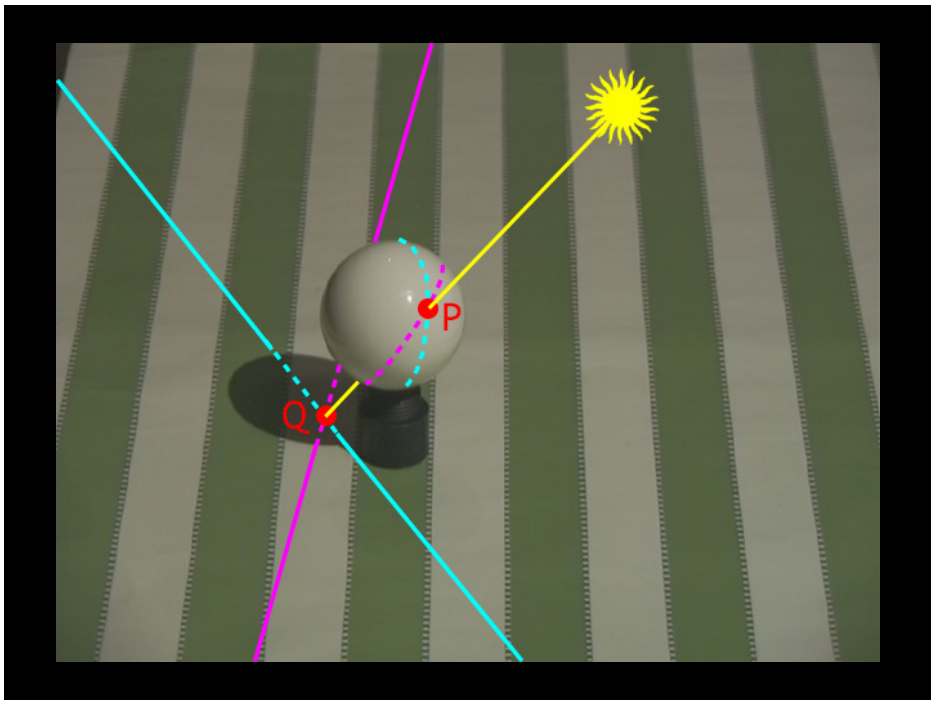
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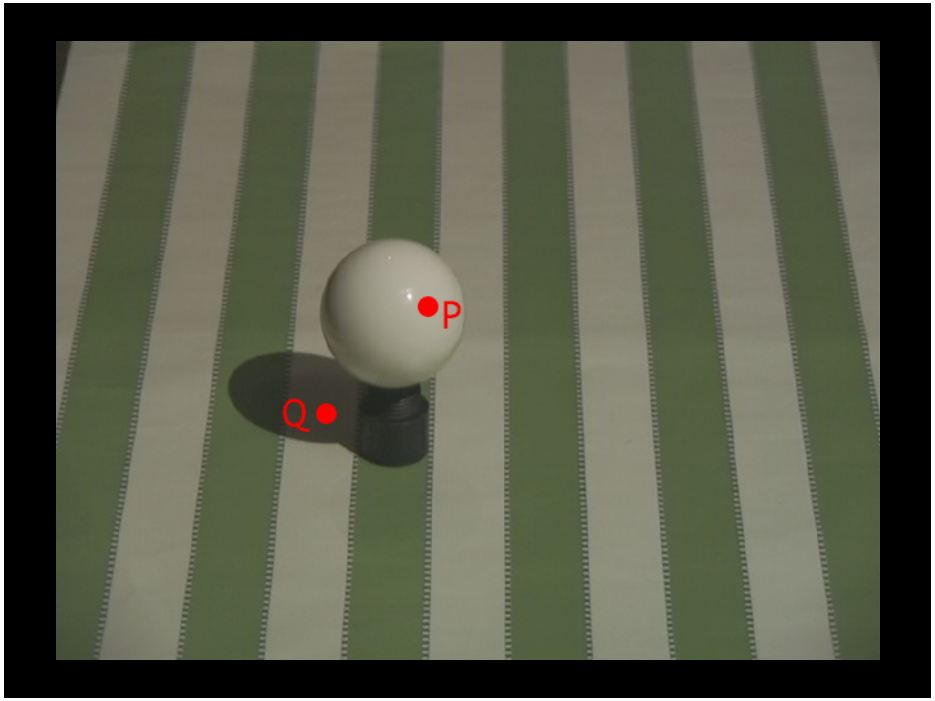
