



High Performance Computing Photogrammetry Pipeline for Underwater Surveying

Evan Garcia

Mentor(s): Jeffrey S. Ellen, Ph.D.

Project # HIP-25-034



Naval Warfare Information Center(NIWC)

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Distribution Statement A. Approved for public release: distribution is unlimited.





Introduction



| **School** | University of California, Los Angeles

| **Major** | Statistics & Data Science

| **Past Research Experience** |

Data Augmentation for Off-Terrain Autonomous Systems

| **Future Plans** |

Explore careers in data science, particularly with an environmental or oceanic focus.

| **Tell us why you applied for the HIP** |

I'm interested in leveraging the data science and machine learning skills that I've developed into an impactful field. I'd like to contribute more to ocean research and learn more about computer vision techniques.

| **LinkedIn** | <https://www.linkedin.com/in/EvAntGarcia/>



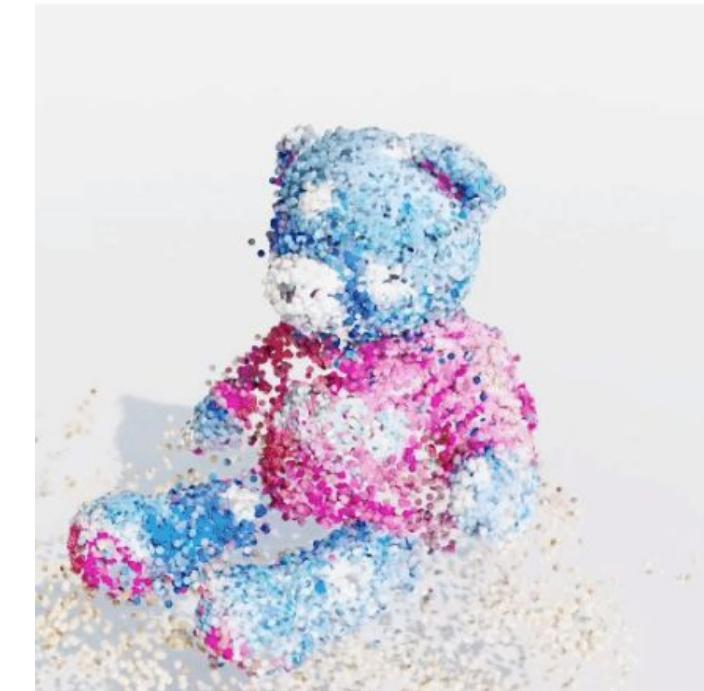
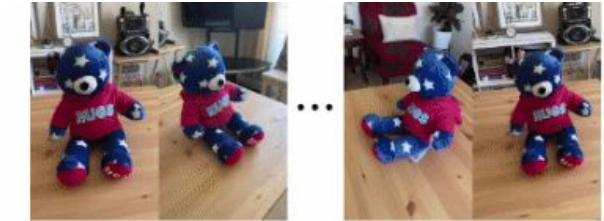
Project

- Improve efficiency/quality of Underwater Surveys(e.g. Coral) via modern Photogrammetry techniques



[1]

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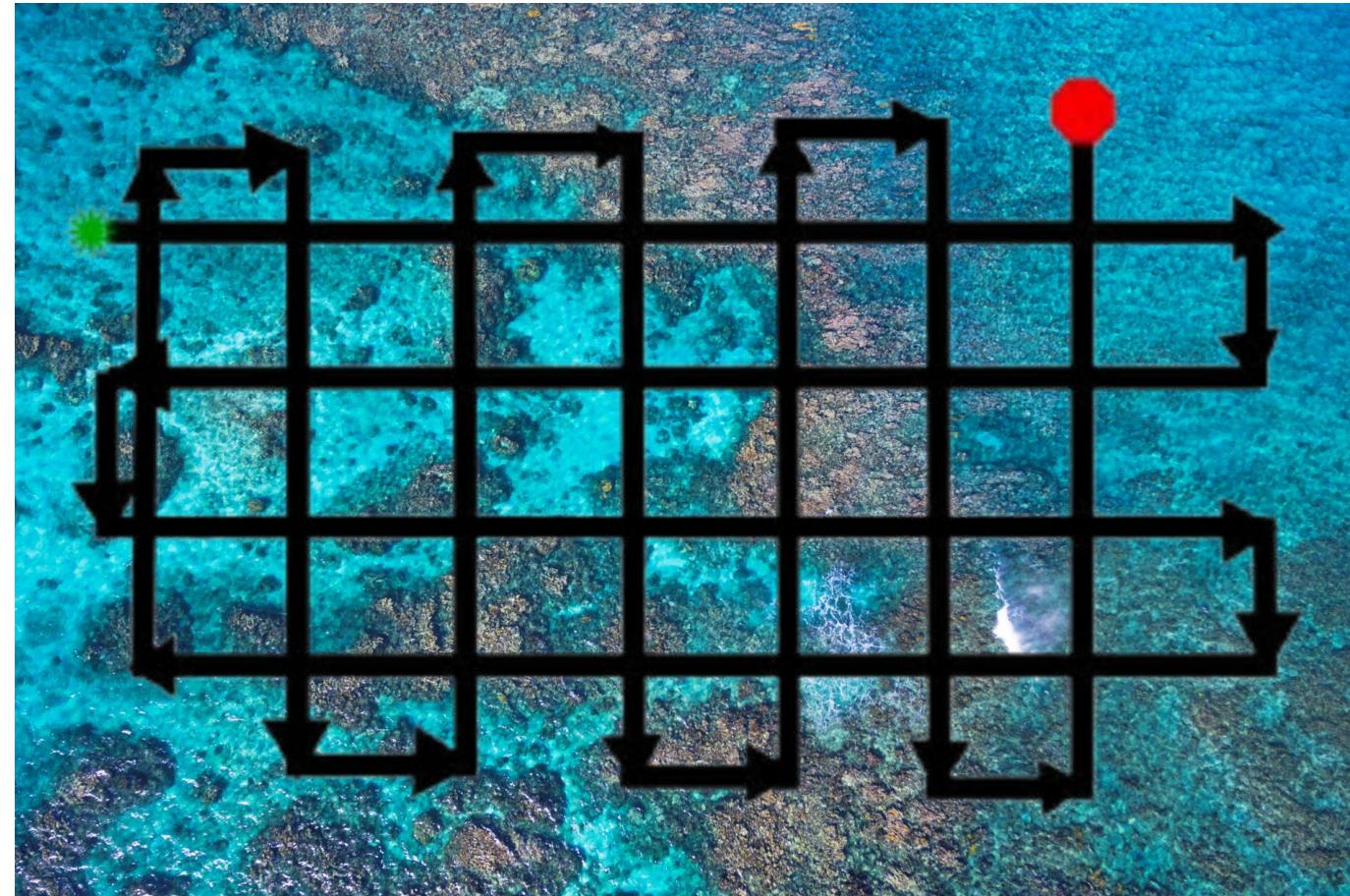
[2]

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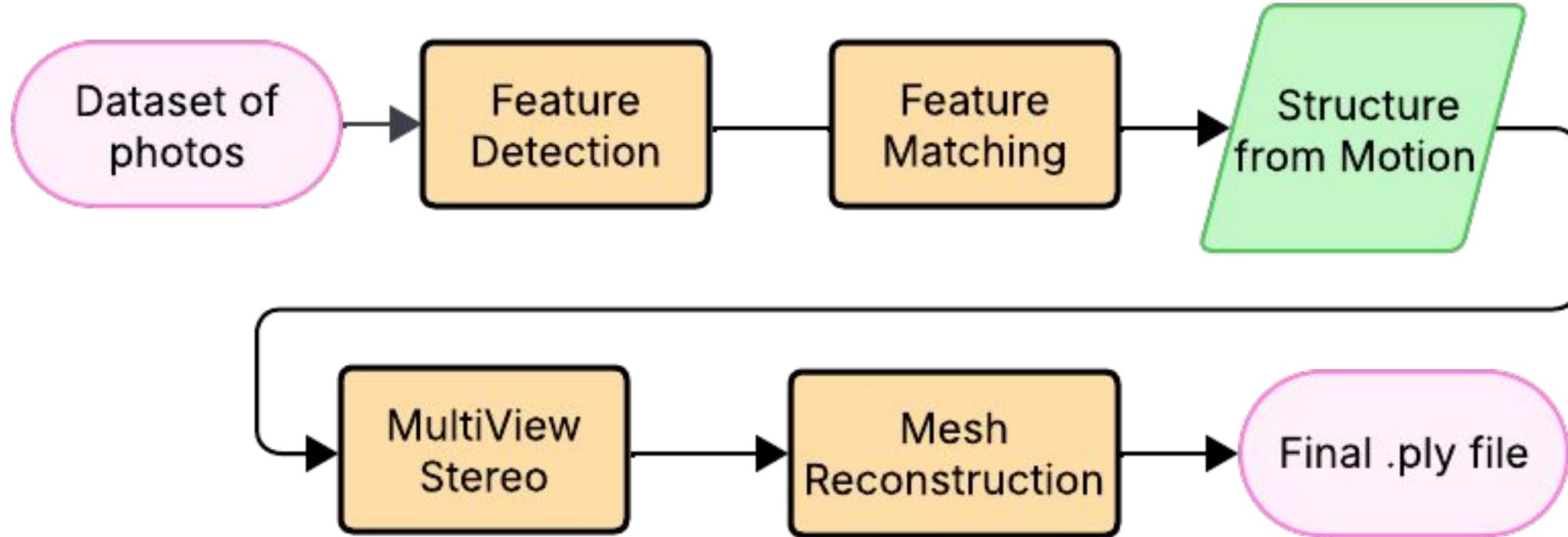
Project - SOP

