Problem statement and motivation

What is the problem that this paper is trying to solve? Why is it important?

What are the drawbacks of previous methods? How does this paper overcome such drawbacks?

What are the main contributions of this paper?

What are the main stages of the proposed algorithm?

Mesh Segmentation

How is the initial mesh obtained from multi-view stereo images?

What is the local curvature attribute used to label the vertices initially?

Possibly principal curvature.

Why were labels based on local curvature chosen? Why not semantic labels of building surfaces?

What are the advantages of the mesh segmentation technique that has been used in the paper?

- local geometric properties + propagation/consistency constraints
- urban surface priors
- scale of structures in the mesh

Mesh Segmentation (Contd)

What is the result of mesh segmentation? What types of structures are present in the segmented mesh?

Contains only meshes. No primitives.

Will the proposed hybrid modelling algorithm work even without an initial coarsely segmented mesh?

Can you formulate the optimization energy used for Mesh segmentation?

Stochastic hybrid reconstruction

What is the distinction made between a cluster C_i and its associated mesh patch m_i? Why is it made?

A cluster contains a fixed number of vertices. The locations of these vertices that form the mesh m_i, are updated in every iteration and therefore can change with time.

How is a primitive parameterized?

This paper takes into account several primitives such as spheres, cylinders, planes, cone and a torus. Each primitive is modelled by its own set of parameters. Therefore, a primitive associated with each mesh cluster c_i is modelled by its own (r_i, θ_i).

Does the hybrid model preserve the topology of the mesh?

Yes.

Stochastic Hybrid reconstruction (contd.)

What is a constraint on the edge vertices? Why is this constraint needed?

A border vertex can be displaced by more than half of the length of the shortest adjacent edge in the original mesh. This prevents non-degenerate cluster adjacency and excludes degenerated models from the set of possible solutions.

Describe the optimization space. What are its components? Are its subspaces, spaces of uniform dimension?

Multi-object energy definitions

What are the components of the optimization energy?

- Picture consistency
- Mesh Smoothness (Thin plate energy)
- Primitive priors (periodicity and orthogonality)

What is photo consistency? Why is it used in the context of choosing a mesh model for a given surface?

How does one control the preference of primitives over meshes or vice-versa? Why is one preferred over the other?

What are advantages and disadvantages of using the photo consistency measure for choosing the right mesh model?

How are degenerate meshes avoided during optimization?

Multi-object energy definitions(Contd.)

How is the thin plate energy formulated?

Are all components of the hybrid model subjected to the smoothness constraint? Why?

Why is a prior on shape layout needed?

To compensate for information not available in images.

Is this prior applicable to all objects in the hybrid model?

No. It applies only to primitives.

What sort of semantic knowledge does this prior impose on the primitives in the hybrid model?

- Prefers parallel and perpendicular primitives
- Prefers repetition of a given primitive rather than the use of many different primitives.

Multi-object energy definitions (Contd.)

What geometric property of the primitives is used to impose these constraints?

The angle of revolution of the primitives. For a sphere, this property does not make any sense. For planes, the normal is considered as the angle of revolution.

What is the Manhattan world assumption? Is the shape prior used in this paper different from the Manhattan assumption?

How is repetition of a particular primitive encouraged? Why is the weight $w_{ii'}$ lower when there are many different primitives? How is it chosen?

Which drawbacks does the shape layout prior specifically overcome?

- Visibility problems associated with photo consistency

Can you think of a situation in which the shape layout prior will fail?

Jump diffusion

What are the two alternating steps of the Jump diffusion algorithm?

What is stochastic relaxation? What effect does it have in this paper?

What are the 'jumps' in this diffusion algorithm? How are they determined? How is preference for one subspace over the other established?

Is the jump dynamic alone sufficient to explore the whole configuration space? Why is a diffusion dynamic introduced?

At low temperatures, how does the diffusion dynamic behave?

Gradients used in the diffusion step

What are the energy terms that contribute to the Mesh and primitive gradients respectively?

Is Brownian motion considered during the calculation of the Mesh gradient? Why?

Are shape changes considered during the primitive diffusion step? Why?

What structures are present in the beginning of the iterative optimization procedure? Can different structures be introduced as the optimization proceeds in time? Why?

Refinement and Experiments

How are meshes and primitives treated at each step of the refinement?

What is the condition that a triangle in a mesh must satisfy in order to sub-divided? Why is this subdivision carried out in the first place?

What are the rules of thumb to choose parameters β, and β_1, β_2 which are used in Mesh segmentation and hybrid model building respectively?

How is the initial temperature for simulated annealing determined? What does the 'energy' at infinite temperature mean?

How is the jump from a primitive to a mesh made possible?

Refinement and Experiments (Contd.)

How are the edge vertices between a mesh-mesh, primitive-mesh and primitive-primitive treated differently at the end of the hybrid model construction?

What is the convergence criteria for the hybrid model selection?

Is this model guaranteed to find the global optimum? Why/Why not?

Miscellaneous questions

What are the limitations of this algorithm? What are the scenarios in which it fails?

What is possible research directions that can leverage this work?

Can this be applied to other mesh applications?

Runtime of the algorithm/number of iterations necessary for convergence?

Nitpicking

What is Delauney triangulation?

What is the one-to-four mesh subdivision scheme?

Why is the jump dynamic bijection function considered to be the identity?