IMAGE LIGHTING EFFECT MANIPULATION FOR AN EFFICIENT STYLIZATION

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Abstract: We propose a model to stylize images through the manipulation of different lighting effects and their stylization. Given an input image, we propose to generate semi-automatically a map containing each effect identified by the user. Then, we propose different distortions and coloring to obtain artistic stylizations. Our model is flexible and well designed to help users who desire to stylize their images following light effects. This model is intended for an image editing tool dedicated to comics stylizations.

1 INTRODUCTION

The purpose of images is to communicate a message that can be emotional or informational. Artists use lighting effects to enhance the desired information and to create atmospheres bringing people to desired psychological state.

Light has always been used in art to enhance specific parts of images. Light effects have been described by J.M. Parramón (Parramón, 1987) and by G.M. Roig (Roig, 2010). They depend on the light source which transmission is direct or diffuse. Shadows can be shadows of objects (shades) or projected shadows representing shapes of objects (drop shadows). The light can also produce dazzling effects due to the reflective properties of the surface. As most of viewers focus on colors used in a pictorial realization, one can imagine that lighting effects are limited to artistic movement techniques. Classical examples are: Chiaroscuro consisting in violent contrasts between light and shadow to attract the viewer eye on a specific part of the painting; Impressionism emphasizing the light: shadows are represented by saturated colors and smooth diminution of light when illuminated objects are in pastel colors; Comics using various styles to depict shadows: complementary colors which are opposed on the chromatic hue wheel (Itten, 1961), hatching (Duc, 1983) and black flat which areas are very common in American comics (McCloud, 1994). Dazzling effects are often represented in comics as white areas with edges to enhance the contrast (Duc, 1983). But for all these artistic movements, the position, size, orientation, even more, presence or absence of each lighting effects such as drop shadows are not obvious. Excepted for the hyperrealistic movement, where lighting effects are reproduced with a high realism, every other pictorial movements propose at most a plausible representation. As an example, in ”The last Supper” by Leonardo da Vinci, the lighting is plausible but physically unrealistic: where are the drop shadows? feet seem to be lit. Even more, some comics vignettes contain strong exaggerations. Artists sometimes willingly add shadows to dramatize the image or on the contrary, to stylize images, they remove some shadows to avoid an overloaded scene. Before considering any stylisation of lighting effects, an artist has to decide their existence and representation (shape, position…).

We provide a solution able to stylize lighting effects but also able to help the user to manipulate them. Starting from a 2D input image, we produce semi-automatically a map containing different kinds of lighting effects. Each effect can be shifted, turned and distorted. Based on an artistic analysis and this map, we propose deformations and six stylizations involving well-known artistic styles ranging from chiaroscuro to comics. In the following, we present previous work, and then our lighting effects representation map. We detail our different stages: distortion and stylization. Finally, our results are given and commented.

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2 PREVIOUS WORK

(Ibrahim and Anupama, 2005) and (Cavallaro et al., 2004) detect shadow in videos or image sequences. Based on retinex theory, (Sun et al., 2008) detect and remove shadow from a single image. The work of Ortiz (Ortiz, 2007) permits to remove dazzling effects from photographs. Unfortunately, these detections have a high computing cost and do not permit to distinguish the different kinds of lighting effects produced by light.

Some research propose to distort images or specific objects in a scene. Carroll et al. (Carroll et al., 2010) have proposed to change the perspective of an image using vanishing points and lines that can be modified by the user. This work is interesting but do not permit to change the appearance of a specific object in the image. Tobita (Tobita, 2010) has presented a non-automatic solution dedicated to exaggerations as the ones we can find in *mangas*. Two main deformations are introduced: on the background (blur ...) and on persons whose position and size can be modified. They are mainly based on fish-eye deformations bending sharply anything that does not pass through the center of the circle.

Stylizations of lighting effects have been proposed. Image-based methods have been proposed to display soft shadows from 3D models (Agrawala et al., 2000). Praun et al. (Praun et al., 2001) proposed a system that creates hatching strokes in 3D scenes. This kind of drawing conveys lighting and properties of the material but we do not have the same information in 2D. Only Sauvaget et al. (Sauvaget and Boyer, 2010) have proposed an image-based stylization model based on a shadow map and in which six stylizations can be combined. In this paper they do not propose to shift or distort the lighting effects. We use these stylizations on our lighting effect manipulation model.