- Capture Coral Via Autonomous Drone, collect image set



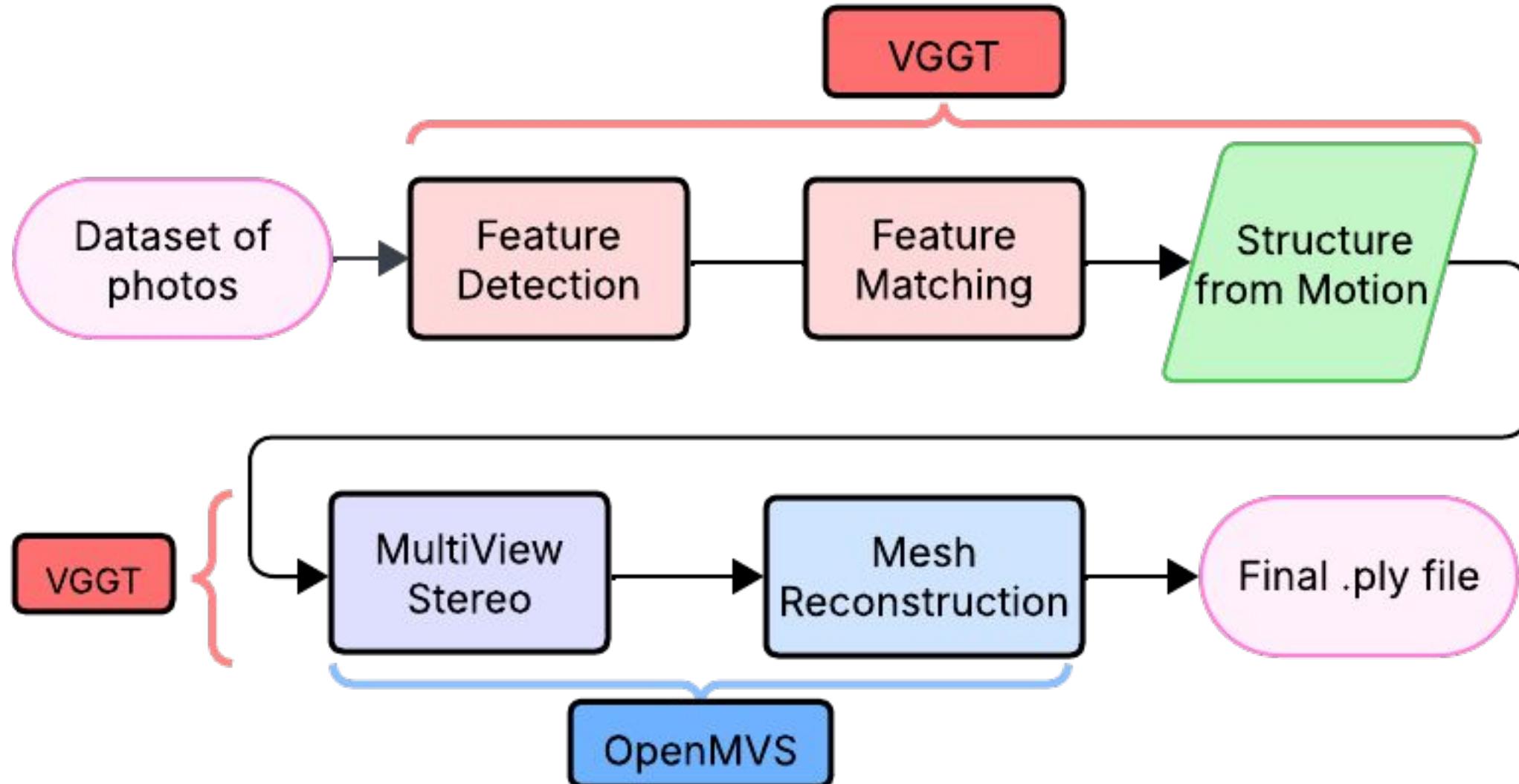


Design/Methods - Pipeline Structure





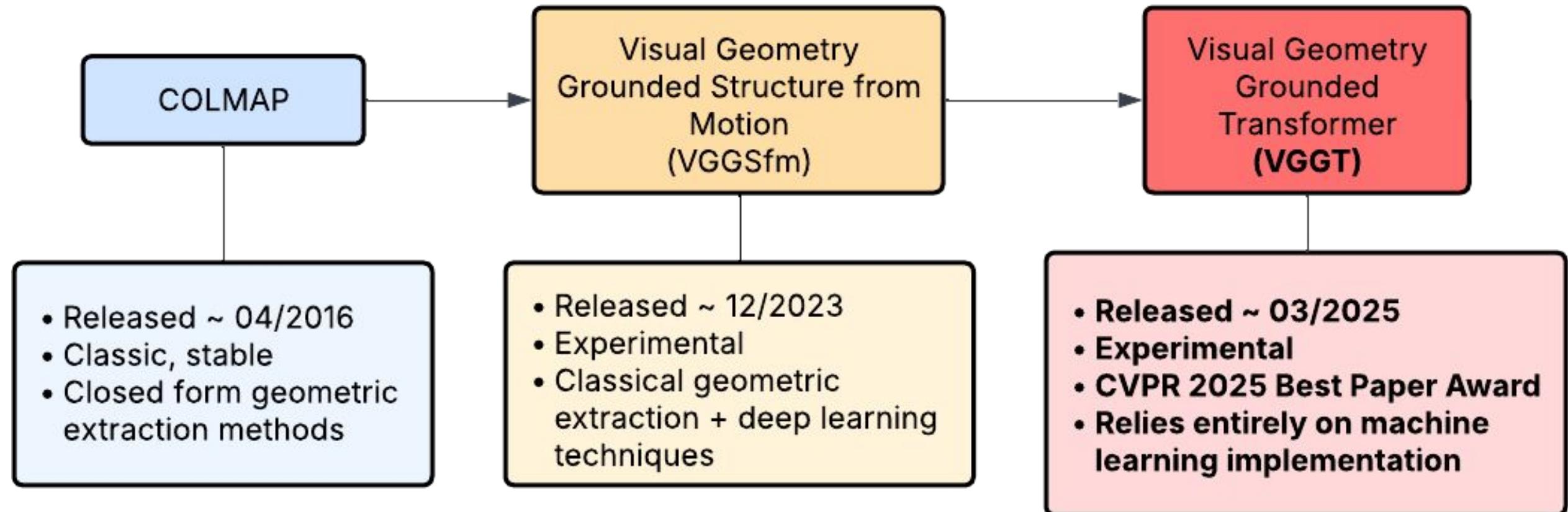
Design/Methods - Pipeline Structure





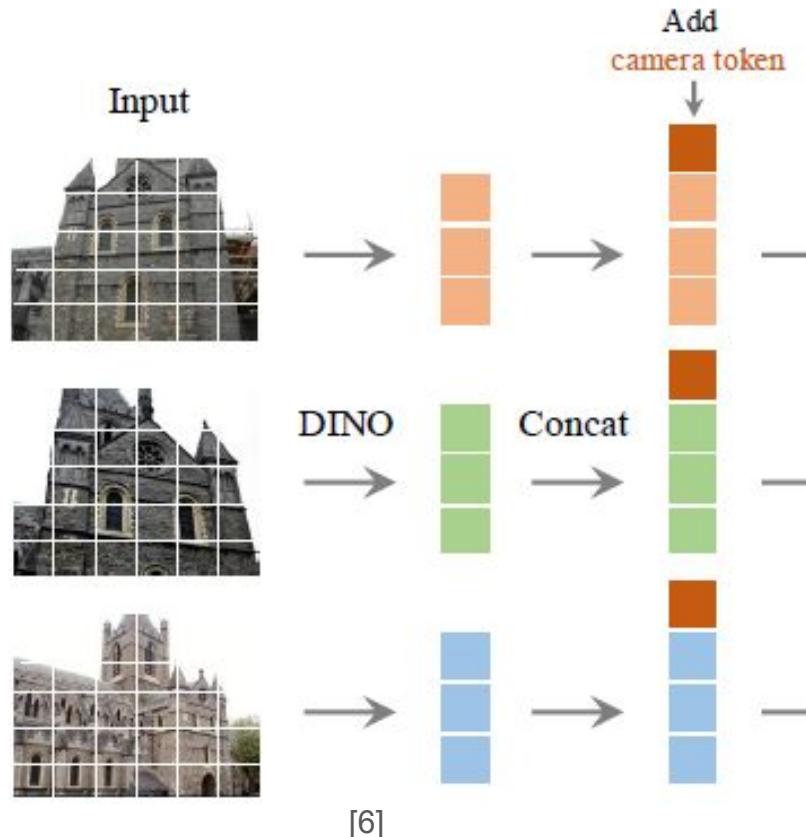
Design/Methods - SfM Software

- Adaption of methods over time



Design/Methods - VGGT

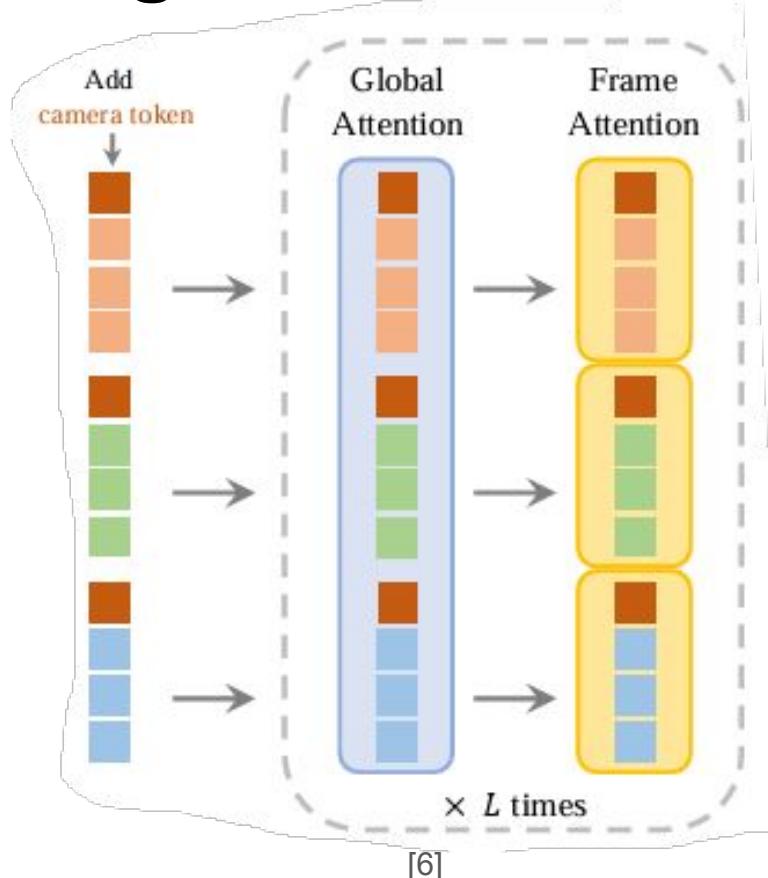
- Images sliced into 14x14 patches
- Encoded into vectors to be fed downstream



[7]

Design/Methods - VGGT (cont'd)

- Alternating Attention Design
- Interprets the info/relevance of frames to compare against the whole scene

