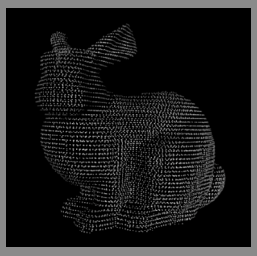
Structuring Methods

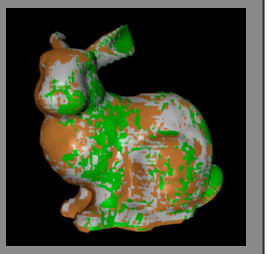
Esdras Medeiros
Luiz Velho

IMPA – Instituto de Matemática Pura e Aplicada

Point Samples × Range Images

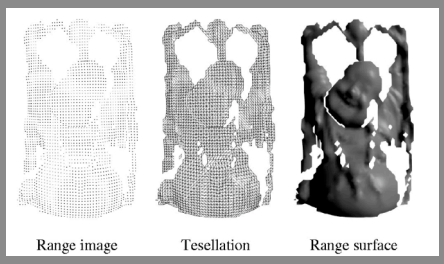


scene space

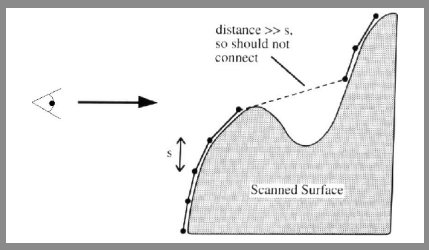


camera space

Range Images and Range Surfaces



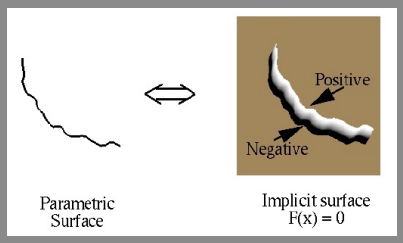
Holes and Visibility



Basic Approaches

- Parametric Methods
  (construct meshes directly)
  – Ball Pivoting
- Implicit Methods
  (construct signed distances to sensor)
  – VRIP + Marching Cubes

Methods and Representation



Volumetric Reconstruction

- Implicit function defined volumetrically
- Usually stored sampled on a 3D grid
  - Can be compressed (e.g., using RLE)
  - Another possibility: hierarchical data structures
- Can extract iso-surface
  (i.e., subset of space where implicit function = 0)

Volumetric Reconstruction Benefits

- Always generates a manifold surface
- Can control sampling density
- Averaging of signed distance functions corresponds to averaging the surfaces

Volumetric Reconstruction Drawbacks

- Represent a 3D entity rather than 2D
  - Running time
  - Storage
- Resampling step – bandlimits the function
- Generates consistent topology,
  but not always the topology you wanted
- Problems with very thin surfaces

Volumetric Reconstruction Overview

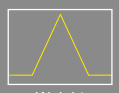
a) Generate signed distance function
   (or something close to it) for each scan
b) Compute average (possibly weighted)
c) Extract iso-surface

VRIP

[*Curless & Levoy, 1996*]

- Implicit functions = ramps along line of sight to scanner
- Weighting along ramps


Function

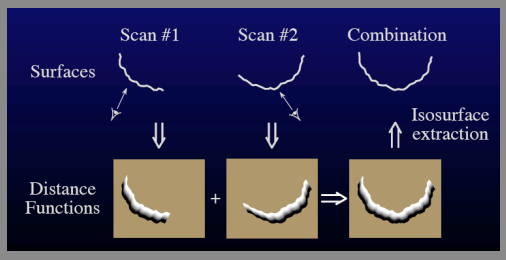

Weight

- Weighting across surface

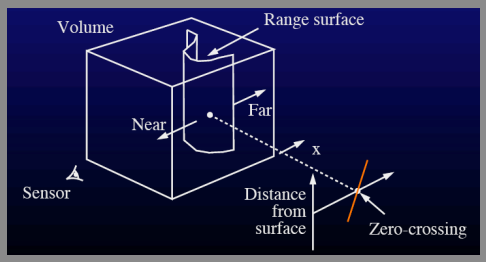
VRIP Properties

- Under appropriate assumptions can prove that average of ramps is least squares estimate of surface position
- Stores ramps only near surface
  - RLE to compress empty space
- Isosurface extraction using marching cubes

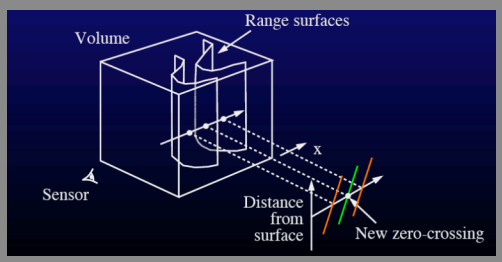
VRIP Overview



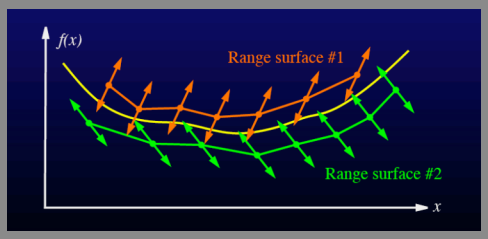
Distance Function



Combination



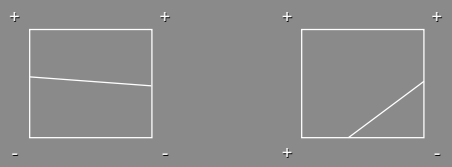
Final Surface



Marching Cubes

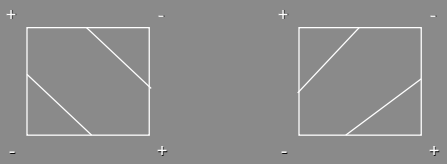
[*Lorensen & Cline, 1987*]

- Consider 2D analogy: "marching squares"
- Look at signs at corners of square



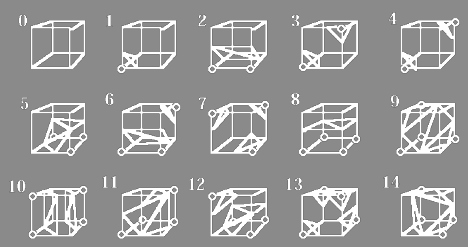
Marching Cubes

- Signs of corners → lookup table → polygons
- Actual values at corners:
  locations of vertices along edges of square / cube
- Sometimes ambiguous



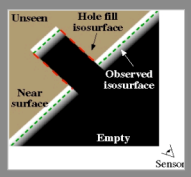
Marching Cubes

- Same idea can be extended to 3D

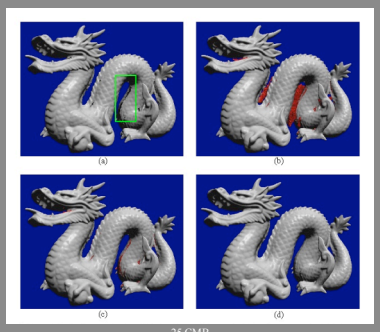


Space Carving in VRIP

- Mark all space between surface and scanner as “outside” (with low weight)
- Extract additional isosurfaces between “outside” and “unseen”



Space Carving in VRIP



Space Carving in VRIP