Freehand acquisition of unstructured scenes

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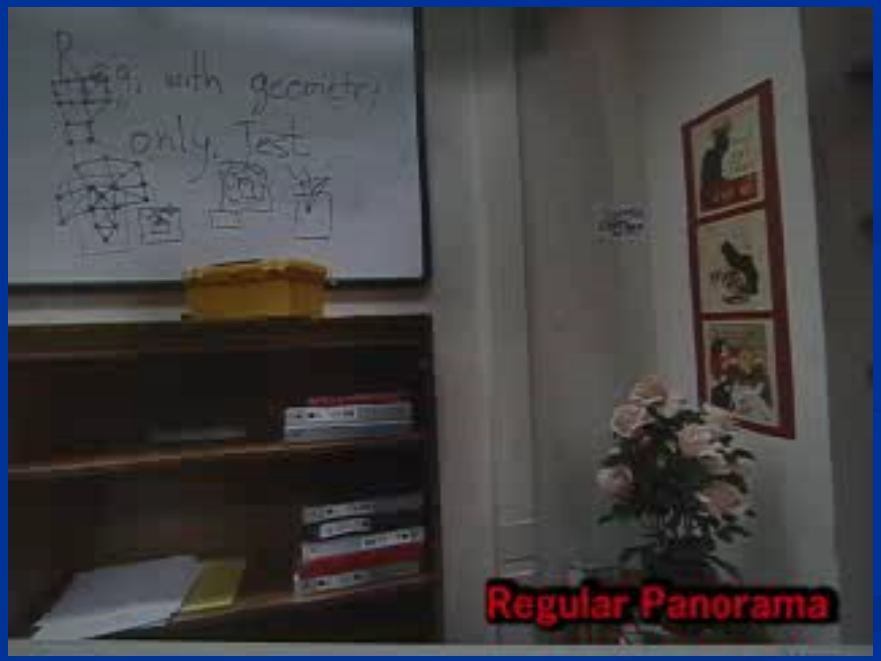
Goals

- Acquire interactively approximate models of unstructured scenes
- Inside-looking-out modeling case
  - Currently working on outside looking in case, to be extended to inside-looking-out
- Freehand

Unstructured scenes

- Scenes that contain many small surfaces
  - Leafy plants, messy desks, coats on a rack



Unstructured scenes

- Detailed modeling requires
  - Huge time investment
  - Expensive acquisition hardware

Challenges

- Data acquisition
  - Acquire depth information from many viewpoints
- Interactivity
  - The operator must be able to get feedback during data acquisition and guide the scanning

Challenges

- Tracking the acquisition device
- Modeling

Our solution

- Use the ModelCamera for acquisition
  - Acquires color frames enhanced with 45 depth samples
  - Evolving model is a colored point cloud
  - Point cloud displayed as we scan

Our solution

- Tracking
  - Previous approach: we used calibrated features (checkers)
    - Not very robust for long sequences
    - Operator had to concentrate on maintaining registration
  - ModelCamera mounted on a mechanical tracking arm