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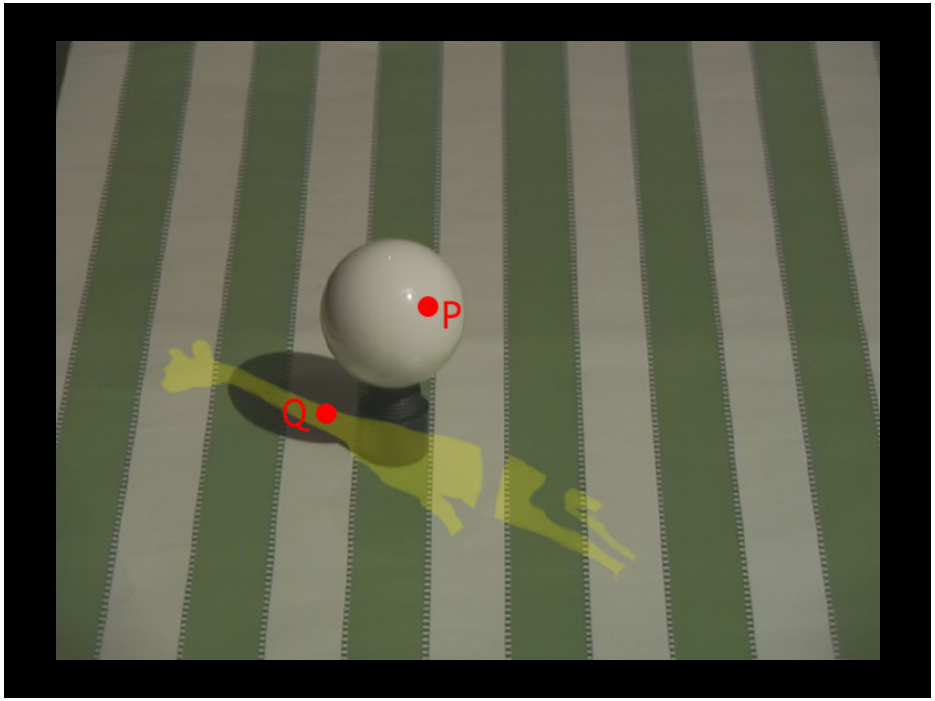
