VIRTUAL FACE IMPLANT FOR VISUAL CHARACTER VARIATIONS

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ABSTRACT

One of the main goals in populating the virtual environments (VEs) with human body models is to increase the visual realism of the simulation. Population created with a template model cloning technique is perceived by the viewer as a synthetic crowd. To increase the degree of the visual realism, mainly the characters are generated with various body sizes and solid skin colors. In the case of avatars, a geometric model is customized according to the features of the real counterpart. In this paper we represent a simple and efficient method to improve the visual variance of the virtual characters by implanting a low resolution on any portrait face image. The effect of this model customization process is improved by adapting the whole body skin color with the average color tone calculated over the input face image.

1. INTRODUCTION

In Computer Graphics (CG), there has been a keen interest in the study of human body design and modeling. With the significant hardware and software developments in CG, sticklike characters give way to the realistic 3D ones. This progression is mostly focused on achieving realism in VEs to improve the visual perception. Depending on the functionality of each element in VEs, efficient shading, skinning, and motion algorithms are developed to simulate their physical properties. Most of these techniques are focused on human body models, which are very important elements of these environments. The evolution in 3D graphics technologies are not only constrained by the software and hardware for better rendering but also by haptic devices, 3D scanners, motion capture devices, caves, etc. which are developed to meet the dramatically increasing requirements of the users for realism. With all these continuous developments, every day the gap between the virtual and the real worlds is getting smaller. However, the degree of the realism of the cloned virtual characters is not limited to the size parameters but also the model texture is an important criterion. Especially the face texture of the model has an important impact on the identity of a virtual character.

Mapping face image on a 3D model from pose variant images is a hot topic [1, 2, 3, 4, 5]. Existing methods mainly focus on the pose variation problem [4] or they are tightly coupled to a specific face model [6]. Even most of them are dependent on a large model database [5] which makes it difficult to port between different platforms. We address in this paper the problem of virtual character cloning from a single face texture captured with an ordinary web camera. We use efficient techniques and light dependency data make our method easy to adapt different platforms. We demonstrate our method's efficiency with a sample application field Virtual Try On (VTO) where it is possible to customize a virtual character both with the body size parameters, face image and skin color. In the following sections we will mention about the method to extract the face image from a webcam captured portrait photo. Following the face detection, we detect facial features over the image and warp it over a uv map of the 3D model. Finally the skin color from the detected face image is extracted by excluding the eyes and mouth regions. Average color is applied on the whole body skin for consistent skin color rendering.

2. VISUALLY REALISTIC SKIN VARIATION

In addition to the changes on the model's geometry, visual realism of the virtual population with size variations can be increased by creating skin color variances, changing face texture with new ones and rendering the skin with its physical properties. In many cases, almost all characters are rendered together with a virtual cloth (see Fig. 1), and only the parts of arms, legs and face are visible to the viewer. Mainly rendering just these regions of the body requires more attention than the others. We focus on especially on the face texture which is an important part of the visual identity and plays a key role in creating variations in a population. Based on this approach, we extended our body modeling pipeline to enable model texture customization by implanting any face picture and adapting the skin color accordingly.

Fig. 1. Customized models with and without clothing.

2.1. Creating Face Texture Variation

In the process of creating many different virtual characters for visual variation, we focus on the efficient methods to improve the variation of a template model from a simple face picture. The goal is to be able to modify both the face texture and the body skin color, thus enabling our system's users to customize easily the existing 3D models by using a single picture. Our approach involves several steps to achieve the goal: first, facial features extraction from the face image; second, mapping face image to template model and third, color correction of the template model.
From a portrait picture of a person, first we detect the face region over the image and then filtering the picture's background and extracting just the face region, we give the resulting picture as an input to our system. This initial filtering allows a robust facial feature extraction by eliminating the environmental artifacts that causes wrong feature detection. A portrait picture taken by a regular webcam or any frontal face image taken from the Internet can be used as an input parameter in our system.

5.1.1. Face Detection
For detecting the face region in a portrait picture, we use the real-time efficient method developed by Viola [7]. A major advantage of this method over the existing ones is that it has high detection accuracy while minimizing the computation time. This method follows three major processing stages to detect a face region in a picture. First, an integral image of the picture is computed (which is similar to a summed area table approach used in CG). On this image, a set of features which are reminiscent of Haar Basis functions are detected. Second, using AdaBoost [8] based classifier, a small set of feature points are extracted. Thirdly, more complex classifiers are cascaded in a structure so that attention is paid on promising regions of the image to detect the face.

2.1.2. Facial Features Extraction
To extract facial features, we have tested several morphable models such as active appearance models (AAM) [9] and active shape models (ASM) [10] which are cited in major research papers. Robustness, rapidity and compactness were the main criteria to select this method. The best compromise has been obtained with a 75 points active shape model (see Fig. 2). ASM are faster and more compact than AAM since they do not model the entire texture but focus only on the surrounding of the feature points. Its robustness is linked to the annotation database used for training the system. We have used an annotated database of frontal and neutral faces. An annotation tool for quick and easy annotation of pictures was developed to create and ameliorate the database.

