

Depth map fusion in the presence of vibrations

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Outline

1. Objectives
2. Data presentation
3. Our solution
4. Results
5. Discussion
6. Future work



1. Objectives

Fuse multiple depth-maps for:

- increased resolution
- populating missing data
- noise reduction



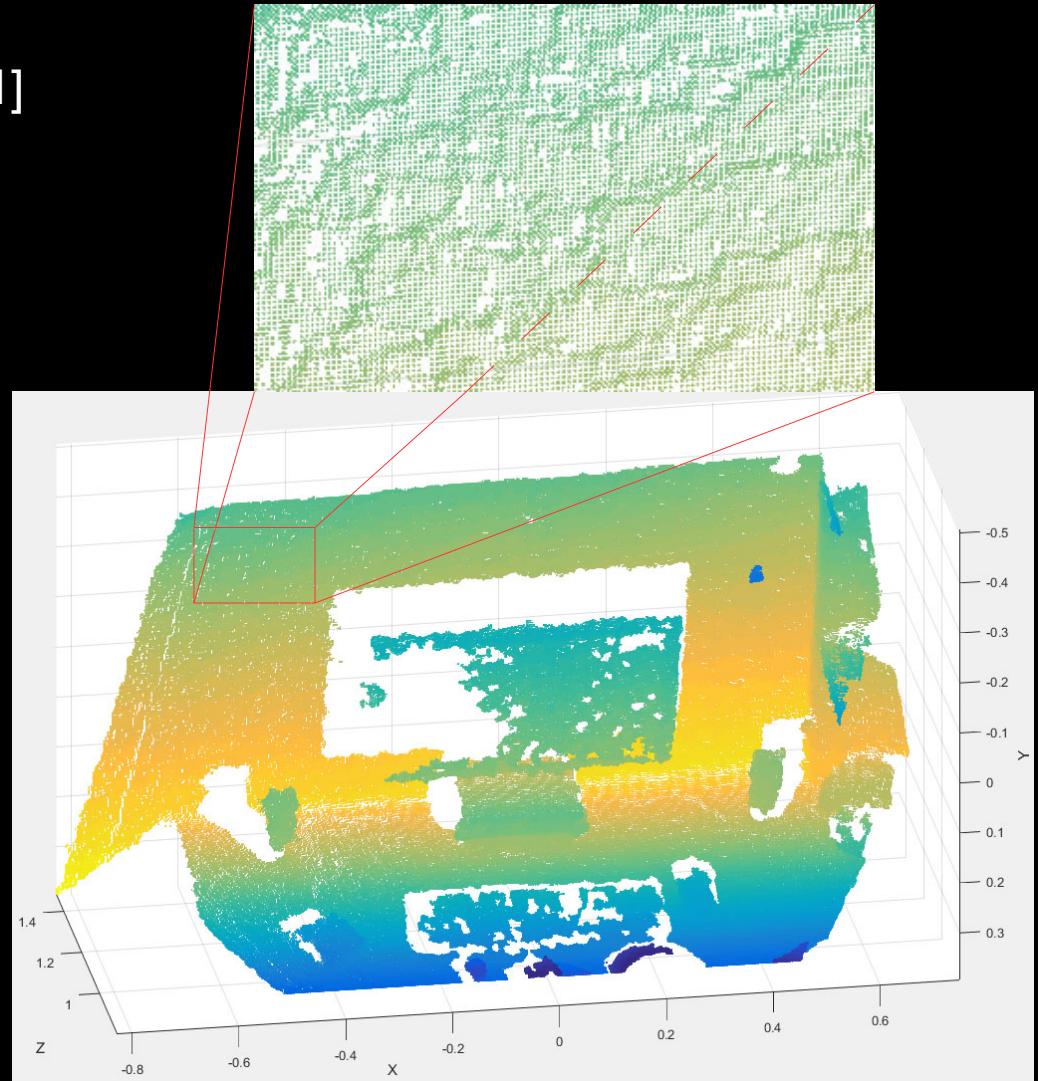
2. Data presentation



640x480 pixels (color)
320x240 pixels (depth)

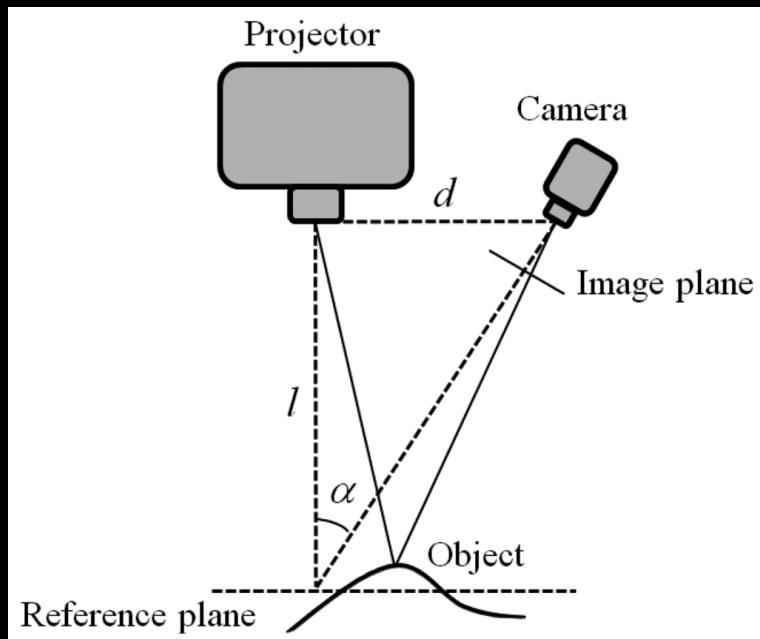
→ noisy and imprecise
→ but real time!

[1]