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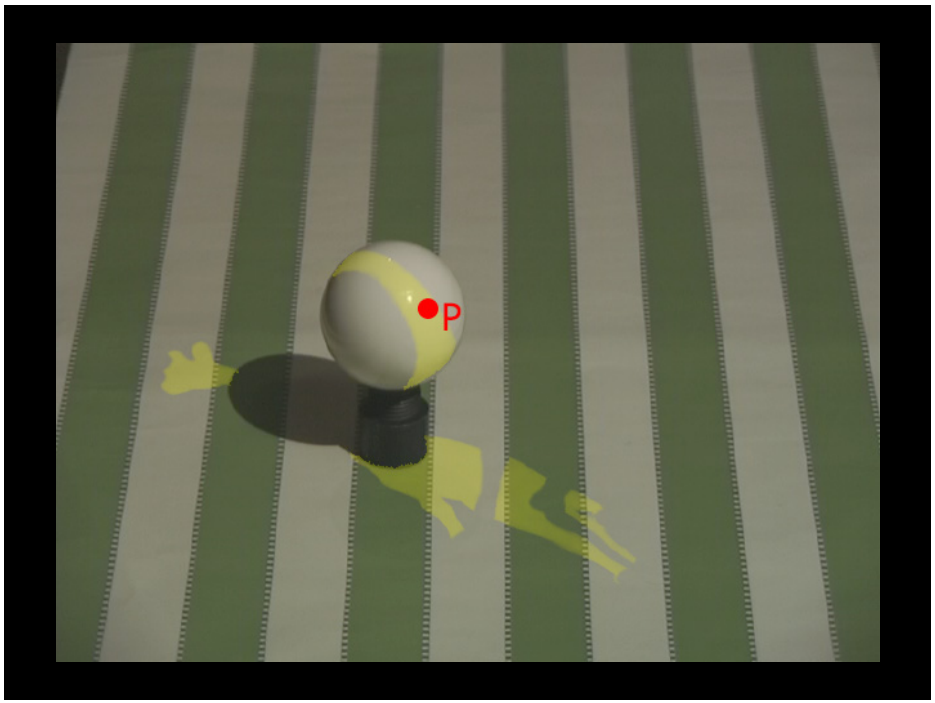
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