Novel approach to View Morphing with smart blending

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Abstract

In this project, we develop a new approach to view morphing. After experimenting on state of the art approaches, we show how to use **estimated 3D geometry** in a new **morphing pipeline** to generate more visually appealing morphed images. We develop a method to **reduce blurring with epipolar geometry**. **Stable Diffusion**'s inpainting pipeline is used for completing the image through outpainting.

Background

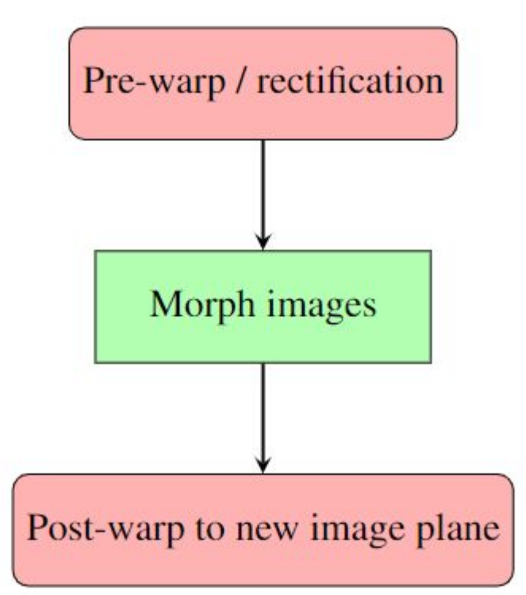
View morphing is the process of generating artificial images from virtual cameras using two images from different angles. This is done using **point correspondences** and **epipolar geometry**. The goal of view morphing is to also **preserve 3D geometry** when generating new images. This has previously been done using both a 2D homography based approach in [1] and using a CNN based method [2]. In recent years novel view synthesis has been dominated by machine learning approaches, while **geometric methods** have not been much further developed .

Baseline Method

As a baseline method, we use a **three-step algorithm** to do "traditional" view morphing, similar to the one proposed in [1]. **First**, we find suitable **homographies** and use them to **pre-warp**, or rectify the images to the same plane. In the new plane, we **morph** the images by linearly blending pixel values according to a **Delauney triangulation** of either image, and fitting them to the synthesized image. The image is then **warped back** to the original coordinate frame.
Point correspondences were found by through machine learning approaches such as **facial feature detection**. This was later supplanted by **manual labeling** to allow for a greater amount of features of arbitrary geometry.

