

# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

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# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

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Capturing face geometry



Beeler et al. [2010] Method

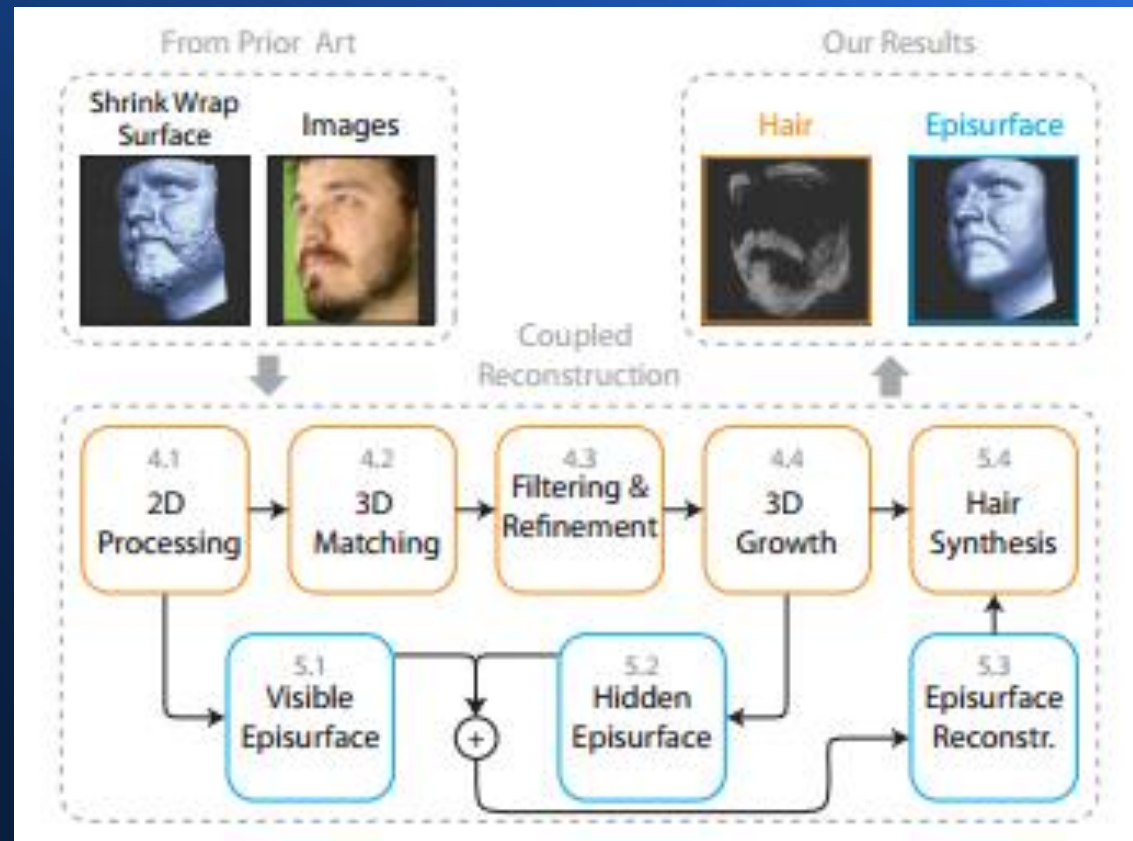
# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

## Pipeline

- separate hairs and skin in the captured images, extract 2D hair fibers using a growing algorithm and remove the detected hairs from the images using inpainting;
- reconstruct, filter, refine and grow 3D fibers in 3-space based on the extracted 2D fibers using multi-view stereo (MVS);
- compute the skin episurface combining traditional MVS and the estimated roots of the 3D fibers;
- synthesize hairs in areas where image data indicates the presence of hair, but individual hairs are indistinct and cannot be reconstructed.

# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

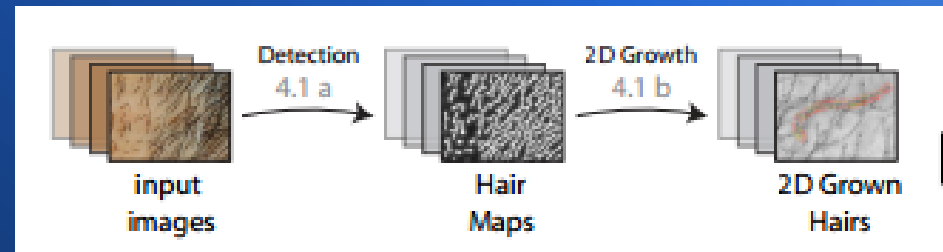
## Pipeline



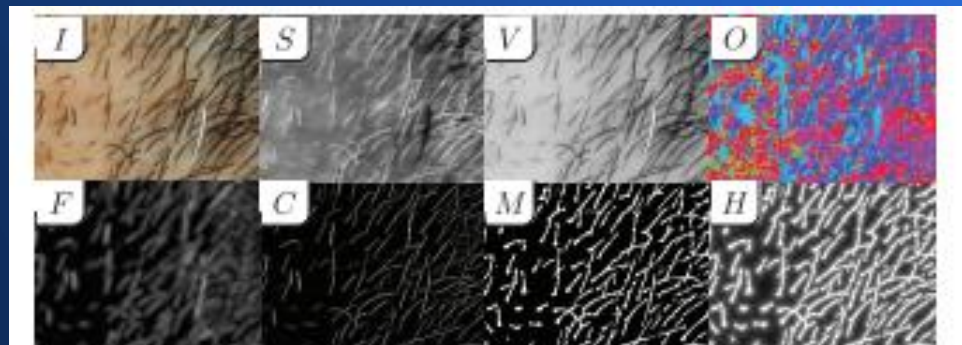


# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

## Computing 3D Hair 2D Processing



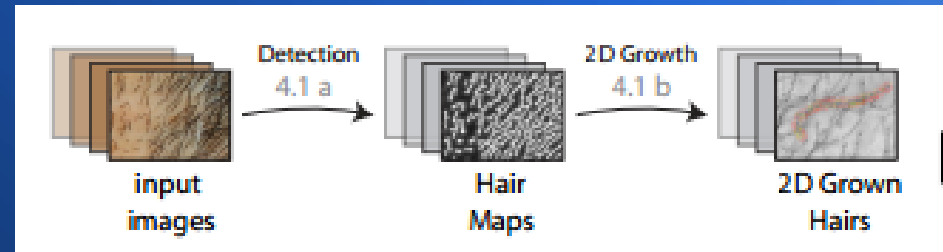
- Computing a 'Hair Map' for each Image



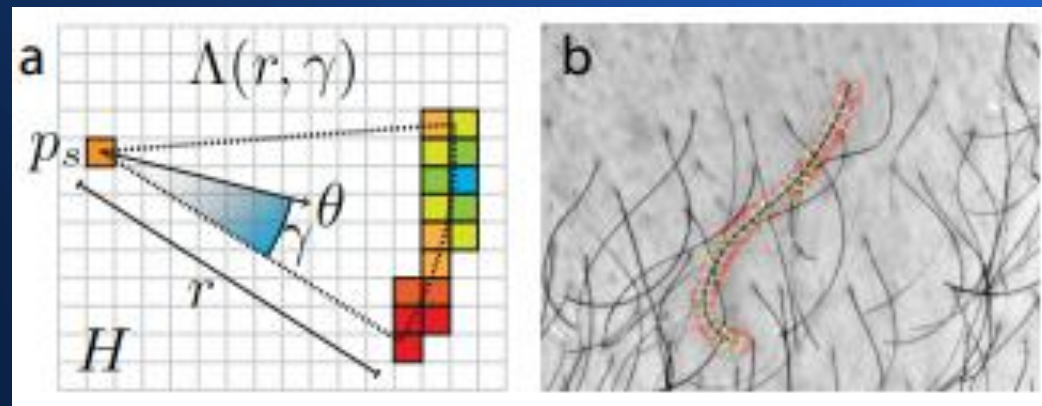
**Figure 5:** Images used during reconstruction: *I*: input image, *S*: saturation channel, *V*: value channel, *O*: orientation map, *F*: Gabor filter response, *C*: confidence map, *M*: binary mask, *H*: hair map.