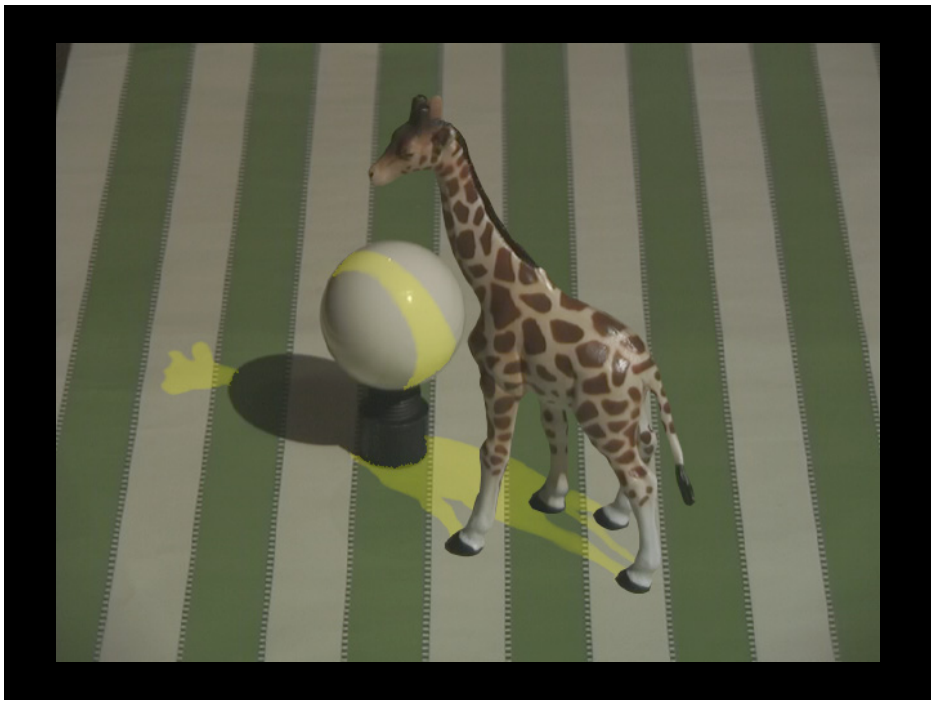

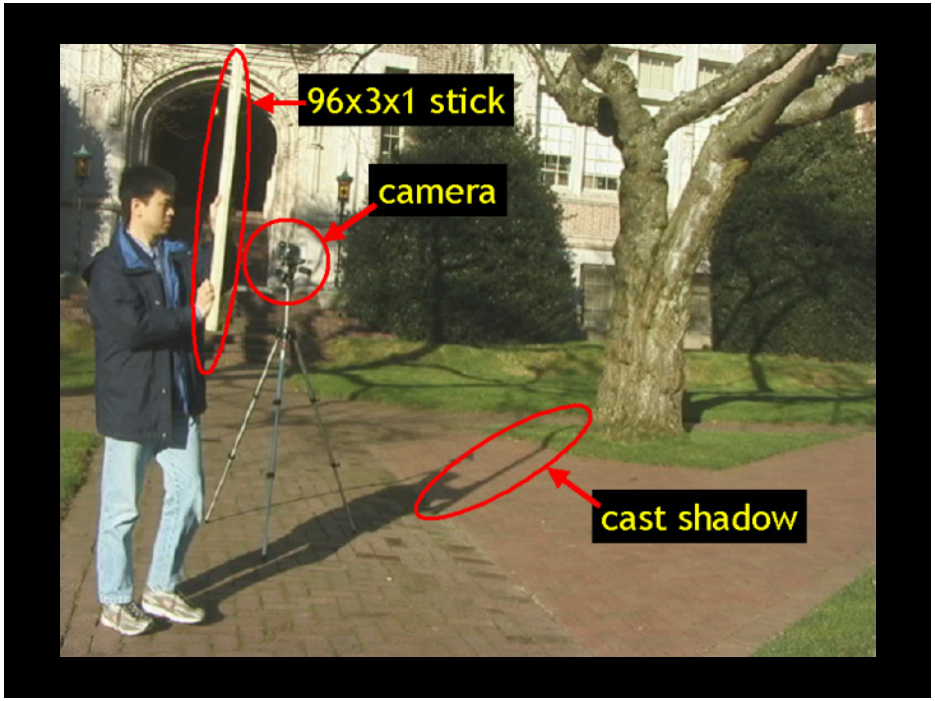
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