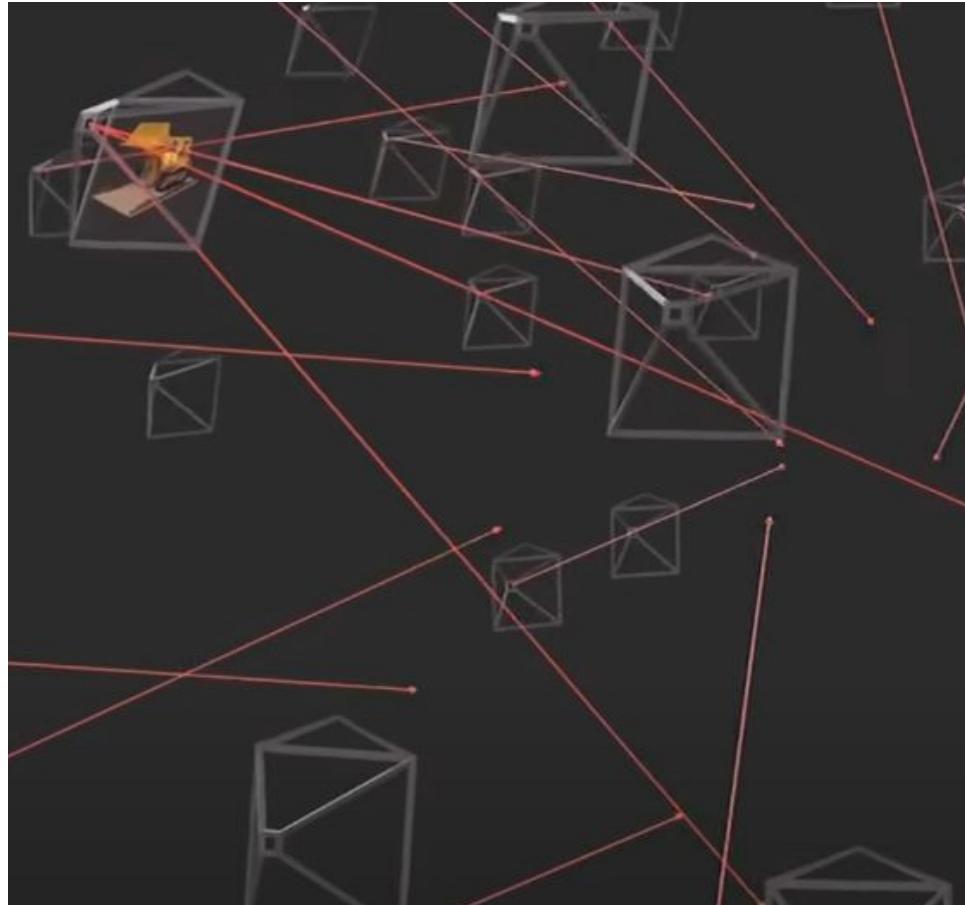


VS



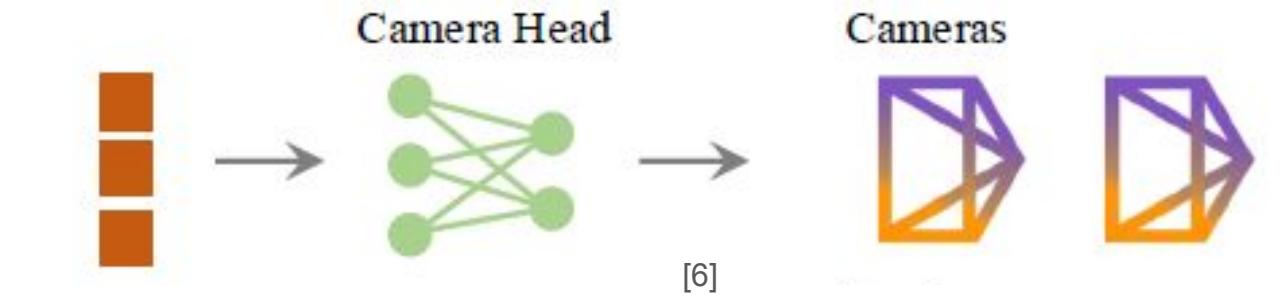
Design/Methods - VGGT (cont'd)

- Camera Pose Estimation
- SfM Output Achieved

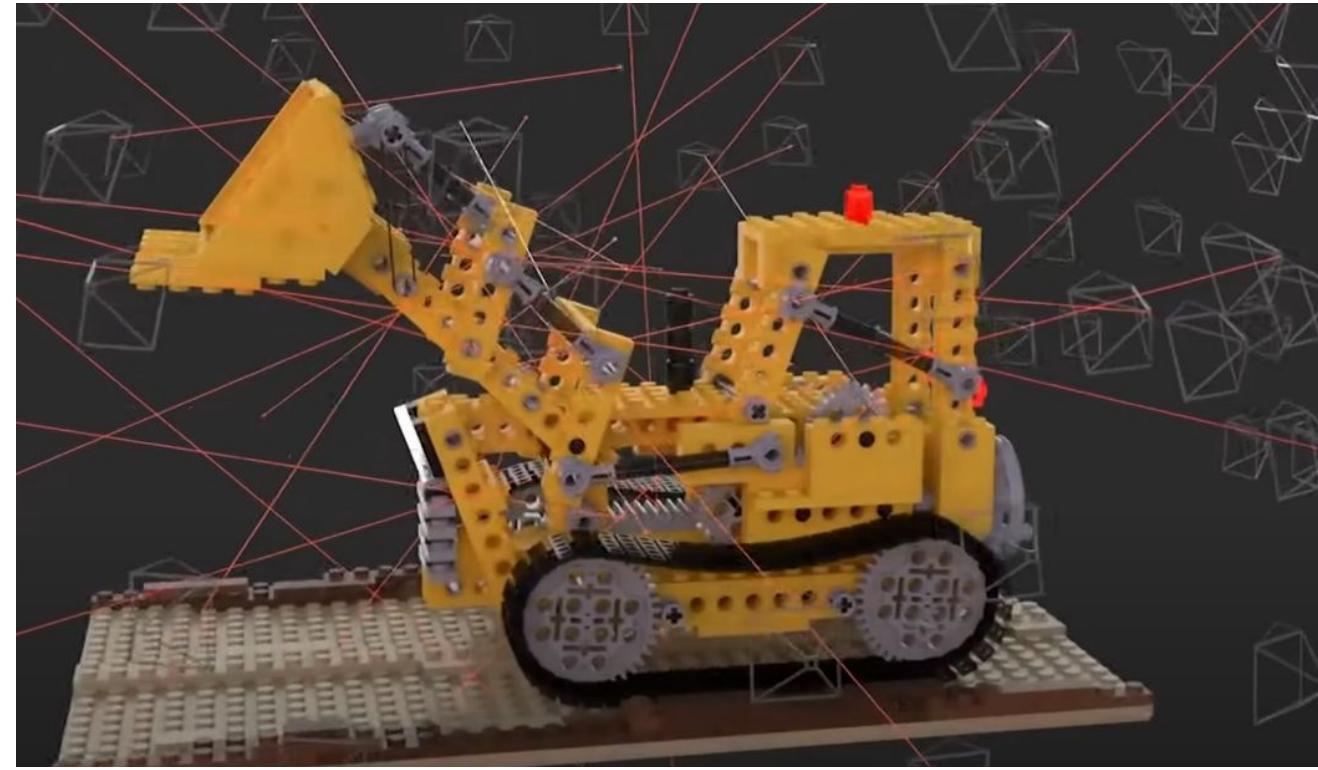


[9]

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[6]



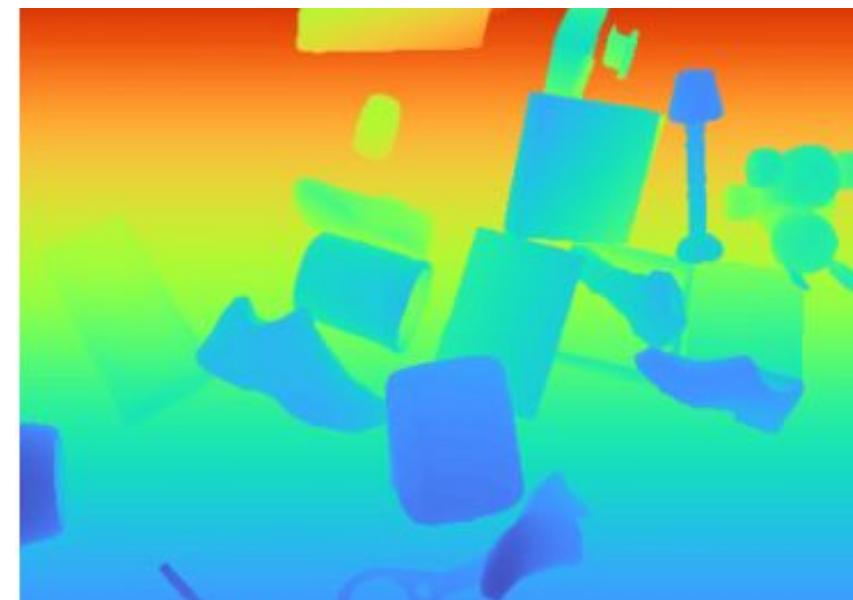
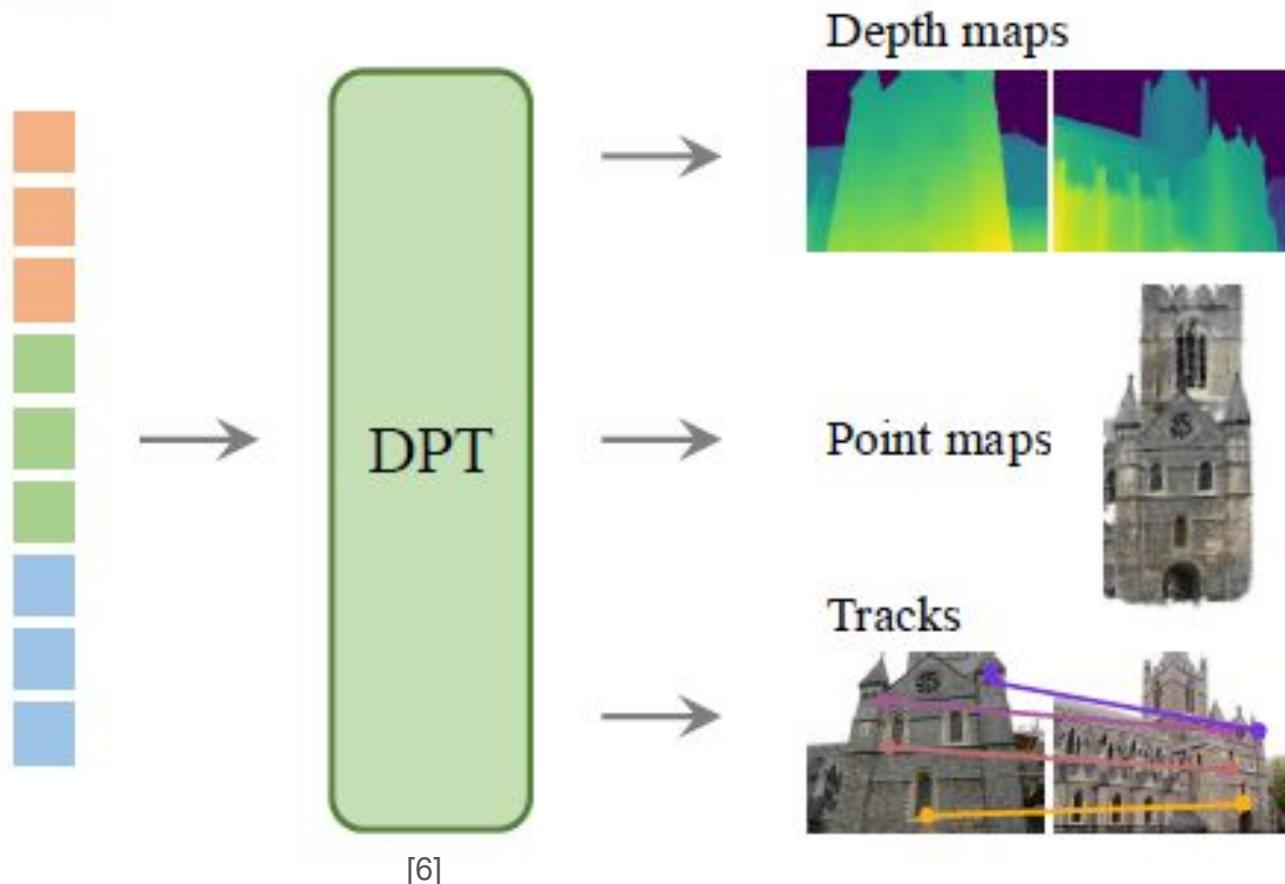
[9]