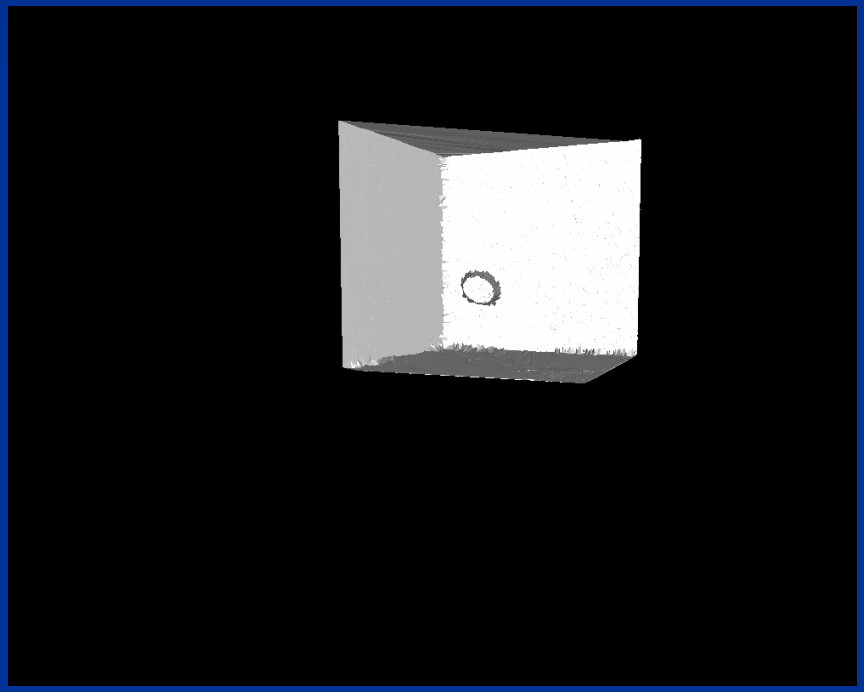
Our Solution

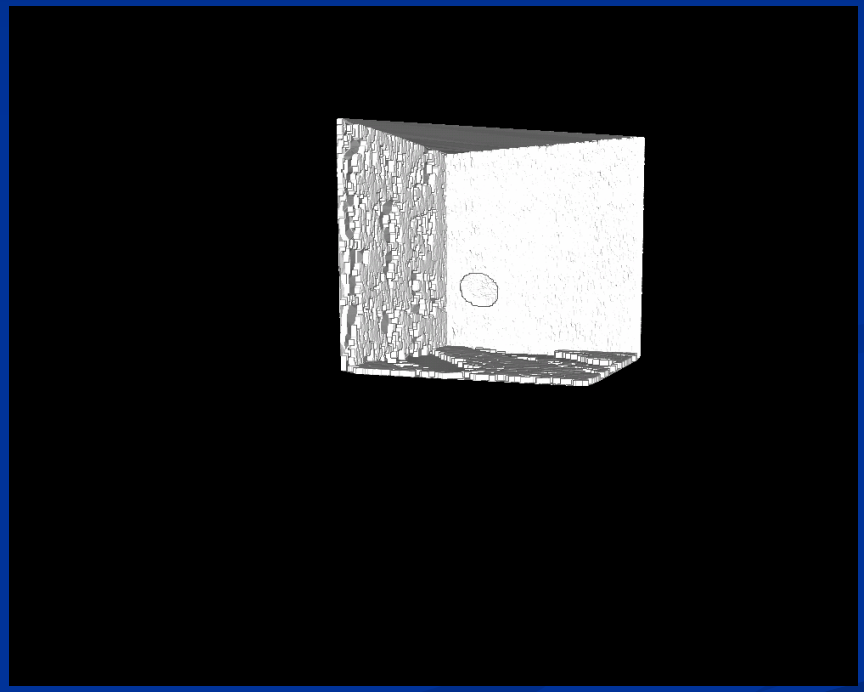
- Modeling
  - Disconnected representation
    - Splatting
  - Connected representation (triangle mesh)
    - Create an approximate mesh for each desired view
    - Color the mesh by projective texture mapping

Our solution

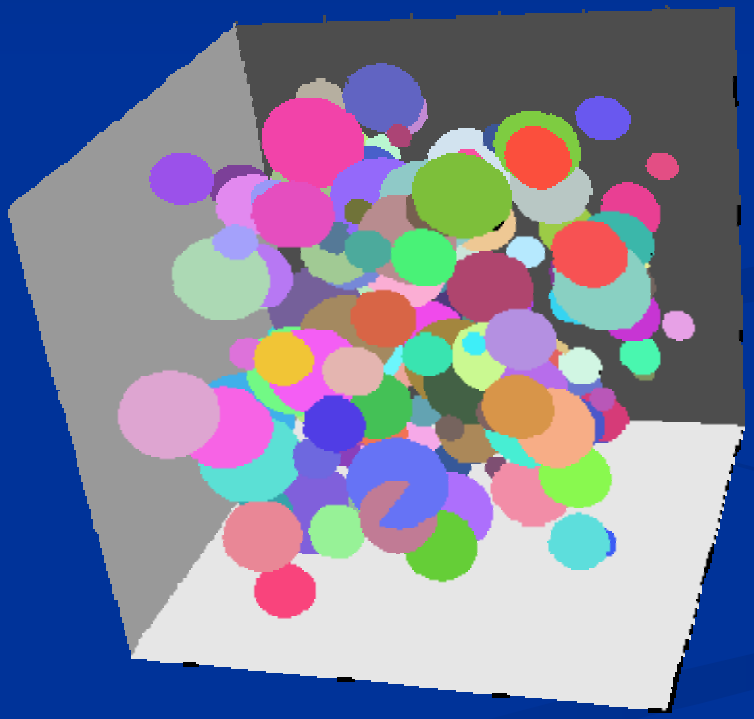
- Mesh generation
  - project points onto the desired view
  - Splat
  - Triangulate in 2D
  - Unproject each pixel covered by a splat into 3D, each such point will be vertex of the 3D mesh
- Advantages
  - Minimizes the size of the skins in the desired view