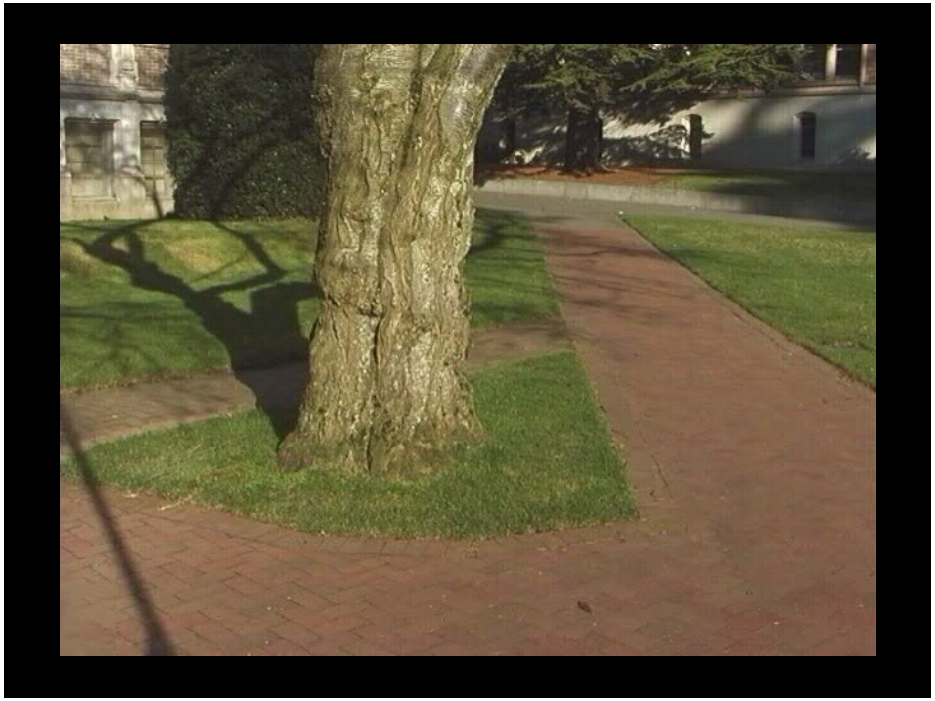
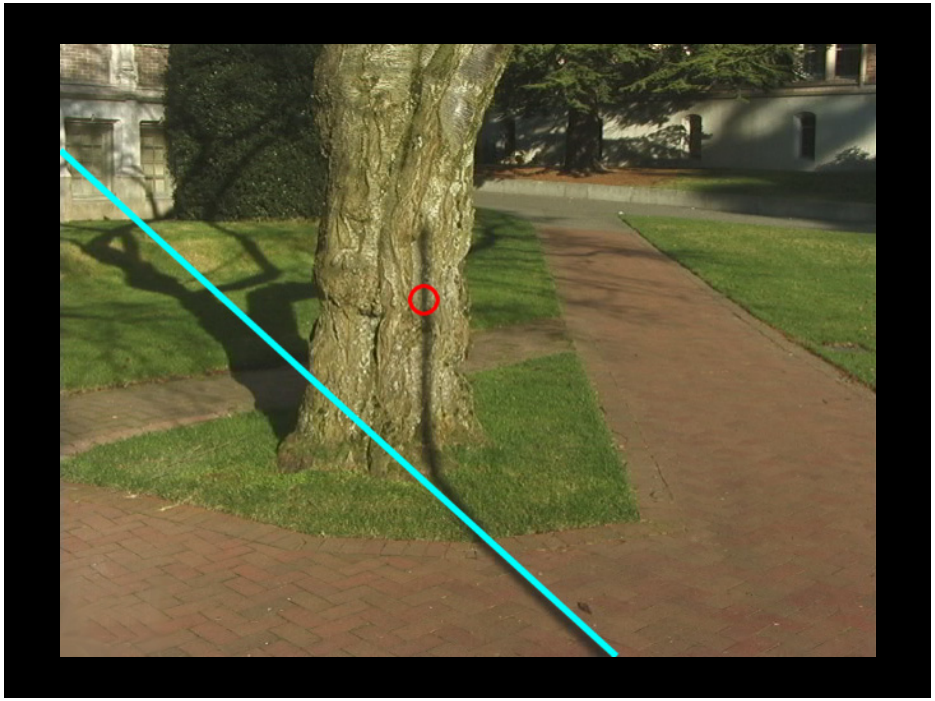
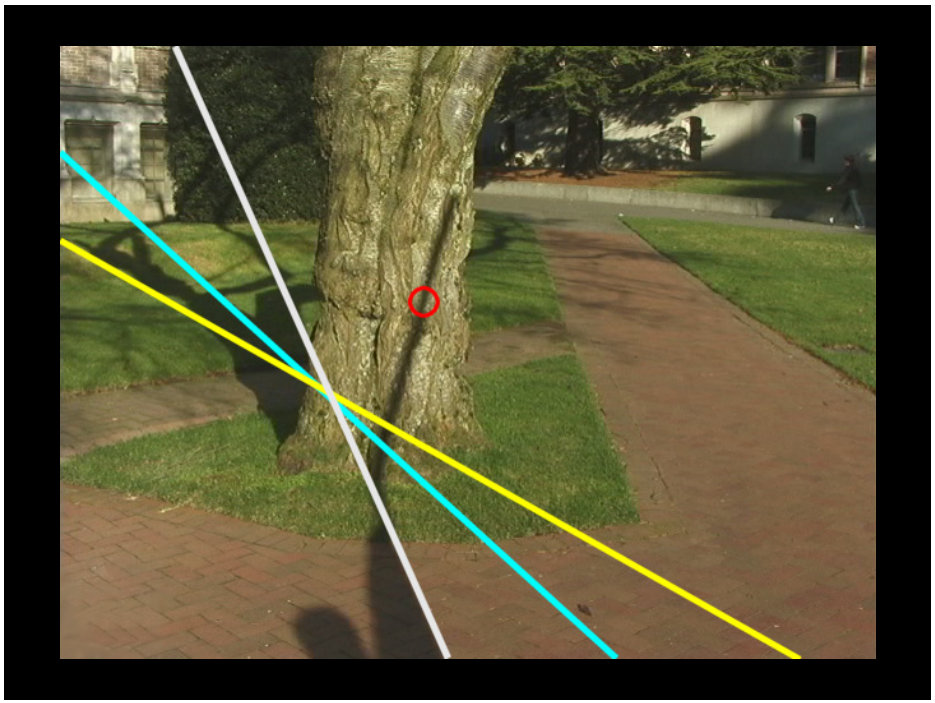
