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Triangulation Matting Report

CSC320 Fall 2019
A1

In this report, we will talk about how we captured our images, the range of imaging conditions we tried, our sets of experiments with different imaging conditions, and the conclusion we agreed on based on the factors mentioned above.

Each experiment has four input images — two different background images and two different composite images with the same object in it. In order to produce the required input images, we put an object on the first background and take a picture of it. Then we take a picture of the first background from the exact same angle with the object removed. Then we put the object on the second background and take a picture of the object on the second background. Then we take a picture of the second background from the exact same angle with the object removed. We could not make sure that the object was placed on the exact same spot for two different backgrounds since we were holding the camera by hand. But we tried very hard to make the camera steady as much as possible and to place the object on a relatively same spot.

The range of imaging conditions we defined can be categorized into imaging conditions for the background and imaging conditions for the object.

Imaging conditions for the background include:

-Similar color as the object

-Jumping out color on the background(not the main color on either the background or the object)

-Patterns on the background

-Too much noise on the background

Imaging conditions for the object include:

-Texture/Material of the object:

Transparency

Reflectiveness

-Text/Images on the object

Experiment Results using reference solution:

Group A: dimension 2992*3000

Background A

Background B

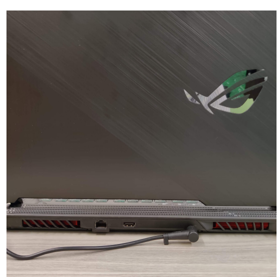


Image A

Image B

Color

Alpha

Composite

This set of images gives us a lot of information. The pattern of the table on the background images has been extracted as part of the object since it is a common area for both backgrounds. The logos on two laptops has been extracted as part of the object as well, even though for each logo, only one of the background has it. Since the water bottle is mostly transparent, on the alpha image we can see that the Apple logo is not obvious but still shown.

Group B: dimension 680*480

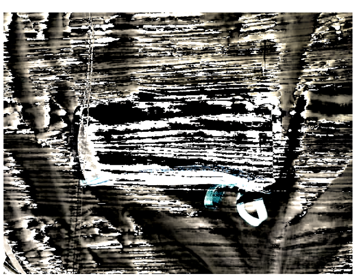
Background A

Background B

Image A

Image B

Color



Alpha

Composite

This set of images is a typical example of background being too noisy. Since there is too much pattern on the background A and the color of this pattern is very similar to the main color on the background B, it is very easy for triangulation matting to mix those up. It will compare the pattern on the image A with image B, however, the color of the pixels of the pattern area on image A can not be differentiated much from those pixels on the image B. As a result, the pattern on the background A will be taken as part of the foreground.

Group C: dimension 680*480

Background A Background B Image A Image B



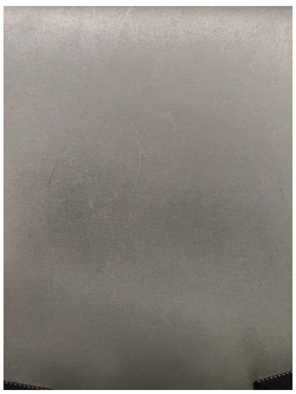

Color Alpha Composite



This set of images shows how the material will affect the performance of triangulation matting. Background A and background B differ a lot in terms of color but they have similar level of lighting. The wallet is made of leather, which will make the centre of the surface area quite reflective. In this case, the centre of the wallet would be a lot lighter than the edges of the wallet, in other words, even though it is all black on the object and its color differs from the backgrounds, because of different levels of intensity, the color image or the alpha image will not show a perfect wallet – the edges are not as black and firm as the centre.

Group D: dimension 480*640

Background A



Background B

Image A

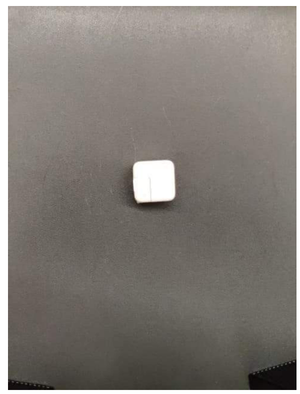
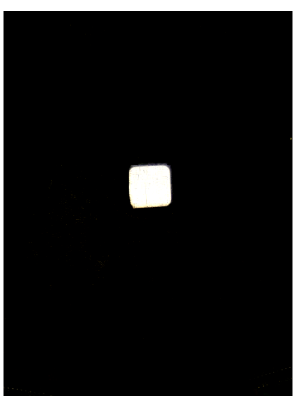
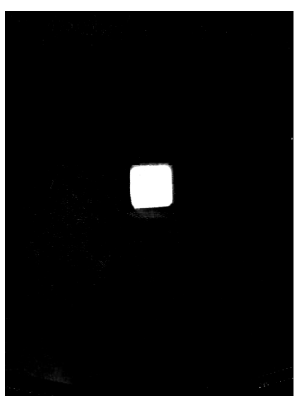


