Hair Modeling from a Single Anime-Style Image

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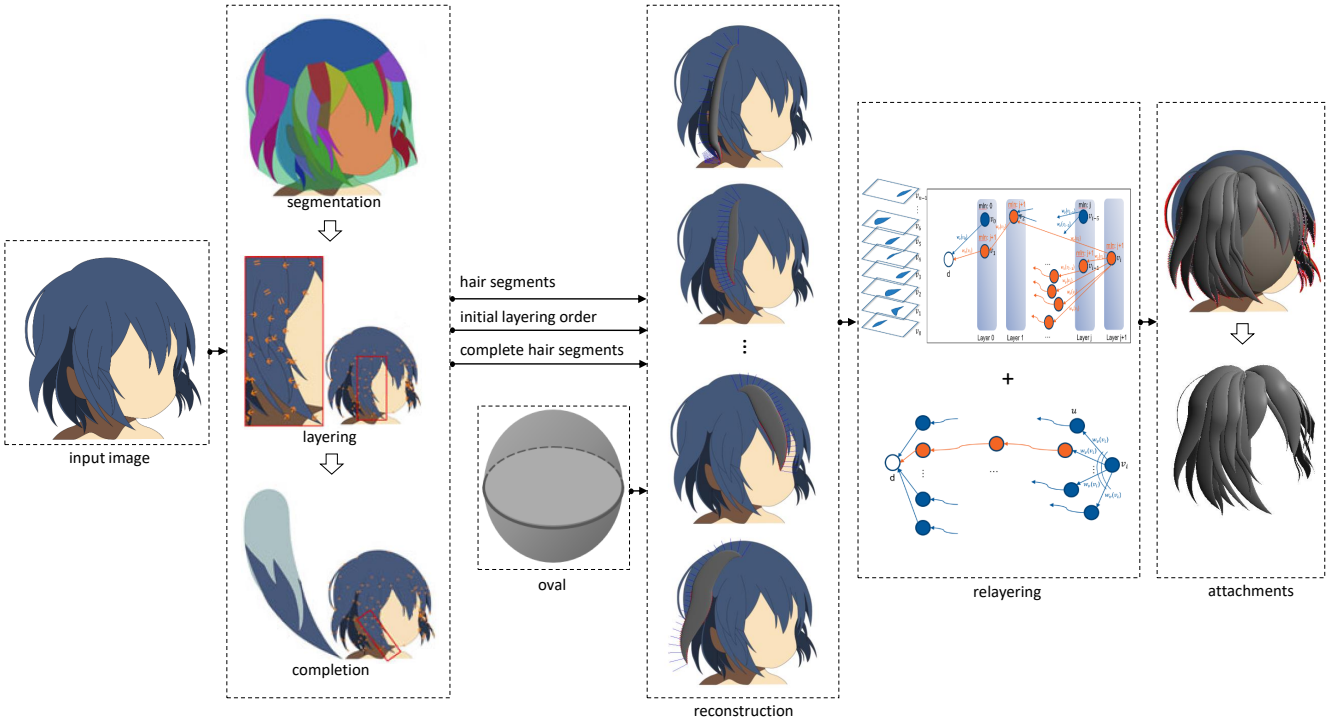

Figure 1: The overview of the proposed system.

CCS CONCEPTS

• **Computing methodologies** → **Mesh models**; **Parametric curve and surface models**; *Shape analysis*;

KEYWORDS

anime hair modeling, single-view modeling

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1 INTRODUCTION

Recently, research of modeling realistic hair from a real-life portrait image has achieved extraordinary results. Modeling cartoon hair from an anime-style image, in contrast, has not drawn much attention from researchers. Yeh et al. [2015] proposed a 2.5D approach which determines a layering order and estimates hidden portions of hair segments from an anime-style image. However, their results are only suitable for a single view angle. In this work, we propose a novel approach to model cartoon hair from an anime-style image

which simulates an artist's workflow and has a broader range of view angles than the method proposed by Yeh et al. [2015].

