

# Adding a Transparent Object on Image

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**Abstract.** Nowadays, image manipulation, which is related to matting and compositing process, is commonly used. Processed object may vary, however matters may arise when the object is transparent. Not many research has been conducted about the issue due to the difficulties in extracting transparency value and object refraction. In this research an application to execute matting process of a transparent object and compositing it into a new image is developed.

Matting process will be executed using Grabcut method, followed by calculation of transparency value of an object using alpha matting. The transparency value is then used in compositing an object with a new background, while refraction will be executed using refraction calculation of ray tracing. Adding a transparent object into new image (new background) process, first user should determine the eye's position and distant between new image and transparent object. Then, assume the additional transparent object as a screen to trace rays from eye. Each ray will be bent and hit the new image. The color of new image will add into the transparent object area.

Experiments result showed that extracted transparency value was affected by lighting, refraction of the old background, which unknown and object's refraction index. Refraction result looks natural compared with the actual condition. Moreover, eye position can be configured by the user to obtain results as desired.

**Keywords:** Matting, Compositing, grabcut, Transparency, Refraction, Alpha channel.

## 1 Background

The need of manipulating an image is common in many aspects, especially in advertising. One of common image manipulating applications is matting and compositing. That are cropping a distinct object from an image and adding the cropped object into a new image as a new background. A matter in doing matting and compositing is if a transparent object is involved. A transparent object shows other object behind it. The color of background object will be blended with the color of the transparent object. It is impossible to separate the blended color when the transparent object is taken from

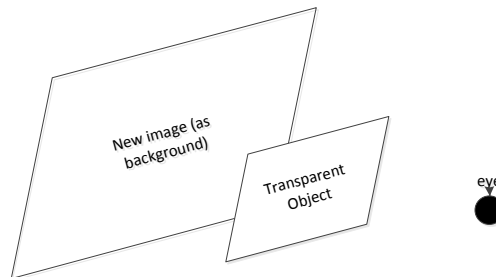
an image. It is difficult to determine which is background's color or the transparent object's color.

In research done by Gong, Liang, Yang R., and Yang, Y.H. in 2010, alpha channel with dot product is used [1]. It separates the interpolation color between foreground and background. This alpha channel is computed based on the statistical color from trimap. Trimap is given area of foreground area, background area and unknown area between those two other areas [2,3,4,5]. Tomas Malmer proposed the combination of statistical calculation and grabcut [6,7] to separate pixel in unknown area which are that belong to foreground, which ones belong to background [8]. Zongker and Han et.al improved the segmentation method over natural environmental or textured background [7,9].

In our research, we develop an application to matte a transparent object using alpha channel and grabcut, and composite it into a new image using refraction mechanism of ray tracing.

## 2 Refraction Mechanism of Ray Tracing

A ray will be traced through the air. When it hit a transparent object, it will be refracted or reflected. The refracted or reflected ray will be traced again[11,12]. This process will be done until it hits a non-transparent object. We modify this mechanism to fit with our case. First the new image will be the non-transparent object. The adding object is assumed as a grid screen where rays will be traced. This grid screen will be placed some distant from the background. Then, an eye will be positioned in front of them. New image, transparent adding object and the eye arrangement like seen on fig.1



**Fig. 1.** The position of new image, adding object and eye

Every transparent object has a refraction index. It determines how far the ray will be refracted. Smaller the refraction index further the refracted ray will be. The refracted ray will be computed using six steps shown in fig 2 [11]. The important variable in computing the refraction ray are angle of coming ray,  $\theta_i$  (from the air into the transparent object) and angle of the refracted ray,  $\theta_t$  (from the transparent object outside). The angle of coming ray is computed using dot product between the ray from eye to the screen of transparent object and the normal plane of the screen. This dot product

can be seen in eq. 1 and the refracted ray can be computed using Snell's law as shown in eq. 2

$$\theta_i = \cos^{-1} \frac{(\text{eye position} - \text{pixel position}) \cdot (\text{normal plane})}{|(\text{eye position} - \text{pixel position})| |(\text{normal plane})|} \quad (1)$$

$$\frac{\sin \theta_i}{\sin \theta_t} = \frac{n_2}{n_1} \quad (2)$$

in eq. 2,  $n_1$  is refracted index of the air (1.0003),  $n_2$  is refracted index of the transparent object.