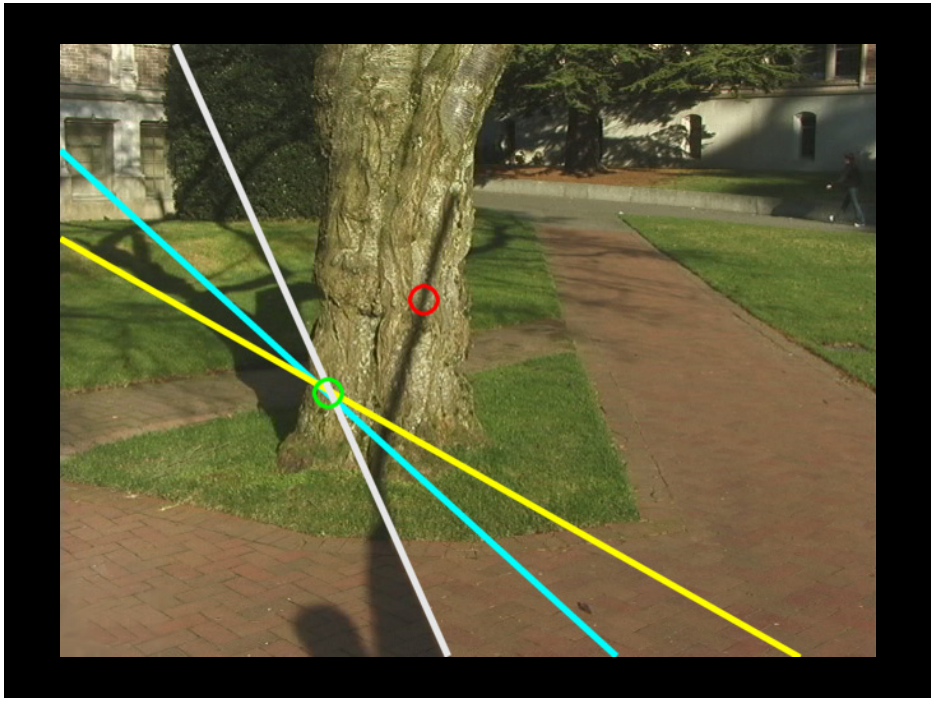
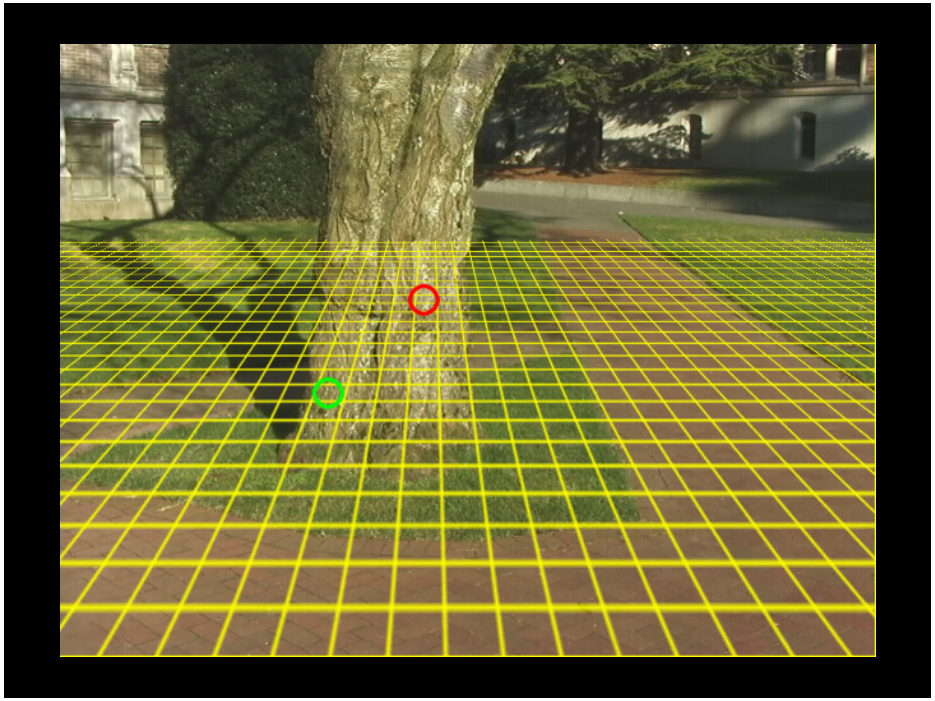
camera
cast shadow

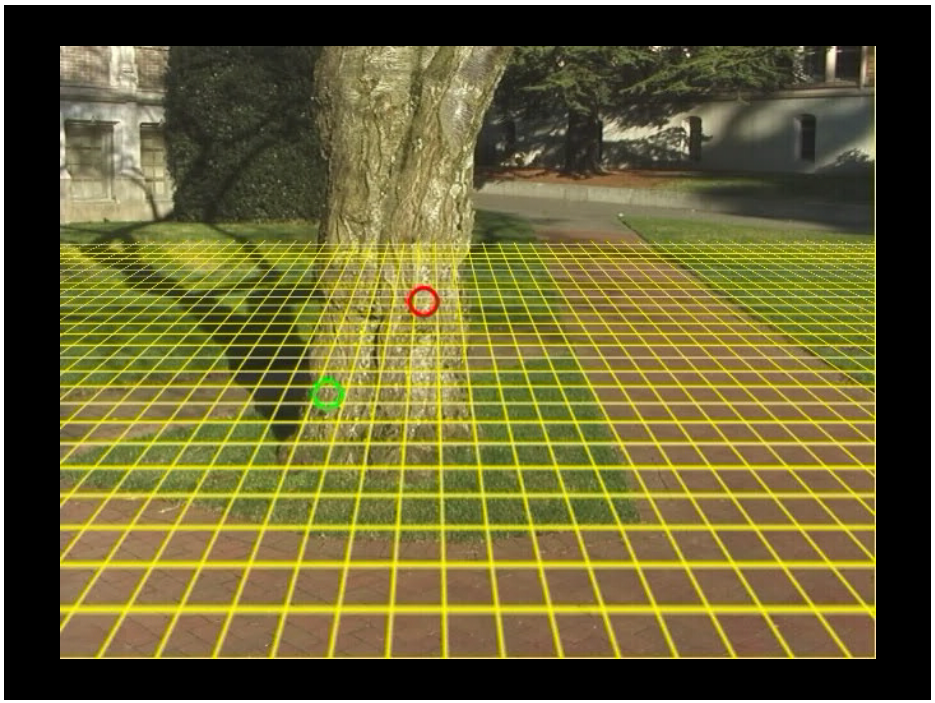


