Automatic Deblurring for Facial Image Based on Patch Synthesis

Masahide KAWAI* Tomoyori IWAO* Akinobu MAEJIMA* Shigeo MORISHIMA†
Waseda University* Waseda Research Institute for Science and Engineering†

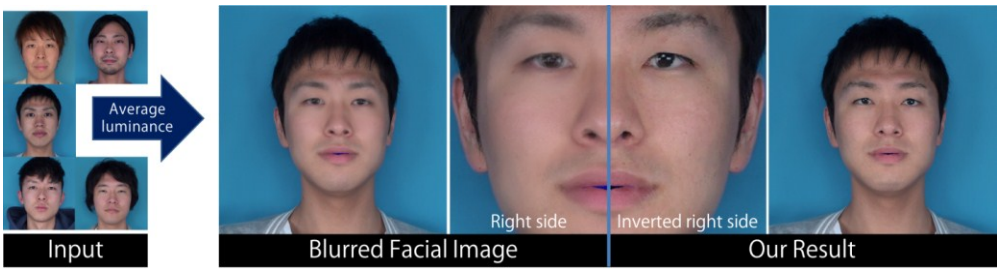

Figure 1: *Comparison between blurrred facial image and our result.*

1. Introduction

Deblurring of a facial image is one of the most important topics in computer vision. Blurriness can occasionally appear on a facial image in different parts, such as a eyes, a nose, a cheek and a mouth because of alignment errors. For example, the morphable model and active appearance model are statistical models that can represent a variety of facial images by changing parameters; however, synthesized facial images can include the same type of blurs as mentioned previously.

To solve these problems, Li et al. [2010] proposed a robust motion deblurring system. Their method enables deblurring of the flat cheek region of facial images, but it cannot fix *inconsistent images*, which are defined as images that include considerably stronger blurs, such as the eyes and the nose. For example, there are strange blurs, such as the white of an eyeball tinged with black color and the nasal cavity tinged with skin color because facial images are created by morphing each pixel. Therefore, we propose a novel method to automatically deblur a variety of facial images that include inconsistent images. Our method is considerably more effective in strong blurs because it can create a novel image by replacing a blurred image with small square images called "*patches,*" without additional databases.

2. Transferring the Facial Luminance Gradient

In this paper, we work with an average face image (*AF image*) composed from five facial images, because the AF image adopts inconsistent images. In addition, we consider the AF image as the input and the five facial images as the database for our deblurring method. The size of all the images is 512×512.

Our method creates a novel image from the five images by calculating the RGB distance between the AF and database images. Therefore, most regions of the resulting image are composed of one image that has skin color resembling that of the AF image. To avoid this bias, we must transfer the luminance value in the AF image to that in the facial images from the database. However, it is difficult to transfer luminance value in a facial image because the luminance gradient in a facial image tends to vary largely in the local values. Therefore, we propose a novel method called "*Patch Color Transfer(PCT)*" that can transfer a luminance value in a facial image to another image using the following procedure. First, the AF and database images are separated into multiple patches of 60×60 pixels with a 15-pixel overlap. Next, a luminance value in the AF patch image is transferred to that in the database patch image at the same position by adding the average value of the difference between the luminance value of the AF and database images in a certain patch to that of the database images per pixel. Afterward, we create the normalized database images by synthesis, proceeding from the top-left to the bottom-right with the 15-pixel overlap.

3. Deblurring the Facial Image

Our deblurring method based on patch-based texture synthesis generates a novel deblurred image from an arbitrary image using normalized database images. We modify the visio-lization method [Mohammed et al. 2009] and apply the modified method to the AF image using the following techniques. The AF and database images are separated into multiple patches of 30×30 pixels with a 9-pixel overlap in the eye region and those of 60×60 pixels with a 15-pixel overlap in the other regions. Although the previous method uses the same patch size, our method can increase the potential for enhancing the representational power of synthesis by changing the patch size in each region. Next, the RGB distance between patches in the input image and the database images are calculated, and the best patch image from the database is selected. However, in the previous method, the patch selection is limited to the same position in the AF and the database images. To select the most suitable patches from the database, our method selects patches from the neighborhood, but not necessarily from the same positions. This flexibility enables the reliable reproduction of the AF patches. Finally, we synthesize a novel image from the top-left to the bottom-right.

4. Discussion and Limitation

The result is shown in Figure 1. Our method is effective to significantly improve the blur and inconsistent images of the face. Particularly, we can deblur inconsistent images that contain the eyes' failure and nose's failure using the PCT and modified visio-lization method. Such representations have been difficult to produce with previous methods. One possible limitation is that the resolution of our result depends on the resolution of the database images. Consequently, constructing databases of high-resolution facial images can further improve the performance of our result.

References

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