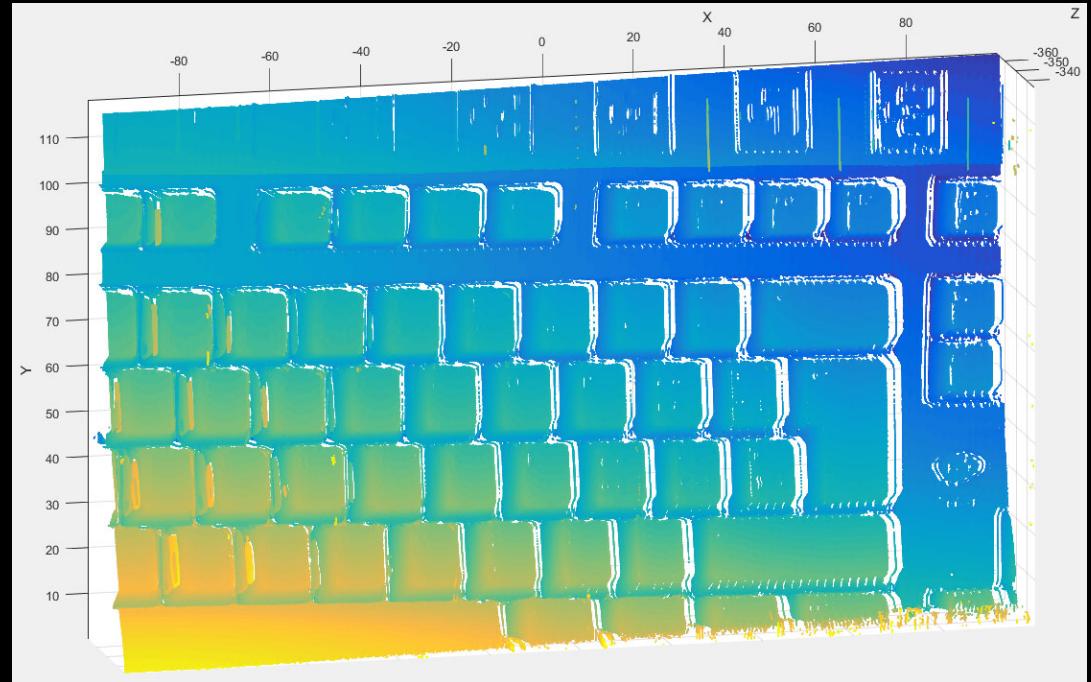


2. Data presentation

Proj. 1920x1080
Cam. 4752x3168



[2]

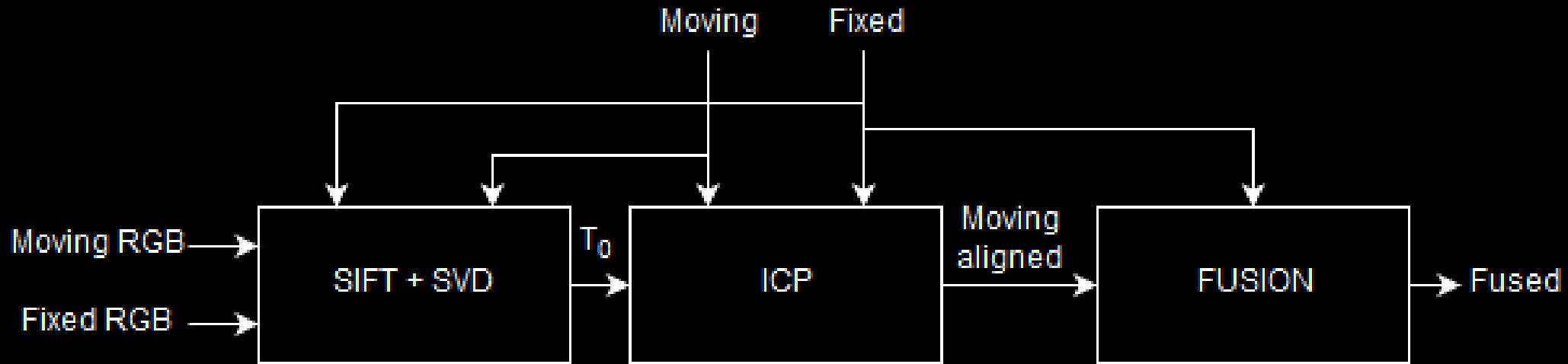


Camera / projector pair

→ lengthy calibration
→ lengthy capture!

Final presentation

3. Our solution



1. SIFT inliers
2. ICP
3. Fusion with:

- union of points (increases noise), or
- box grid filter (decreases resolution)



3. Our solution - algorithms

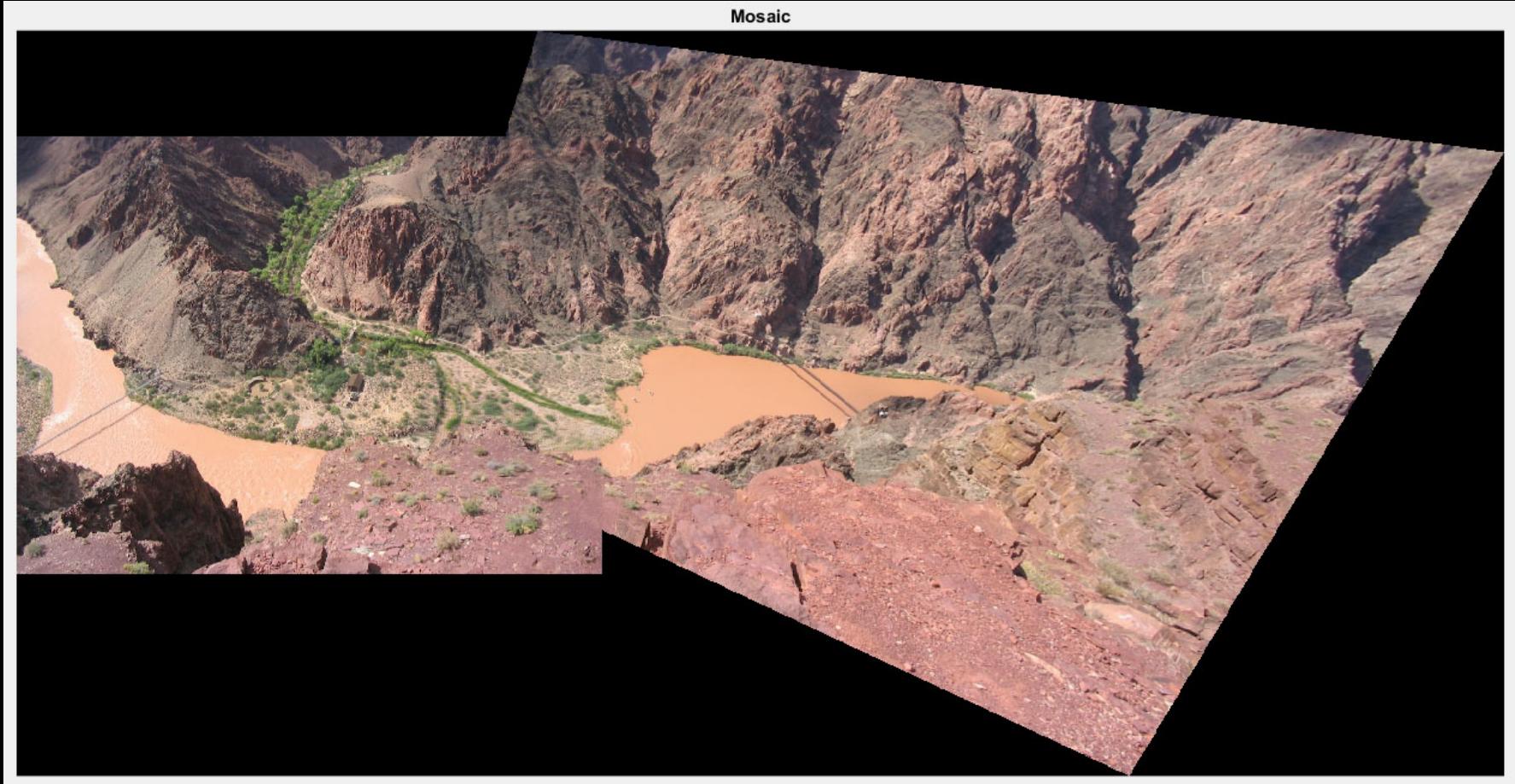
$$E(T_{g,k}) = \sum_{\substack{\mathbf{u} \in \mathcal{U} \\ \Omega_k(\mathbf{u}) \neq \text{null}}} \left\| \left(T_{g,k} \dot{V}_k(\mathbf{u}) - \hat{V}_{k-1}^g(\hat{\mathbf{u}}) \right)^T \hat{N}_{k-1}^g(\hat{\mathbf{u}}) \right\|_2$$