3 OUR MODEL

We present a new approach to manipulate and stylize the different lighting effects of an image. Our model permits to re-lit the previous shadow locations which have been manipulated. We extend the model proposed by Sauvaget et al. We present briefly the model to guide the reader and only detail hereafter our contribution.

3.1 Map Creation

We represent lighting effects with a map which has the size of the image and where each kind of lighting effects is represented by a color. Note that we offer the user to refine it manually. The map is created in two steps: detection, refinement.

3.1.1 Detection

A shadow is a decrease of the light intensity. We use the HLS model with L1 norm which is well designed for shadow detection (Angulo, 2004). As depicted in Sauvaget et al., we consider the the maximal and median values of lightness. We compute $\mathcal{G}$ the global threshold with I the number of intensity levels(see formula 1):

$$\mathcal{G} = (max - med) \times \frac{med}{I} \qquad (1)$$

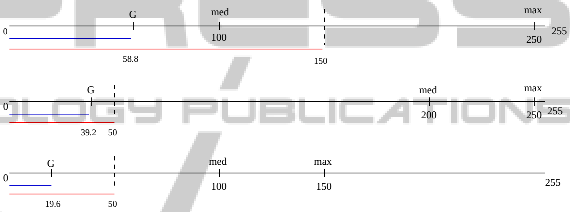

Figure 1: Threshold detection examples.

With this method, only a part of pixels which is smaller than the lightness threshold is considered. The smaller the distance is between max and med (in red figure 1), the smaller the considered area is as well and avoid to take into account the highest lightness values as shadow. This area is weighted by the median value influencing directly the size of the new area (in blue figure 1). The smaller med is, the more shadow pixels are grouped and the more important reduction of threshold is needed. For now, these pixels are considered as shadow without distinction of kind, the other pixels are considered as lit parts in the image. Some results of this detection are shown in section 4. As we propose to distinguish hard and soft shadows, we choose to binarize the map for hard shadows (black/white) or to preserve the original lightness values of the original image for soft shadows.

3.1.2 Refinement

As in Sauvaget et al., to distinguish shades and drop shadows, the user is invited to keep the previous black color (or grey level shading) for the shades and to put in blue the drop shadows. If some pixels are black in the original image, our method does not permit to distinguish them from shadows in the original image.

In such a case, the user can refine the map adding them in the lit parts (in white). To specify the dazzling effects in the map, a red color is used.

3.2 Manipulation

Once the map is created, the user is allowed to modify the place and the shape of lighting effects. With such modifications, the image is changed and ”empty” areas may appear due to the displacement of an effect. We present our displacement and deformation stage, then we explain how we fill these empty areas.

3.2.1 Displacement and Deformation

A bounding box is created during the selection of a region defining a lighting effect in the map. Its size is $x_{max} - x_{min} \times y_{max} - y_{min}$. Only the part of the image corresponding to the selected lighting effect is kept in the quad. The rest of the quad is transparent (see figure 2). When placed on the image, the quad may undergo classical transformations in three dimensions. Moreover, artists sometimes remove shadows to simplify the image. Our model allows this by removing the selection.

The second image of figure 2 presents our map with user refinements for drop shadows. The bounding box (in green) encompassing the drop shadow represents the selection. The previous location of the effect must be filled as if it was an lit part.

Note that deformations proposed figure 3 are actually possible with our system. Starting with the left image, automatic transformations can provide the center image. For the image on the right, the user would have to refine the map since the polygon should be deformed.

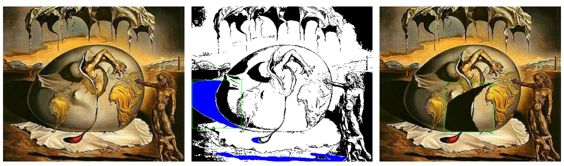

Figure 2: *Geopoliticus Child Watching the Birth of the New Man* by Salvador Dali (1934); map with the selected shadow (quad in red); displacement and rotation on x.

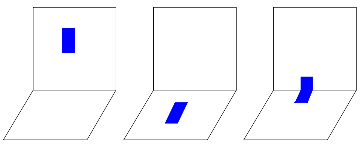

Figure 3: Example of a drop shadow on a wall; possible transformation; possible transformation with refinement.