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## Computing 3D Hair 2D Processing

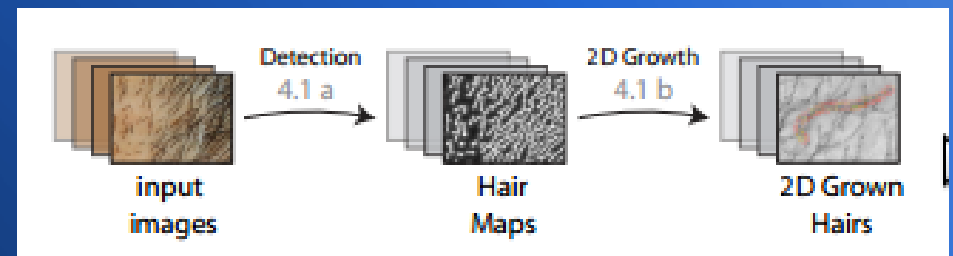


- Growing Hair in 2D

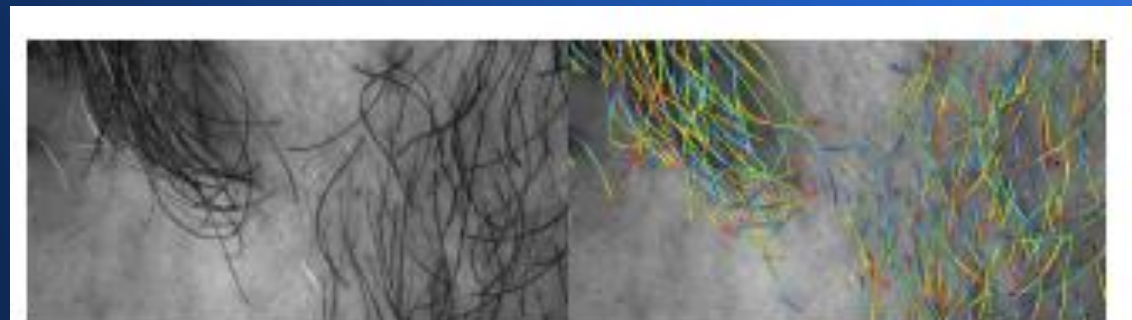


# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

Computing 3D Hair  
Matching Hair Segments in 3D



- Detected segments in matching across images



**Figure 7:** *The reconstructed hairs projected into one of the views.*

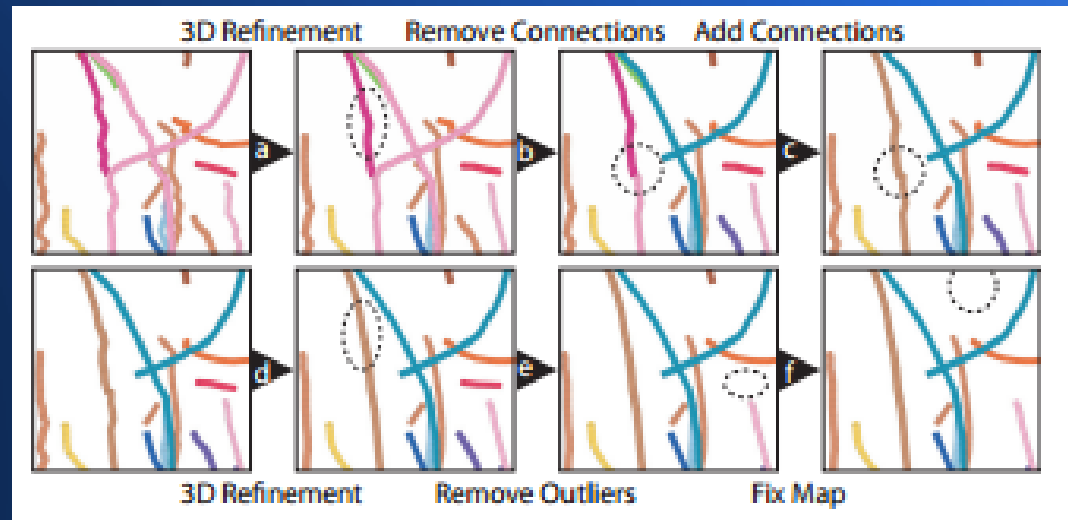


# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

## Computing 3D Hair Refinement and Outlier Removal

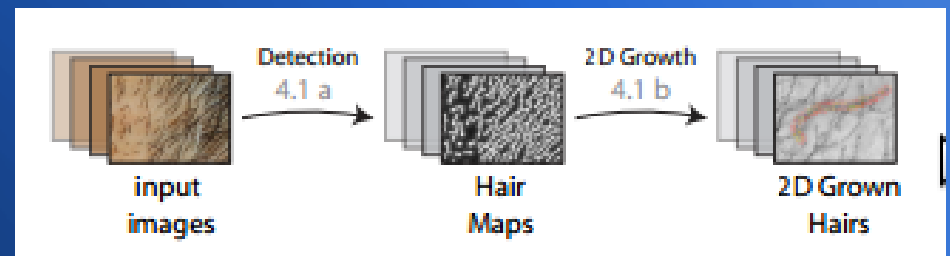


- Overview of the refinement and outlier removal steps

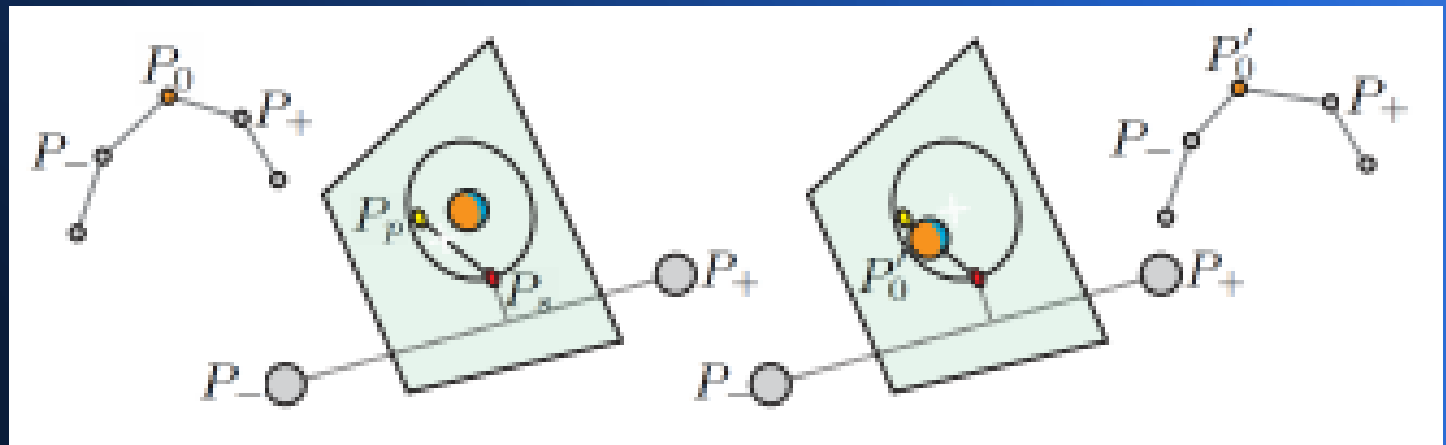


# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

Computing 3D Hair  
Refinement and Outlier Removal

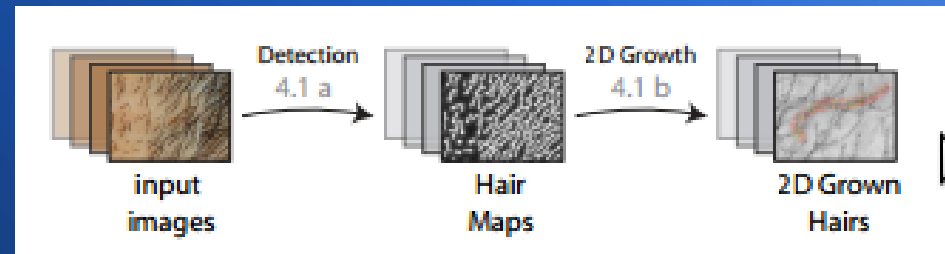


- 3D Refinement of Computed Hair Segments

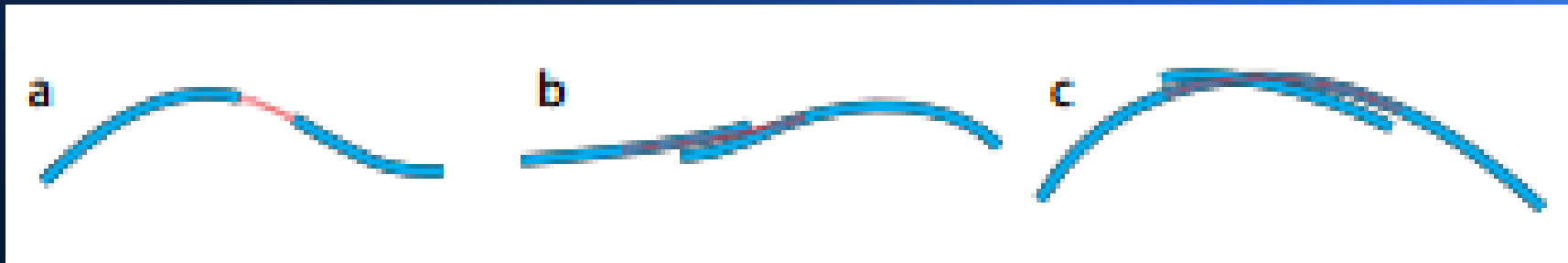


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Computing 3D Hair  
Refinement and Outlier Removal

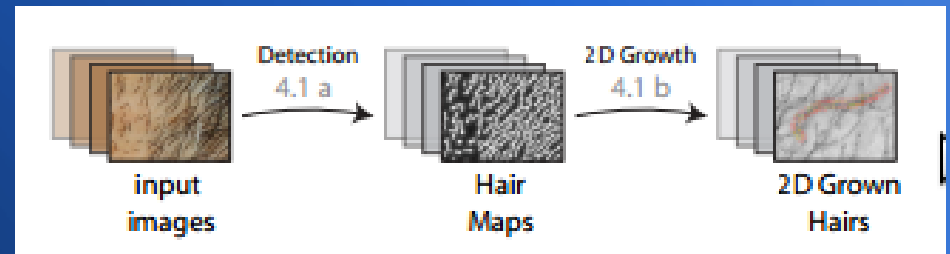


- Addition of New Connectivity



# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

## Computing 3D Hair Refinement and Outlier Removal



- Removal of 3D Outliers

**Outlier removal is done by creating a grid for the 3D workspace, counting the number of hairs in each voxel, and deleting hairs which are distant from the surface or isolated.**

# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

Computing 3D Hair  
Refinement and Outlier Removal



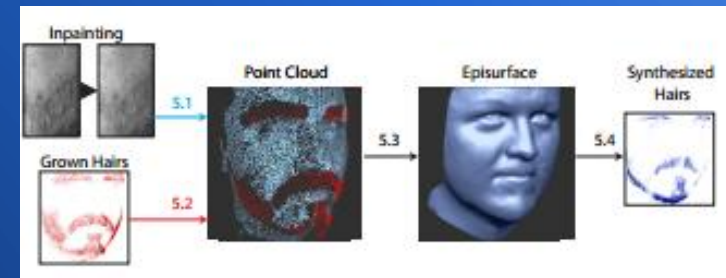
- Fix Map



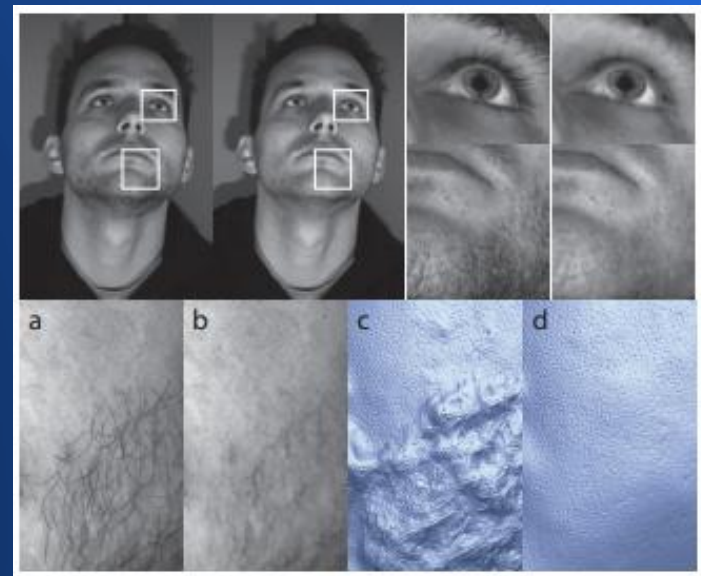


# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

Computing Skin Episurface  
Computing Visible Skin Episurface

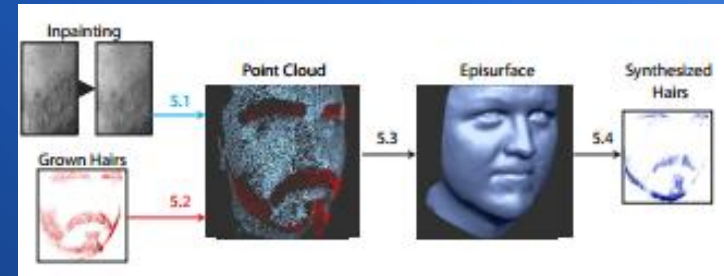


- Masking & Inpainting



# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

Computing Skin Episurface  
Estimating Hidden Skin Episurface

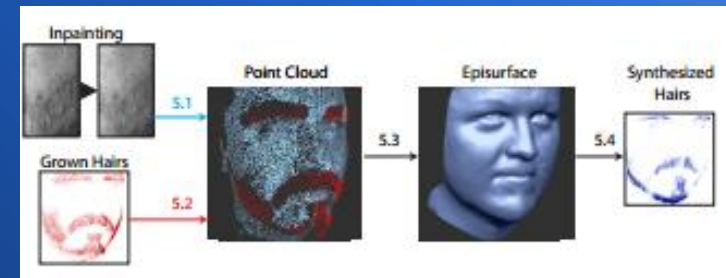


- The part of the skin episurface that is not exposed to the cameras

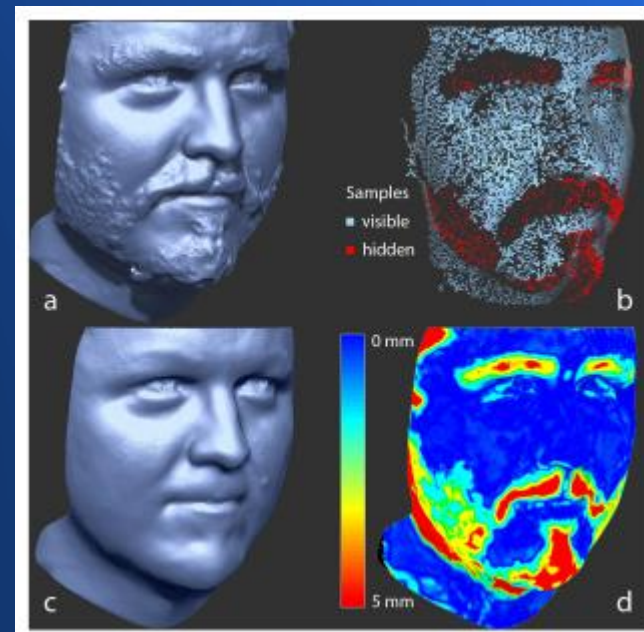
**3 steps are performed to produce a point cloud which is a sampling of the underlying hidden episurface.**

# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

## Computing Skin Episurface

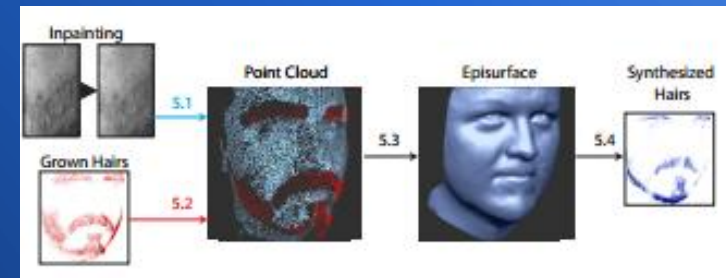


- The previous three steps produce two sets of points for the visible and the hidden skin episurface