Iterative Closest Point (ICP)_[3,4]

→ finds transform that minimizes E



3. Our solution - algorithms

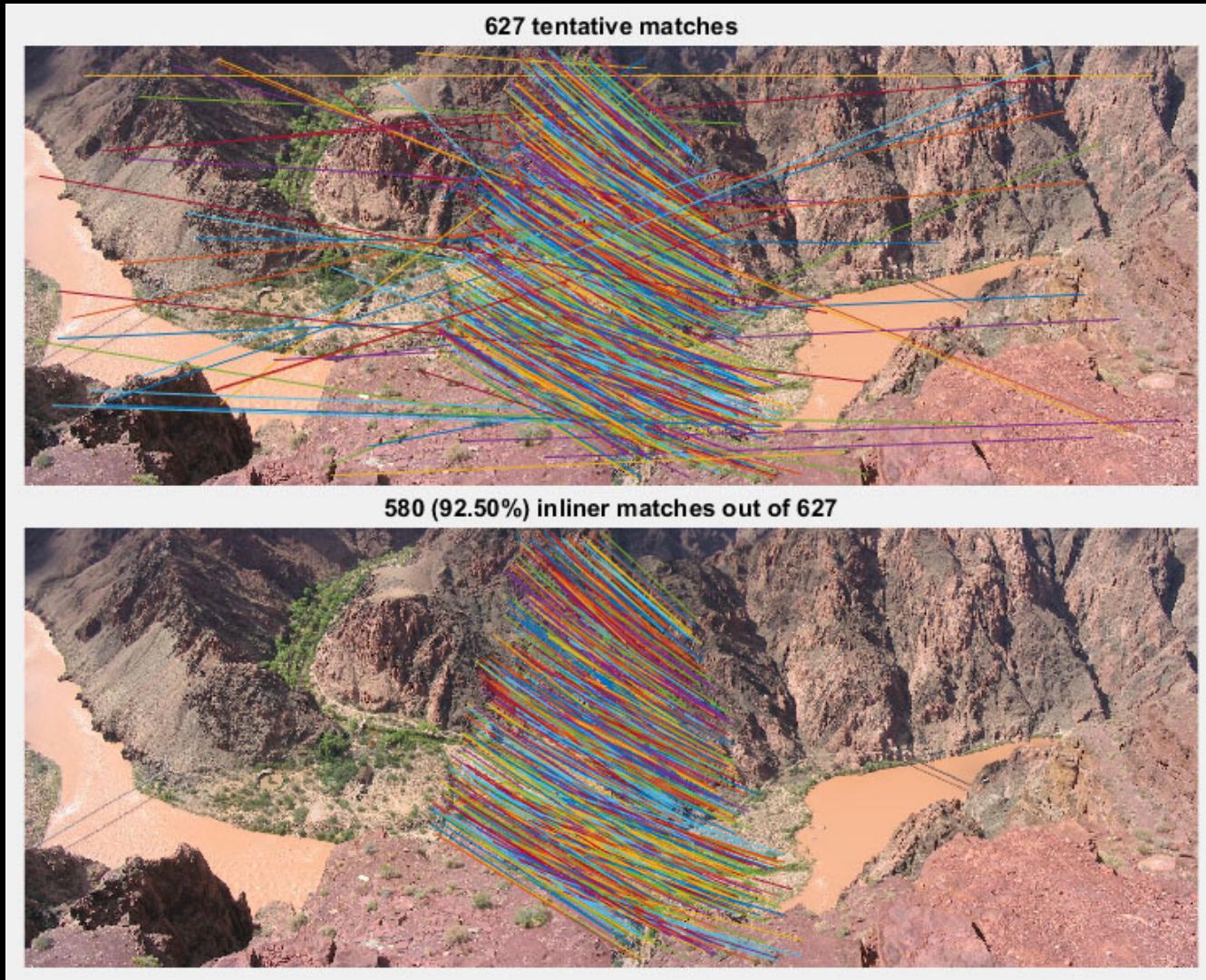


SIFT



Final presentation

3. Our solution - algorithms

