Triangulation Matting Update: Eliminating Constrain on Fix Viewpoint

1. Introduction

In the assignment 1, we studied triangulation matting technique and did some experiments on it. We observed that the ordinary triangulation matting is strictly restricted to many constrains, like same lightness, same viewpoint, same background and foreground for one pair of inputs...

1.1. Background

A fixed viewpoint is one of them. Good quality images can not be produced by the algorithm even if the viewpoints only changed a little bit through four source images. The solution we came up with was that:

1. We placed the camera onto a triangle stand.
2. We remotely control the camera in order to eliminate any vibrations that may caused by clicking the shutter button.

1.2. Goal

Such this process was very unfriendly and inconvenient, thus our goal here is to eliminating the constrain of triangulation matting on fixed viewpoint. Specifically, we will revise triangulation matting algorithm by firstly process the source images using patch match algorithm, which was introduced in assignment 3. Details will be described below.

2. Modify Existing Algorithm

To minimize the effect of changing viewpoint on result image quality, designed a new algorithm which basically consists two parts: original triangulation matting algorithm and add on. Below are details of the new process:

1. Take four source images, namely compA, compB, backA, backB, with all constrains except fix view points.
2. Process the source image pairs compA, compB and backA, backB with patch matching algorithm and A being source and B being target. Therefore, we will get reconstructed version of A images, call it re-compA and re-backA.
3. Take compA, re-compA, backA, re-backA as inputs of the triangulation matting algorithm and get the final images.

2.1. Principle

The key idea behind is that the patch match algorithm allows us to reconstruct the source images by filling every spots with pixels in target image. Ideally, the foreground object in the source image can be well reconstructed with small changes in viewpoint, since the foreground objects are almost identical in both source and target images, which is, the patch matching algorithm can essentially find corresponding pixel in the target image and use it. Whereas, finding similar background patch in the target image is not as easy as finding the foreground. The reason is that we use two different color backgrounds in two pairs of images, so that the patch match algorithm can not find pixels with exact same intensities to the background, regardless how many iterations it processes (the target image is missing required information). Same process applies to the pair of pure background images, and ideally it will produce background images with same pixel intensity with background pixels in re-compA. Therefore, we now get compA, re-compA, backA, re-backA pairs and notice that ideally, compA and re-compA will share same foreground object pixel intensity, compA and backA will share same background pixel intensity, re-compA and re-backA will share same background pixel intensity, where it is different from compA and backA. Finally, use triangulation matting algorithm to process these two pairs of images and theoretically, we can get desirable results.

3. Experiment Design

Before the experiments, we prepare a laptop and photographing tool which can be smart phone, SLR camera or half lens camera, and we select a not dark placeFirstly, we select different backgrounds such as solid or having different color and different foregrounds which has no reflection, and then make sure that each foreground does not contain the same colour with the corresponding background and control the illumination strongly when we take the photos to be our test subject. Every times we do the experiment, at first, we take four source images, namely compA, compB, backA, backB, with all constrains except fix view points. Then, we process the source image pairs compA, compB and backA, backB with patch matching algorithm and A being source and B being target. Therefore, we will get reconstructed version of A images, call it re-compA and re-backA use these image inputs do different experiments. Finally, we take compA, re-compA, backA, re-backA as inputs of the triangulation matting algorithm and get the final images. As the above, we repeat same steps to do the experiment with different image inputs.

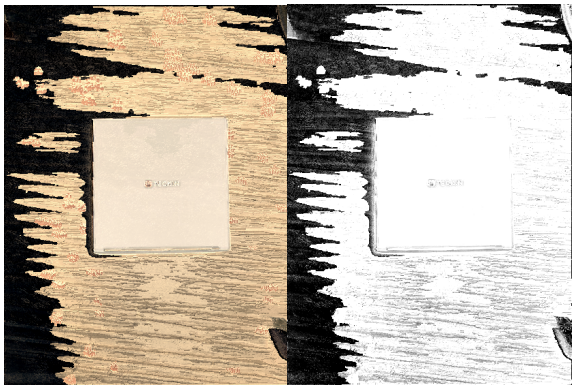
4. Experiment Results

In order to test our new designed algorithm, we did several experiments according to the experiment procedures that we proposed above.

4.1. Failed Experiments

Overall, the experiment results were not very perfect. The main reason is that this composed process increases the sensitivities to other constrains. For instance, the illumination and similarity between foreground color and background color may have less effect on ordinary triangulation matting algorithm. However, they have much more effect on the quality of output images in the new designed algorithm. Below, we will summarize some factors that may lead to these situations.