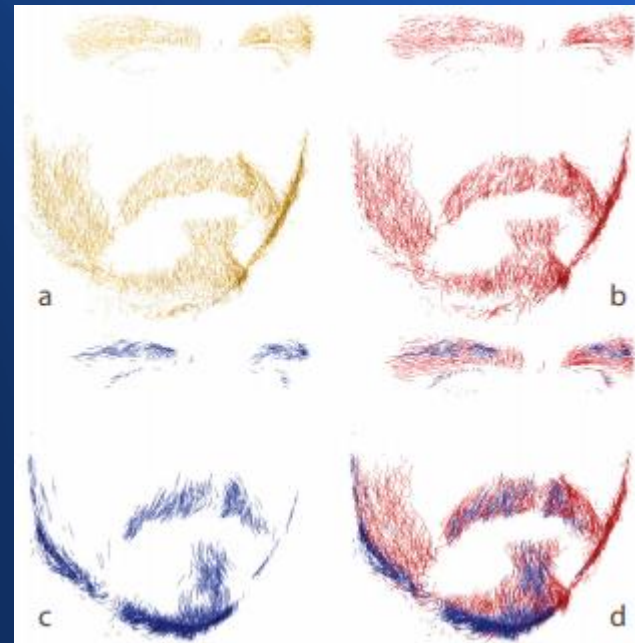


# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

Computing Skin Episurface  
Synthesizing Hair



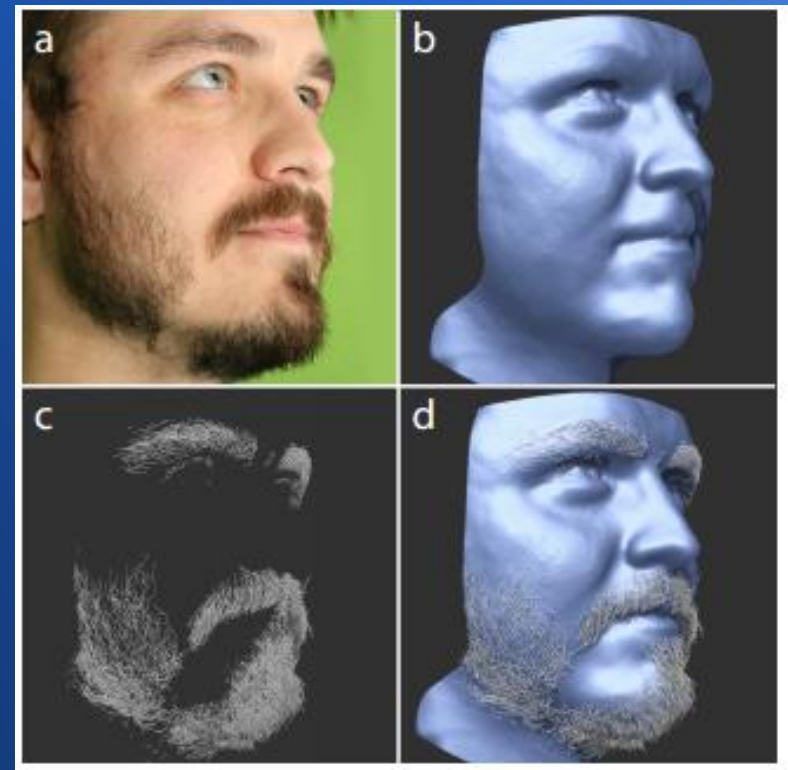
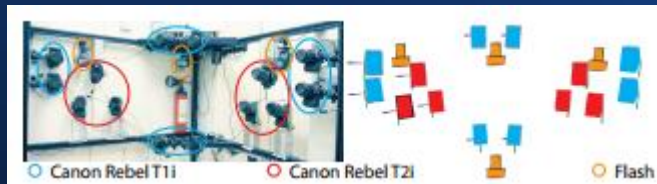
- Finding Seed points & Growing Hair



# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

## Results

- Setup used to capture the data



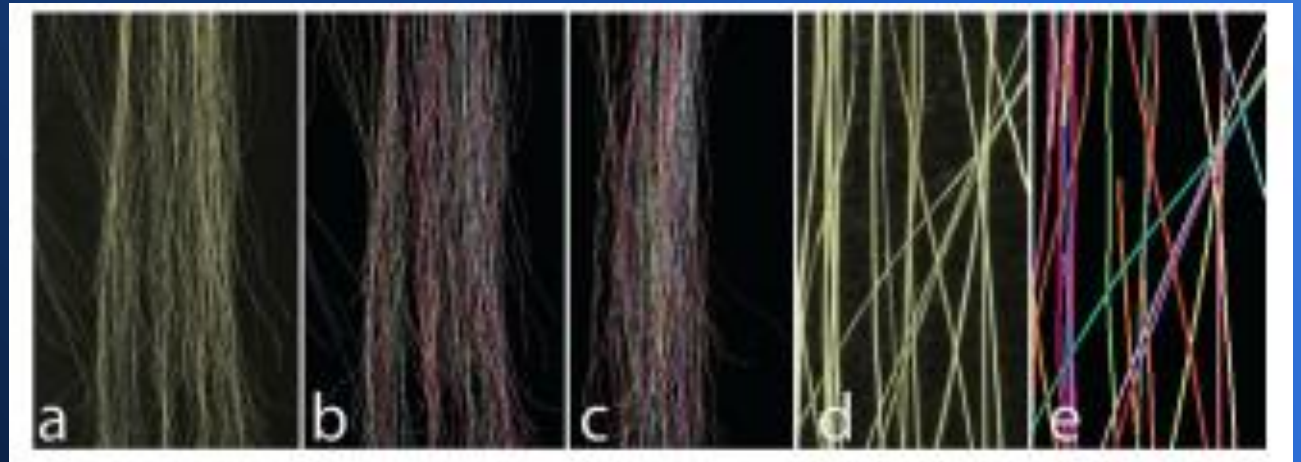
- Individual steps of the reconstruction pipeline



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## Conclusion

- Future work



- Synthetic long hair test

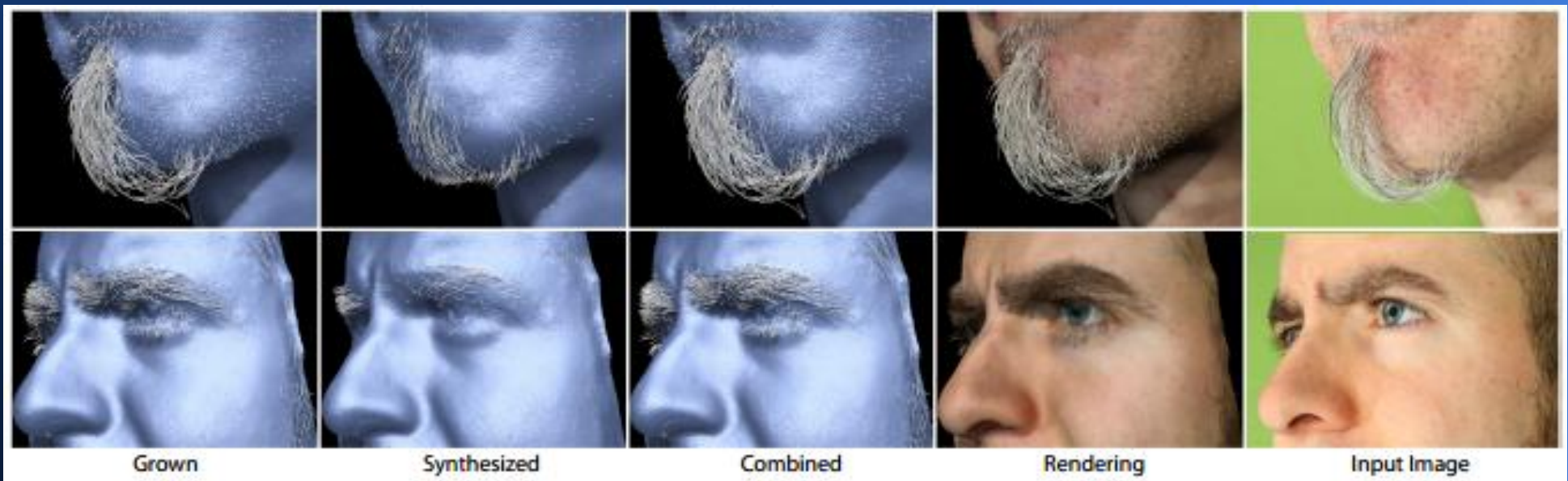
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More results



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More results



# Coupled 3D Reconstruction of Sparse Facial Hair and Skin

Video