(a) before post warp

(b) After post warp



Our approach - with 3D reconstruction

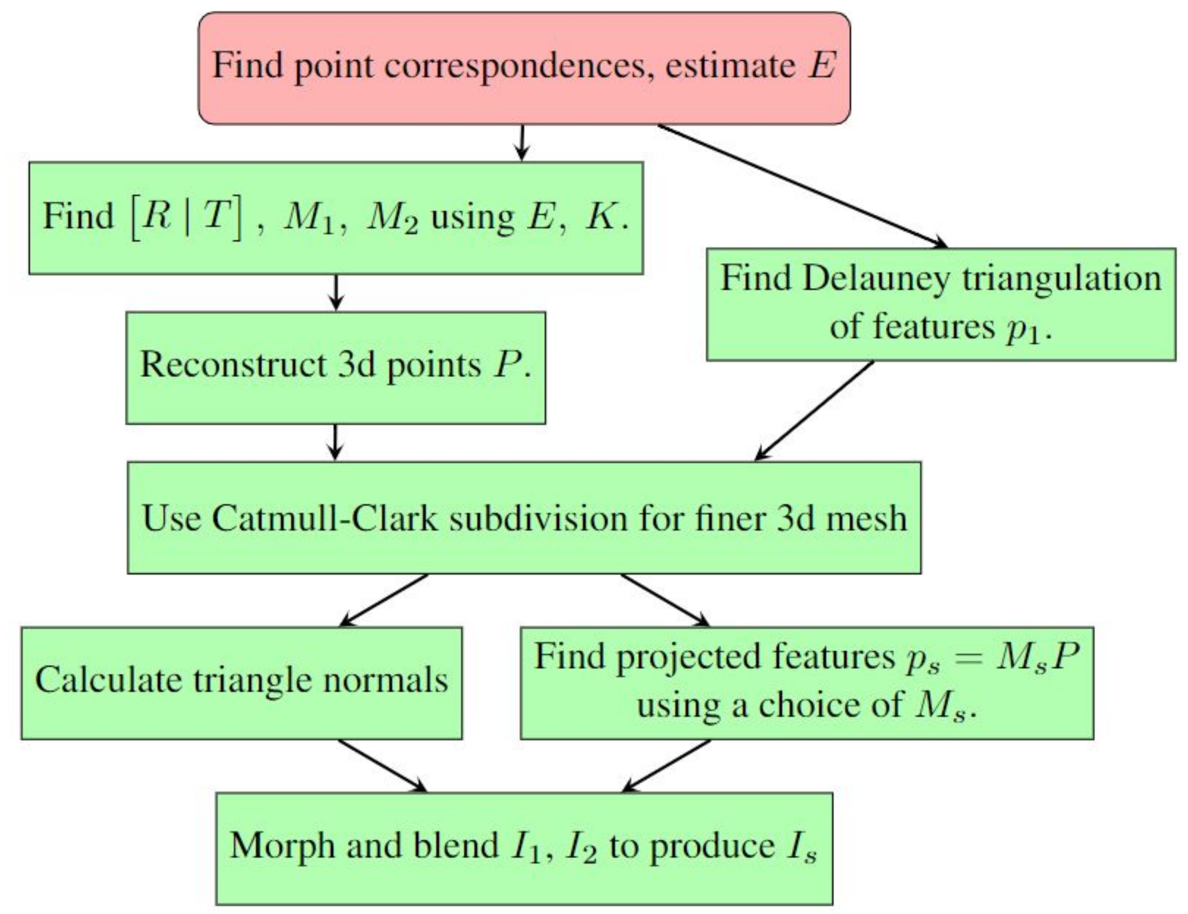


Figure 1: Block-diagram of steps

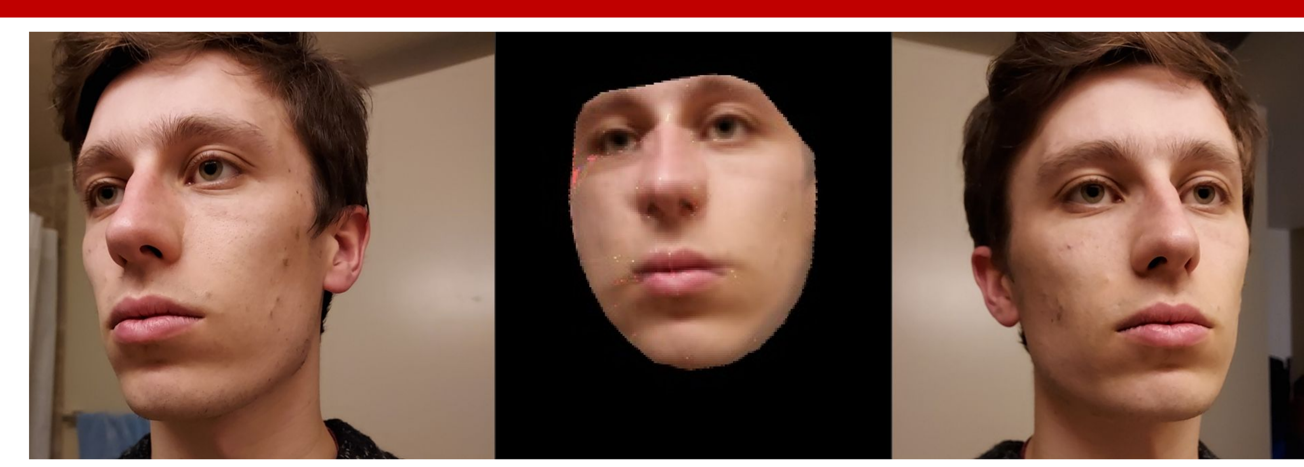
New blending/anti-fold algorithm:
Using **normals** $\hat{n}$ of the 3D triangle mesh surfaces and $\hat{v}$ of the image planes to **cull surfaces** that do not face the virtual camera. A **blending heuristic** was developed to capitalize on the 3D information.

$$s_1' = (0.01 - \min(\hat{n} \cdot \hat{v}_1, 0))$$
$$s_2' = (0.01 - \min(\hat{n} \cdot \hat{v}_2, 0))$$
$$s_1 = \frac{s_1'}{s_1' + s_2'} \qquad s_2 = \frac{s_2'}{s_1' + s_2'}$$

Effect of anti-folding heuristic

With (left) and **without** (right).
Notice the **clarity** in the left image. Also notice the natural **shadows** in the left.