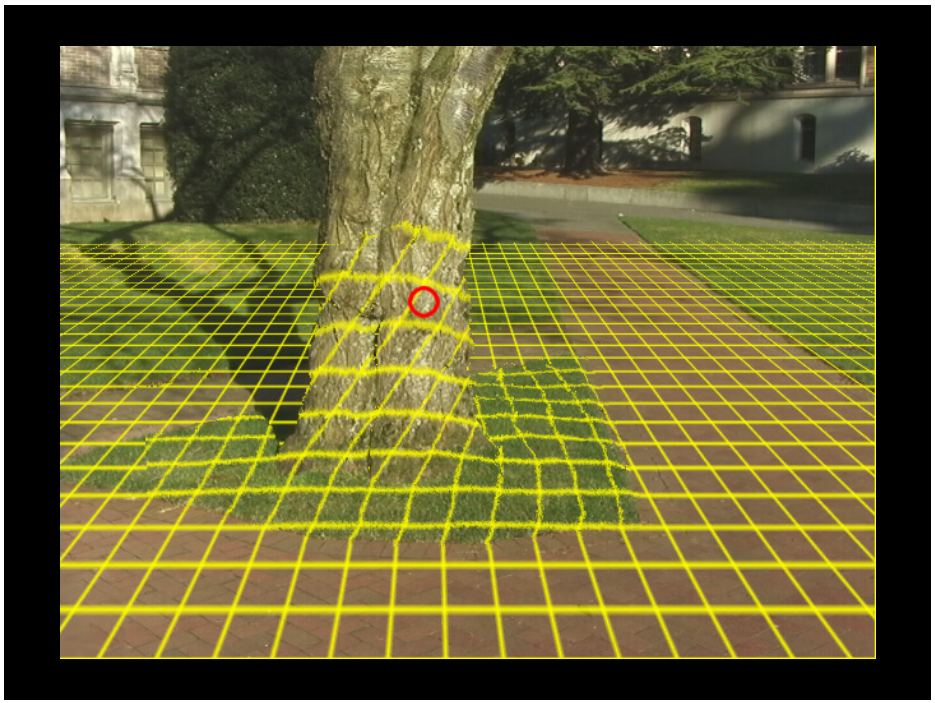


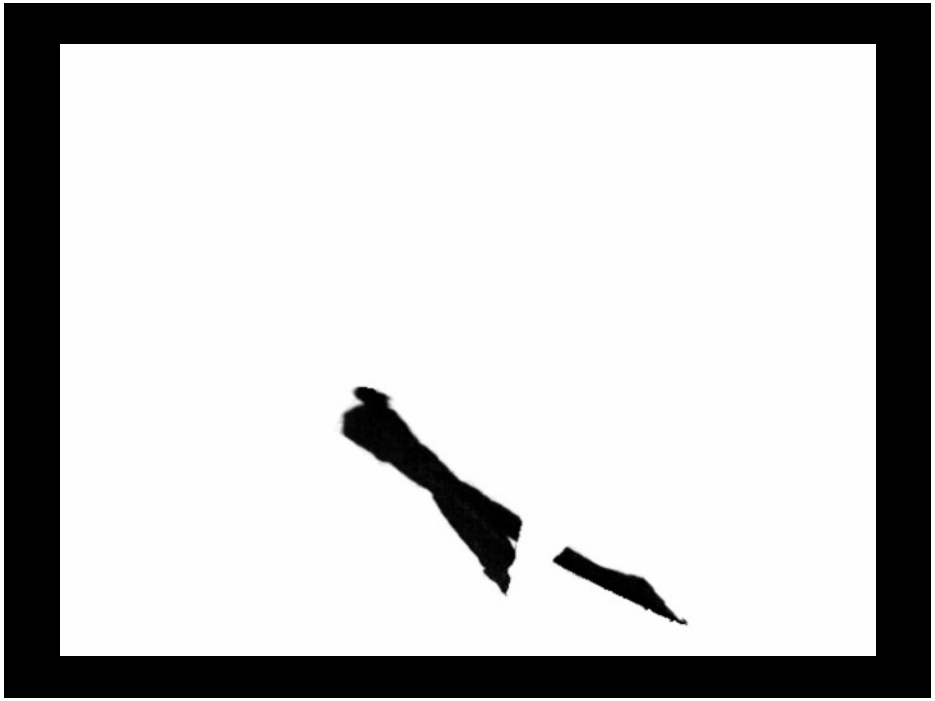


