Lecture 17: Mosaicing and Stabilization

Recall: Planar Projection

Point on plane

Pixel coords

Perspective projection

Homography

Rotation + Translation

Recall: Projective (un)Warping

Source Image

Destination image

Applications: Stabilization

Stabilization Example

Given a sequence of video frames, warp them into a common image coordinate system.

This “stabilizes” the video to appear as if the camera is not moving.

Recall: Planar Projection

Object plane

Perspective camera parameters

Active transformations caused by linear lens distortion of real cameras

VIVID project
Stabilization by Chaining

What if the reference image does not overlap with all the source images? As long as there are pairwise overlaps, we can chain (compose) pairwise homographies.

\[ H_k = H_0 \cdot H_1 \cdot H_2 \cdot H_3 \]

Not recommended for long sequences, as alignment errors accumulate over time.

Applications: Mosaicing

Source 1  Destination image  Source 2

Mosaic

Note on Planar Mosaicing

Assumes scene is roughly planar.

What if scene isn’t planar? Alignment will not be good if significant 3D relief

“Ghosting”

Ghosting Example

Source image  Reference image

Mosaics from Rotating Cameras

However, there is a mitigating factor in regards to ghosting…

Images taken from a rotating camera are related by a 2D homography… regardless of scene structure!
Rays in camera coord system are invariant!
**Special Case: Rotating Camera**

Relative Rotation of camera

Translation is 0

This is important!

**Relations among Images Taken by Rotating Camera**

Image 1

\[
\begin{bmatrix}
    x \\
    y \\
    1
\end{bmatrix} \sim
\begin{bmatrix}
h_{11} & h_{12} & h_{13} \\
h_{21} & h_{22} & h_{23} \\
h_{31} & h_{32} & h_{33}
\end{bmatrix}
\begin{bmatrix}
    X \\
    Y \\
    Z
\end{bmatrix}
\]

Same ray!

Image 2

\[
\begin{bmatrix}
x' \\
    y' \\
    1
\end{bmatrix} \sim
\begin{bmatrix}
h'_{11} & h'_{12} & h'_{13} \\
h'_{21} & h'_{22} & h'_{23} \\
h'_{31} & h'_{32} & h'_{33}
\end{bmatrix}
\begin{bmatrix}
    X' \\
    Y' \\
    Z
\end{bmatrix}
\]

**Approaches to Blending**

How to combine colors in area of overlap?

1. Straight averaging  \( P = (P_1 + P_2) / 2 \)

2. Feathering  \( P = (w_1*P_1 + w_2*P_2) / (w_1+w_2) \)

   With \( w \) being distance from image border

3. Equalize intensity statistics (gain, offset)
360 Degree Panoramas?

Problem: Can’t just choose a reference image to map all other images to.

Solution: Use cylindrical or spherical mosaic surface rather than a plane.

Panorama Input images

Spherical Panorama Result

Quicktime VR

This example from www.panoguide.com/gallery/

Also big list at http://www.multimedialibrary.com/diana/qtvr_sites.asp
This example from www.ems.psu.edu/~fraser/qtvr/