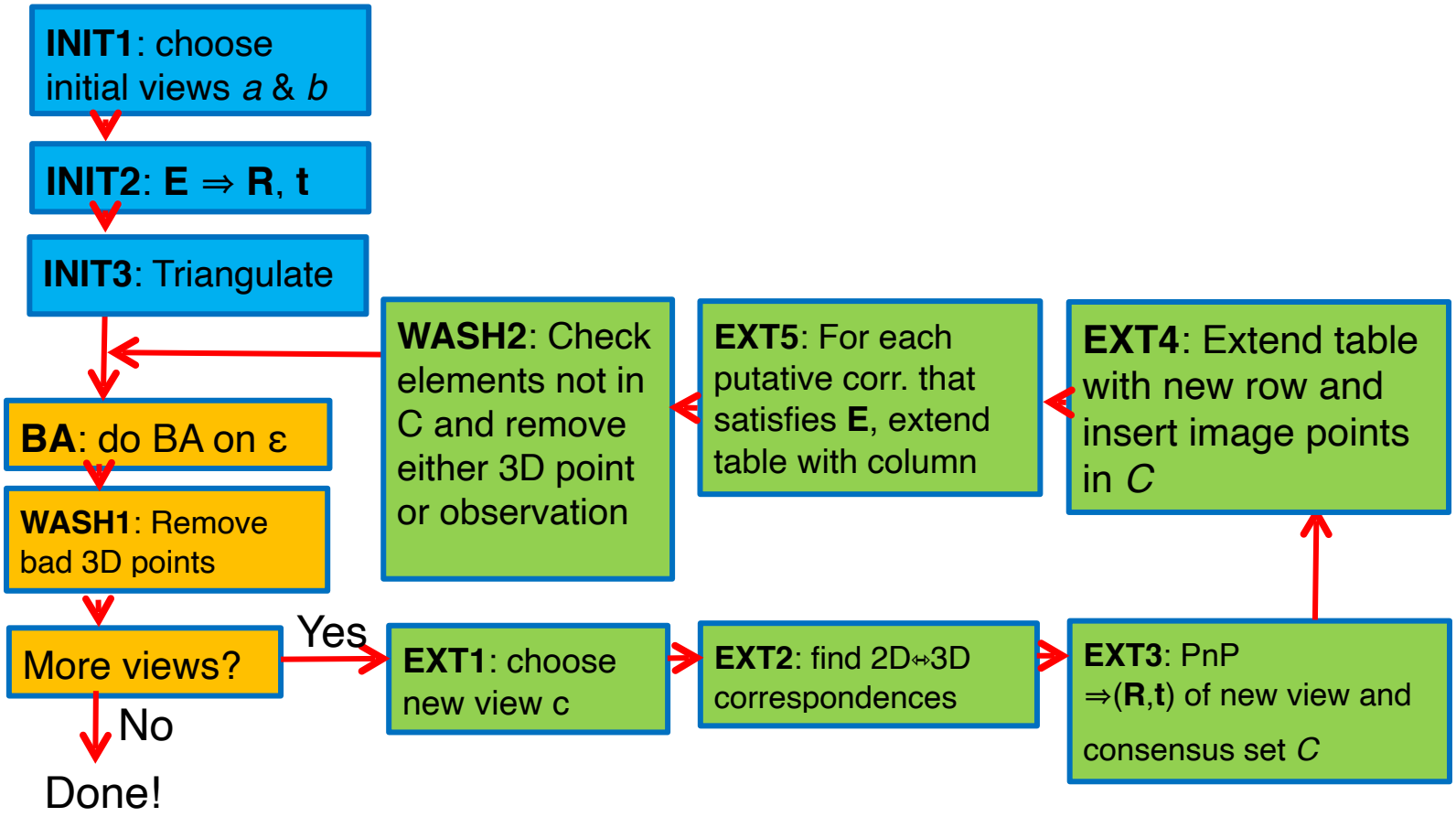
TSBB15
Computer Vision

Lecture 14
Multi-view stereo

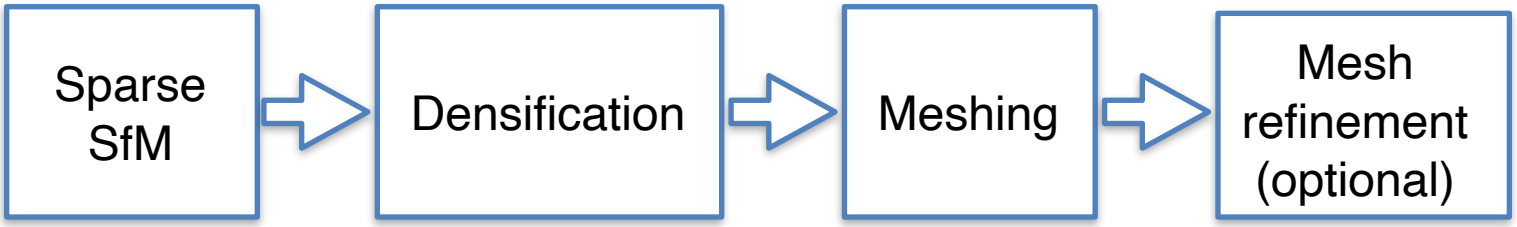
Recap: Incremental SfM pipeline from Lecture 12



Dense 3D models

The output of incremental SfM is a sparse 3D model and a set of camera poses.