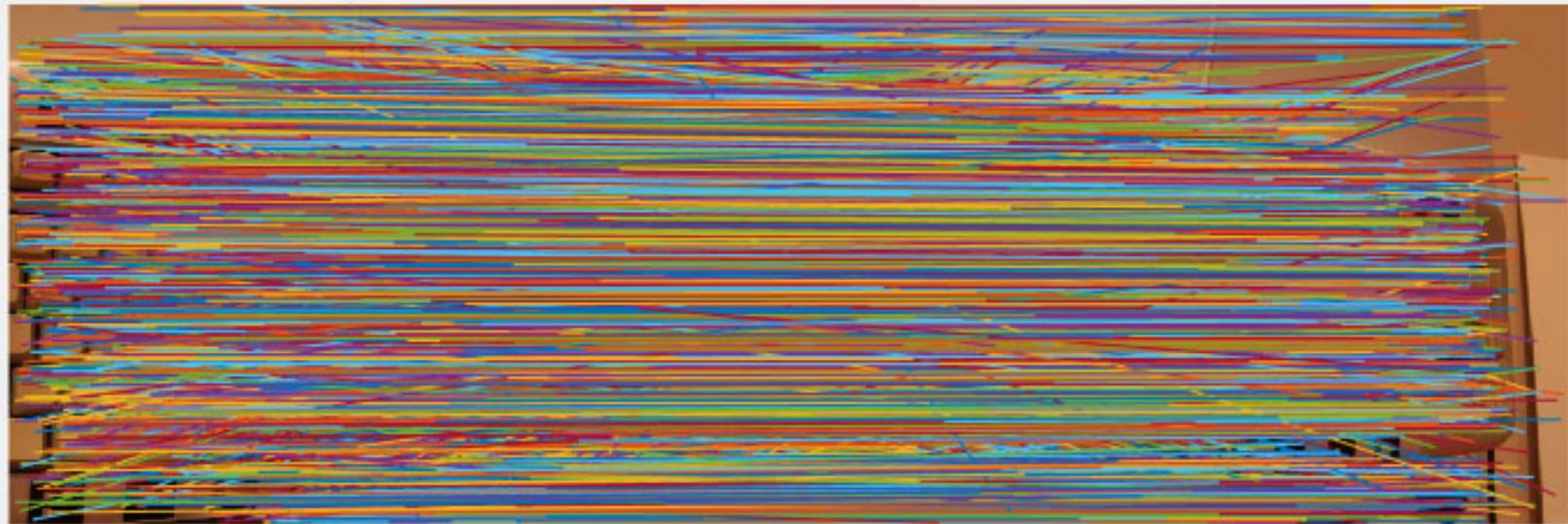


4. Results



Final presentation

4703 tentative matches



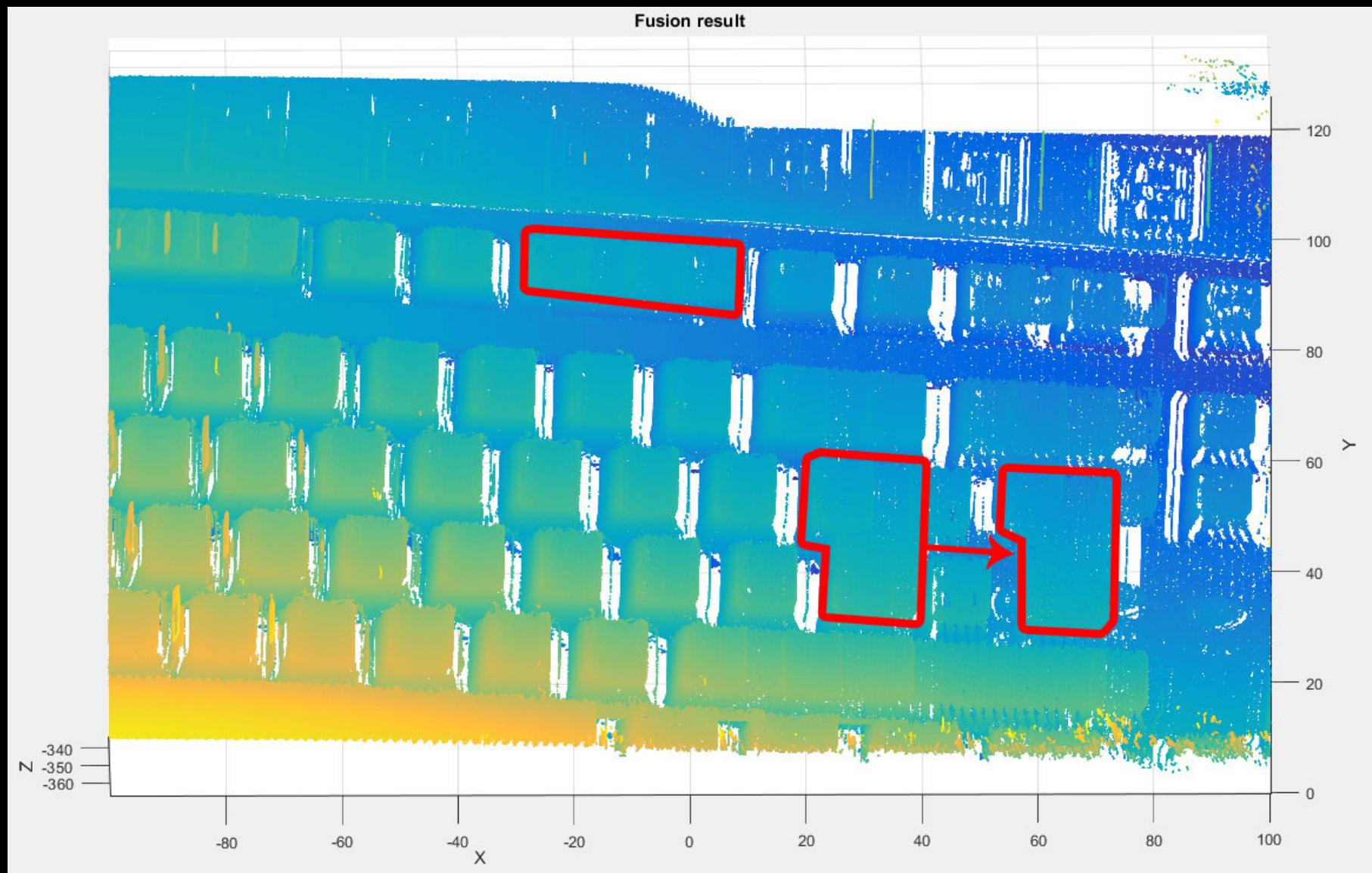
1740 (37.00%) inliner matches out of 4703