Image B

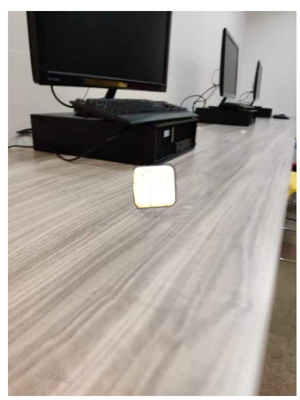
Color



Alpha



Composite



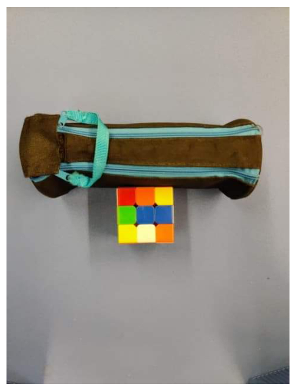
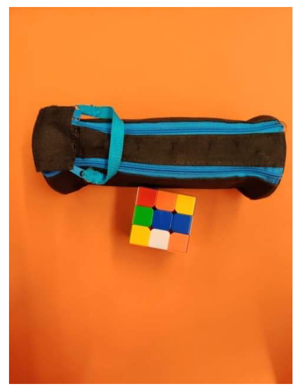
This set of images shows the conditions that triangulation matting would work well under. The colours of the backgrounds are solid and not similar at all. The colour of the object is not similar to either of the colors of the backgrounds. There is no noise on either of the backgrounds.

There is no special property of the object that will mix itself with the backgrounds. There is one imperfection of this matting – the small gap on the charger head. Since the details on the charger head are too small, i.e, limited pixels to gather information on, and Image A is slightly lighter than Image B, triangulation matting could not differentiate all of the pixels belonged to the small gap from background A in grey.

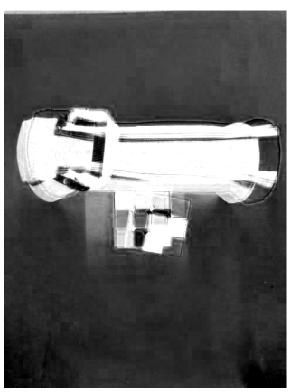
Group E: dimension 480*640

Background A Background B Image A Image B



Color Alpha

This set of images shows where triangulation matting has advantages over other matting solutions. Since we have two solid backgrounds with two different colors, we are able to differentiate the orange pixels on the cube from the orange background. The imperfection of this example is that, since there is shadow around the cube and the pencil case, the color of the backgrounds tend to go darker than its original color, in which case the edge of the pencil case could not be separated from the background perfectly.

Group F: dimension 480*640

Background A

Background B

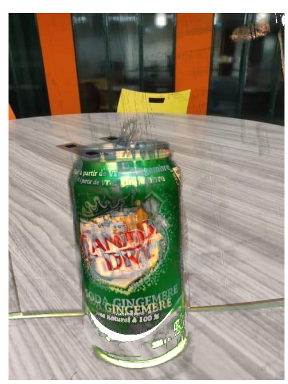
Image A

Image B

Color

Alpha

Composite



This set of images shows how text or images on the object could influence the final result. It was very hard to keep the can at a constant angle when we change the background. Therefore, tiny changes in placing the can will twist the pixels of the text or pattern on the can. Since both Image A and Image B have the same pattern on the can with a slight difference on the angle, triangulation matting would still differentiate the can from the background but with loss of information — it does not know what to put in the pixels where the patterns of Image A and Image B do not match.

Summary

Based on the above experiments, we conclude that triangulation matting works well if the colours of the backgrounds are very different than each other, if the colour of the object is not similar to both of the colours of the background(i.e., the colour of the object can be similar to one of the background colour) and if both the object and the backgrounds are solid.

The limitations of triangulation matting:

-if the background is too noisy

-if the colour of the object is similar to both of the colours of the backgrounds

-if the object has special texture/properties, for example, a water bottle is transparent; leather or aluminum is reflective at different levels;

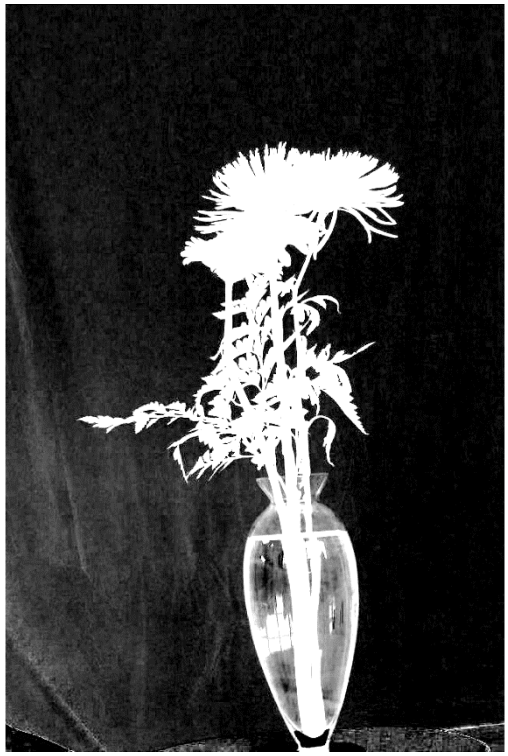
-if the intensity on the background has a sharp change, for example, the logo on the laptop has higher intensity than the other pixels on the back of the laptop, then it would be separated from the background.

