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3D Mesh Deformation Technology for Generation of Virtual Garments

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Abstract

In recent years, the area of sketch-based virtual garments generation has attracted more and more attention. In this paper, we propose a new method to develop 3D virtual garments by applying mesh deformation technology for the sketch-based approach. Compared to the traditional methods, the 3D garments, generated by our method, can be obtained easily and directly. The technology of mesh deformation in our paper involves two algorithms: Laplacian mesh editing/optimization, and mean-value geometry encoding/decoding. Given the modified positions for a set of anchor vertices, the mean-value encoding and decoding are used to transform the positions for the rest of the mesh vertices. Laplacian mesh editing and optimization are capable of improving the quality of the triangulation while preserving the shape properties of the original models. The resulting 3D garment validates the effectiveness of the proposed method.

Keywords: Virtual Garment; Laplacian Smooth; Mean-value Encoding and Decoding

1 Introduction

Traditionally, the generation of 3D virtual garments usually contains two different methods. The first is constructing the 3D garments by sewing 2D patterns [1], it is used for physical models. The second is using parametric contour curves and style curves to make 3D garments, these two types of curves are introduced automatically, and the 3D shape is much more precise to enhance the 2D pattern flattening quality [2, 3]. In recent years, the area of sketch-based virtual garments generation has attracted more and more researchers. It is also called sketch-based interface modeling. The core of this technique is to deform the initial 3D garment mesh, which can be shaped by distance fields from 3D mannequin [4]. Hence, the final results of garments will be affected by the methods of mesh deformation or mesh editing.

Earlier mesh deformation techniques used hierarchical mesh encoding [5, 6]. The mesh is decomposed into more details, with each level of detail edited with respect to the previous one.

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Guskov et al. [7] developed an editing method where a vertex of a 3D mesh is encoded as a distance of a normal, from the average of the neighbour vertices, since most existing mesh vertices are not positioned strictly around the average of the neighbours. Instead, it requires remeshing to satisfy the positioning requirement. Bischoff et al. [8] proposed linear techniques for modifying the base smooth mesh. However, as simple linear formulation can not distinguish rotation with scaling and translation, the deformation can lead to undesired artefacts.

Laplacian mesh smoothing is recently widely used. The laplacian coordinates [9] provide a local mesh encoding and the coordinates of each vertex is represented by the difference to the average of its neighbours. Hence, it is also called differential coordinates. The mesh editing is extremely efficient, as the computation is only needed to solve a linear matrix system. Lipman et al. [10] reconstructed the surface from discrete Laplacians matrix and spatial boundary conditions by solving a least-square system. They also proposed the drawbacks of their method, which is the need to rotate the local coordinate to preserve the orientation of local details. They exploited an explicit solution to this problem. Sorkine et al. [11] introduced a method to implicitly transform the differential coordinates based on finding an optimal solution for each vertex. The transformation is defined by a linear system of local coordinates and control points. The solution of this system preserves the mesh size and the orientation of the detail levels.

Sheffer and Kraevoy [12] proposed Pyramid coordinates, which the local mesh deformation, based on mean-value weighting, has a property of rotation invariant. However, this algorithm leads to abnormal deformation near control points. Hence, they advanced this algorithm later and named mean-value encoding and decoding [13]. The mean-value encoding consists of the set of coefficients deduced by the angles and lengths between each vertex and all the neighbour vertices.

In this paper, we propose a new method to generate the 3D garment from the input sketches. The original design is first digitalized and triangulated as the template model, and then the template model is deformed in terms of Laplacian mesh editing and optimization against the sketching lines. The final result is obtained via mean-value encoding/decoding, as shown in Fig. 1.

Fig. 1: 3D virtual garments generation based on surface deformation. Left: digitalized designer's sketches. Right: resulting 3D garment model.

To facilitate our expression, a skirt model is employed as an example. We called this skirt the "template-skirt". The details of mesh deformation are prescribed in the following sections. Sec-