Video Registration: Key Challenges

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Key Challenges

1. **Mosaics and panoramas**
2. **Object-based segmentation (MPEG-4)**
3. **Engineering Support Data**
4. **3-D registration**
5. **Wide base-line stereo**
6. **Correlation**
7. **Video registration vs. visual tracking**
8. **Role of image features**
9. **Next most important problems**
10. **Most successful solutions and approaches**
Mosaics and Panoramas

• Accomplishments:
  – Fast “direct” methods
  – Feature-based approaches for large motion
  – True “3D” alignment (*spherical mosaics*)
  – Focal length \((f)\) estimation (*self-calibration*)
  – Moving objects (*deghosting*)
  – Exposure compensation
Mosaics and Panoramas
Mosaics and Panoramas

- Removing moving objects (*deghosting*)
Mosaics and Panoramas

• Removing moving objects (*deghosting*)
Mosaics and Panoramas

- Exposure compensation
Mosaics and Panoramas

- Exposure compensation and deghosting
Mosaics and Panoramas

- **Challenges:**
  - dealing with parallax
  - dealing with more complex motions
  - large motions
Wide-baseline stereo

- *Is wide base-line stereo solved now?*

Input image

Sum Abs Diff

Mean field

Graph cuts
Wide-baseline stereo

- What about really wide baselines?
Wide-baseline stereo

- What about *untextured regions*?
Wide-baseline stereo

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- What about *untextured regions*?
Wide-baseline stereo

- What is it being used for?
  - view interpolation
  - view extrapolation
  - object removal / insertion
  - video compression

- Desired solution depends on application
Role of image features

- Needed to establish original epipolar geometry [but see Hannah’s direct methods]
- Once epipolar geometry is known, can use linear features or direct methods
- Useful for long-range motion: efficiency and robustness
- Features may vary in appearance [nice recent work by Schmid and Lowe]
Role of image features

- **Not statistically optimal:**
  1. Weighting by feature certainty (doable)
  2. Not using all of the pixels

- **Patch-based alignment [Shum & Szeliski]**

\[
A \approx \sum_j J_j A_j J_j^T \quad \text{with} \quad A_j = \sum_{i \in \mathcal{P}_j} g_i g_i^T
\]

\[
b \approx \sum_j J_j b_j \quad \text{with} \quad b_j = \sum_{i \in \mathcal{P}_j} e_i g_i.
\]

- **Spline-based registration [Szeliski & Coughlan]**
Role of image features

- Can your feature tracker track this?
- Sometime direct methods track the *only* data in the sequence
Next most important problems

1. Sub-pixel accurate registration

2. Transparency, reflections and specularities

3. Non-rigid motion
Sub-pixel accurate registration

- Problems at and near occlusions
- Incorrect color extraction, no partial occupancy in (mixed) border pixels
Layered Stereo

- Layers with \textit{alpha} (opacity)
Results: Michael and Lee
Results: Anne and books

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Richard Szelski
Non-rigid motion

- Multiple moving objects (segmentation)
- Articulated and “soft” motion
- Video textures (quasi-random or quasi-periodic)
VideoTextures

video clip  video texture
Video Textures

How do we find good transitions?
Complete animation
Summary

• Video clips → Video Textures
  – discover Markov structure
  – preserve dynamics
  – disguise visual discontinuities
  – separate regions
  – user input
  – create video-based animations

• Example of Video-Based Rendering
Next most important problems

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