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Design/Methods - VGGT (cont'd)

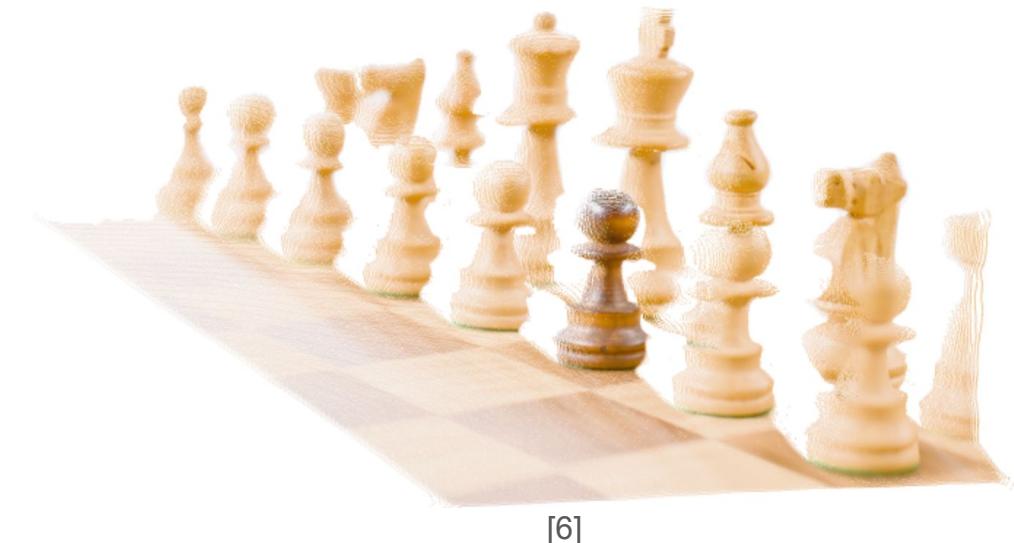
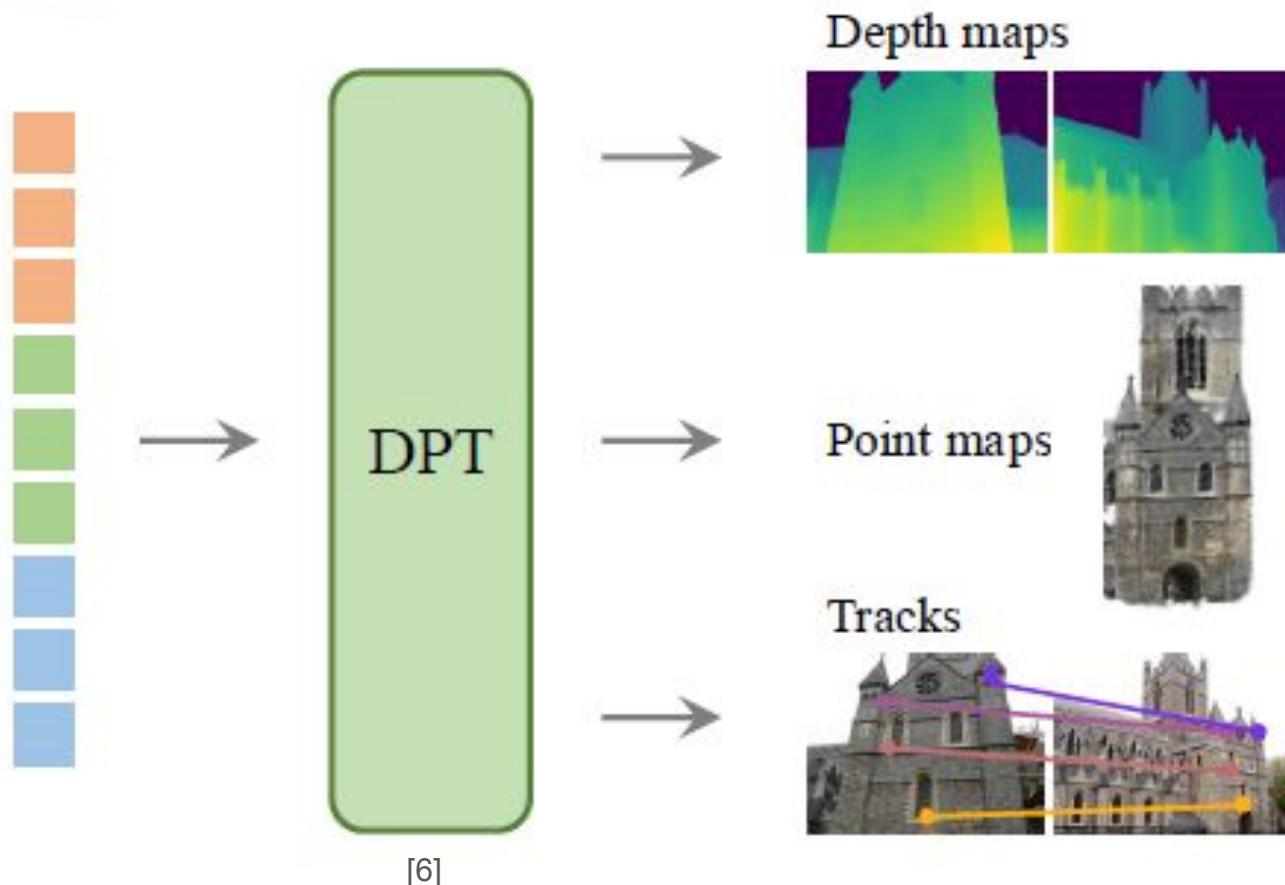
- Depth output
- Maps depth values to pixels





Design/Methods - VGGT (cont'd)

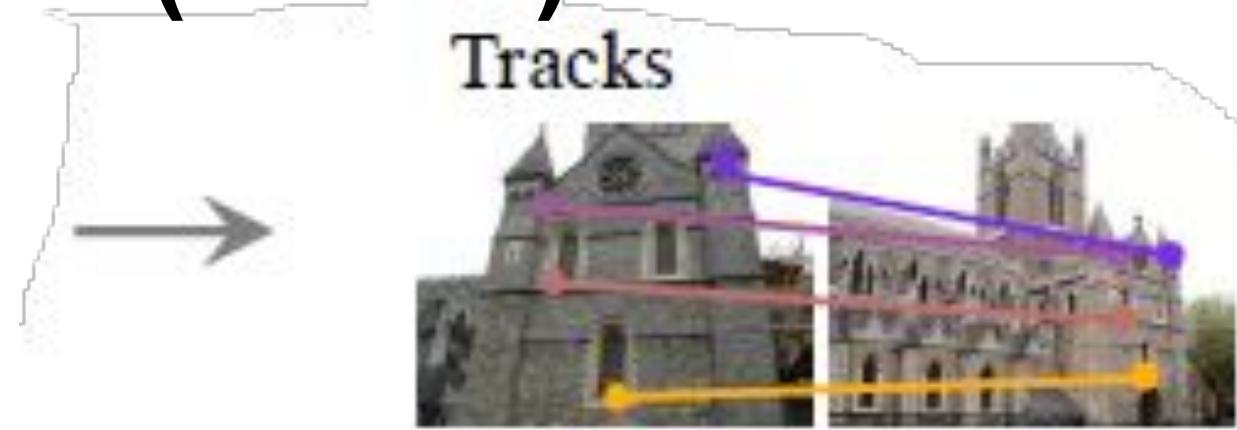
- Point Maps
- Reconstructed 3D points





Design/Methods - VGGT (cont'd)

- Point tracking
- Implicit feature detection and feature matching



Design/Methods - OpenMVS

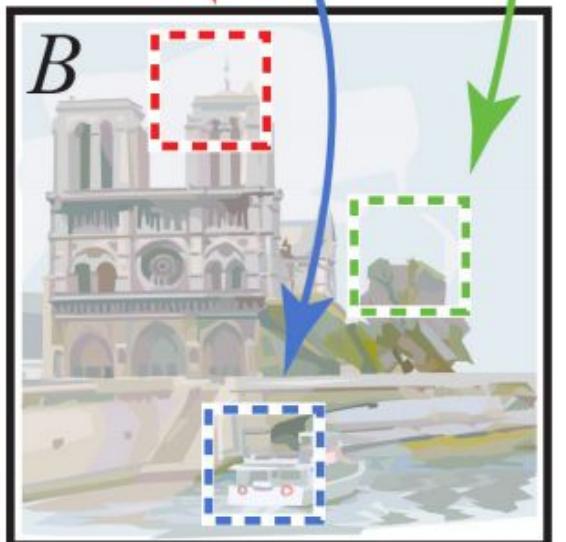
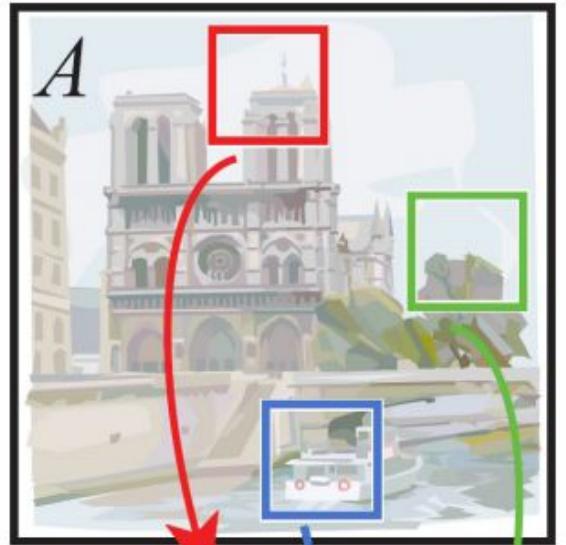
- Densifies
existing
pointcloud



