Multi-perspective Panoramas

Slides from a talk by Lihi Zelnik-Manor at ICCV’07 3DRR workshop
Pictures capture memories
Panoramas

Registration: Brown & Lowe, ICCV’05
Visualization: Kopf et al., SIGGRAPH, 2007
Bad panorama?

Output of Brown & Lowe software
No geometrically consistent solution
Scientists solution to panoramas: Single center of projection

Registration: Brown & Lowe, ICCV’05
Visualization: Kopf et al., SIGGRAPH, 2007

No 3D!!!
From sphere to plane

Distortions are unavoidable
Distorted panoramas

Output of Brown & Lowe software

Actual appearance
Objectives

1. Better looking panoramas

2. Let the camera move:
   • Any view
   • Natural photographing
Stand on the shoulders of giants

Cartographers

Artists
Cartographic projections

- Cylindrical
- Conical
- Azimuthal
Common panorama projections

- Perspective
- Stereographic
- Cylindrical
Global Projections

Perspective

Stereographic

Cylindrical
Learn from the artists

Multiple view points

De Chirico “Mystery and Melancholy of a Street”, 1914

Sharp discontinuity
Renaissance painters solution

“School of Athens”, Raffaello Sanzio ~1510

Give a separate treatment to different parts of the scene!!
Personalized projections

“School of Athens”, Raffaello Sanzio ~1510

Give a separate treatment to different parts of the scene!!
Multiple planes of projection

Sharp discontinuities can often be well hidden
Single view

Our multi-view result
Our multi-view result
Single view

Our multi-view result
Applying personalized projections

Input images

Foreground

Background panorama
Single view

Our multi-view result
Single view

Our multi-view result
Objectives - revisited

1. Better looking panoramas

2. Let the camera move:
   - Any view
   - Natural photographing

Multiple views can live together
Multi-view compositions

David Hockney, Place Furstenberg, (1985)
Why multi-view?

Multiple viewpoints

David Hockney, Place Furstenberg, 1985

Single viewpoint

Melissa Slemin, Place Furstenberg, 2003
Multi-view panoramas

Single view

Multiview

Zomet et al. (PAMI'03)

Requires video input
Long Imaging

Agarwala et al. (SIGGRAPH 2006)
Smooth Multi-View

Google maps
What’s wrong in the picture?

Google maps
Non-smooth

Google maps
The Chair

David Hockney (1985)
Joiners are popular

Flickr statistics (Aug’07):

4,985 photos matching joiners.

4,007 photos matching Hockney.

41 groups about Hockney

Thousands of members
Main goals:

Automate joiners

Generalize panoramas to general image collections
Objectives

• For Artists:
  Reduce manual labor

Manual: ~40min.  Fully automatic
Objectives

• For Artists:
  Reduce manual labor

• For non-artists:
  Generate pleasing-to-the-eye joiners
Objectives

• For Artists:
  Reduce manual labor

• For non-artists:
  Generate pleasing-to-the-eye joiners

• For data exploration:
  Organize images spatially
What’s going on here?
A cacti garden
Principles
Principles

• Convey topology

Correct

Incorrect
Principles

• Convey topology

• A 2D layering of images

Blending: blurry
Graph-cut: cuts hood
Desired joiner
Principles

• Convey topology

• A 2D layering of images

• Don’t distort images

translate  rotate  scale
Principles

• Convey topology
• A 2D layering of images
• Don’t distort images
• Minimize inconsistencies

Bad

Good
Algorithm
Step 1: Feature matching

Brown & Lowe, ICCV’03
Step 2: Align

Large inconsistencies

Brown & Lowe, ICCV’03
Step 3: Order

Reduced inconsistencies
Ordering images

Try all orders: only for small datasets
Ordering images

Try all orders: only for small datasets

complexity: \((m+n)\alpha\)

\[ m = \# \text{ images} \]
\[ n = \# \text{ overlaps} \]
\[ \alpha = \# \text{ acyclic orders} \]
Ordering images

Observations:

– Typically each image overlaps with only a few others
– Many decisions can be taken locally
Ordering images

Approximate solution:

– Solve for each image independently
– Iterate over all images
Can we do better?
Step 4: Improve alignment
Iterate Align-Order-Importance
Iterative refinement

Initial

Final
Iterative refinement

Initial

Final
Iterative refinement

Initial

Final
That’s me reading
Anza-Borrego
Tractor
Art reproduction

Paolo Uccello, 1436
Art reproduction

Paolo Uccello, 1436

Zelnik & Perona, 2006
Art reproduction

Single view-point

Zelnik & Perona, 2006
Our automatic result
Failure?
GUI

- Load
- Matches
- RANSAC
- Align
- Order
- Weights
- Render Joiner
- Export PSD

Show/Hide
- All matches
- Inliers
- Weights

Constraints
- Manual align
- Orientation
- Importance
- Incorporate

Joiner_images

Joiner_manual_align

Image 1
- Mark
- Use Inliers
- Align
- Cancel
- Save
- Done

Aligned
The Impossible Bridge
Homage to David Hockney
Take home

- Incorrect geometries are possible and fun!
- Geometry is not enough, we need scene analysis

- A highly related work:
  "Scene Collages and Flexible Camera Arrays,"
  Y. Nomura, L. Zhang and S.K. Nayar,
Thank You