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Seam carving based aesthetics enhancement for photos ☆

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ABSTRACT

Recently people are becoming more and more interested in the quality of photographs with the growing interest of image aesthetics. Many previous works start to focus on aesthetically enhancing the quality of images. In this paper, we come up with a novel approach to enhance image aesthetics. An aesthetically beautiful image usually has a clever composition of objects, the optimal positions of which have been deeply discussed by previous methods and reached good performance. After getting the optimal position of the object in images, we try to rearrange all the objects. Instead of picking the object out and pasting it on the suggested place, we propose an improved seam carving approach to change the relative positions of the objects in the image, which is able to move the object to a better place. We adopt the energy function to measure the saliency of each pixel and then find out the seams that should be cut off and inserted. After cutting off unimportant seams by pixel-removing and inserting seams by inpainting, we are able to maintain the resolution of the image as well as enhance the aesthetics in composition. In order to test the effectiveness of our method, we compare the performance of our approach with other state-of-the-art techniques, which well illustrates the satisfying performance of our method.

1. Introduction

With the growing interest of image aesthetics, people have been paying more attention to the quality of photographs and much work has been done in this field. Professional photographers and editors focus on the hue, clarity, contrast and composition of the photos, among which we highlight the importance of composition of the objects [1–4].

Many previous works start to pay attention to the aesthetics of photos. Sheikh et al. [5] developed a novel quality assessment (QA) algorithm through natural scene statistical models to automatically assess the quality of images. Datta et al. [6] extracted visual features on intuition and build an automated classifier through machine learning, the goal of which is to explore the relationship between the low-level content and aesthetical quality of the image. Ke et al. [7] considered perceptual factors to design high level semantic features to distinguish professional photos from snapshots.

Though many professional photographers and researchers start to realize the importance of composition in photography, they have not formalized the concept of adjusting the composition of the photo post production. Freeman [8], in his book, gave lectures on the composition, presentation and technical production of photography, which regards composition as an art form to explore the beauty in photography. Also, Banerjee et al. [9] proposed a joint optical-digital framework, the goal of which is to guide users to obtain better composition effects in photography.

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To generate better composition effects, Santella [10] et al. adopted eye tracking to recognize important image content and then conducted cropping. Experimental results of user study showed that the cropped image creates better aesthetical effect. Nishiyama et al. [11] used a quality classifier to evaluate the quality of the cropped region.

Based on some well-ground composition guidelines, Liu et al. [12] proposed the first optimization method to produce aesthetically better images. They used cropping and retargeting to change the relative position of salient regions in the image to modify its composition aesthetics. However, their method ignored the background information which leads to unwanted content changes or large distortions.

Image classification plays an important role to enhance the quality of images. Ref. [13] developed a new fine-grained image categorization system that improves spatial pyramid matching. Ref. [14] constructed a feature correlation hypergraph (FCH) to model the high-order relations among multimodal features. Ref. [15] proposed a model to recognize architecture style by introducing blocklets that captured the characteristics of buildings. Inspired by these works, researchers could classify images and consequently use different strategies to enhanced image aesthetic.

To improve the performance, Bhattacharya et al. [16] presented an interactive learning-based technique to recompose the object to a better position. Guo et al. [17] built a unified model and used seam carving to generate the optimized image by considering composition aesthetics and adding image similarity to assess the artifacts caused by composition adjustment. In [18], the authors added a real-time retargeting method to compute the energy for salient region, and further decided the optimal position. The common problem of these approaches is that they all move objects separately without regarding the information of the whole image. Recently, Zhang et al. [19] improved the previous works by adopting region dependence analysis and object position optimization to optimize photo composition.

After detecting the object of the image, existing works may perform a set of computations to find out the optimal position for the object [19]. As has been shown in many previous works, a professional photograph should obey some principle of composition. There should be a careful arrangement of lines to ensure the simplicity and balance of an image. Also, the object of an image should be correctly placed. According to the rules, such as the rule of thirds (ROT) as well as the diagonal rule, the object of an image should always be put around the diagonal, closing to the point of intersection of ROT.

There are a large number of existing works, which pick out the object from the image and rearrange it to the proposed position. However, this may produce unexpected results. For example, imagine that we have an image where there is a cat standing on the snowfield in the middle, which goes against our composition rules. To rearrange the cat, previous methods pick the cat out and move it a little to the right (or left), which will leave a hole in the snowfield [19]. Also, other previous seam carving based methods may cause the information missing of the original image, which may inevitably cut off some important objects due to their deficiency in selecting seams [17].

Therefore, in existing works, large holes are opened up during recomposition which cannot be filled nicely with inpainting. Alternatively, seams are opened up instead of holes which makes inpainting more applicable. But seam carving may cause image distortion when the seams crossing important object are inevitably cut off. In order to solve problems discussed above, we come up with the idea of improved seam carving for better composition with considering the content of the whole image. As a result, our approach can avoid cutting the important content and insert seams unnoticeable.

The rest of this paper is arranged as follows: some related works will be introduced in Section 2. In Section 3, we propose our approach based on the improved seam carving. We evaluate the performance of our approach in Section 4. Finally, we draw our conclusions in Section 5.

2. Related works

There are many existing works in rearranging the position of the object, which could be categorized into two major fields, i.e. inpainting based [20] and retargeting based [21]. Zhang et al. [19] came up with an inpainting method to fill the hole caused by “cut-and-paste”; while Guo et al.[17] used a retargeting approach to rearrange the object. However, both of them have limitations in order to aesthetically enhance the quality of images. The former method may blur the image while filling the hole with inpainting; and the latter one may cut the important object due to the limitation of seam carving.

2.1. Inpainting based approach

There were two parts of Zhang et al.'s work, including region dependence analysis and object position optimization.

Firstly, in order to understand the relationship between content of an image, authors in [19] used an iterative saliency-cut approach [22] to determine the foreground and background of a photo and they also used a segmentation method [23] to divide the image into over-segmented regions. Then, they computed three features (acutance, sharpness and harmony between main colors), and used them to compute the energy function. After getting the energy function for each region, multi-label graph cut was adopted to implement dependence analysis, which might maintain the connection between the object and the region that were strongly tied to it.

Secondly, they considered four composition rules, i.e. distance from power points D_p, distance from diagonal lines D_L, visual balance D_V, relevance of objects $R(i,j)$ as well as constraints and penalty ρ_i to build energy function.

$$E = D_p + D_L + D_V + \sum_{i}^{n} \rho_i + \omega \sum_{i}^{n} \sum_{j \neq i}^{n} R(i,j) \tag{1}$$

where the default value for ω was 1 and $n = 1000$.

Finally, they rearranged the pixel values of each foreground object to the proposed place, which could be understood as picking the object out and pasting it to the right place (so we called it “cut-and-paste” approach