[11]



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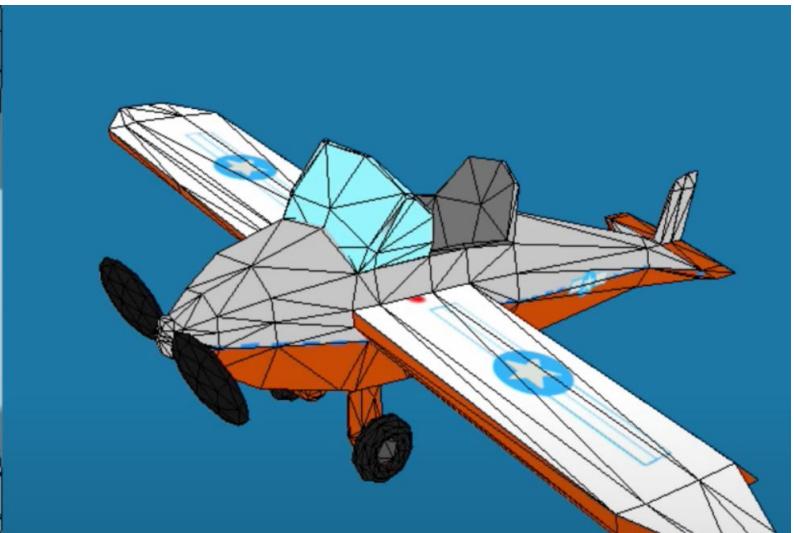
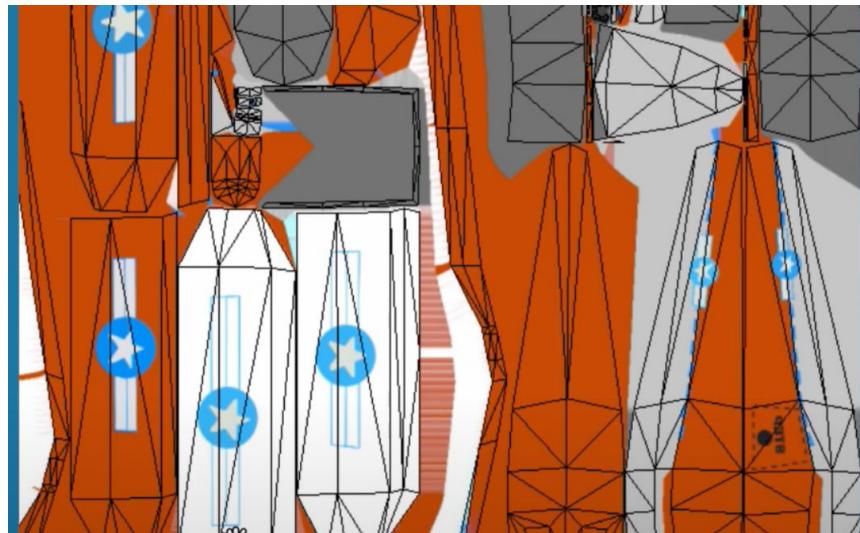
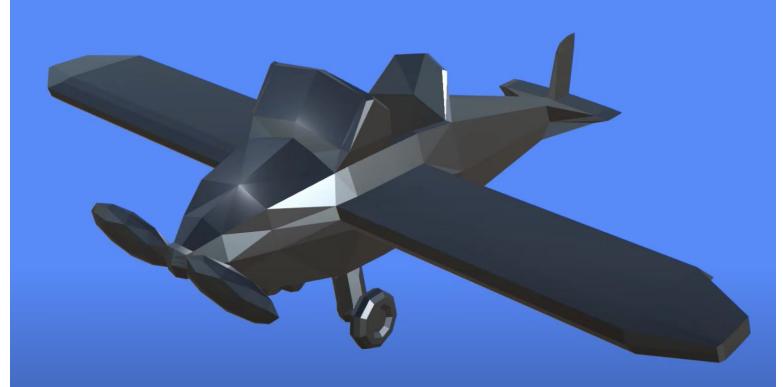
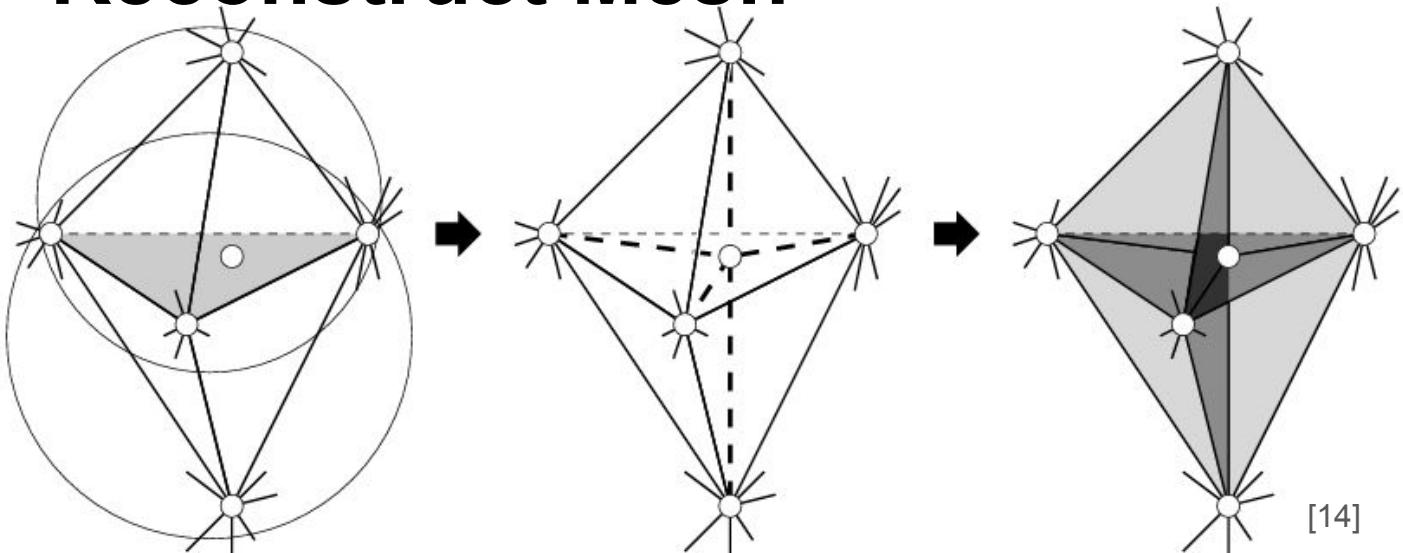


[13]



Design/Methods - OpenMVS (cont'd)

- Reconstruct Mesh





Data/Results - Doors Data

- 17 images of a door with an Aruco Marker

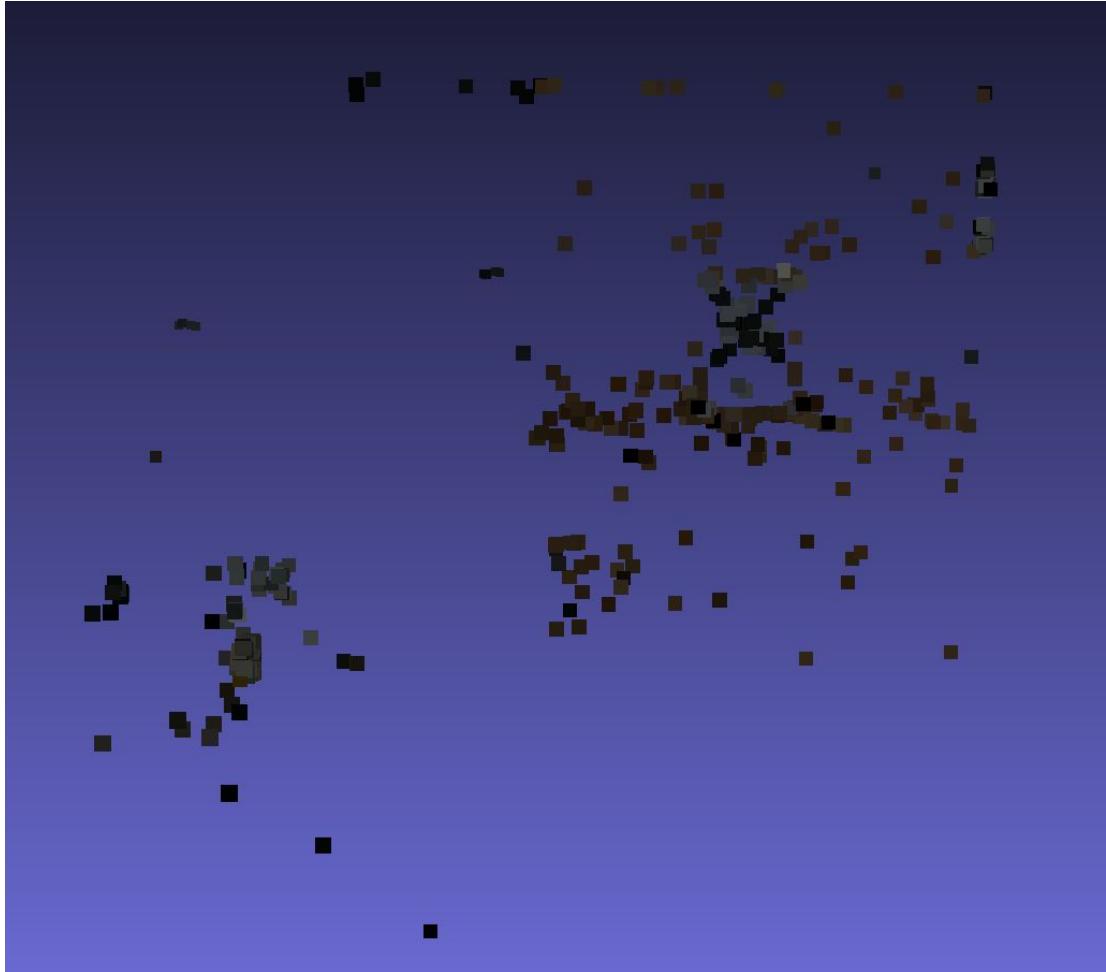


[16]

