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Multi-View Hair Capture using Orientation Fields

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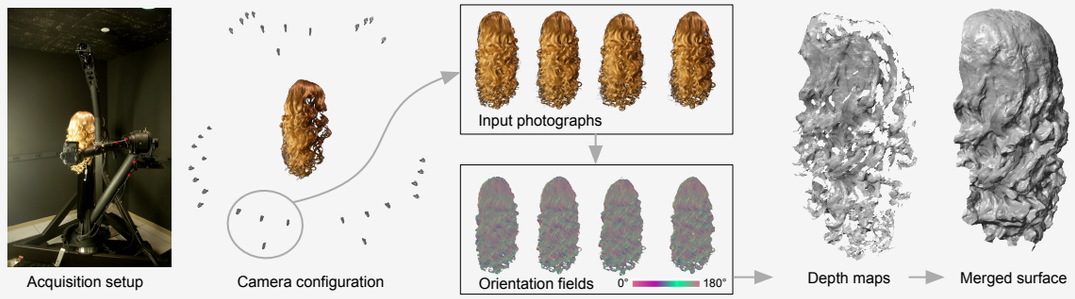



Dynamic acquisition setup

Motivation

- Hair is difficult for conventional passive multi-view stereo due to omni-present occlusions, complex discontinuities and specular appearance
- State-of-the-art active hair capture systems are inefficient or inaccurate
- Hair orientation is a prominent feature

Overview

We propose a multi-view stereo algorithm that:

- matches hair's *local orientation fields*
- enforces continuity along *local hair structures* through aggregation
- fuses multiple depth maps by *iterative surface deformation*
- reveals *fine hair structures*

Acquisition

Static setup:

- Wigs
- 32 views (8 groups)
- 1404 × 936
- Robotic gantry
- Normal lighting

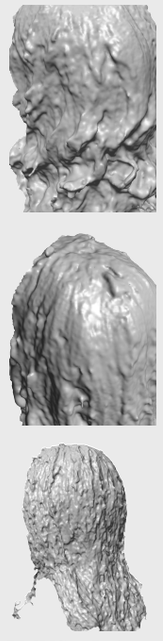
Dynamic setup:

- Real moving hair
- 4 views (1 group)
- 640 × 480
- 100 FPS
- Strong lighting

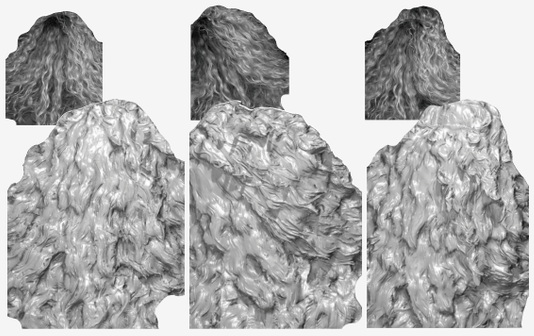
Results

- Reveals finer hair details compared to state-of-the-art method (PMVS + Poisson)
- Average error evaluated on synthetic hairstyle: 3~5mm

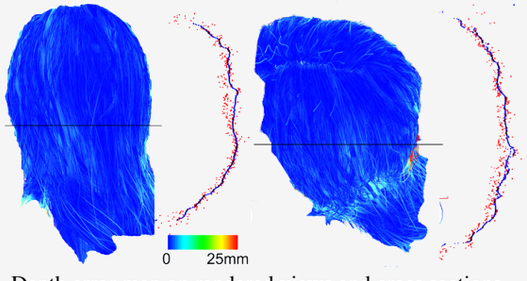

Static reconstruction results on two real hairstyles and one synthetic hairstyle (3 views)


PMVS + Poisson

Dynamic Hair Capture


Sample frames of dynamic hair capture results

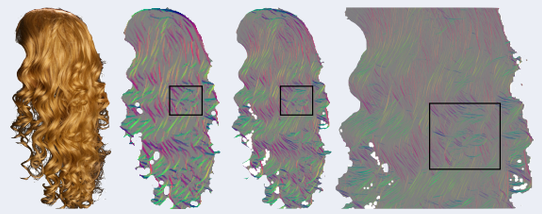
Quantitative Evaluation



Depth error map on rendered views and cross sections

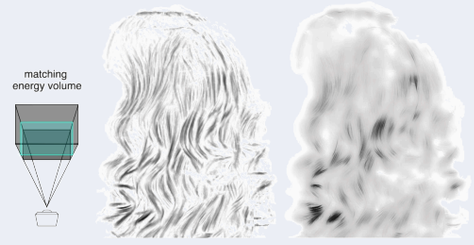
1 Multi-resolution Orientation Fields

- Detect orientations at peak responses of oriented filters
- Only consider highlighted hair structures (better SNR)


Input image Level 1 Level 2 Level 3

2 Structure-Aware Aggregation

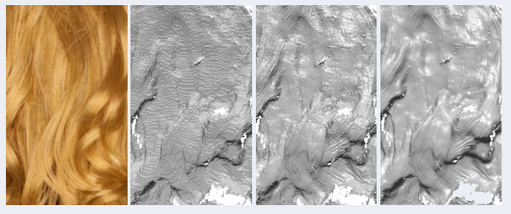
- Guided filtering on matching energy volume based on orientation similarity
- Improves SNR and disambiguates stereo matching for MRF



Without aggregation With aggregation

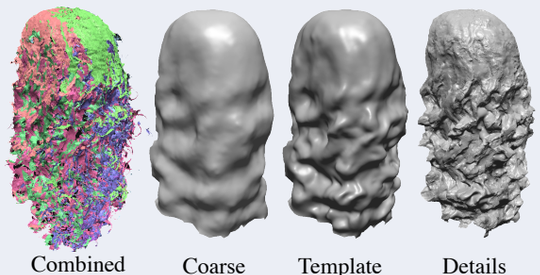
3 Depth Map Refinement

- Refine depth by fitting quadratic polynomial to the adjacent 3 energy values
- Guided filtering stereo noise based on orientation similarity


Input image MRF output Sub-pixel refined Guided filtered

4 Merging

- Construct coarse template (Poisson)
- Refine template by iterative surface deformation
- Reintroduce geometric details


Combined depth maps Coarse template Template refinement Details reintroduced