Mosaic

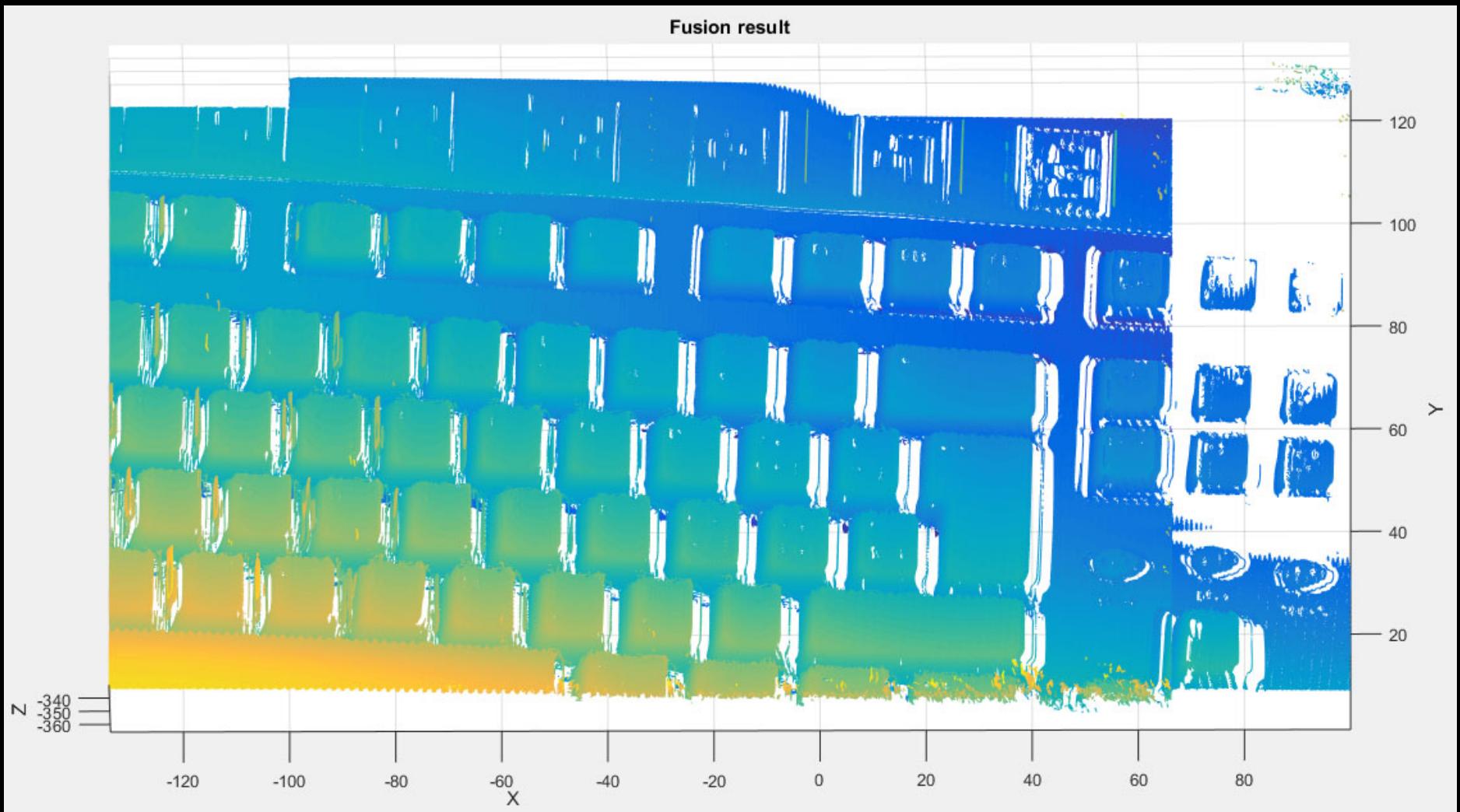


Final presentation



ICP without SIFT...



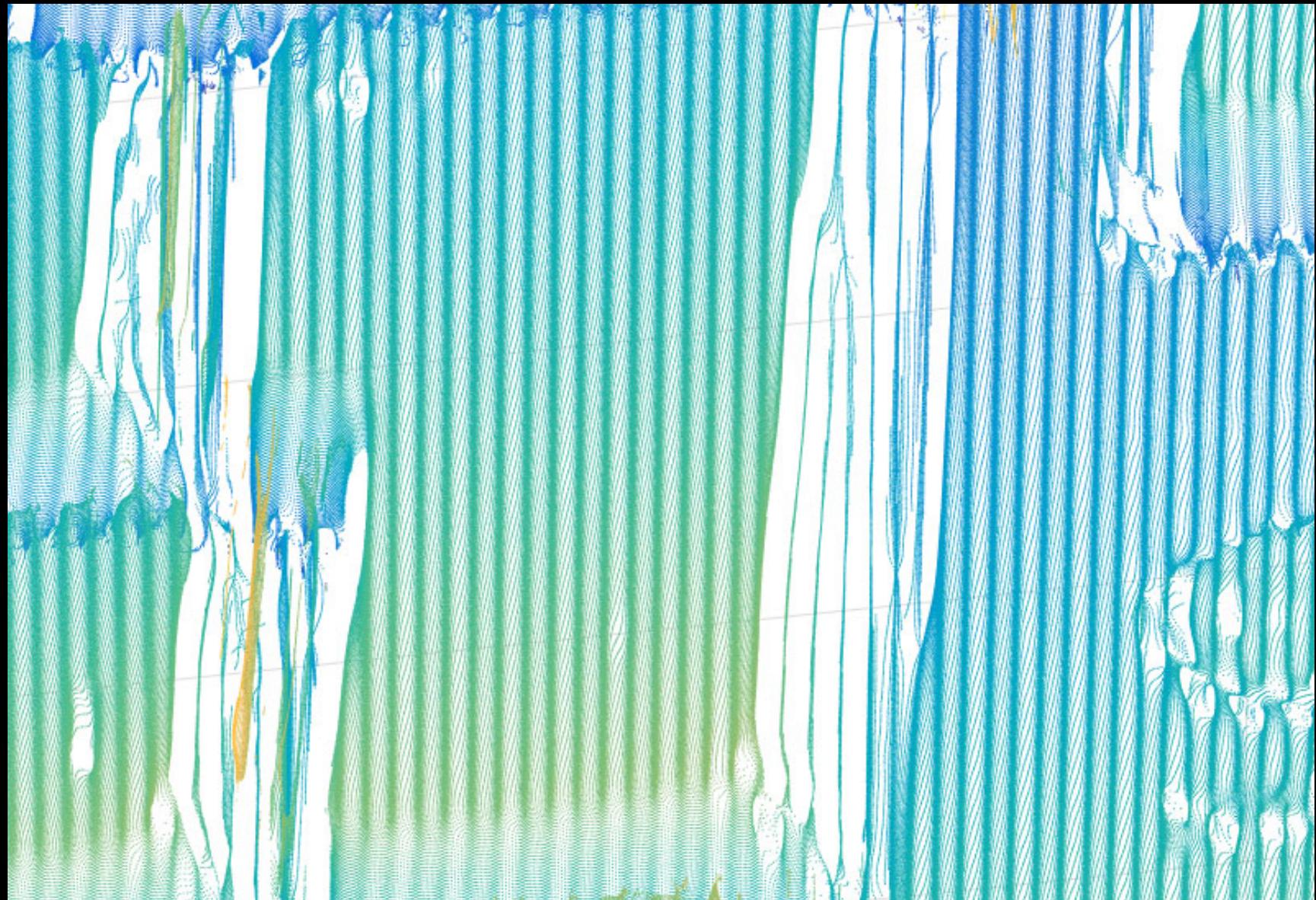


ICP with SIFT!