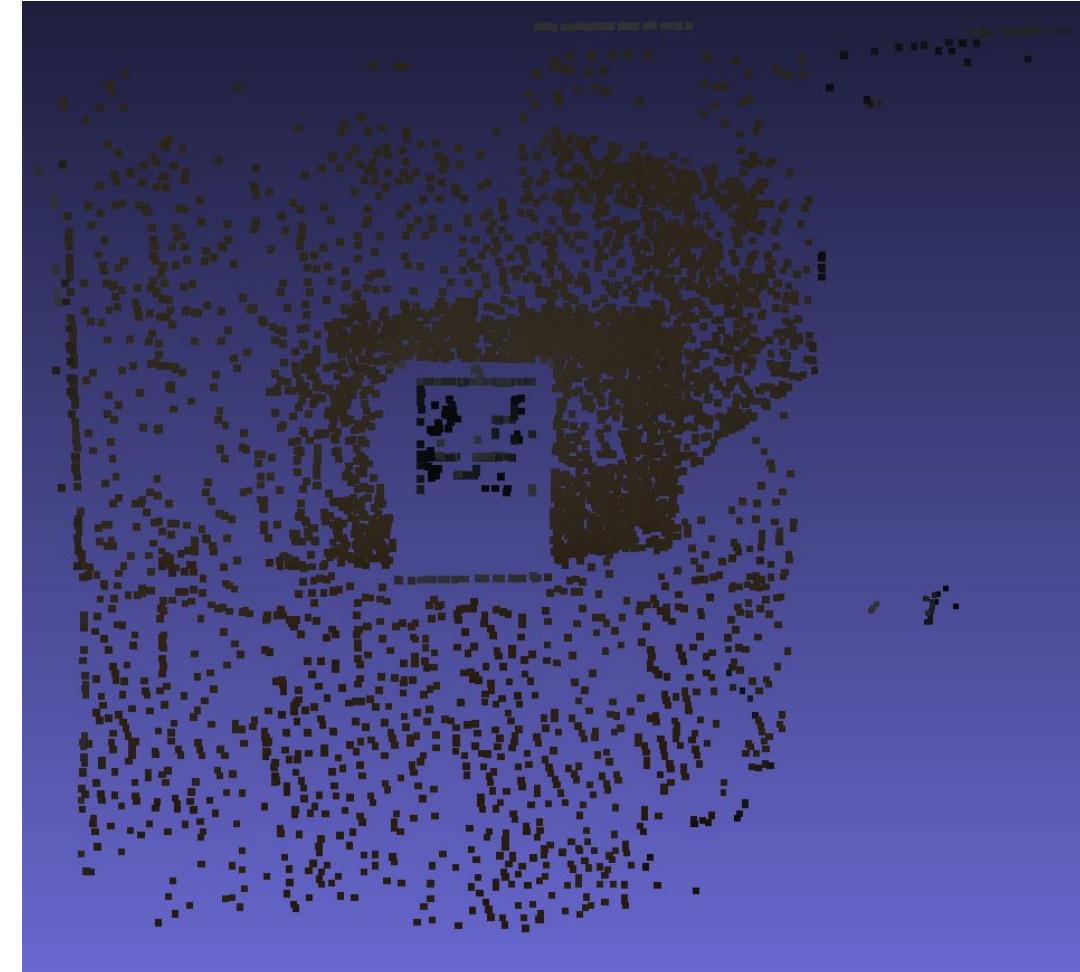


Data/Results - Doors Data (cont'd)

- COLMAP Output



VGGSSfM Output



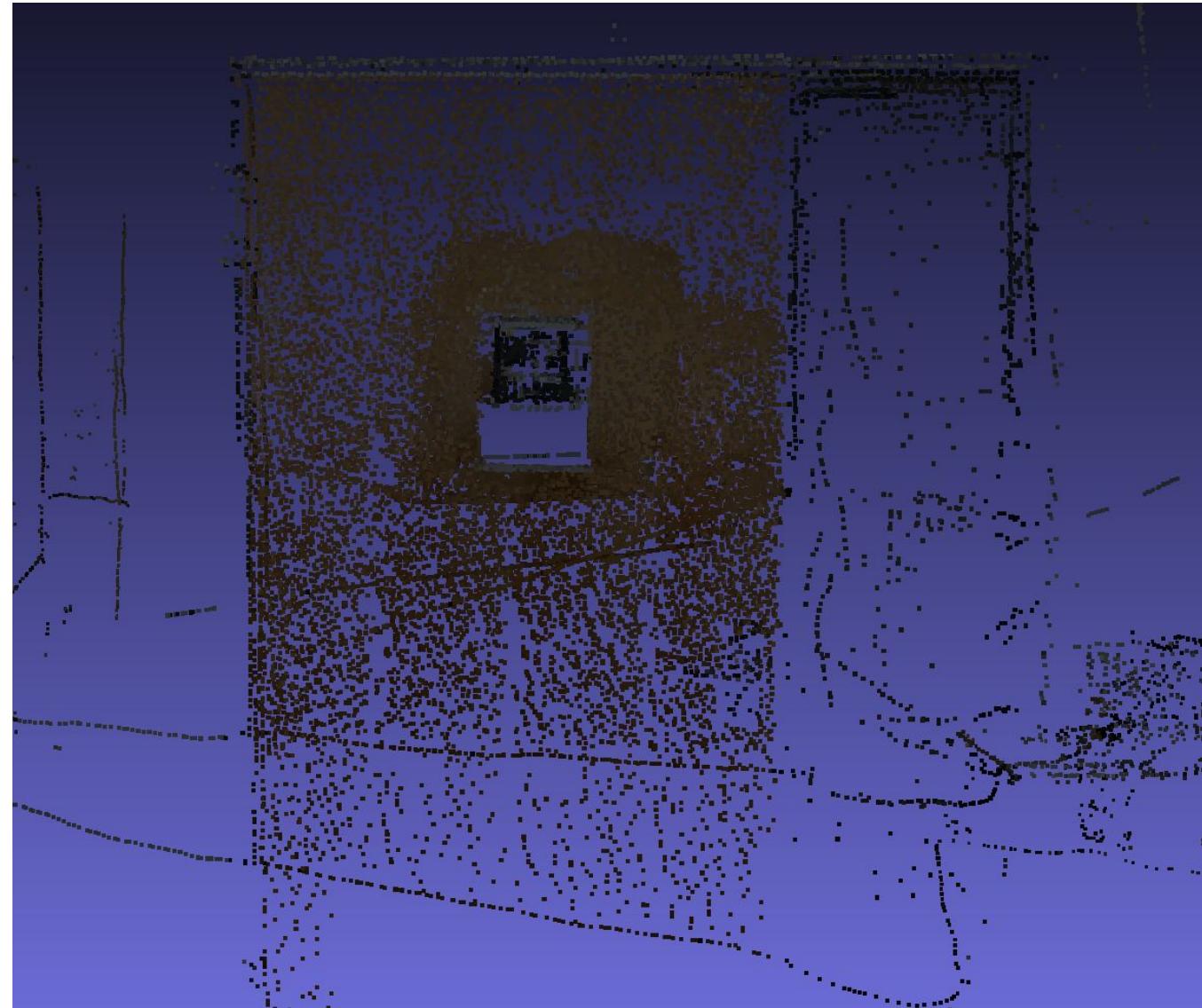


Data/Results - Doors Data (cont'd)

- VGGT Output
- 33,282 Vertices



[16]





Data/Results - Panama Coral

- Initial Image set, 18 images

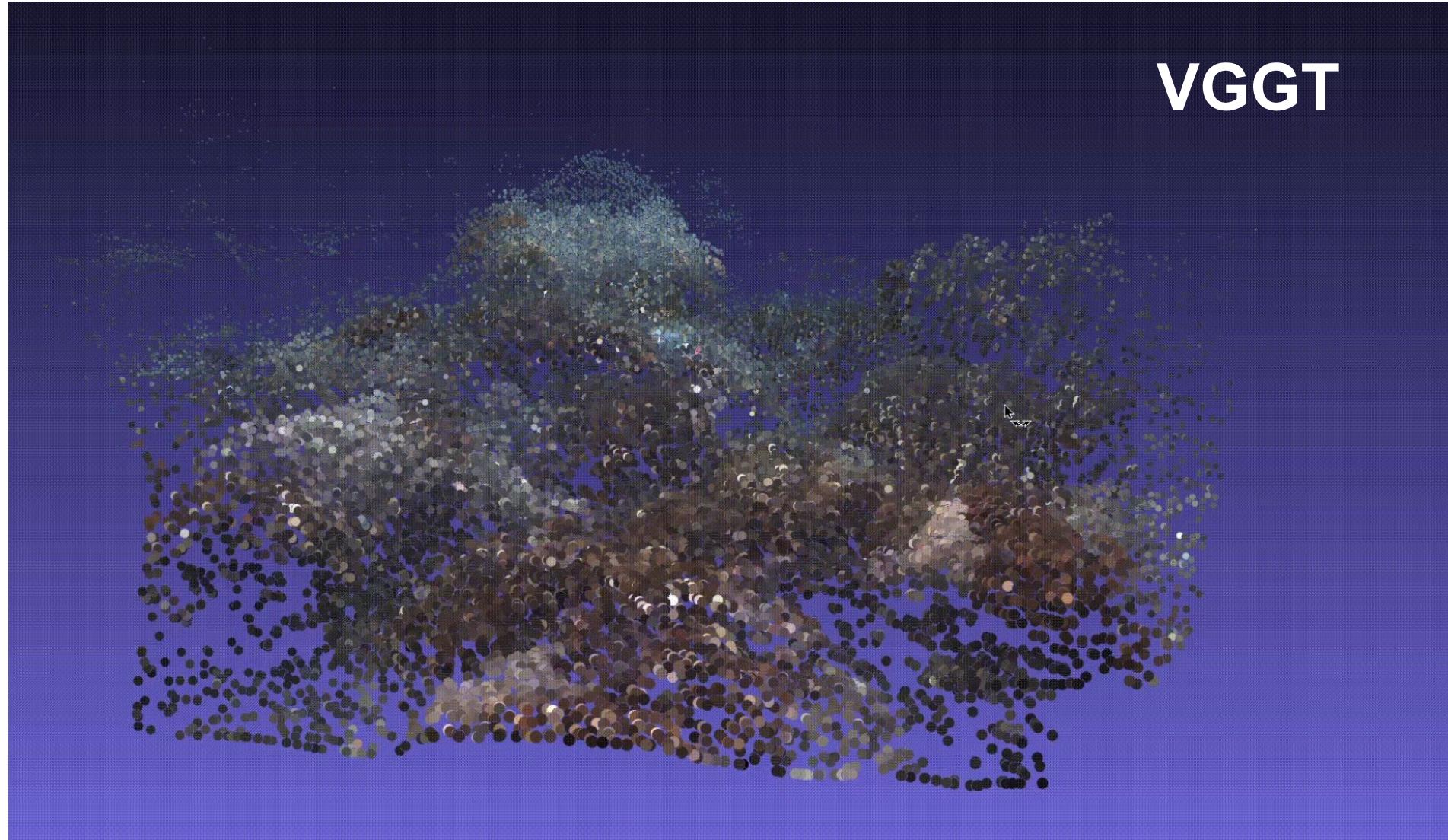


[17]