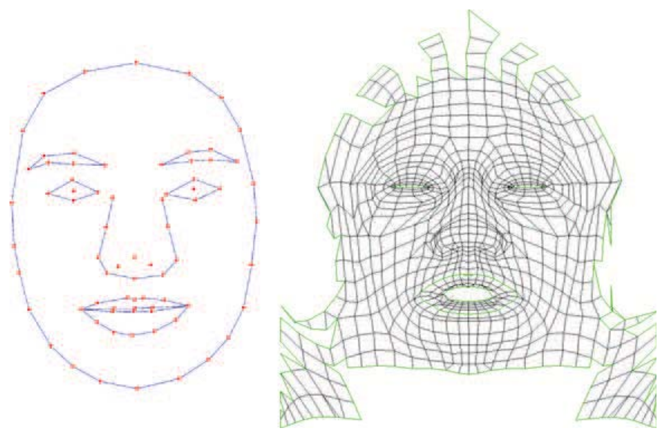

Fig. 2. Face image mapping to template model. (a) the average 75 points ASM model, (b) the template UV map.

2.1.3. Mapping Face Image
To map the face image to the template texture map, we have to establish a correspondence between the extracted feature points (active shape model) on the portrait face picture and the 3D model's UV texture map. Using affine transformation methods, we deform the extracted face image with the overlapping ASM feature points to the predefined feature points on the template 3D body models texture map. Criteria to find the best transformation from the ASM to the 2D texture map is based on the least-square difference where we minimize the distances between the template and ASM model [11].

2.1.4. Color Correction
For correct integration of the face image on the template body model, we have to correct the color of the whole body skin. To perform this correction we need first to evaluate the skin color on the face image. Using the locations of detected feature points in ASM model, we easily select areas of the

pure skin where the eyebrows, eyes, nose (so the shading) and mouth regions are removed (see Fig. 4.e). Then we compute the average color of the skin through this filtered face segment. We then align the body skin color to this average color (see Fig. 3) to minimize the color difference between the implanted face image and the template body model's skin color. We have also performed some tests on automatic hair color detection which would increase the resemblance between the 3D model and the input face. But because of the high possibility in hair style variation, it is not easy to detect hair region from the background.

Fig. 3. Customized template body model with different face textures and skin colors.

In figure 4, we illustrate the stages mentioned in the previous sections as a diagram. Following this figure, here is the summary of the stages mentioned: a) Portrait picture that will be used to map on the template model b) Detect face region on a portrait picture by using Viola-Jones cascade [7] c) Use ASM model to fit the template annotation on the face region d) Extract face region e) Extract eyes, eyebrows and mouth for skin color detection f) Template body model with unwarped texture coordinates g) Transform the detected ASM annotation on the unwarped texture coordinates and so the detected face region h) Adapt the skin color of the model texture according to the detected average skin color i) Final template body model with new skin color and the face.

3. CONCLUSION

There exist several aspects of the visual realism to be considered while modeling virtual human bodies. Apart from geometric deformation, skin surface reflectance and face texture are important visual features of the identity and require additional consideration while creating model variations. In this paper we focused on the efficient techniques to achieve visual variance with low cost, limited computation resources. We represented a new approach to customize the face texture by implanting a new image on the template body model. Using any portrait picture of a person provided, we replace the existing facial image of the template body model's texture with this one. Deforming the new face image to the size of the template one we preserve the size correspondence between the new and the template texture. Also analyzing the skin color of the new face image, we change the whole body skin color to keep the skin color features consistent. This approach makes it possible to create variety in face identity in addition to the body size capability in VTO like applications. The resulting data can be used in social network applications to represent one's own 3D model instead of a 2D image or in many other applications such as games for personalized game characters, virtual try on for simulating cloth on his/her virtual clone and so on.

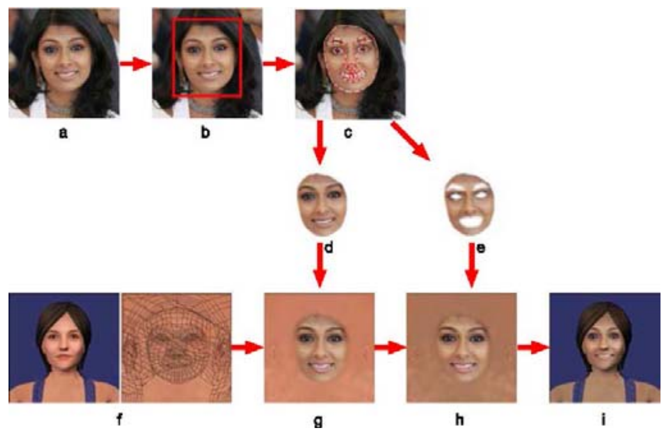

Fig. 4. Creating visual variations of the template body model.

4. ACKNOWLEDGEMENTS

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