Final presentation

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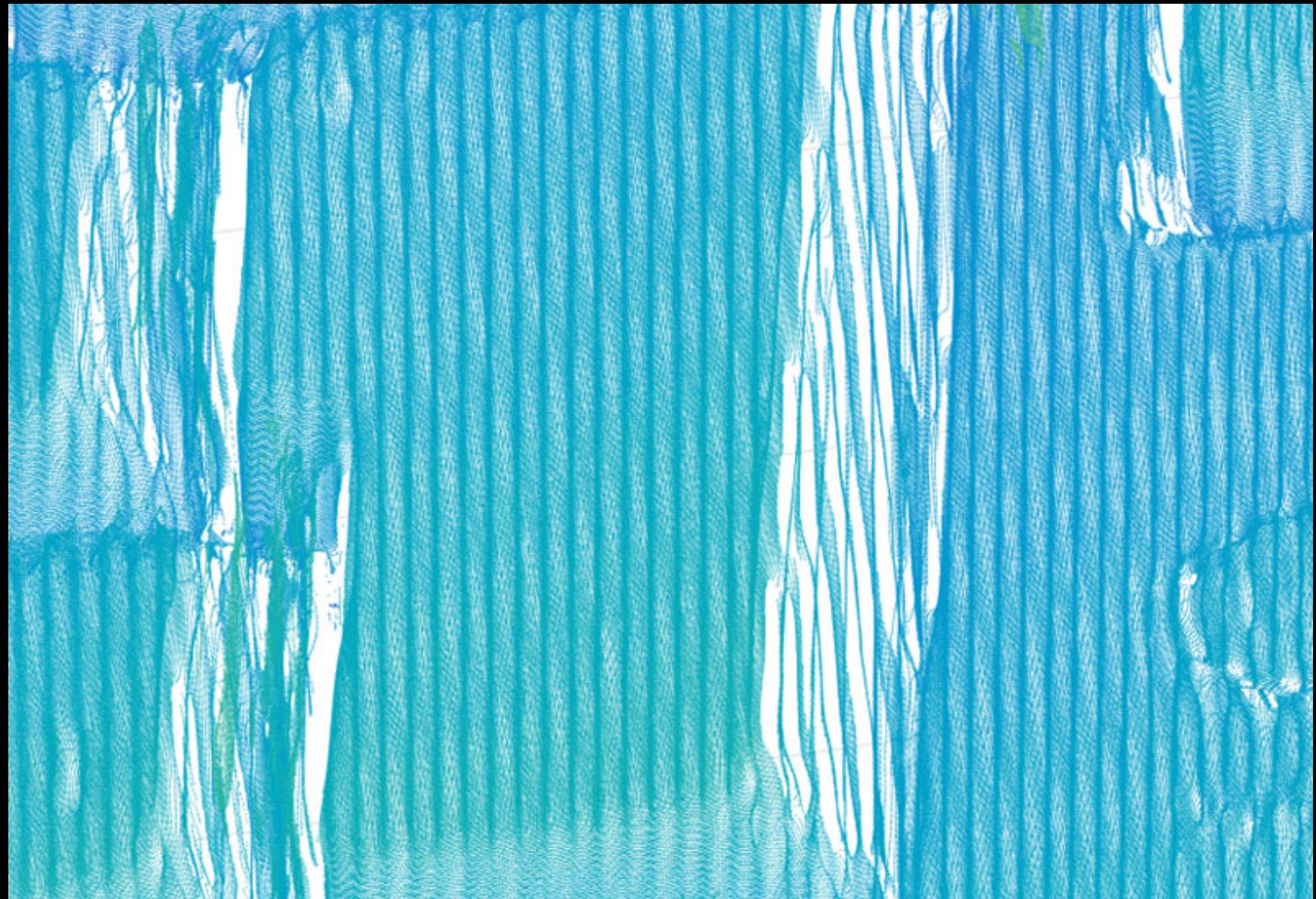


Stitching small pieces together



Final presentation

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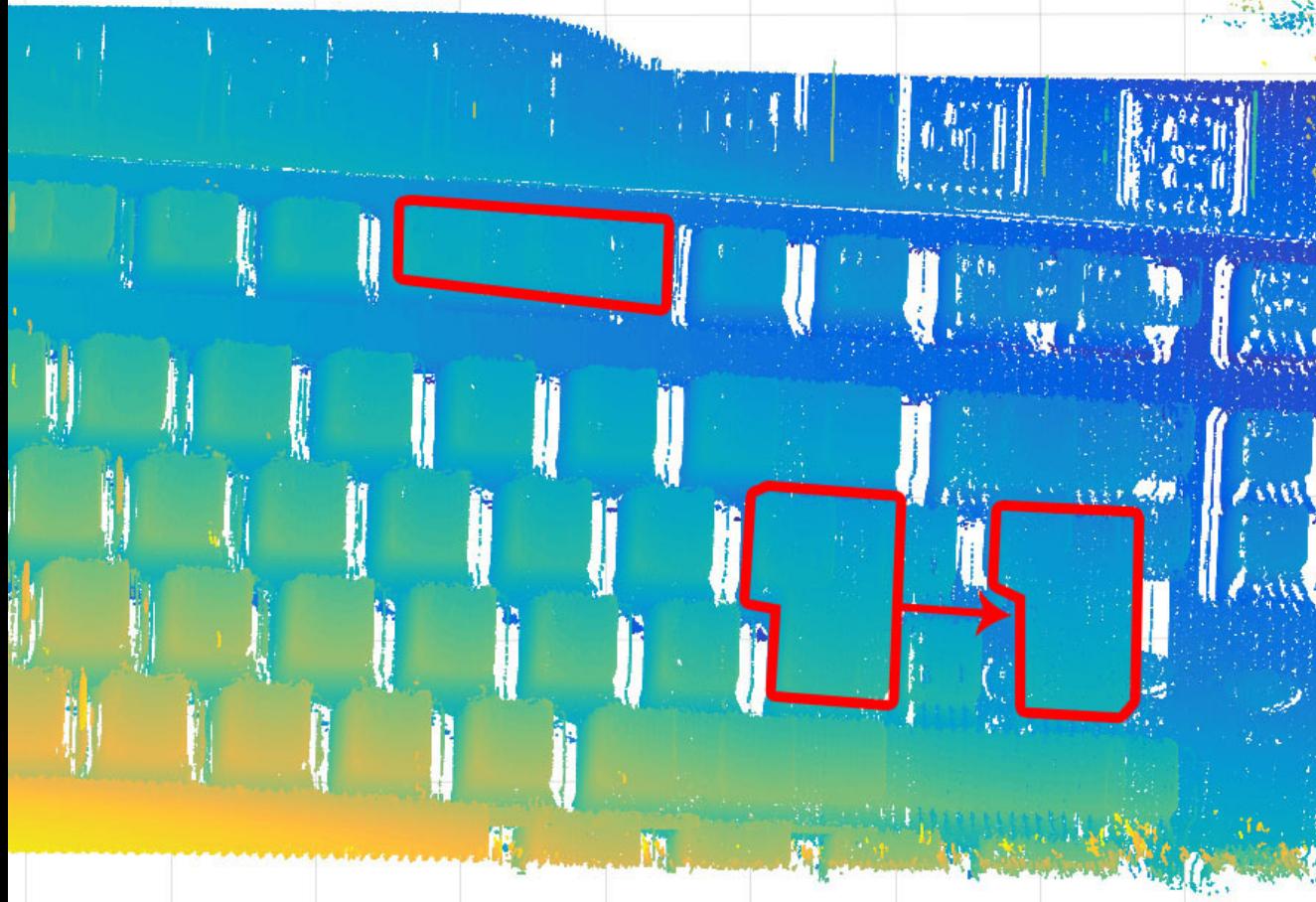
Stitching: after fusion



