9/11/07 ①

Matting

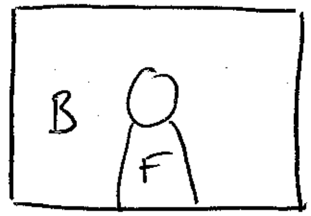
$$I = \alpha F + (1-\alpha) B$$

"foreground" object

image you capture

alpha matte

background image



Once you have α, F, B you can generate new image I_{new} with new background B_{new}:

$$\alpha F + (1-\alpha) B_{new} = I_{new}.$$

So how do you solve for α, F, B for a single I?

Solution 1:

Use a constant-color background whose color is not found in F. ~ blue screen / green screen

$$F_i = [R_i \;\; G_i \;\; 0]$$
$$B_i = [0 \;\; 0 \;\; B_B]$$

use this

$$I_B = \underbrace{\alpha 0}_{0} + (1-\alpha) B_B$$

$$\alpha = 1 - \frac{I_B}{B_B} \leftarrow \text{compute } \alpha.$$

Then $$F = \frac{I - (1-\alpha)B}{\alpha}$$

This is a huge assumption, restricting foreground colors to the RG plane!

Solution 2 :

Assume that foreground color is gray, constant-color background.

$$F = \{k, k, k\}$$ unknown

$$I_R = k\alpha$$

$$I_g = k\alpha$$

no background color

$$I_b = \underbrace{k\alpha}_{I_R = I_g} + (1-\alpha) B_b$$ known

$$\text{so} \quad \frac{(I_b - I_R)}{B_b} = 1 - \alpha$$

$$\alpha = 1 - \frac{I_b - I_R}{B_b}$$

$$k = \frac{I_R}{\alpha}$$

$$\therefore \quad \alpha, F, B$$

Solution 3: Triangulation using 2 different background colors, foreground is unknown

$$F = \{F_r, F_g, F_b\}$$
$$B_1 = \{0, 0, B_{b_1}\}$$
$$B_2 = \{0, 0, B_{b_2}\}$$

$$I_{b_1} = \alpha F_b + (1-\alpha) B_{b_1}$$
$$I_{b_2} = \alpha F_b + (1-\alpha) B_{b_2}$$

$$I_{b_1} - I_{b_2} = (1-\alpha) B_{b_1} - (1-\alpha) B_{b_2}$$

$$I_{b_1} - I_{b_2} = (1-\alpha)(B_{b_1} - B_{b_2})$$

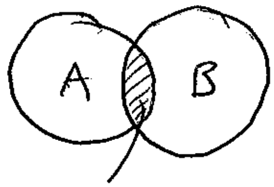
$$\alpha = 1 - \frac{I_{b_1} - I_{b_2}}{B_{b_1} - B_{b_2}}$$

Bayesian Matting

likelihood prior

Bayes Theor: $$\underbrace{P(A|B)}_{\text{posterior}} = \frac{\overbrace{P(B|A)}^{\text{likelihood}}\ \overbrace{P(A)}^{\text{prior}}}{\underbrace{P(B)}_{\text{normalizing constant}}}$$

$P(A|B)$



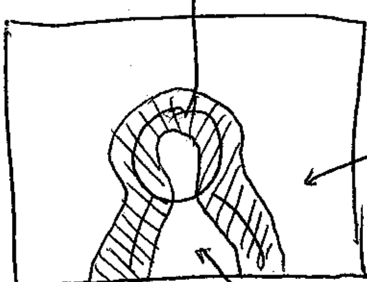
$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

$$P(B|A) = \frac{P(A \cap B)}{P(A)}$$

equate

$$P(B)\,P(A|B) = P(B|A)\,P(A)$$

$$\boxed{P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}}$$



Maximum a posteriori (MAP): $\underset{F,B,\alpha}{\arg\max}\ P(F, B, \alpha \,|\, I)$

Apply Bayes rule

$$= \underset{F,B,\alpha}{\arg\max}\ P(I \,|\, F, B, \alpha)\, P(F)\, P(B)\, P(\alpha) \,/\, \cancel{P(I)}$$

constant with respect to optimization

(5)

Take $\log P() = L()$

$$= \arg\max_{F,B,\alpha} \underbrace{L(I \mid F,B,\alpha)}_{1} + \underbrace{L(F)}_{2} + \underbrace{L(B)}_{3} + \underbrace{L(\alpha)}_{4}$$

Think of this like this: "Find F, B, α that result in the image as close as possible to I while observing the probability distributions of F, B, and α!"

Now model each term.

1. $L(I \mid F, B, \alpha)$

e.g. Probability distribution of I given F, B, α

well $I_{THEORY} = \alpha F + (1-\alpha) B$ ← center of the distribution

measured image

$$L(I \mid F, B, \alpha) = \frac{-\|I_{meas} - I_{THEORY}\|^2}{\sigma_I^2}$$

where σ_I standard deviation

image you are computing

You want $I_{THEORY} \rightarrow I_{meas}$

2, 3. $L(F)$ measured in a window around the pixel that is in the known foreground

Same for background

4. $L(\alpha)$ assumed constant.