3.2.2 Space Filling

We propose two methods to transform the previous location of the effect in a lit part of the image. The first method consists in a comparison between neighbor surrounding pixels of the effect and the pixels of the effect. We search for the neighbor surrounding pixel which has the closest hue and saturation to the mean hue and saturation of the pixels of the effect. Once we find the best pixel, we apply its lightness to the selection shape. This lightness is applied everywhere in our selection implies the probability to create flat region : the volume previously existing in the shadow is no more in this new lit part. This method is well adapted in flat colored textures but not if shading exist. To preserve the volume, we propose a second method consisting in calculating in the input image the difference between lit parts and shadow parts from our map. This difference is added to each pixel of our selection. With this method, the volume of the shape is preserved.

Remark that these methods cannot guaranty that an area too desaturated or dark is rebuilt correctly because we only re-light and do not change the saturation. Figure 4 illustrates this problem. On the left, the original image with a yellow background HLS (60, 90, 100). The second image corresponds to the map and we select the top left shadow which is a dark yellow. The last images show the result of each method. With the first method (left image), the closest value is the yellow background color (L=90) and this value is given to our selection. We obtain a color close to a white HLS (60, 90, 18), because our selection has a low saturation. With the second method, adding the difference between lit parts and shadow parts gives us the following color: HLS (60, 83, 18). None of these methods provide a suitable solution. The extreme case is black color HLS (0, 0, 0), where the hue is red defined.

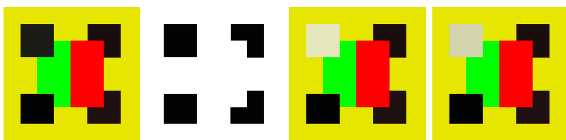

Figure 4: Original; map; first method result; second method result.

3.2.3 Style Propositions

We propose six different stylizations following Sauvaget et al. (Sauvaget and Boyer, 2010): chiaroscuro, impressionism, complementary color, hatching, black flat areas and dazzling effects. The user chooses to apply the stylization on a specific component (effect) of the map.

4 RESULTS

We present some results obtained with our model. All of these images have been produced in real-time on a Pentium 2.5GHz with 3Go of memory.

Figure 5 presents an original image from Le Pixx, the map and the lighting effect transformation results on the drop shadow of the chair. The result of the closest method to fill in the previous location is shown. Figure 6 shows a mixed result from our lighting effect stylization model and from comics stylization model (Sauvaget and Boyer, 2008).

An assessment protocol has been realized on our results. Ten persons (novices, experts in computer graphics and illustrators) evaluated fifty images (interior and exterior scenes, illustrations…).

We would like to know if the users succeed in creating the stylization they desired with the existing possibilities of our tool. All of them found intuitive to shift, rotate and distort the lighting effects. However, when not combining some of our lighting stylizations with the comics stylization model of Sauvaget et al. that permits to obtain a global coherence in the stylization of the image, 90% of them felt disturbed. Artists felt limited by the actual number of possible shadow stylizations but they appreciated the mix between the atmosphere and light effects (see figure 6).

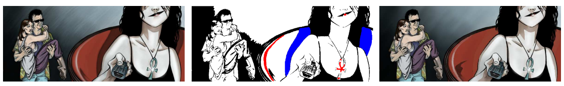

Figure 5: Original; map; result.

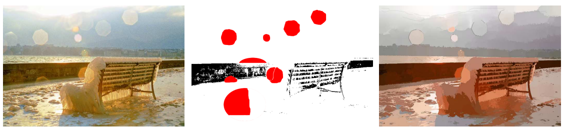

Figure 6: Original; map; result mixing our model and Sauvaget et al. comics stylization one.

5 CONCLUSIONS

We have proposed a model to manipulate and stylize lighting effects for 2D images. The principal limit of the detection method is that dark objects are detected as shadow. Our model permits a visual and semantic distinction between the lighting effects. It is flexible and allows different stylizations on different lighting effects.

In future work, we will improve our model by adding more stylizations and colored light effects. We plan to add existing effects like hatching using gradients. We also plan to consider coupling our approach with the depth map produced by (Sauvaget and Boyer, 2008) to enhance the contrast between the different kinds of lighting.

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