Optical Flow Based Tracking and Retexturing of Garments

Anna Hilsmann, Peter Eisert
Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institute, Berlin, Germany
anna.hilsmann@hhi.fraunhofer.de

Fraunhofer Institut Nachrichtentechnik Heinrich-Hertz-Institut

Overview

- Dynamic texture overlay for real-time visualization of garments
- Tracking of complex garment deformations from monocular images exploiting optical flow constraints
- Illumination and shading recovery from original image

Optical Flow Based Garment Tracking

- We exploit the optical flow constraint along with a predefined motion model. Finding the best transformation amounts to minimizing a quadratic error that can be solved in a least squares sense:

$$E = \sum_{i=1}^{n} \left(\nabla I(x_i, y_i) \cdot \mathbf{d}(x_i, y_i) + \frac{\partial I}{\partial t}(x_i, y_i) \right)^2$$

- We use a mesh-based motion parameterziation:

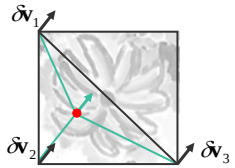
$$\mathbf{d}(x_i, y_i) = \sum_{j=1}^{3} B_j(x_i, y_i) \cdot \delta \mathbf{v}_j$$

- Incorporating additional smoothing constraints yields:

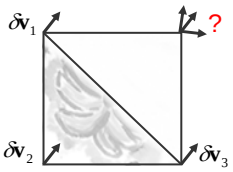
$$E = \sum_{i=1}^{n} \left(\nabla I(x_i, y_i) \cdot \mathbf{d}(x_i, y_i) + \frac{\partial I}{\partial t}(x_i, y_i) \right)^2 + \lambda \sum_{k=1}^{K} w_k E_s(\delta \mathbf{v}_k)$$

with

$$E_s(\delta \mathbf{v}_k) = \left(\delta \mathbf{v}_k - \frac{1}{|N_k|} \sum_{n \in N_k} \delta \mathbf{v}_n \right)^2$$



Surface parameterization with Barycentric coordinates

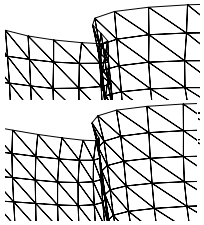


Necessity of *smoothing constraints*

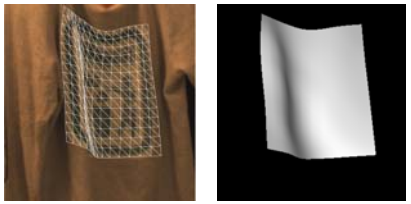
- The smoothing constraints regularize the optical flow field. They are neccessary if a vertex displacement is unconstrained by the optical flow constraint equation.

Self-Occlusion Handling

- Foldings of the 2D mesh at self-occlusion boundaries cause inaccuracies during tracking. Self-occlusions are handled by weighting the smoothing constraints locally according to the self-occlusion of a region [1].



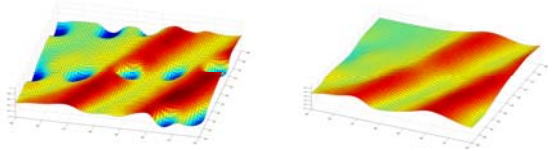
Occlusion boundary with and without self-occlusion handling



Original image and occlusion map

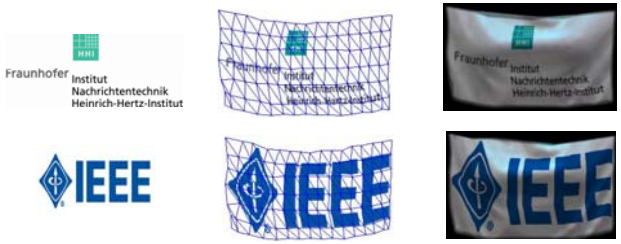
Illumination and Shading Recovery

- Tracking and retexturing from monocular images without 3D reconstruction requires an estimation of illumination and shading.
- The input images already exhibit the illumination and shadows to be rendered onto the virtual texture.
- We use textures that consist of points, lines or curves and a shading map is established by removing the structure and interpolating the intensity of the texture pixels.



Representation of intensities as height fields before and after interpolation

- The result is a smooth shading map that preserves shadows at main wrinkles and fold overs.



Realistic rendering of the virtual texture: original texture, deformed texture and deformed and illuminated texture (left to right)

Results

- Robust deformable surface tracking method from monocular images sequences that can cope with strong deformations and partial self-occlusions.
- The exploitation of real lighting for retexturing increases the realistic percepction of the virtual texture.
- The method is integrated into a real-time Virtual Mirror setup for virtual garment fitting.

Cloth tracking and retexturing. Original images and augmented results (left to right)

References

[1] A. Hilsmann and P. Eisert: *Tracking Deformable Surfaces with Optical Flow in the Presence of Self-Occlusions in Monocular Image Sequences*, CVPR Workshop on Non-Rigid Shape Analysis and Deformable Image Alignment, Alaska, June 2008

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