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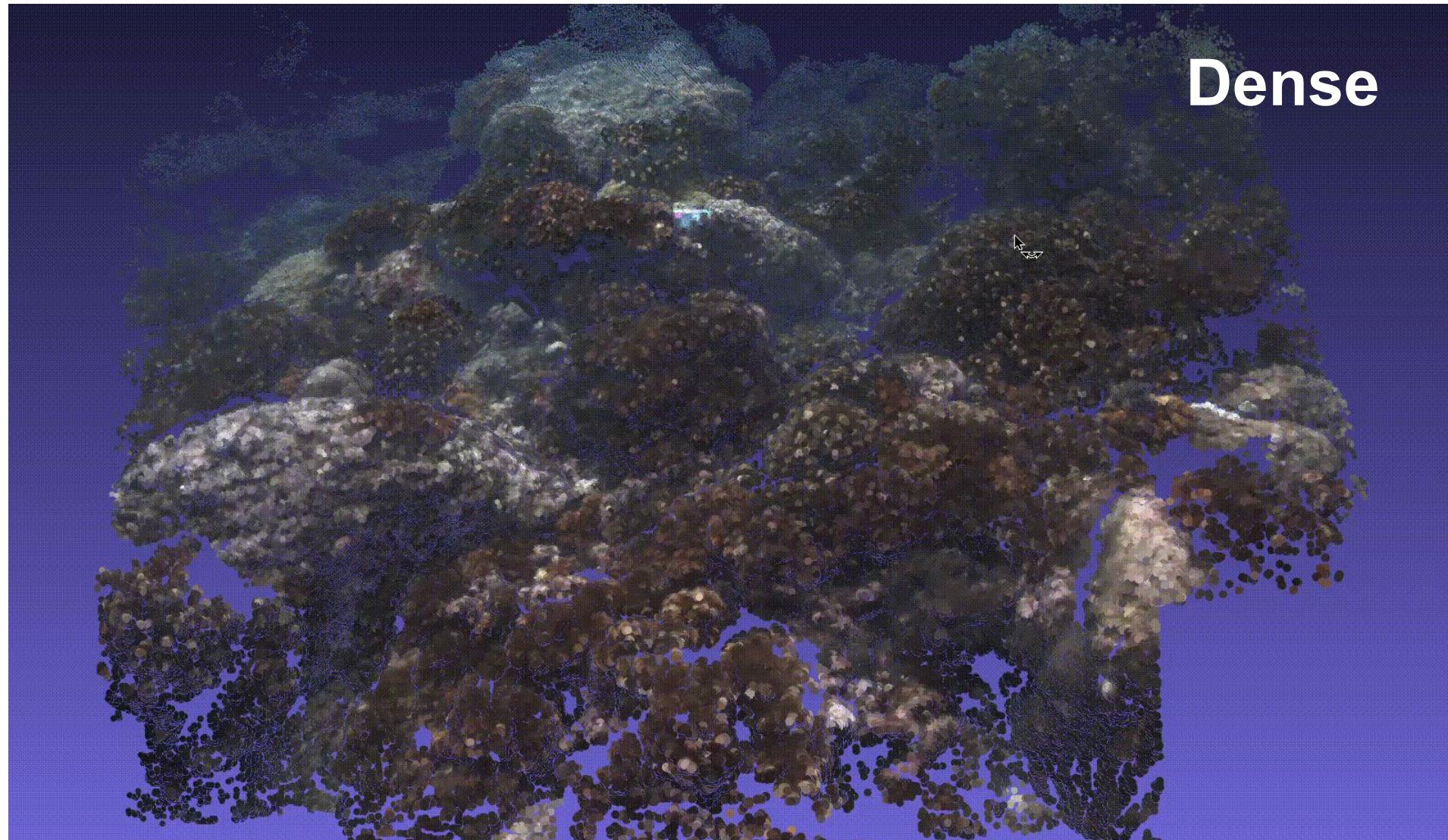


Data/Results - Panama Coral (cont'd)





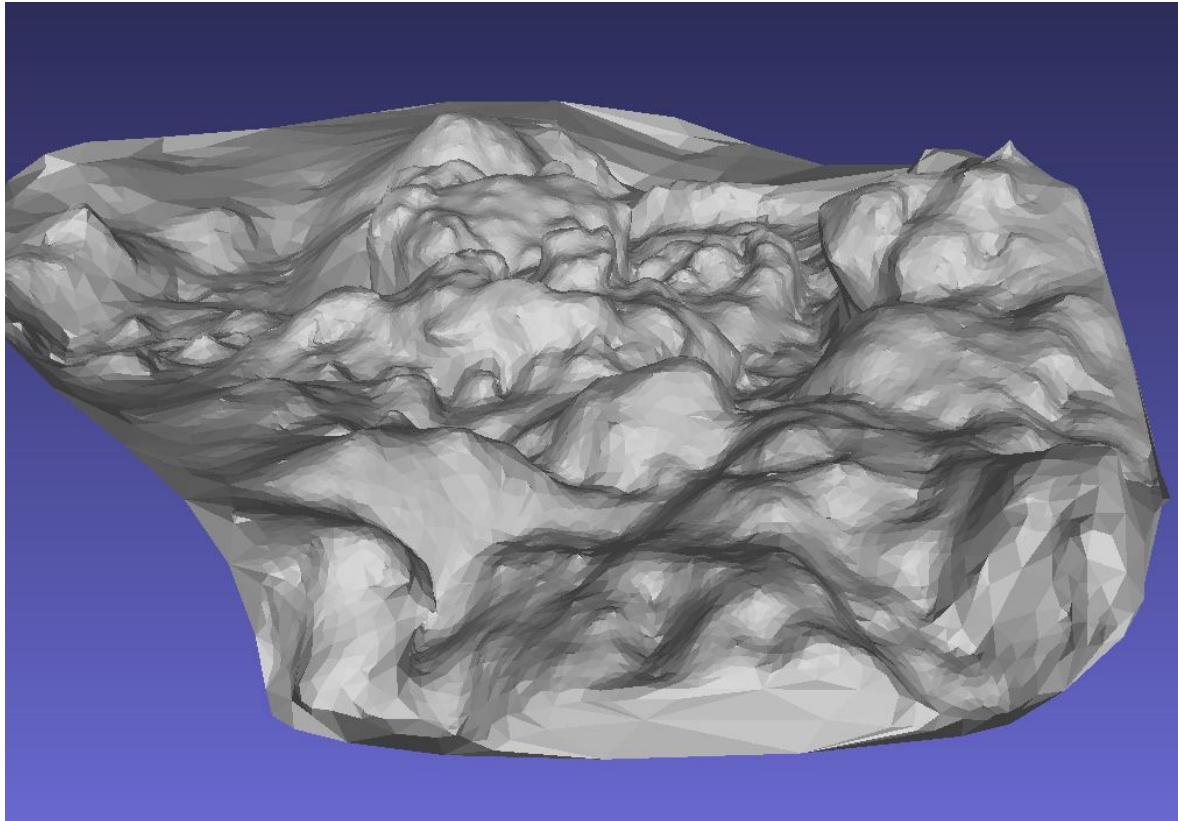
Data/Results - Panama Coral (cont'd)



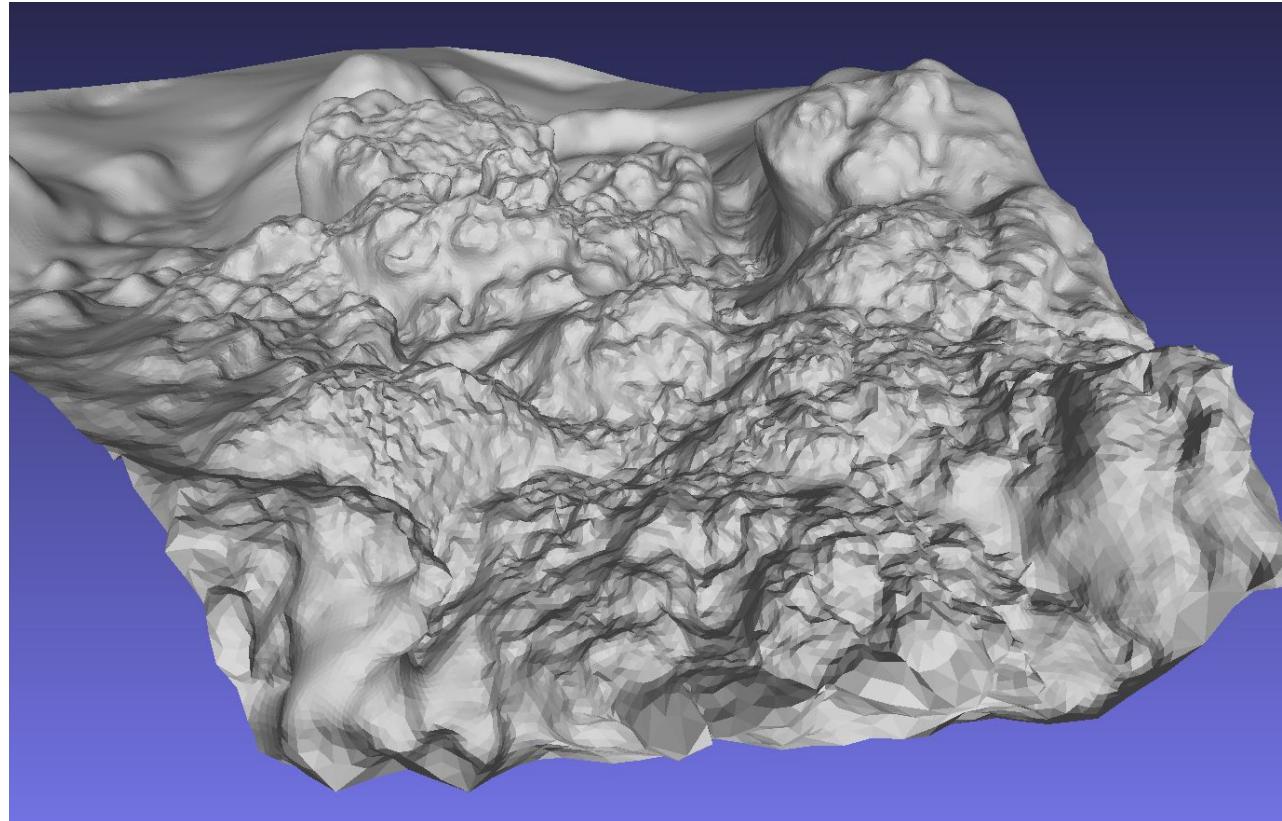


Data/Results - Panama Coral (cont'd)

