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Unstructured Lumigraph Rendering
Goals

- Combine the following desirable properties
  1. Use of geometric proxies
  2. Epipole consistency
  3. Minimal angular deviation / Continuity
  4. Resolution sensitivity
  5. Equivalent ray consistency
  6. Real-time
Unstructured input: Accept input images from cameras in general position. No camera array is required.
Epipole Consistency

- A camera, which is in the field of view of the new camera, needs to be emphasized most in reconstruction.

- In this case, it is C1, C2, C3, and C6.
Minimal Angular Deviation

- What is the most relevant camera?
  - Light fields algorithm
  - Minimal angular deviation / Continuity
Resolution Sensitivity

- Resolutions of the same proxy are different related to the distance between the proxy and camera.
The reconstruction of the same ray should be consistent.
Proposed Algorithm

1. Angular penalty
2. Resolution penalty
3. Field-of-View penalty
4. Triangulation and Rendering
Angular Penalty

\[ w_{ang}(i) = 1 - \frac{\text{penalty}_{ang}(i)}{\text{thresh}_{ang}}. \]

\[ \tilde{w}_{ang}(i) = \frac{w_{ang}(i)}{\sum_{j=1}^{k} w_{ang}(j)}. \]
Resolution Penalty

\[
\text{penalty}_{res}(i) = \max(0, \|p - C_i\| - \|p - D\|)
\]
Field-of-View penalty

\[ \text{penalty}_{fov}(i) = \begin{cases} 
0 & \text{if } r_i \text{ within field-of-view} \\
\infty & \text{otherwise}
\end{cases} \]
Combined Penalty

\[
\text{penalty}_{\text{comb}}(i) = \alpha \text{penalty}_{\text{ang}}(i) + \beta \text{penalty}_{\text{res}}(i) + \gamma \text{penalty}_{\text{fov}}(i)
\]

Define the combined weight \( \tilde{w}_{\text{comb}}(i) \) based on K–nearest cameras

\[
\tilde{w}_{\text{comb}}(i) = 1 - \frac{\text{penalty}_{\text{comb}}(i)}{\text{thresh}_{\text{comb}}}
\]

\[
\tilde{w}_{\text{comb}}(i) = \frac{w_{\text{comb}}(i)}{\sum_{j=1}^{k} w_{\text{comb}}(j)}
\]
1. Draw rectangle grid

2. Search cameras (C1, C2) inside the view of the new Camera D
3. Line D–Cn to get the position e on the plane.
4. Triangulation
Experiment

- Hallway
- A camera is mounted on a robot.
- The position of the photo is recorded.
- The robot continue move along the hallway
Q & A
Discussion

- What are the differences between this approach and:
  - Light fields
  - Lumigraph

- What can we use this for?
Thank you!