4.1.1 When Backgrounds are Complicated



final images

images after patch match process

raw input images

In this case, our algorithm has a relatively good performance on foreground object, since the foreground object on output color image is almost identical to re-compB. However, it also treats some background object as foreground. It is mainly due to that the background object in target images are not in pure color, it is composed of some grains, so that when we ran patch match algorithm on compA and compB, it can not fully recognize background object and uses different color at different pixel location. It even filled some background pixel with foreground object's pixel. Whereas, when there is not foreground object presents, the reconstruction was pretty good. This error was enlarged after we applied triangulation matting algorithm, and may disappear if we have unify color background.

4.1.2 When Foreground and Background Shares Similar Color

final images

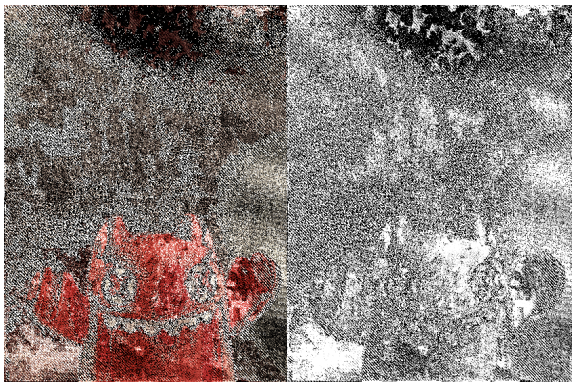
images after patch match process

raw input images

Despite the fact that backA is not unify-colored, it is the best fit one that we can get to demonstrate, since the most crucial problem here is the color similarity.

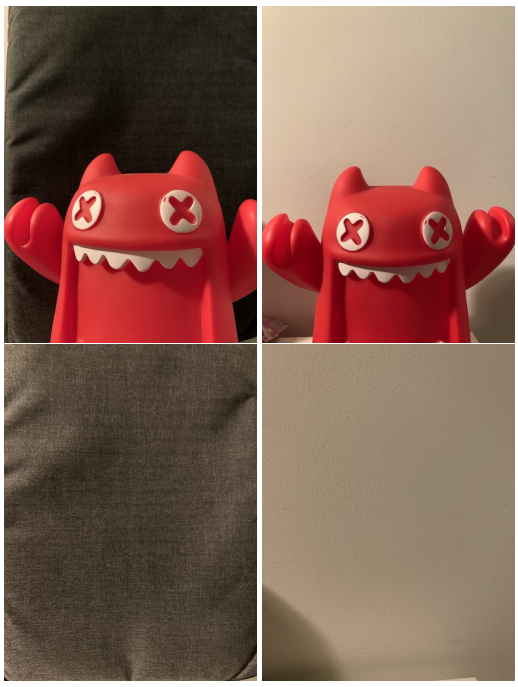
It is easy to notice that the pixel values of foreground object and background object in compA are too similar, so that the patch match algorithm uses pixels from foreground object in compB to fill the entire background in compA. Originally, we suppose that the algorithm can fill the background pixels and foreground pixels in compA with background pixels and foreground pixels in compB respectively, but such that similarity in pixel values leads error occurs: we can not get foreground pixels when processing backA and backB, and thus background colors in re-compA and re-backA are different. Therefore, the final triangulation matting results were unacceptable.

4.1.3 Bad Illumination



final images

images after patch match process



raw input images

In this experiment, there are two major problems:
1. The source of light is located at upper left corner, so that

shadow appears at lower right corner in compB, since the foreground object is blocking the light.
2. The background object in compA and backA is reflective. Although shadow can not be seen directly in compA, the background object in backA appears much brighter since no foreground object is blocking light anymore, and the material itself is good at reflecting light. The center part of backB shares similar situation.

Therefore, there is no way for re-compA and re-backA get same background pixel values after patch match process, this can be proven by result images listed above. On top of that, the background color for compA and backA is also different. Thus, the final results produced by triangulation matting process were extremely bad.

5. Limitation

With the improved Triangulation Matting Algorithm, the user needs to ensure to have the strict control of illumination, best to use a unify color background, foreground does not contain the similar color with the background and all input images need to have the same size. In concluding, there is no doubt that this algorithm indeed eliminates the constrain on fixed view point, which is users no longer need to use a camera stand and remote to control the camera, but any other constrains in both triangulation matting algorithm and patch matching algorithm are enlarged during this process.

6. Application

The application for this improved Triangulation Matting Algorithm is to separate foreground from background which does not have to be solid (white color cannot be used as background) for an image which is taken that does not have to use camera fixed device.

7. Reference

References