Triangulation Matting Project (10%)

ITCS381 Introduction to Multimedia Systems

Due Date : Feb 28, 2021

Goal : The goal of project is to **extract transparent or semi-transparent objects** as the foreground matte and composite in a new background picture.

The matting problem is separation of a foreground image from a background image.

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

Solving the above equation is hard since we have more unknown than known values.
Normally, we will know C, but we don't know F , B, α.
Let's assume the color model used in our picture is *red, green, blue (r, g, b).*
Let's also assume that we know 2 different backgrounds (B_1 and B_2) and we can take pictures of the same foreground object against these 2 backgrounds. So we have

$$C_{r_1} = \alpha F_r + (1 - \alpha)B_{r_1} \qquad C_{r_2} = \alpha F_r + (1 - \alpha)B_{r_2}$$
$$C_{g_1} = \alpha F_g + (1 - \alpha)B_{g_1} \qquad C_{g_2} = \alpha F_g + (1 - \alpha)B_{g_2}$$
$$C_{b_1} = \alpha F_b + (1 - \alpha)B_{b_1} \qquad C_{b_2} = \alpha F_b + (1 - \alpha)B_{b_2}$$

Now our problem is that we will have a set of 6 equations to solve for 4 unknowns (F_r, F_g, F_b and α).

A classic paper by Alvy Ray Smith and James F. Blinn [1] called "Blue Screen Matting" introduced a technique to solve this problem by assuming the foreground object to be shot against two arbitrary different backgrounds. They presented a solution to this matting problem. Here is the formula to solve α

$$\alpha = 1 - \frac{(C_{r_1} - C_{r_2})(B_{r_1} - B_{r_2}) + (C_{g_1} - C_{g_2})(B_{g_1} - B_{g_2}) + (C_{b_1} - C_{b_2})(B_{b_1} - B_{b_2})}{(B_{r_1} - B_{r_2})^2 + (B_{g_1} - B_{g_2})^2 + (B_{b_1} - B_{b_2})^2}$$

Once we know α, then we can solve for F_r, F_g, F_b.

What you need to do :

1) Since we are in the middle of COVID-19 situation, this project will be an individual project.
2) You are given 3 datasets that contain sample pictures. Each dataset contains 7 pictures :
    a. 2 pictures are backgrounds only (BackgroundImg01.jpg, BackgroundImg02.jpg)
    b. 2 pictures are foreground objects taken against the two backgrounds (CompositeImg01.jpg, CompositeImg02.jpg)
    c. 1 picture is a new background (NewBackground01.jpg)
    d. 1 picture is the extracted matte or foreground objects (Foreground_with_watermark.jpg) (Note that the foreground objects are shown against the white background to make clearer to visualize)
    e. 1 picture is the new composite picture (NewComposite_with_watermark.jpg)

New background | Extracted matte | New composite

Dataset 1

New background | Extracted matte | New composite

Dataset 2

Dataset 3

New background

Extracted matte

New composite

3) You need to write a MATLAB code on your own using the previous explained matting algorithm to separate foreground objects from backgrounds. And also you need to composite the foreground objects onto a new background. Your code should produce the results similar to the sample results given in the datasets.
4) As another requirement, each student must take pictures by yourself to create your own data set that contain a semi-transparent or transparent object in front of 2 different background colors (Total of 4 pictures/set). You must also be able to run your code with your own dataset.

What do you need to submit?

1) (3%) Your own dataset (7 pictures)
    a. 2 pictures which are backgrounds only
    b. 2 pictures which are foreground objects taken against the two backgrounds
    c. 1 picture which is a new background
    d. 1 picture which is your extracted matte result
    e. 1 picture which is your composite result with a new background
2) (7%) Your Matlab code which should be able to run and display all these 5 pictures + 2 result pictures.

References

[1] Alvy Ray Smith , James F. Blinn, Blue screen matting, Siggraph 1996, Proceedings of the 23rd annual conference on Computer graphics and interactive techniques, p.259-268, August 1996.