Multi-View Image Compositions

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Caltech
With Pietro Perona and Gabi Peters
Pictures capture memories

Stephen Johnson:
“pictures depict a memory of a place”
Extended memories

Stephen Johnson:
“pictures depict a memory of a place”
“memories are acquired over time in many moments”
“photography is often a concatenated experience”
Organized memories
Panoramas
Why panoramas?

Regular photo

Fish-eye

A lot better
Scientists solution = Single center of projection
From sphere to plane

How can we flatten the sphere to obtain a flat image?
An already solved problem?

Cartographers

Artists
Perspective Projection

- Cannot handle wide fields of view
- Distorts foreground objects

[Pirenne, 1970] [Zelnik & Perona, 2005]
Perspective Distortion
Perspective Works If…

• You stand at the center of projection

But…

• People move the picture or around the picture, when they look at it
Cylindrical Projection

- Can handle full sphere
- Bends horizontal lines
Equidistant; Rectangular; Cylindrical

- Bends horizontal lines
- Distorts proportions
Mercator

• Bends horizontal lines
• Preserves proportions
Preserving Proportions

Rectangular

Mercator
Transverse Mercator

- Bends vertical lines
- Preserves proportions
Thin and Tall

Rectangular

Mercator

Transverse Mercator
Global Projections

Postel

Stereographic

Mercator

Perspective
Observations

• “We want the best of cylindrical and perspective”

• “Perspective is better for narrow fields of view, cylindrical for wide”
Learn from the artists

Multiple view points

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

Sharp discontinuities can often be well hidden
Cylindrical

Multi-Plane
Cylindrical

Multi-Plane
Cylindrical

Multi-Plane
Foreground objects are still distorted!
The Distortions of Perspective

Input images

Single-View Perspective
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!!
Applying personalized projections

Input images

Foreground

Filled background [Efros & Leung 99]
Background panorama
Multi-View panorama
Multi-View panorama

Single-View Perspective
Cylindrical

Multi-View
Perspective

Multi-View panorama
Some observations

Stephen Johnson:
- “memories are acquired over time in many moments”
- “photography is often a concatenated experience”

Multiple views can live happily together on the same canvas
Let the camera move

Avoid obstacles

See more of the scene
Long Imaging

Michael Koller
• “The Seamless City Scenes are absolutely NOT stitched panorama photos!”
• “Each segment is made from many, many photos shot from all kinds of angles that are then edited and composited in Photoshop to create the illusion of a seamless single image.”
Moving Camera Problem

No geometrically consistent solution
Non-smooth compositions

David Hockney
Non-smooth compositions

James Balog
Key ideas (1)

- Align images on the composition plane
- Consider only translation, rotation and scale

Align + blend

Alignment imperfect => Blur
Key ideas (2)

- Align images on the composition plane
- Consider only translation, rotation and scale
- Layer the images (rather than blend)
Key ideas (3)

• Align images on the composition plane
• Consider only translation, rotation and scale
• Layer the images (rather than blend)
• Optimize mostly visible discontinuities
System Overview

Match features

Align

Order the layers + prioritize matches

Important

Iterate
Joiners - step 1
Feature matching
Joiners - step 2
Align
Joiners - step 3
Order
Joiners - step 4
Important features
Joiners - step 5
Iterate Align-Order-Importance
Long Beach
Cacti
Anza-Borrego
Truck
Tractor
Semi Automatic
Japanese Bridge
Art Reproduction

Paolo Uccello, 1436

Zelnik & Perona, 2006
From Flickr
Manual by Photographer
Homage to David Hockney
Organized Memories
Take home

• Mosaic construction is not a pure geometrical problem.

• Incorrect geometries should not be banned.
Thank You