Final presentation

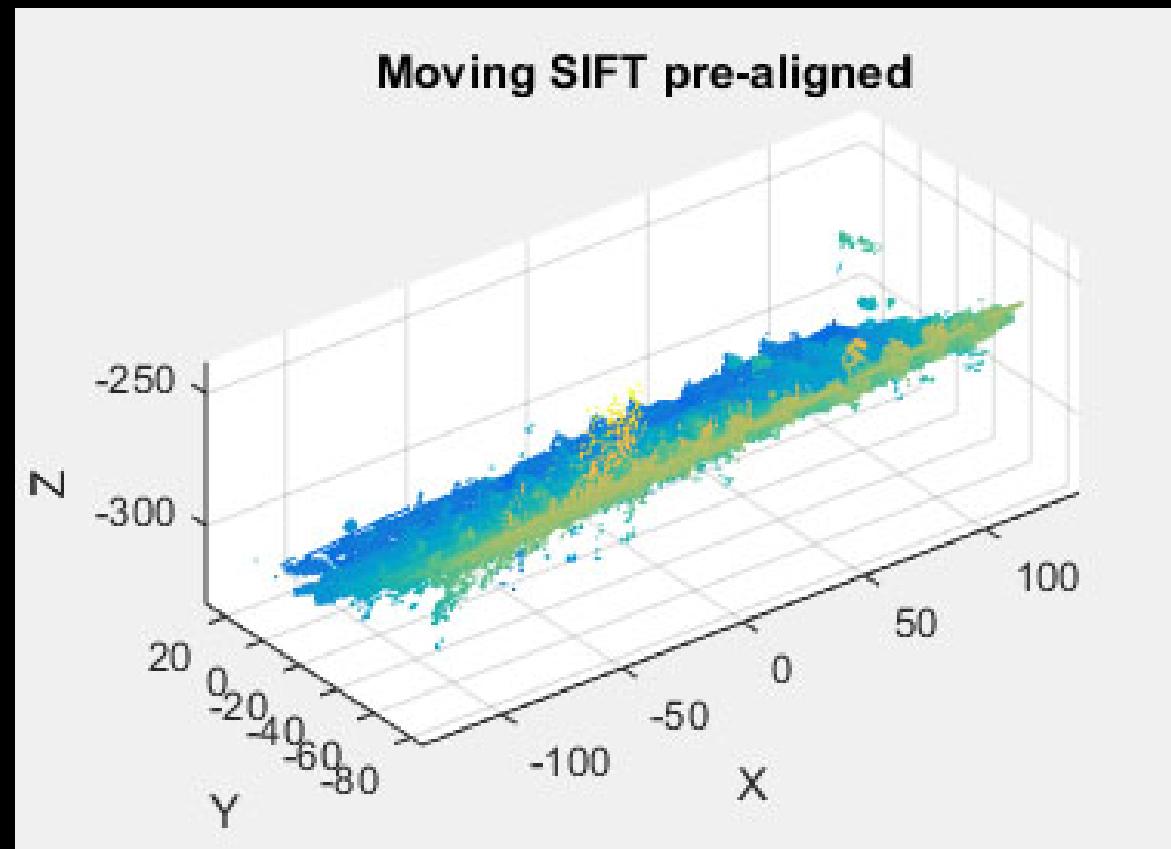
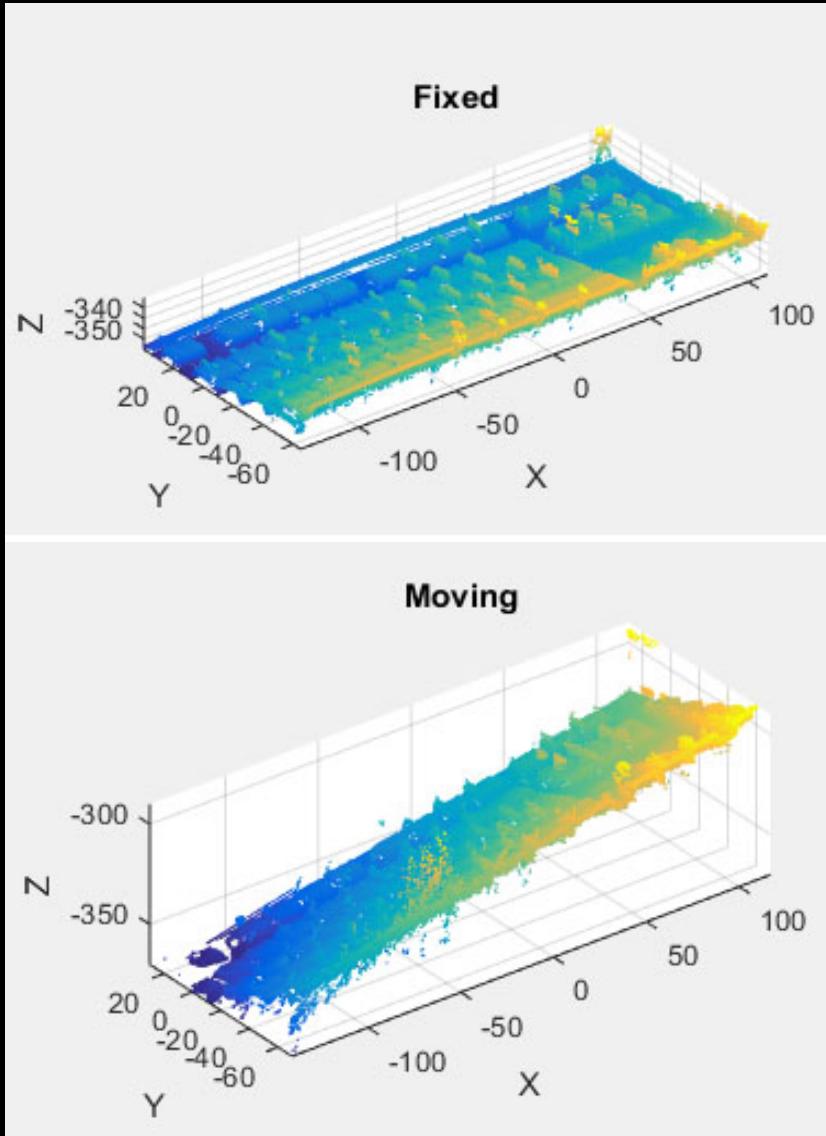
16