Design and artistic factors affect the difficulty of our task. Anime hairstyles are more stylized than realistic ones, and anime-style portraits do not contain regular physical cues found in real-life portrait images. Character designers make individual artistic choices and adjust character features to produce an appealing result whereas real-life portraits reflect the physical properties of the portrait's subject, environmental lighting, and 3D perspective. The various artistic styles and absence of faithful physical cues make reconstruction of anime hair a challenging problem.

2 TECHNICAL APPROACH

Figure 1 shows the system overview of our proposed approach. Given an anime-style image as input, we first apply the method proposed by Yeh et al. [2015] to obtain the initial contours of partially completed hair segments and an initial hair segment layering order. Then, for each hair segment, we compute an initial skeleton and contour-skeleton correspondence using the 3-sweep technique for generalized cylinders [Chen et al. 2013].

The user then manually adjusts the size of an oval head to approximately fit the size of the character's head in the input image, and we further complete the hair segments by solving an initial value problem (IVP) of a system of ordinary differential equations (ODE). The ODE is designed to have a single sink equilibrium point based on the tendency of convergence of flow of anime-style hair to the top of the character's head. We obtain the full skeleton of each hair segment by concatenating the initial skeleton with the trajectory of points found by solving the IVP.

Hair clumps are then reconstructed based on a parametric curve model which uses bevel and taper objects [Blender Documentation Team 2017] to control the 3D geometry. The hair segments' skeletons and taper objects are fit to Bézier curves through constrained least squares optimization.

Next, we create a hair-hair graph from the initial layering order to determine the thickness of bevel objects and combine non-overlapping hair clumps into the same layer. The hair-hair graph is a directed acyclic graph, constructed such that each vertex is a completed hair clump and there exists an edge from v_i to v_j if and only if v_i occludes v_j. We use an AABB tree [Alliez et al. 2018] to determine overlapping hair clumps and determine the thickness of bevel objects so that thicker hair clumps occlude thinner ones to simulate the clumpy style of anime hair.

Once the bevel objects and layer index of each hair clump are determined, we compute an adjustment to each hair clump by solving single source longest path problems for each vertex in the hair-hair graph. The adjustment is the distance from the surface of the oval head based on the maximum thickness of hair clumps along the longest path. Finally, for each hair clump, we estimate its depth, refine its contour and attach it to the oval head. Results obtained from our system can rotate to some degree.

3 LIMITATIONS AND FUTURE WORK

Our method can reconstruct hairstyles, such as bobs, and flyaway hair as shown in Figure 2, but may not be suitable for more complex hairstyles, for example, ponytails, buns, and spiky hair. Because we use an oval as a replacement for an anime-style head, in some instances, the hair reconstruction may collide with facial features if used with a more complex head model. Finally, our method does not reconstruct hair fully occluded in the input image. In the future, we would like to address these limitations and extend our method to jointly reconstruct a 3D head model and hairstyle from a single anime-style image.

Figure 2: The input anime-style portrait and the hair reconstruction shown from multiple viewing angles.

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REFERENCES

Pierre Alliez, Stéphane Tayeb, and Camille Wormser. 2018. *3D Fast Intersection and Distance Computation* (4.12 ed.). CGAL Editorial Board. https://doc.cgal.org/4.12/Manual/packages.html#PkgAABB_treeSummary

Blender Documentation Team. 2017. *Blender 2.79 Manual.* Blender Foundation. https://docs.blender.org/manual/en/dev/modeling/curves/properties/geometry.html

Tao Chen, Zhe Zhu, Ariel Shamir, Shi-Min Hu, and Daniel Cohen-Or. 2013. 3-Sweep: Extracting Editable Objects from a Single Photo. *ACM Trans. Graph.* 32, 6, Article 195 (Nov. 2013), 10 pages. https://doi.org/10.1145/2508363.2508378

Chih-Kuo Yeh, Pradeep Kumar Jayaraman, Xiaopei Liu, Chi-Wing Fu, and Tong-Yee Lee. 2015. 2.5D Cartoon Hair Modeling and Manipulation. *IEEE Transactions on Visualization and Computer Graphics* 21, 3 (March 2015), 304–314. https://doi.org/10.1109/TVCG.2014.2360406