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Computer Graphics I
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Literature Review I

The papers that I choose as the primary paper is that **"Portrait Lighting Transfer Using a Mass Transport Approach"**, and the secondary paper that I choose is that **“The Quotient Image: Class Based Re-rendering and Recognition With Varying Illuminations”**

First, let's talk about **"Portrait Lighting Transfer Using a Mass Transport Approach"**.

As we know, to take a good portrait, lighting is an important element. But it would cost considerable time even to the professional photographer who may have to use multiplex equipment to create a good lighting design to show the character, not to speak of the casual photographers. This Literature tries to transfer the desired illumination of one portrait onto another. So this technology would make portrait lighting easier, because it only needs the original image and the target lighting. In other words, if we can give an input image I and a reference image R, it can create a relight output image O with the lighting of the reference and the pose, identity, and expression of the input photograph.

When the algorithm starts to analyze the picture from the standard color histogram matching, it will get the global color and hue of lighting by transferring the color distribution of the reference to the input portrait. But this method will produce some poor results, because of the shading. So they create a three-dimensional model that can fit the portrait. Then use this model to increase the color of each pixel. Then, they use the known histogram matching formula as the mass transfer approach and extend it from color space to high dimension {color} $\times$ {position} $\times$ {normal} space. This generates a color map of known attributes of the face. By smoothing the color distribution of the input and reference, it further enhances the facial features and make the color distribution smoother.

In general, given a face image, the reference portrait should have a similar pose to provide sufficient pixel position and normal statistics. Using the mass transport approach formula, the algorithm is rich to a range of postural differences. But it also faces some difficulties. Just like an example of a photo taken in a different view using a single reference retouch in this article. The authors observe that as the postural differences between input and reference increase, the result becomes less convincing.

After all authors have proposed an efficient algorithm to transfer the illumination from the reference portrait image onto another portrait image that may have different objects and have introduced a new formulation of the re-illuminate problem as a mass transport problem and have shown how to regularize it using random sampling.

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The second paper I read is called **“The Quotient Image: Class Based Re-rendering and Recognition With Varying Illuminations”.**

This paper addresses the issue of "class-based" image-based and variable-lighting rendering. The rendering problem is that given a single input image of an object, as well as image samples of different lighting conditions for other objects of the same general class, the input image is re-rendered to simulate a new lighting condition.

The key result in this article is based on the definition of an invariant signed image that can generate image space with different lighting analyzes. In many cases, the performance of the recognition result outperforms the traditional approach and the re-rendering is of outstanding quality, taking into account the size of the sample image database and the gentle preprocessing required for algorithmic work. In another words, in a fairly general case, an illumination-invariant "signature" image of each new category object can be extracted from a set of sample images, extracted from only a single input image.

This method is based on a new result which shows that a collection of all images of all Lambertian objects with the same shape but different surface texture (albedo) illumination conditions can be analyzed using the images of the prototype object and a Indicator countries unchanged) "Signed" image for each object. The Cartesian product between the signed image of object y and the linear subspace determined by the image of the prototype object yields y image space. The second result is how to get the signature image from the database of sample images of several objects, and prove that the obtained signature image is unchanged for the lighting conditions.

Both of these papers talk about the effect of illumination to the images. But the time interval between them are almost 20 years. During this years, computer graphic develop rapidly. The second article proposed the ratio image technique for face relighting, where an input face image is relight by multiplying it by the ratio of a known reference face captured under novel lighting and the original input lighting.

In face recognition, single image face relighting has been widely studied. The techniques proposed by Riklin-Raviv and Shashua lay the foundation for later research. For example, ratio images can be used to convey delicate shadow changes that caused by changes in facial expressions, or face geometry, albedo and scene lighting can be to reconstruct from a single image using low-dimensional shapes and texture models.

However, these techniques are inevitable having their limitations, for instance, requiring accurate 3D models under the Lambertian shadows, and their accuracy is diminished if the conditions are not met.So when objects display in a complex lighting conditions, it is difficult to achieve accurate

3D reconstruction, therefore, the result from these techniques would not seem good enough.

There is something interesting to me that many analytical experiments are based on black and white images before. However, the method of this article is based on the analysis of varying illuminations effects by grayscale images and color images (represented by RGB channels). So they make an assumption that the different illuminations would not effect hue composition of the image, after that, they decouple the hue from ease the analysis. To compare with the secondary article, mass transport one need to capture the global color and hue of the lighting so that, they can analyze the color and put it onto the portrait.