

View-Image Collections

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IMPA

Outline

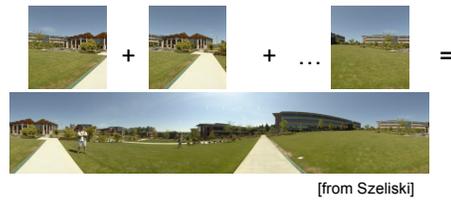
- Motivation
- Image Mosaics
- Panorama Assembly
- Results
- Generalizations

Basic Setup

- ★ Variable Camera Pose
- Fixed Scene
 - Static
- Fixed Subjects
 - Small Motion
- Fixed Illumination

➤ *Images or Video*

Image Mosaics



[from Szeliski]

- Goal
Stitch together several images into a seamless composite

How to Do It?

- Naïve Procedure
 1. Take a sequence of images from the same position
 2. Repeat for each image:
 - Compute transformation between current and next image
 - Shift the next image to overlap with the current image
 - Blend the two images together to create a mosaic

Technology Evolution

- 1D Rotations (θ)
 - Ordering \Rightarrow matching images



- 2D Rotations (θ, ϕ)
 - Ordering \neq matching images



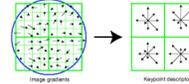
[from Brown]

Operations

- Feature Correspondence
- Image Matching and Transformation
- Global Registration
- Image Blending

Invariant Features

- SIFT Features
 - *Geometrically invariant* to similarity transforms,
 - *Photometrically invariant* to changes in intensity
- Descriptor overview:
 - Determine **scale** by maximizing DoG in scale and in space, and **local orientation** as the dominant gradient direction. (*makes all further computations invariant to scale and rotation*).
 - Compute **gradient orientation histograms** of several small windows
 - Normalize the descriptor to make it invariant to intensity change



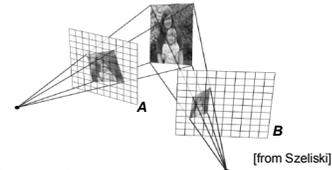
D. Lowe. "Distinctive Image Features from Scale-Invariant Keypoints". *IJCV* 2004

Feature Matching

- Exhaustive search
 - for each feature in one image, look at *all* the other features in the other image(s)
- Nearest neighbor techniques
 - Find k-NN for each feature
 - k ≈ number of overlapping images
 - Use k-d tree
 - k-d tree recursively bi-partitions data at mean in the dimension of maximum variance
 - Approximate nearest neighbors found in O(nlogn)

Transformation Estimation

"What happens when we take two images with a camera and try to align them?"



- Image Reprojection
 - Feature Correspondences
 - Projective Warp from Image A to Image B

Homographies

- Perspective projection of a plane
 - Modeled as a 2D warp using homogeneous coordinates

$$\begin{bmatrix} wx' \\ wy' \\ w \end{bmatrix} = \mathbf{H} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

➤ 8 Parameters to Estimate

- Projective Image Warping

Global Alignment

- Local Alignment
 - Problem: Drift
- Global Solution
 - *Bundle Adjustment*

Minimize projection error over all transformations

Blending

- Many Techniques
 - Linear Blending
 - Poisson Blending
 - Graph Cut Blending
 - Multi-Band Blending

➤ 2-band Blending

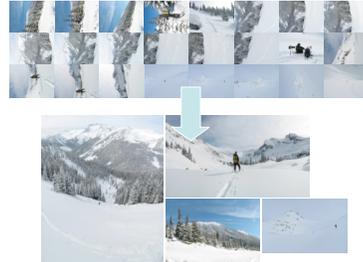
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Automatic Panorama Assembly

[Brown and Lowe 2003]



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Beyond Panoramas

Generalize Restrictions

- GIS Mosaics
- Photo-finish
- Cyclographs
- Video Summarization
- Video Coding
- Multiperspective
- Tapestry

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References

- *"Recognizing Panoramas"*,
M. Brown and D. Lowe
- *"Image alignment and stitching: A tutorial"*,
Richard Szeliski.

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