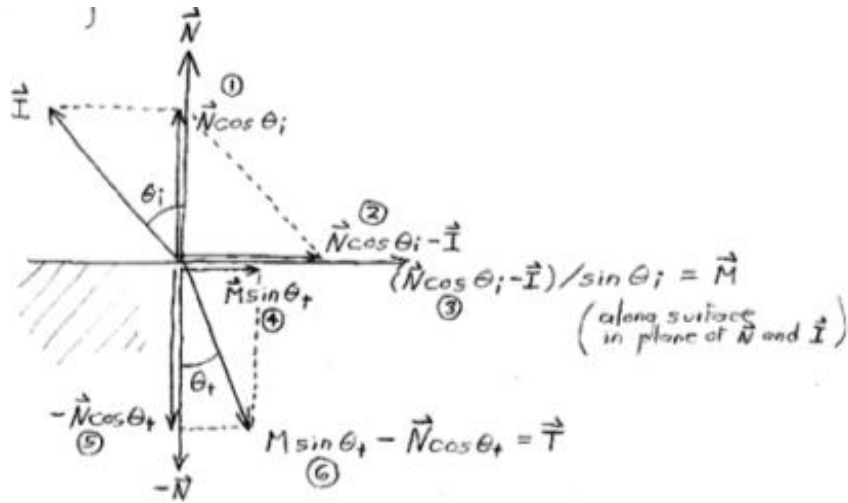


Fig. 2. Six steps to compute the refracted ray[11]

After compute the refracted ray, the refracted ray will be trace until hit the new image behind it. The color of the pixel which is hit by the refracted ray will be added into the color of the pixel on the transparent object where the ray comes from. To find the position of the pixel which is hit, we use intersection between a line and a plane, shown in eq.4 First, the time when the refracted ray hit the new image is count. Then, the time will be used in the eq. 3 [11, 12].

$$t = \frac{d - N \cdot S}{N \cdot \text{refracted ray}} \quad (3)$$

$$\text{pixel position which is hit} = S + t \cdot \text{refracted ray} \quad (4)$$

$t$  is time when the refracted ray hit the new image.  $d$  is the distant of the new image. in this research,  $d=0$ .  $N$  is the normal of the new image (0, 0, 1).  $S$  is the position of the pixel on the transparent object where the refracted ray comes from. Operation between  $N$  and  $S$  is a dot product.

### 3 Object Adding Transparent into a new Background

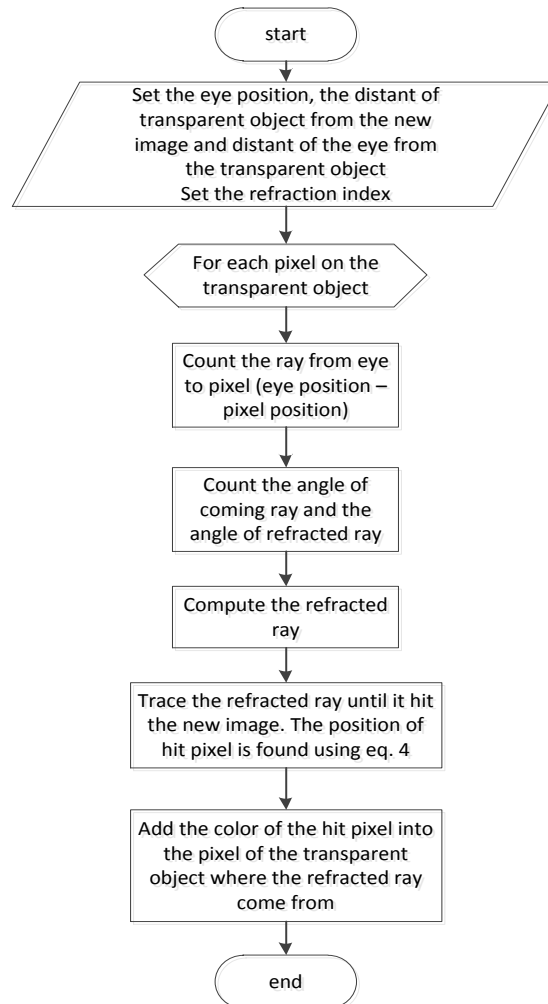
There are three main processes in this application, define the trimap, crop the target object, and adding the transparent object into a new image. Adding the transparent object is done by interpolating the color of the transparent object with the background color found using eq. 4.

User defines the trimap. After calculate the alpha channel from the unknown area, then the transparent object will be added into a new image as a new background. The diagram that shows the whole process can be seen in fig. 3. The focus of this research is adding the transparent object into a new image.



