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IMAGE BASED RETEXURING OF DEFORMED SURFACES FROM A SINGLE IMAGE

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Problem Definition

We introduce an approach for automatic texture replacement of a deformed regular texture (e.g. cloth) in an image such that texture distortion as well as lighting conditions of the original texture are preserved.

Key challenges:

- Separation of surface albedo (i.e the actual local texture) from photometric or shading information without knowlegde of scene geometry
- Estimation of texture deformation as a spatial deviation from the regular texture

Overview

Assumed image model:

$$\mathcal{I}(\mathbf{x}) = \mathcal{M}_S(\mathbf{x}) \cdot \mathcal{T}(\mathcal{W}(\mathbf{x})) + \alpha \cdot \mathcal{M}_{HF}(\mathbf{x})$$

Image — shading map — warped regular texture — high frequency details

Decomposition and retexturing steps:

1. Texton appearance estimation from clustered feature points
2. Generation of a regular texture from mesh topology and assumed texture regularity
3. Texture deformation and shading estimation in an image based optimization scheme
4. Final retexturing

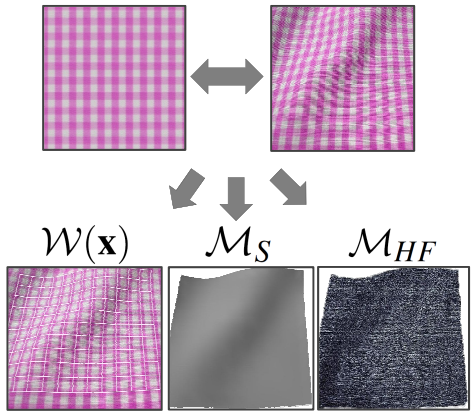
Texton appearance estimation

The frontal appearance of a *texton* is estimated by generating suitable feature points (e.g. SIFT) on the image and grouping them using unsupervised clustering. For each cluster, a mean texton template is estimated from a mesh model consistent with the geometric relationship between feature points and the assumed texture regularity. This results in one or more candidate texton appearances (there can be more than one as each shifted version of a texton is also a valid texton)

Different texton appearance estimation results

Deformation and shading estimation

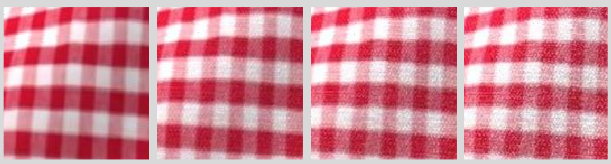
The estimated texton template and the topology of the assumed texture regularity is used to generate an image of the undeformed texture. A texture deformation grid and a shading map are estimated by registering the synthetic regular texture onto the original image using an image-based optimization scheme initialized with the detected texton positions. The residual image after registration represents an estimate of high frequency structures, representing self shadowing e.g. from the yarn structure.



Texture deformation grid, estimated shading map and high frequency structure (colors scaled)

Final Retexturing

Once the original input image has been processed and decomposed into a deformation grid, a shading map and high frequency details, any new texture can be visualized with the same deformation and shading effects as in the original image. Furthermore, as we model the high frequency details as an additive component, their influence can be modified by the user.



Using different weights for the high frequency structure (left to right: 0, 0.2, 0.6, 1)

Retexturing results: The first and third images are the original input images