Motivation

- Planetary nebulae (PN): gaseous clouds around dying stars
- 2D image observable from Earth
- 3D reconstruction usually a lot of manual work
- Physical assumptions can partially automatize the modeling process

Hybrid Models

- Subsequent eruptions of PN create nested shells
- Purely emissive homogeneous gas inside shell
- Hot dust and debris collected on shell surface; can emit or absorb light
- ⇒ Mesh-based model with volumetric emission and surface textures for emission and absorption

Workflow

1. User specifies input image (a) and geometry assumptions: object silhouettes (e) or a full model.
2. Geometry is generated from silhouettes if necessary (f).
3. Observed image is decomposed into additive contributions of the objects (b, c).
4. Volumetric emission of objects is estimated (g).
5. Surface effects of objects are calculated (h).
6. Models are volume-rendered at interactive frame rates (d, h).

Results

- Cat’s Eye nebula: observed image, perspective rendering from original viewpoint, additional perspective renderings.
- Saturn nebula: observed image, perspective rendering from original viewpoint, additional perspective renderings.

Algorithm Details

- Object separation: extrapolation from known parts by texture synthesis; variation within each object is minimized during optimization.
- Volumetric emission: least squares fit to observation.
- Visualization: mesh-based volume rendering using depth peeling.

Outlook

- Self-similar detail synthesis for surface textures.
- Volumetric detail synthesis for fly-through animations.
- Applications: planetarium live shows, education.

Further Information

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