In commercial 3D modelling systems, sparse SfM is followed by two or three additional steps:



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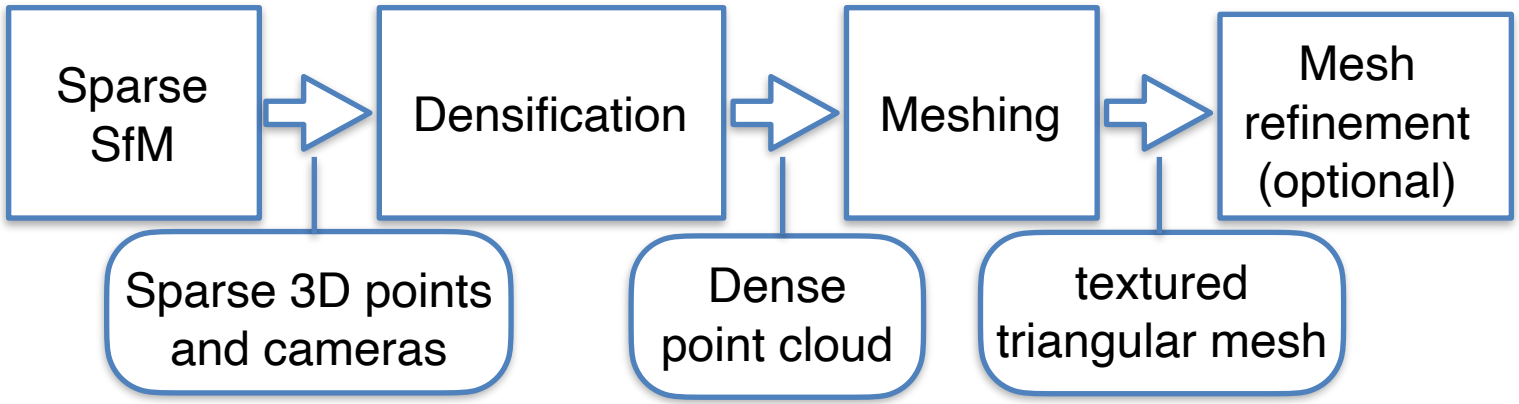
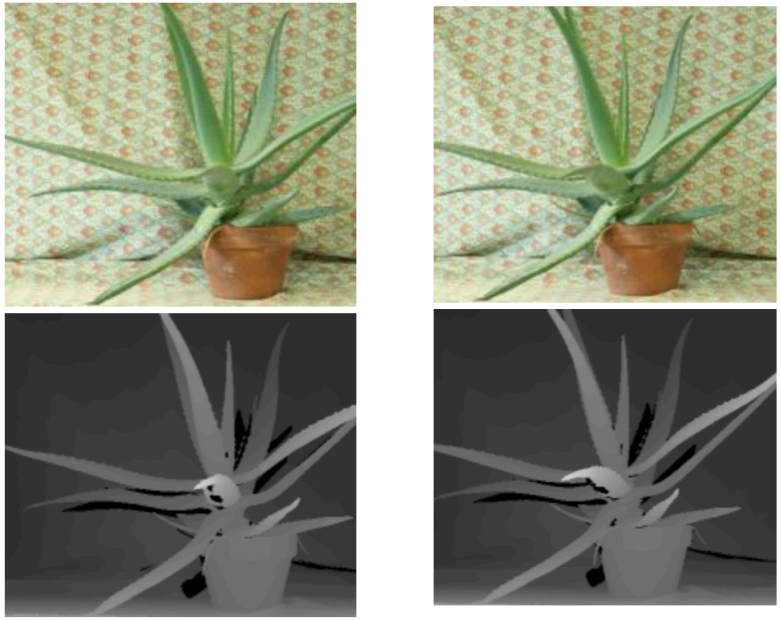