Initial Mesh

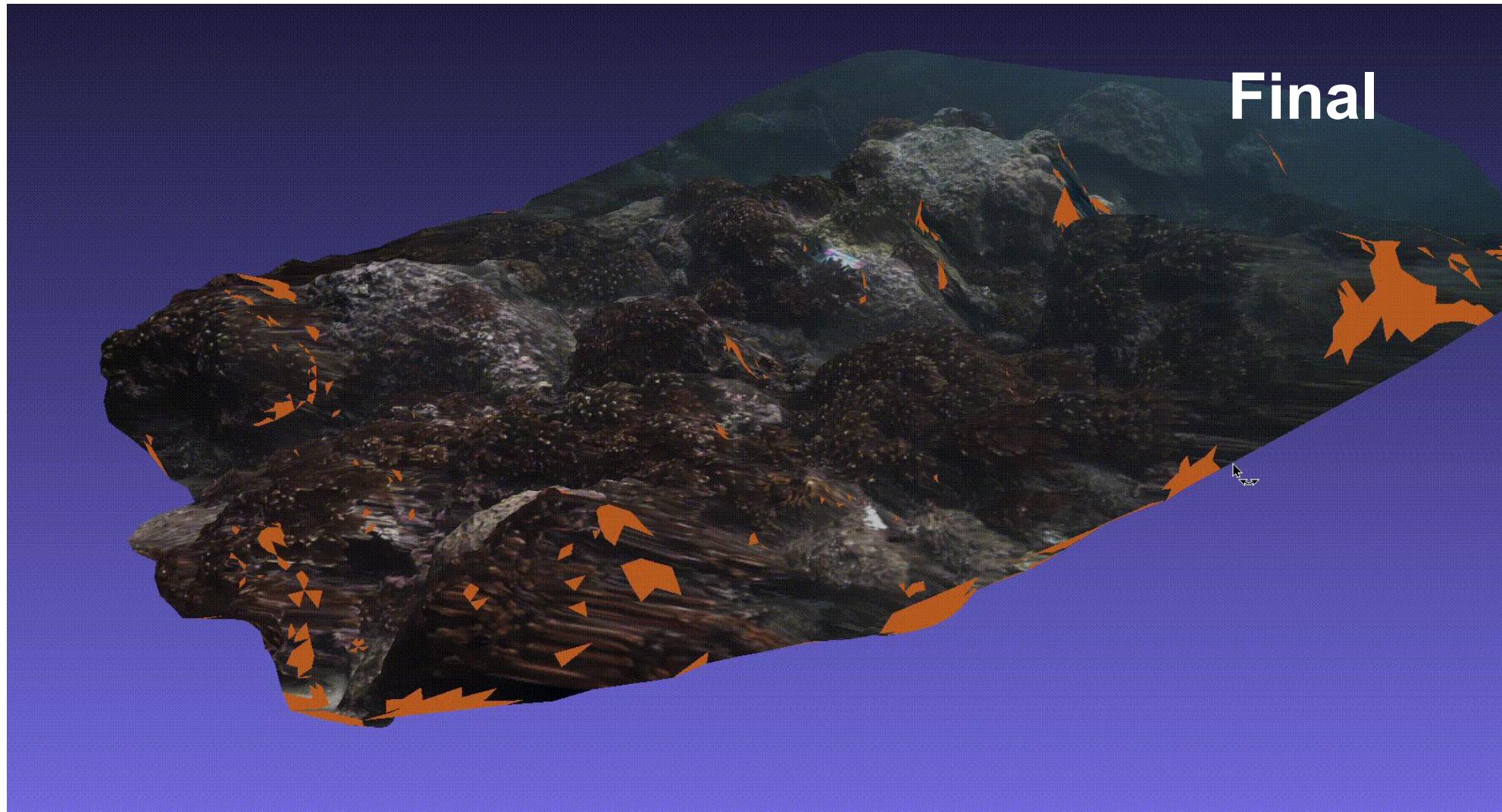


Mesh Refinement





Data/Results - Panama Coral (cont'd)





Data/Results - Panama Coral (cont'd)





Discussion & Conclusions - Issues

- Outdated documentation OpenMVS
- Bleeding Edge VGGT
- Out of Memory on Narwhal in SfM



[18]

The screenshot shows a GitHub repository named "vgggt" which is public. The commit history is as follows:

Commit	Description	Date
jytime	Update composed_dataset.py	c6bf698 · yesterday
docs	provide details to inst...	4 months ago
examples	Initial commit	4 months ago
training	Update composed_da...	yesterday
vggt	fix wrong comments	last week

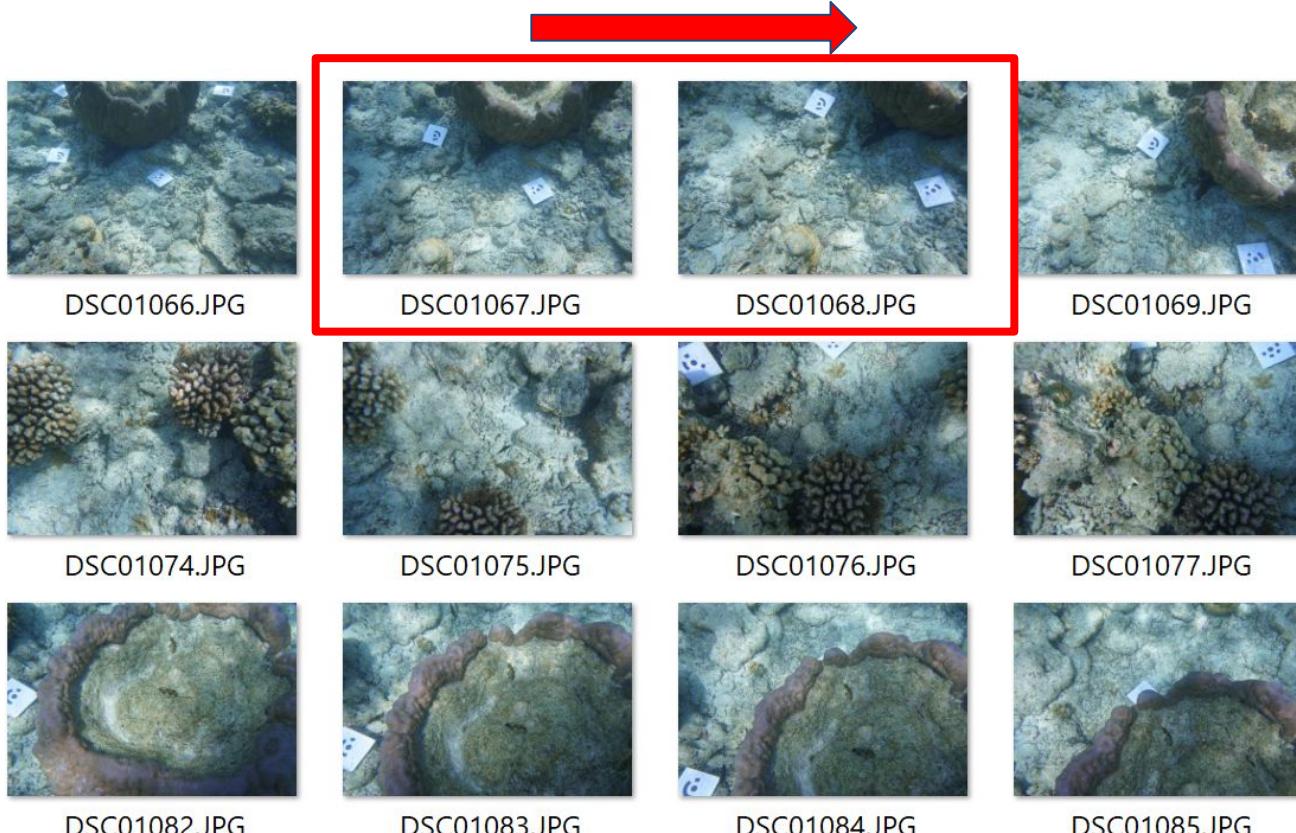


[19]



Discussion & Conclusions - Forward

- Solve Out of memory issue
- Capture Geometric info
- Volumetric data over time

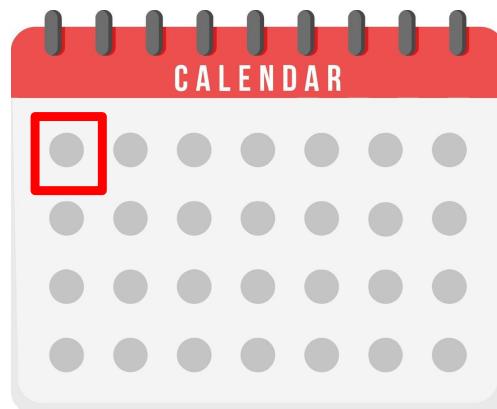
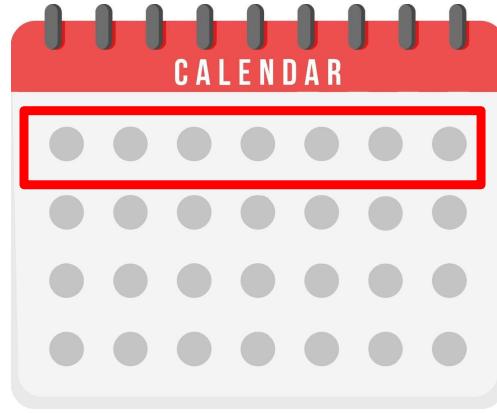


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Discussion & Conclusions - Impact

- Efficiently & reliably & evaluate impact of Navy activity
- Aid in efforts to protect Coral Reefs





Acknowledgments

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- Oak Ridge Institute for Science and Education (ORISE)
- Mentor - Jeffrey S. Ellen, Ph.D. (jeffrey.s.ellen.civ@us.navy.mil)



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