**Fig. 3.** The diagram of the whole process from matting until compositing the transparent object

The flowchart that represents the adding transparent object into a new image algorithm can be seen in fig. 4. First, the eye position, the distant between eye and the transparent object and the distant between transparent object to the new image should be given. Ray tracing mechanism needs 3D environment. Thus, the given distant input give the depth for the 2D image. Assuming the transparent object as a screen, the rays from eye trace through the each pixel on the screen. After that, the rays will be bend using eq. 2. The pixel position on the screen (row and colom represent x and y axis) will be the start point of the refracted ray. The refracted ray will be traced and checked the intersection with the plane behind it, that is the new image. The color of the hit pixel on the new image will be interpolated with the color of the transparent object multiply with the alpha value. The new color will be the color of the transparent object after combine with the new background.



**Fig. 4.** Flowchart of compositing a transparent object into a new background

## 4 Experiment

Experiment is done in several aspects, comparison with actual condition, the matting and compositing result, and experiment using two different distant between transparent object and eye. The result of comparison between actual condition with our application result can be seen on table 1, while the matting a transparent object and compositing it into a new image can be seen on table 2. The table 3 shows the result of experiment with “near” and “far” distant of eye position from the transparent object.


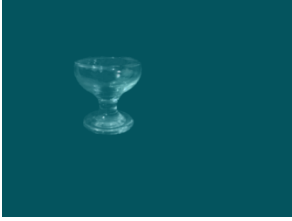


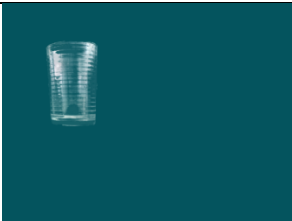


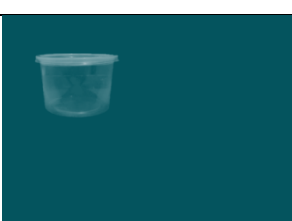
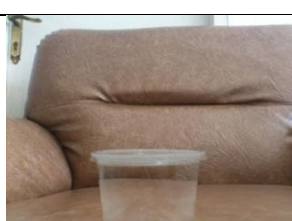

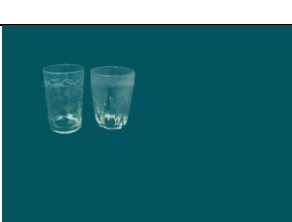

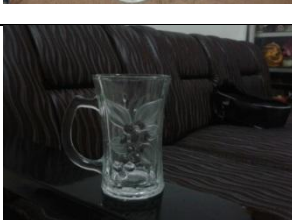
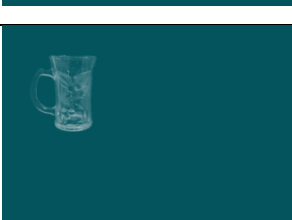

**Table 1.** The comparison between the result of this application with the actual condition


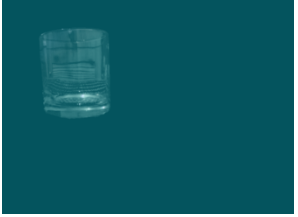




Actual condition	This application's result
	
	
	
	

Table 1 shows similarity between the actual condition and the simulation result of our mechanism. The difficulty in reconstructing the result is to determine the distant between eye and the transparent object and how many refraction index of the material. In this experiment, we use common home's utility so the refraction index can be determined easily.





In order to examine the result yielded by various distant between eye and the transparent object, and vertical position, we set two different positions categorized near and far. The result can be seen in table 2.

**Table 2.** The result of grabbed object (middle column) into a new image (right column)

The original image	Cropped transparent object	Compositing into the new image
		
		
		
		
		

The original image	Cropped transparent object	Compositing into the new image
		
		

**Table 3.** Result of various eye position toward the transparent object

Near	Far in front of the transparent object
	
	





Near	Far in front of the transparent object
	

Table 3 shows the appearance of other objects on the transparent object is effected by the eye's position. Further the eye's position, smaller the objects behind it then it will be looked wider the field of view through the transparent object. Further the eye's position, the more distortion of the object behind it will be looked.

## 5 Conclusion

From the experiment have done, ray tracing mechanism can be implement well in simulating the compositing a transparent object into a new background. The hit position of the new background should be discrete (pixel position) while the computation gives a decimal number. However, this problem doesn't effect the result's appearance.

## 6 References

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