Photogeometric Stereo

CS635

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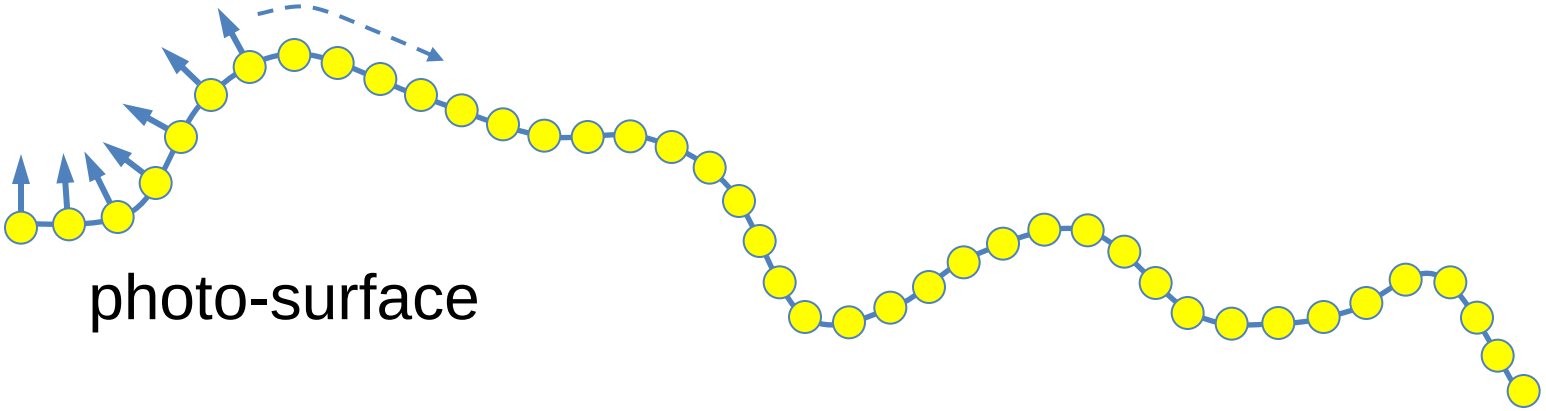
Photogeometric Approach

- Combine photometric stereo with geometric stereo
  - High resolution of photometric stereo
  - Accuracy of geometric method
  - Can lead to self-calibration of entire acquisition process