Densification approaches

- Classic stereo, using two images and the epipolar constraint [Scharstein & Szeliski IJCV02]
  http://vision.middlebury.edu/stereo/taxonomy-IJCV.pdf



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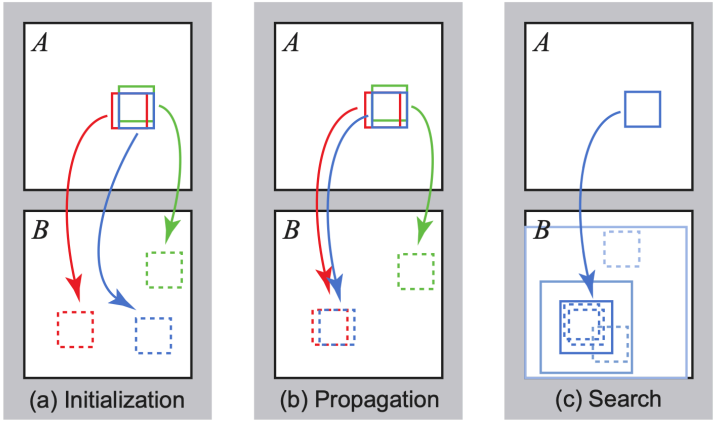

Image from Barnes et al. SIGRRAPH'09

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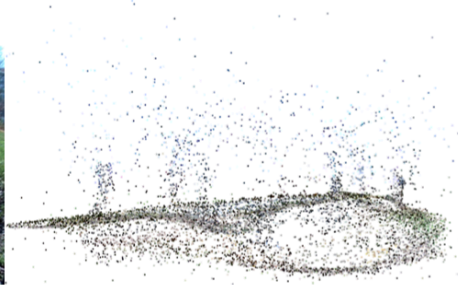
(a) View of the scene.



(b) Sparse point cloud from Kontiki

(c) Result after densification.

Images from CDIO-project GoPro Trails 2018

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- Depth map search by optimization.
  Can be parallelized on GPU using the plane-sweep algorithm. [Gallup et al. CVPR07]
  https://inf.ethz.ch/personal/pomarc/pubs/GallupCVPR07.pdf
- Multi-view methods from the Furukawa&Hernández tutorial.

Meshing approaches

- Delaunay tetrahedralization from convex hull of point cloud. Or triangulation from successive projections of point cloud. See Furukawa&Hernández.
- Volumetric methods:
  The surface should go through the 3D points, so let them be constraints in 3D.
  Signed distance fields [Curless&Levoy SIGGRAPH96]
  https://graphics.stanford.edu/papers/volrange/volrange.pdf
  Poisson Surface Reconstruction [Kazhdan&Hoppe TOG'13]
- Voxels can be converted to a mesh using marching cubes [Lorenzen&Cline SIGGRAPH'87]
  https://dl.acm.org/doi/10.1145/37401.37422

Mesh refinement

Mesh refinement is covered in the Furukawa and Hernández tutorial.

Image source: A. Fitzgibbon, G. Cross and A. Zisserman, Automatic 3D Model Construction for Turn-Table Sequences, in 3D Structure from Multiple Images of Large-Scale Environments , Editors Koch & Van Gool, Springer Verlag 1998