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

No 3D!!!

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

Distortions are unavoidable
Distorted panoramas

Actual appearance

Output of Brown & Lowe software
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
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: \(~40\text{min.}\)  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
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: $(m + n)\alpha$
- $m = \#$ images
- $n = \#$ overlaps
- $\alpha = \#$ 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
What is this?
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
Manual by Photographer
Our automatic result
Failure?
GUI
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,
15-463 Class Project from 2007

http://www.cs.cmu.edu/afs/andrew/scs/cs/5-463/f07/proj_final/www/echuang}s/