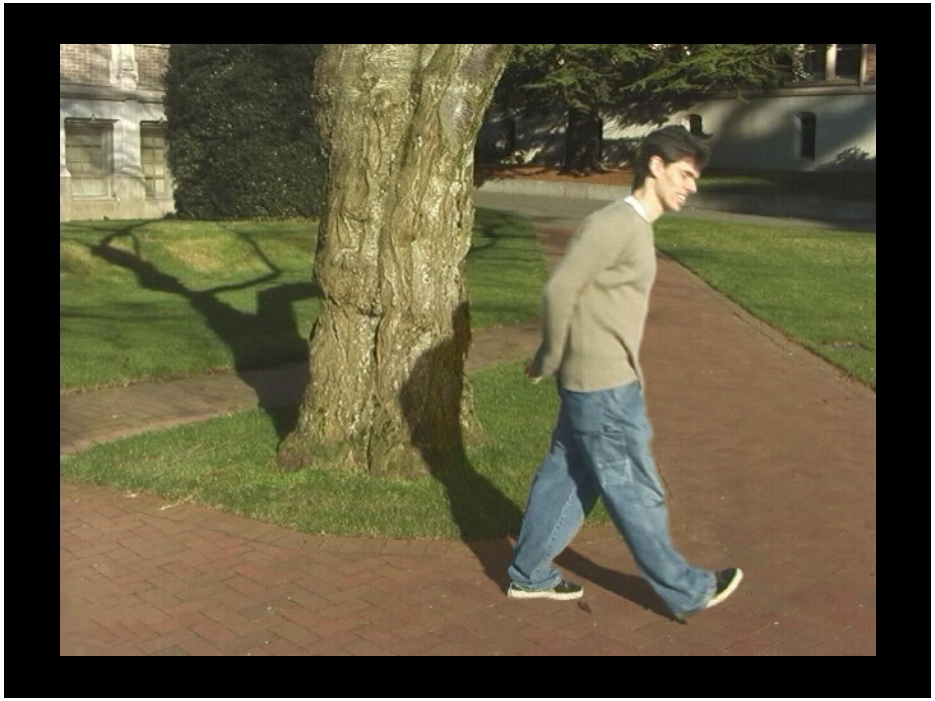


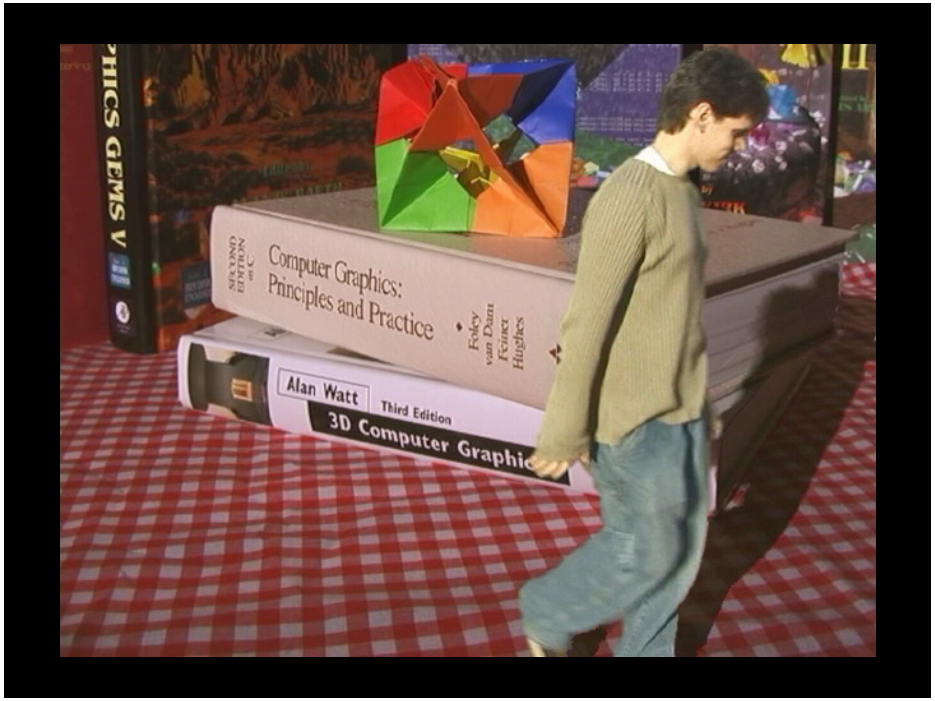








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