Mesh

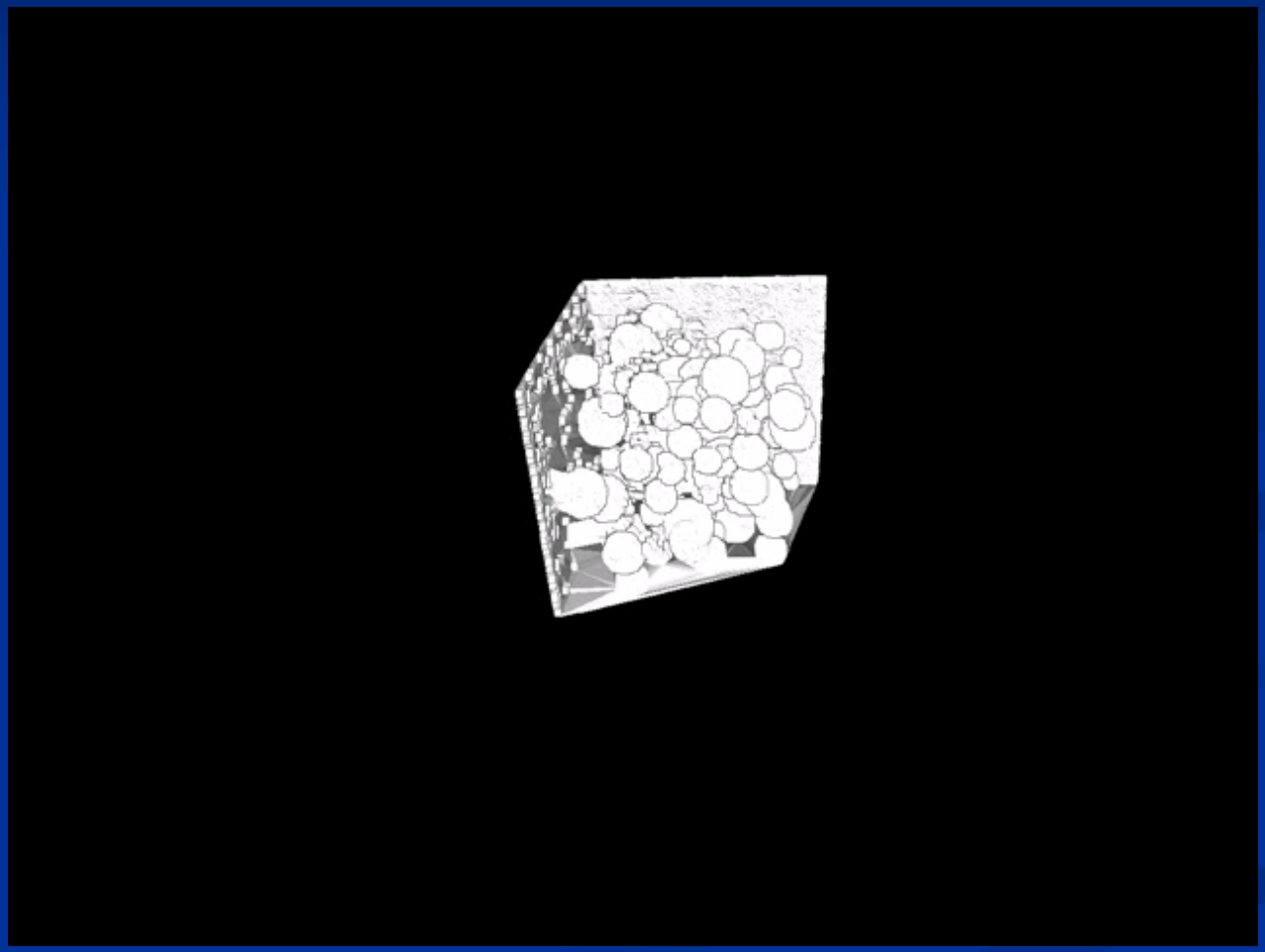




Mesh example



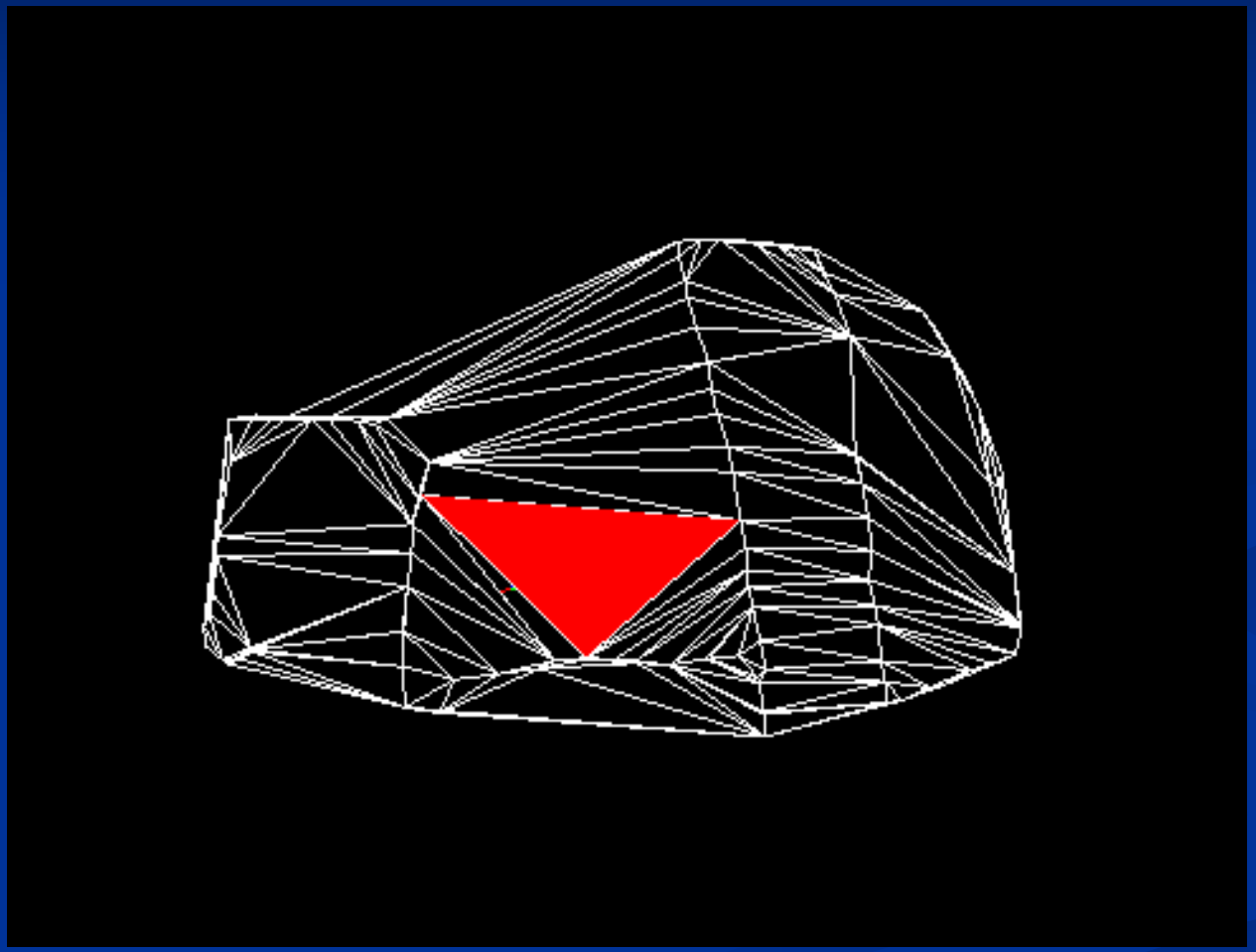
Mesh



Coloring

- Which reference images to use ?
  - Project reference COPs onto a sphere centered around the object
  - Triangulate projections
  - When rendering, project the desired view COP onto the sphere, find the triangle and color using the corresponding reference cameras
- Assumption : the entire object is visible in the reference images

Coloring



Coloring

- Order reference cameras by the distance between the desired view COP projection and the reference camera COP projections onto the sphere
- For each desired view pixel find the pixel in the reference image where the corresponding 3D point projects
- Compare the depth of the point with the depth in the reference image (zbuffers for reference images are pre-computed)
- If the point is visible in the reference image, assign color

Coloring skins

- No good solution
- Skins are approximations of the surface, thus will get incorrect color from the reference cameras
- Currently, skin pixels which remain without color after the previously described step will get color from the closest reference camera, regardless of visibility

Results

Future work

- Extending the method to inside-looking-out case
  - Mesh generation method would work as is for a room model !
  - Adapting the coloring for the case when only part of the scene is visible in the reference views
- Speeding up rendering

Thank you