-if the position of the object is changed then there will be loss of information, for example, if there is a lot of text on the object, then slight change of position will result in missing content.

Reflection

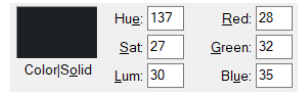
After doing this assignment, we realized that for triangulation matting, proper equipments are crucial. In order to have triangulation matting work perfectly, we need 2 images with objects at the exact same position, the background image itself to be the exact same background for the image with the object pixel-wise and the camera setting to be consistent for all of the images since the lighting/intensity can influence a lot even though the color looks similar. Therefore, it makes sense that green background is very important to weather broadcasting, film making or any other industry that heavily relies on image/video editing.

Part 3

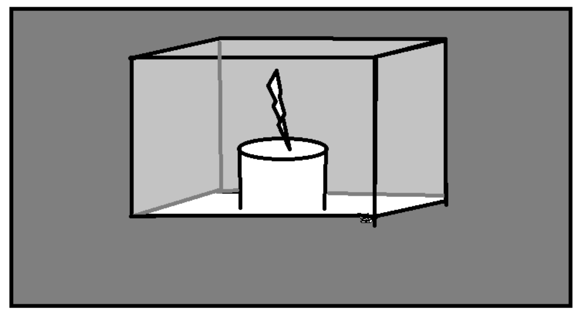

3.1:

The pixels on the left side of the object have non-zero alpha because the algorithm thinks that there are foreground objects that exist there. The alpha picture above has its brightness upped by 50% to highlight the non-zero alpha to the left of the object. The non-zero alpha is here because in the original picture with the object and the lighter background, there are wrinkles and creases in the background that are picked up by the algorithm are not in the left side of the other darker background. From the result of the experiments we did with the given implementation of the algorithm, when there are significant objects in the background, like shiny logo(experiment A), or heavy creases in cloth (experiment B), they will be picked up by the algorithm despite also being in the pure background picture. This is because despite being the same background, the background in the composite picture with the object is slightly darker than the pure background without the object. This slight difference caused the wrinkles to be determined to be foreground. The lighter background is relatively even to the top and the right of the object, so they did not get picked up as part of the foreground objects. Therefore, the non-zero alpha to the right of the object is the uneven background picked up by the algorithm to be part of the foreground. However, there are also uneven wrinkles in the darker background, to the right of the object. These did not appear in the alpha picture though. This is because the colour of the darker background is very close to pure black (colour sample pictured to the right), which is Red=0, Green=0, Blue=0. Because it is this close, it is not recognizable when put in the alpha picture. Also, this small difference also caused the slight brightness difference between the composite and pure background pictures to be a non-issue.



3.2:

C = Composite of all four layers.



F = Front face of case, foreground

O = Object, foreground

B = Back face of case, background

K = Background behind the case, background

$C_{BK} = \alpha_B * C_B + (1 - \alpha_B) * C_K$

$C_{OBK} = \alpha_O * C_O + (1 - \alpha_O) * C_{BK}$

$C = \alpha_F * C_F + (1 - \alpha_F) * C_{OBK}$

Part 4

One potential solution that might be able to solve the problem of live matting is with a slow-motion capturing camera and two backgrounds that can switch much faster relative to the motion of the foreground object. Although I am not sure how feasible this solution is in a real-life situation, if the two background can be switched fast enough, relatively, the foreground would seem like it is not moving. The slow-motion camera is expensive but available, and the background could be digital or physical, as long as it can be switched much faster in relative to the motion of the foreground object. Another potential solution is inspired by the research paper titled "Integrated Foreground Segmentation and Boundary Matting for Live Videos". For this paper, the author purposed to use machine learning, to "train and maintain two competing one-class support vector machines at each pixel location, which model local color distributions for both foreground and background, respectively." This technique can capture moving foreground objects and moving background at the same time and discriminate between the two. Thus, this technique can also be applied to a moving foreground and two static background. In fact, I believe that this technique is probably overkill for our situation. The use of machine learning on the moving object with two different background can probably also solve our live matting problem, with enough training.

References:

Gong, M., Qian, Y., & Cheng, L. (2015). Integrated Foreground Segmentation and Boundary Matting for Live Videos. *IEEE Transactions on Image Processing*, *24*(4), 1356–1370. doi: 10.1109/tip.2015.2401516