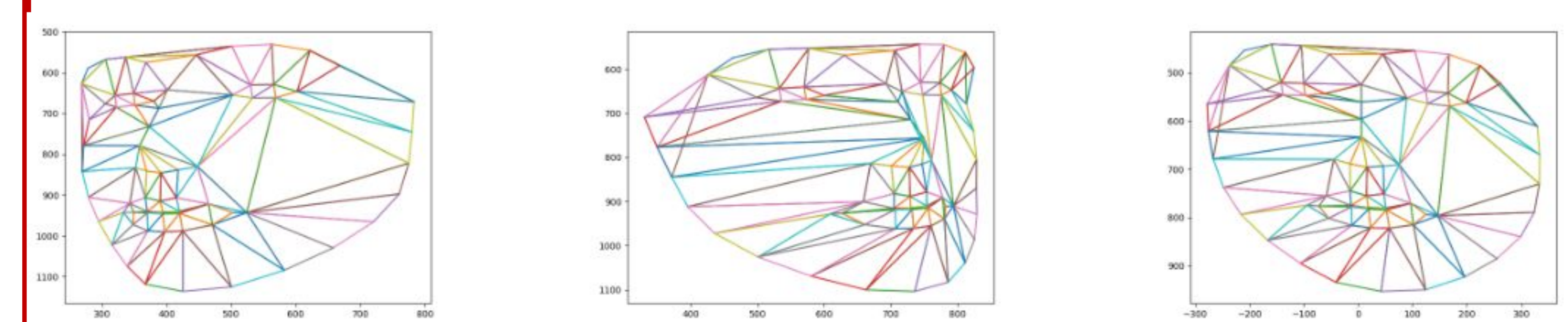
Results - Baseline



Left image Morphed image Right image

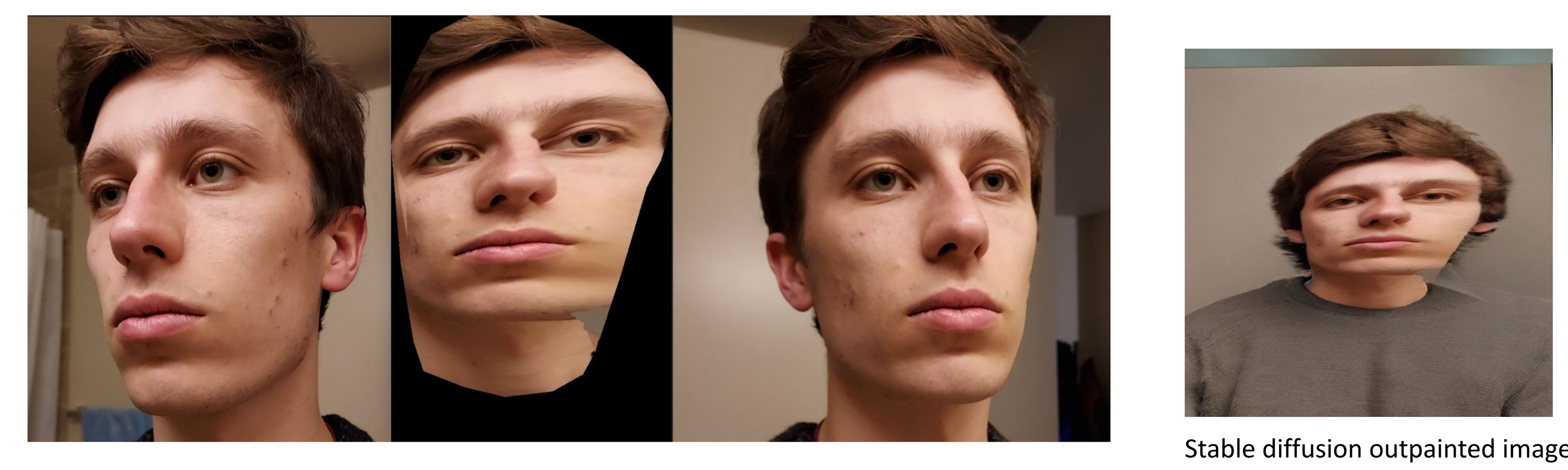
Results - Our approach

3d Mesh Projection:



(a) Left (b) Right (c) Morphed, s=0.5

View Morph using geometry:



Left image Morphed image Right image Stable diffusion outpainted image

Conclusions

The report presents a novel method for view morphing that further benefits from **3D reconstruction** capabilities made possible through **camera calibration**. By using **Catmull-Clark** and novel **anti-folding algorithms**, we mitigate **blurring effects** and improve the images' visual appearance. We also show how **generative tools** can complement our algorithm by **out-painting** our morphed image with **Stable Diffusion**. We have constrained ourselves to facial view morphing, but future work would explore how well the method generalizes to view morphing of **other objects**. **Improved blending heuristics** could prove to further reduce **visual artefacts**, and use of **arbitrary view matrices** could be explored.

References

[1] Steven M Seitz and Charles R Dyer. View morphing. In Proceedings of the 23rd annual conference on Computer graphics and interactive techniques, pages 21–30, 1996
[2] Dinghuang Ji, Junghyun Kwon, Max McFarland, and Silvio Savarese. Deep view morphing. In Proceedings of the
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