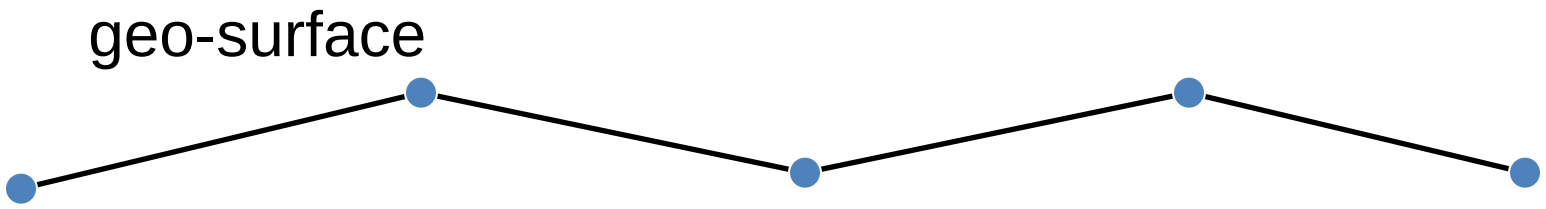
Photogeometric Upsampling

1. Integrate surface normals



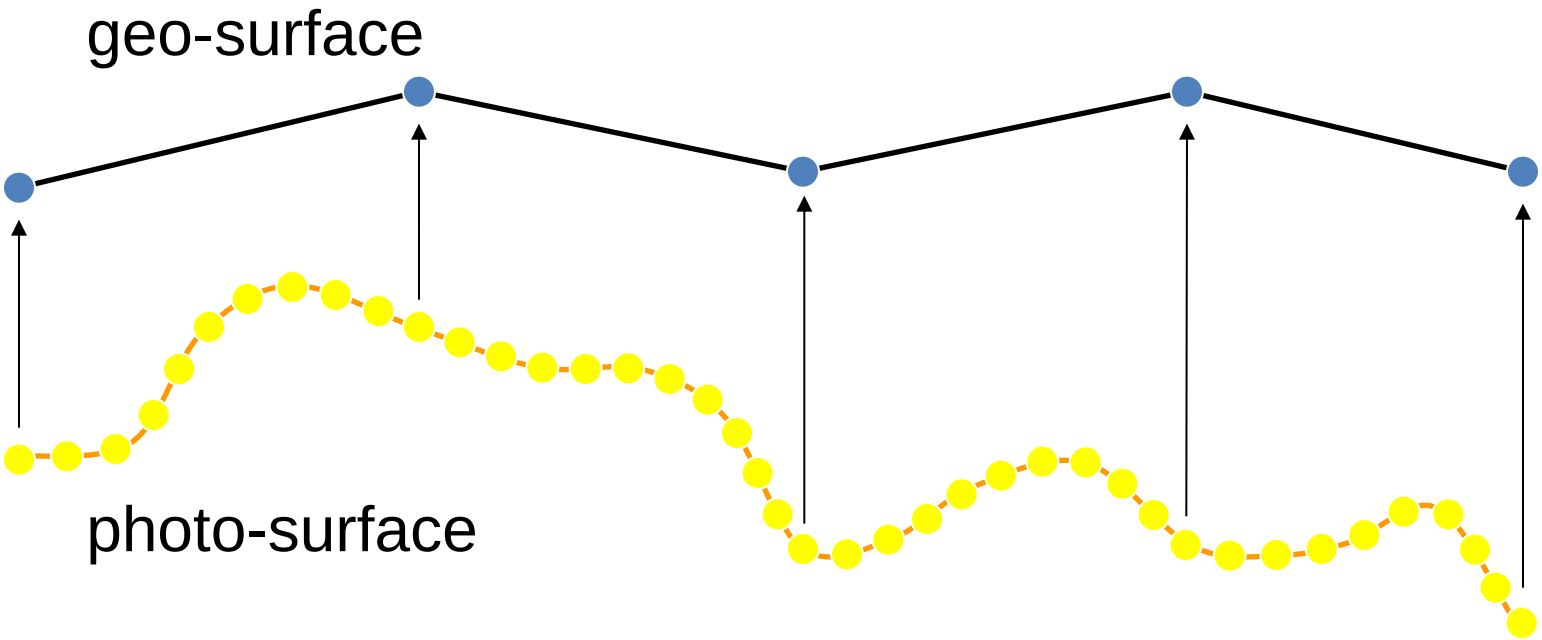
Photogeometric Upsampling

2. Compute sparse geometric model



Photogeometric Upsampling

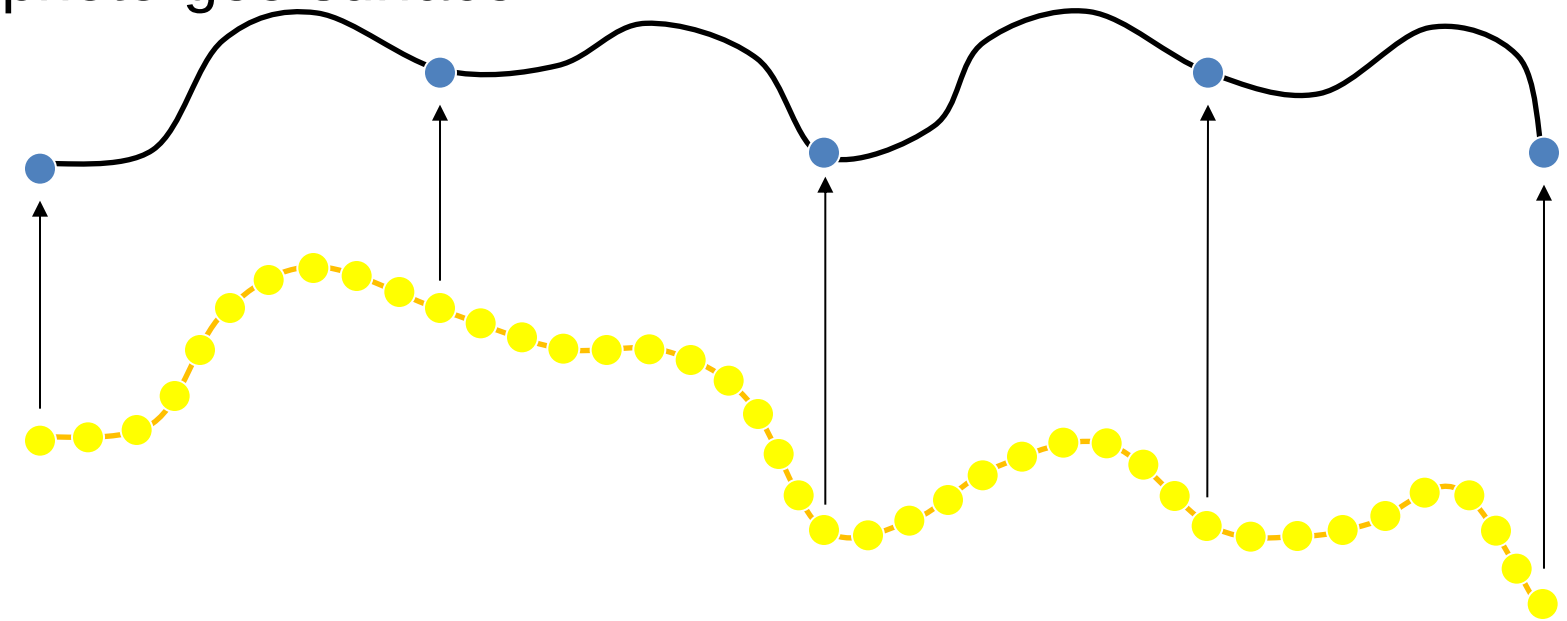
3. Warp photometric surface to geometric surface



Photogeometric Upsampling

3. Warp photometric surface to geometric surface

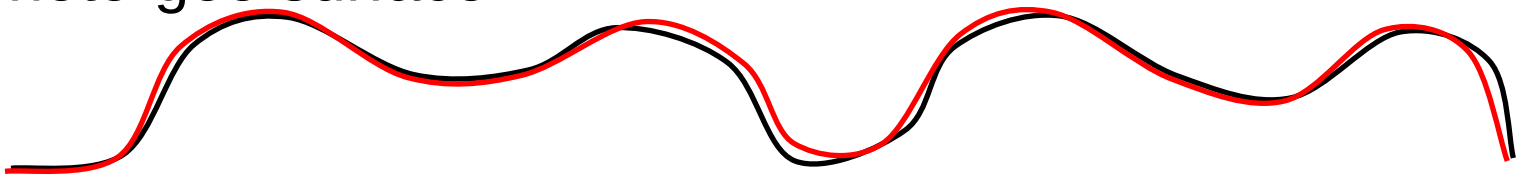
photo-geo surface



Photogeometric Upsampling

4. Triangulate and proceed to optimization

photo-geo surface



true surface

Photogeometric Optimization

- Linear system in the unknown 3D points (p_i)
- Supports multi-view reconstruction
- Weighted combination of three error terms:

$$e = (1-\lambda)(1-\tau)\kappa_g e_g + \lambda\kappa_p e_p + \tau\kappa_r e_r \rightarrow 0$$

where

e_g = error of reprojection

e_p = error of perpendicularity of normal-to-tangent

e_r = error of relative distance change

Photogeometric Optimization

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where

$$e_g = \sum_j \sum_i \begin{bmatrix} \hat{p}_{ij_x} - \left(\frac{u_{ij}\hat{p}_{ij_z}}{f}\right) \\ \hat{p}_{ij_y} - \left(\frac{v_{ij}\hat{p}_{ij_z}}{f}\right) \end{bmatrix}$$

$$e_p = \sum_i \delta_{ik}(n_i \cdot (p_i - p_k))$$

$$e_r = \sum_i \delta_{ik}((p_i - p_{ik}) - d_{ik})$$

Photogeometric Reconstruction

photographs

reconstruction

Faces…

- “Photogeometric Scene Flow for High-Detail Dynamic 3D Reconstruction”

- https://www.youtube.com/watch?v=Cx54WPwsG2w