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Technical Section

Automatic flexible face replacement with no auxiliary data

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ABSTRACT

In this paper, we propose a system for flexible face replacement in photos that does not require human intervention. The proposed replacement algorithm is able to efficiently paste one person's face into another's with different head poses and/or hairstyles. This work can enhance the quality of group photos that contain human faces, as they are seldom flawless. Previous methods require complex user interaction or auxiliary data such as a 3D head model library or a photo library, while our system does not. Given a photo, the faces are automatically detected and transformed into similar poses by fitting corresponding facial features. We then construct an energy function and optimize it for a better face contour between the transformed source face and the target one, followed by applying seamless cloning. Our system removes hair before face transfer and adds it back afterwards, maintaining the same hairstyles. We demonstrate that our system produces high-quality results without manual tuning of parameters.

1. Introduction

Techniques for manipulating and replacing a source image patch into a target one have received considerable attention in recent years. Alpha matting [1] and seamless cloning [2,3] show that realistic results can be obtained without extensive user interaction. Among all the applications of image manipulation, face replacement is one of the most challenging tasks, as human eyes are highly sensitive to faces. Thus, facial features should be accurately maintained during replacement, and artifacts will meet with very low tolerance.

Researchers have made substantial efforts [4–7] to improve the results of face replacement. However, there are still some major limitations of these methods. First, Photomontage [8] and similar systems are not able to transfer faces with different shapes or poses directly, and they require heavy user interaction. Second, most of the state-of-the-art methods [4,5] require auxiliary data such as a 3D face model library or a photo library, which are not easy to acquire. Third, they seldom consider the effect of hairstyles, which are often difficult for human observers to ignore in figure photos.

We propose a more general automatic face replacement system to transfer faces with different head poses and/or hairstyles easily. To replace faces with different shapes, we propose an algorithm to optimize the face contour, which applies a cubic B-spline curve fitted using genetic algorithm optimization. Our system can align inclined faces and maintain the same hairstyle during replacement. Unlike prior research, our system does not require any auxiliary data. It preserves more details from the source face than previous work does, as we transfer the whole face rather than only the interior area. Fig. 1 shows some interesting results, in which the facial features and layout from the source face are well maintained, and our system adjusts the color tone and head poses automatically. Moreover, the user interaction of our system is very simple, as selecting recognized faces is sufficient to accomplish all the work. These examples show that our system can retain details of the whole face and avoid artifacts between faces with different shapes and poses.

Our system can be applied to different applications. For example, it is common that a photo captured for a perfect moment may turn out to be unsatisfactory due to bad expressions or closed eyes. Our system is able to transfer faces with better expressions from different candidate photos to a target one, improving the quality of group photos or creating interesting compositions.

The rest of this paper is organized as follows. In Section 2, we briefly review some existing face replacement methods and related work. The system pipeline is elaborated in Section 3. Details are provided in Sections 4–6. Section 7 presents experimental results, and Section 8 presents our conclusions.

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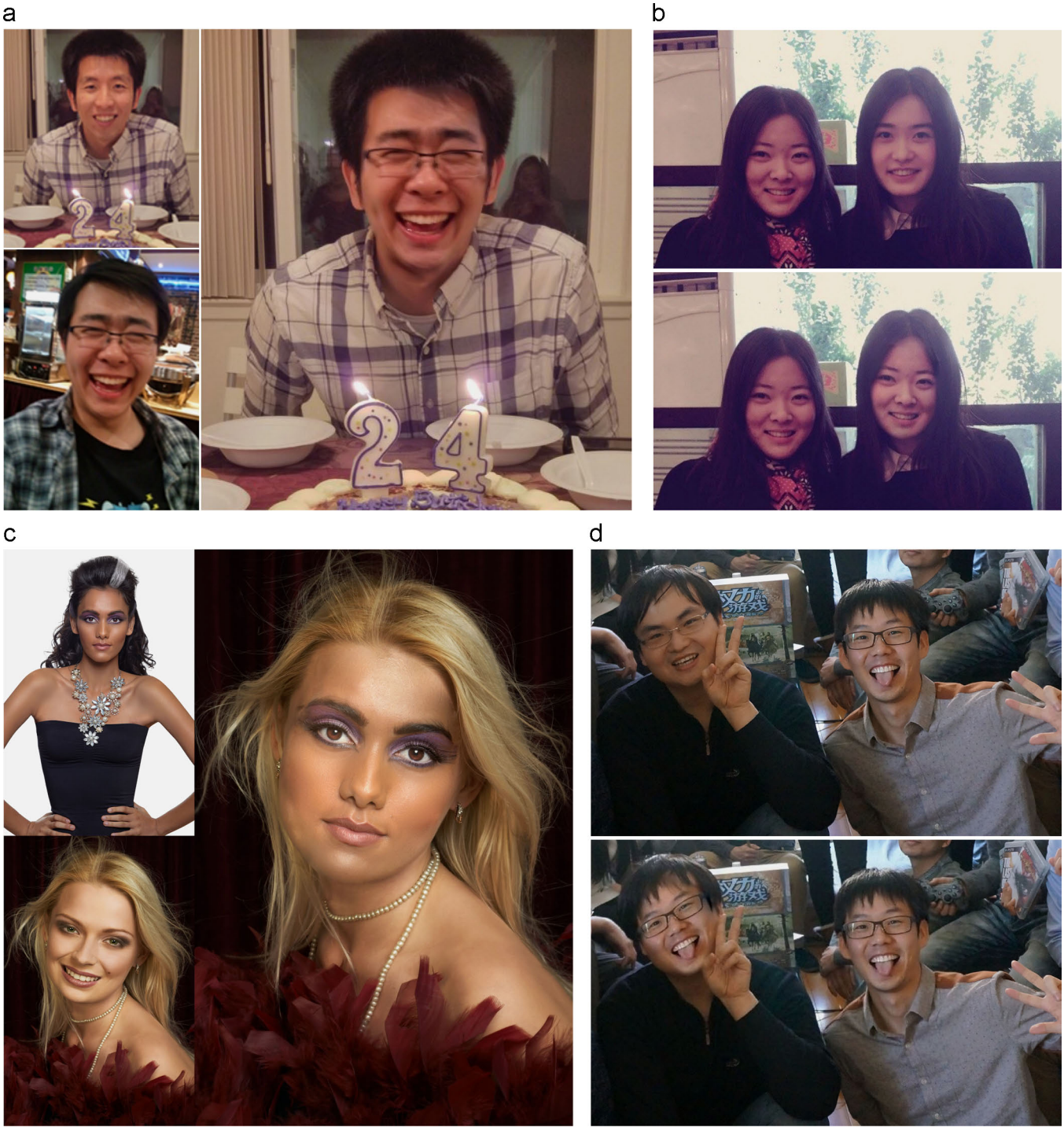

Fig. 1. (a) We transfer faces from different people while maintaining details such as hair and shadow. (b) An example with faces of different color tones. (c) High-resolution photo with faces of different skin colors. (d) An example with faces wearing glasses, which are aligned well with our system. (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this article.)

To summarize, our work has made the following contributions:

- A novel framework for providing automatic replacement, without human intervention, of faces across different head poses, face shapes, facial expressions and hairstyles.
- An energy function for more appealing final compositions with instant cloning.
- A face contour optimization algorithm with cubic B-spline curve fitting.
- An algorithm for maintaining the same hairstyle through guided inpainting and alpha matting during replacement.

2. Related work

Our work is related to previous research on general image editing and on face editing in images and videos. There are also some existing applications to compare with our system.