Plenoptic Modeling: An Image-Based Rendering System
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Presented for E-295
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Overview
- Image-Based Rendering
- The Plenoptic Function
- Plenoptic Modeling
  - Image acquisition
  - Determining flow fields
  - Resampling for new view

Image-Based Rendering
- IBR uses images as the scene description
- IBR uses ideas from CG and computer vision
- Given a set of reference images, synthesize a new image:
  - From a different viewpoint
  - Looking in a different direction

Why IBR?
- Very realistic scene descriptions can be acquired with a camera. Remember IBL
- Geometric models for real-world scenes are complicated and difficult to capture

The Plenoptic Function
- Imagine a function that provides a complete description of the scene
- For every viewpoint and view direction, the PF describes the incident ray
- To render a scene, pick the view parameters and get the rays from the PF

\[ \mu = P(V, \theta, \phi, \lambda, t) \]

The Plenoptic Function Shows Us Everything We Can View in a Scene
Plenoptic Modeling
- Plenoptic modeling is the approach to IBR taken by McMillan and Bishop.
  - Store reference images as cylindrical projections.
  - Sample PF to get reference images.
  - Infer flow field from reference images.
  - Resample PF to get the desired image.

Use Cylindrical Reference Images
- Good representation for real-world scenes.
  - Maps to a rectangular grid easily.
  - Complete coverage of scene in azimuth.
  - Good coverage in elevation.
  - Spheres might be better, but they're hard to map to a plane.

Acquiring Cylindrical Projections
- Regular camera with a panning tripod.
  - Camera model and rotations can be inferred from planar reference images.
  - Combine planar images and then compute the projection onto cylinder.

Find the Flow Field
- Figure out the relative positions between cylinders by looking at corresponding points in the scene.
  - Done by hand for a small number of points.
  - Flow field is the set of correspondences expressed as vectors.

Resample and reproject
- Warping equations are produced based on flow fields and cylinder positions.
  - The desired cylindrical image can be reprojected onto a plane for viewing.

Does it work?
- Given the reference images and the flow fields, the image at the new cylinder can be found.

[1]
After performing the warp, we must take visibility into account. Scene elements may occlude other scene elements with the new center of projection. There is a scheme that uses Painter’s algorithm along with rules for deciding which pixels get drawn first.

**Inherent Limitations**

- **Exposure:** Scene element that was hidden in reference image is visible in the desired image.
- **Occlusion:** Foreground scene element in desired image that isn’t really in the scene. Often the result of some problem with reconstructing the image after the warp.

**References**