Example Based Caricature Synthesis

Wenjuan Chen[1)], Hongchuan Yu[2)], Jianjun Zhang[2)]
1) Animation school, Communication University of China ,beijing cwj@cuc.edu.cn
2) National Centre for Computer Animation, Bournemouth University, United Kingdom
{hyu, jzhang}@bournemouth.ac.uk;

ABSTRACT

The likeness of a caricature to the original face image is an essential and often overlooked part of caricature production. In this paper we present an example based caricature synthesis technique, consisting of shape exaggeration, relationship exaggeration, and optimization for likeness. Rather than relying on a large training set of caricature face pairs, our shape exaggeration step is based on only one or a small number of examples of facial features. The relationship exaggeration step introduces two definitions which facilitate global facial feature synthesis. The first is the *T-Shape* rule, which describes the relative relationship between the facial elements in an intuitive manner. The second is the so called *proportions*, which characterizes the facial features in a proportion form. Finally we introduce a similarity metric as the likeness metric based on the Modified Hausdorff Distance (MHD) which allows us to optimize the configuration of facial elements, maximizing likeness while satisfying a number of constraints. The effectiveness of our algorithm is demonstrated with experimental results.

Keywords: Caricature Synthesis, Exaggeration, Likeness, Modified Hausdorff Distance, Texture Style Transferring

1 INTRODUCTION

This paper presents a new technique for the synthesis of novel human face caricatures learning from existing examples. There are three elements essential to caricatures: exaggeration, likeness, and statement [1]. A caricaturist must decide *which* features to exaggerate, and the *scale* of the exaggeration. The likeness emphasizes the visual similarity of the caricature to the subject. Statement allows the artist to add some personality to the subject by editorializing the caricature. Statement is an artistic process and cannot be emulated by a computer. In this paper we address exaggeration and likeness with the aim to create exciting caricatures by learning from available examples.

Example based learning methods usually need a large training set from a particular artistic tradition, such as [2]. In practice, however, it is impossible to get a large training set of caricatures that have the same style or from the same artist. Commonly only a small number of caricatures from the same caricaturist or the same artistic tradition are available, making these conventional example-based learning approaches ineffective.

Facial features (e.g. facial contour, eyes and nose etc.) are essential elements of a caricature. Different caricaturists and artistic traditions draw them differently which give caricatures a distinct style. Therefore a new caricature can be created by taking these individual elements from several caricature examples. For instance, one may want to exaggerate a face with a narrow facial contour and short nose. If both features are present in different examples, the solution is to pick up the necessary features from the respective example caricatures. However, because the facial features are from different examples, harmonious arrangement of these features is essential.

2 ALGORITHM

• **Shape exaggeration:** The shape exaggeration of individual face elements is computed based on only one or a small number of examples. Let $\{X_0, X_0^*\}$ be a given face image-caricature pair, where X_0 denotes the original natural face while X_0^* denotes the caricatured one. In terms of the training set $\{X_i\}$, one can build an eigenface space. It is therefore expected to build a mapping between $X_i^* - X_0^*$ and $X_i - X_0$,which is described as follows:

$$X_i^* - X_0^* = U_k[\lambda_k]U_k^T(X_i - X_0), \qquad (1)$$

where $[\lambda_k]$ denotes the approximation coefficients in a diagonal matrix form. We formulate this problem of seeking λ over the training set $\{X_i\}$ as a minimization problem with respect to λ as follows,

$$\min_{\lambda} \sum_{i=0}^{n} \left\| X_0^* - U[\lambda]U^T X_i \right\|^2 . \qquad (2)$$

Once λ is yielded, one can select the first k principal components to compute the deformed X_i^* with Eq.(1).

• **Relationship Exaggeration:** Most present approaches exaggerate the difference from the mean[3], although the results of this approach have often been criticized. In fact caricaturists tend to emphasize only one or two salient features in a caricature[4]. In this paper, the proportion description of the features is introduced. Normalizing the proportion differences of a feature by using its mean is viewed as an expression of the feature distinctiveness.

Caricatures think that all the facial features relate to one another fundamentally, and we cannot make a change to one feature without it affecting the others. This is one of the few constants you can rely on with respect to drawing caricatures: Action and Reaction**.** The T-Shape rule [1] are utilized to exaggerate the relationships between the facial features, which can be stated as follows: if the eyes move apart from each other, the nose should be shortening; whereas, if the nose is lengthening, the eyes should move closer to each other. It proves both simple and intuitive.

• **Likeness:** In existing methods, "likeness" was seldom considered for caricature synthesis due to lack of a "likeness" metric. We introduce the Modified Hausdorff Distance (MHD) [5]to measure the visual similarity. Based on this metric the likeness is incorporated into the integral caricature by optimizing the configuration of the facial elements, ensuring the resulting caricature resembles the original subject.

Some line-drawing caricatures are produced by three steps above : the shape exaggeration, relationship exaggeration and likeness optimization shown in Fig 1.

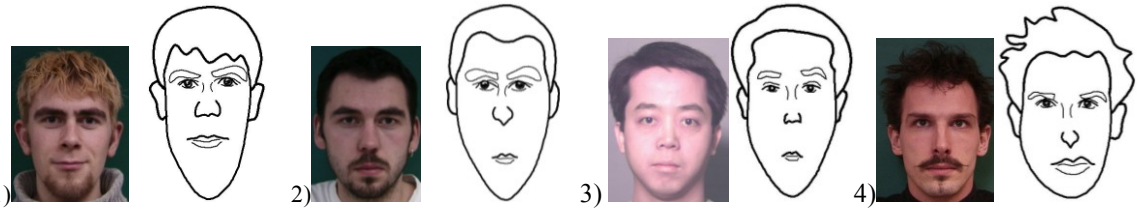

Fig. 1. The generated caricatures using our approach.

3 CONCLUSION

In this paper, we present an example based caricature synthesis approach. Unlike other published approaches, our new shape exaggeration method is based on only one or a few examples of facial components. So it's easy to change caricature style. Regarding the measurement of face likeness, there was little work done in the area of caricature synthesis. Our MHD based similarity metric definition attempts to tackle this issue.

However, there remain a number of issues in our current development, which will be investigated in the future. The hair style and head shape have not been considered due to the problem of hair occlusion. In addition, we will also try to incorporate different texture styles, such as watercolor and pencil sketch, a process known as *texture style transferring*. Combining a caricature with versatile texture styles is likely to produce more fantastic exaggeration effects.

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