5. Discussion



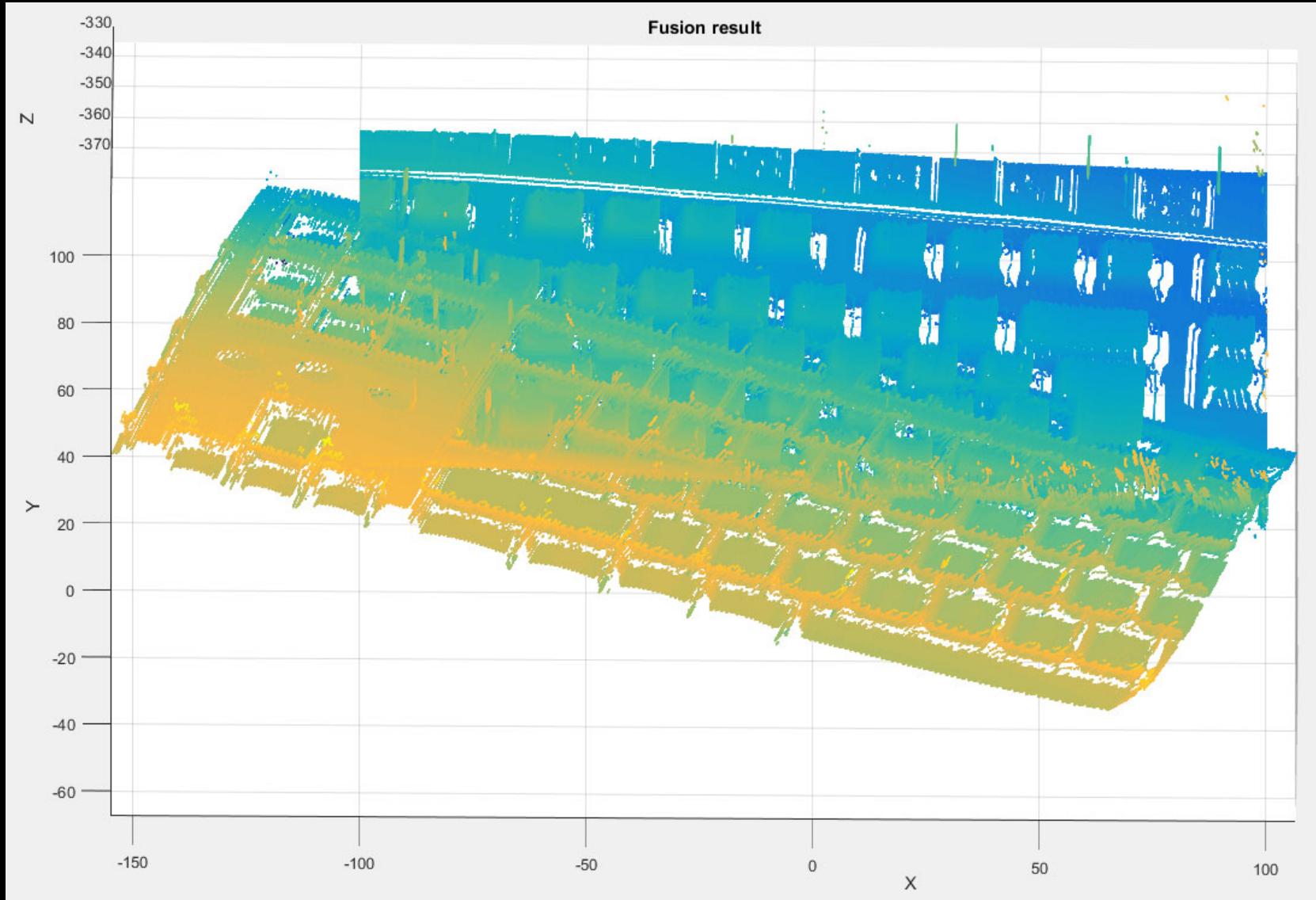
ICP falls in local minimum





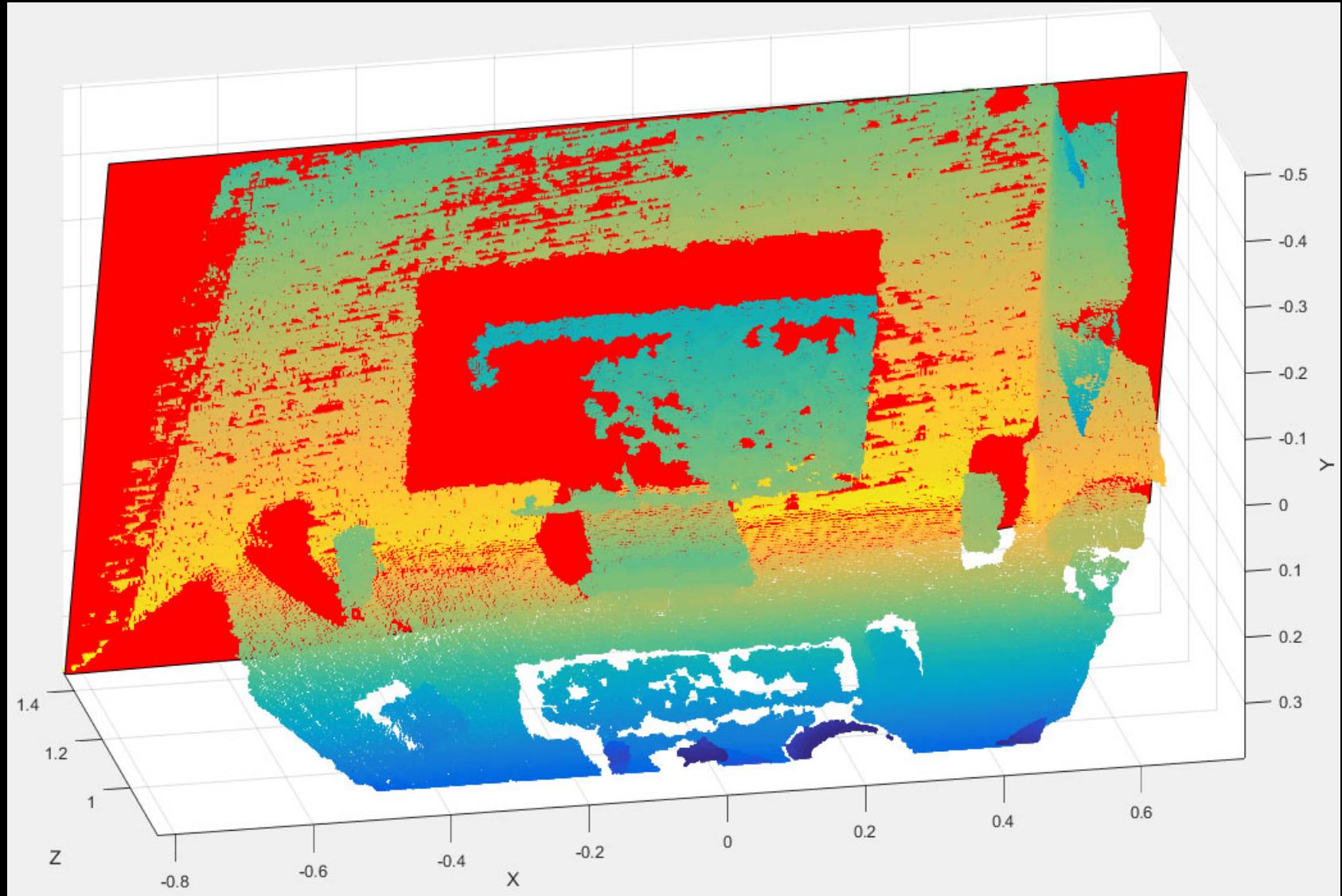
SIFT estimate not robust enough





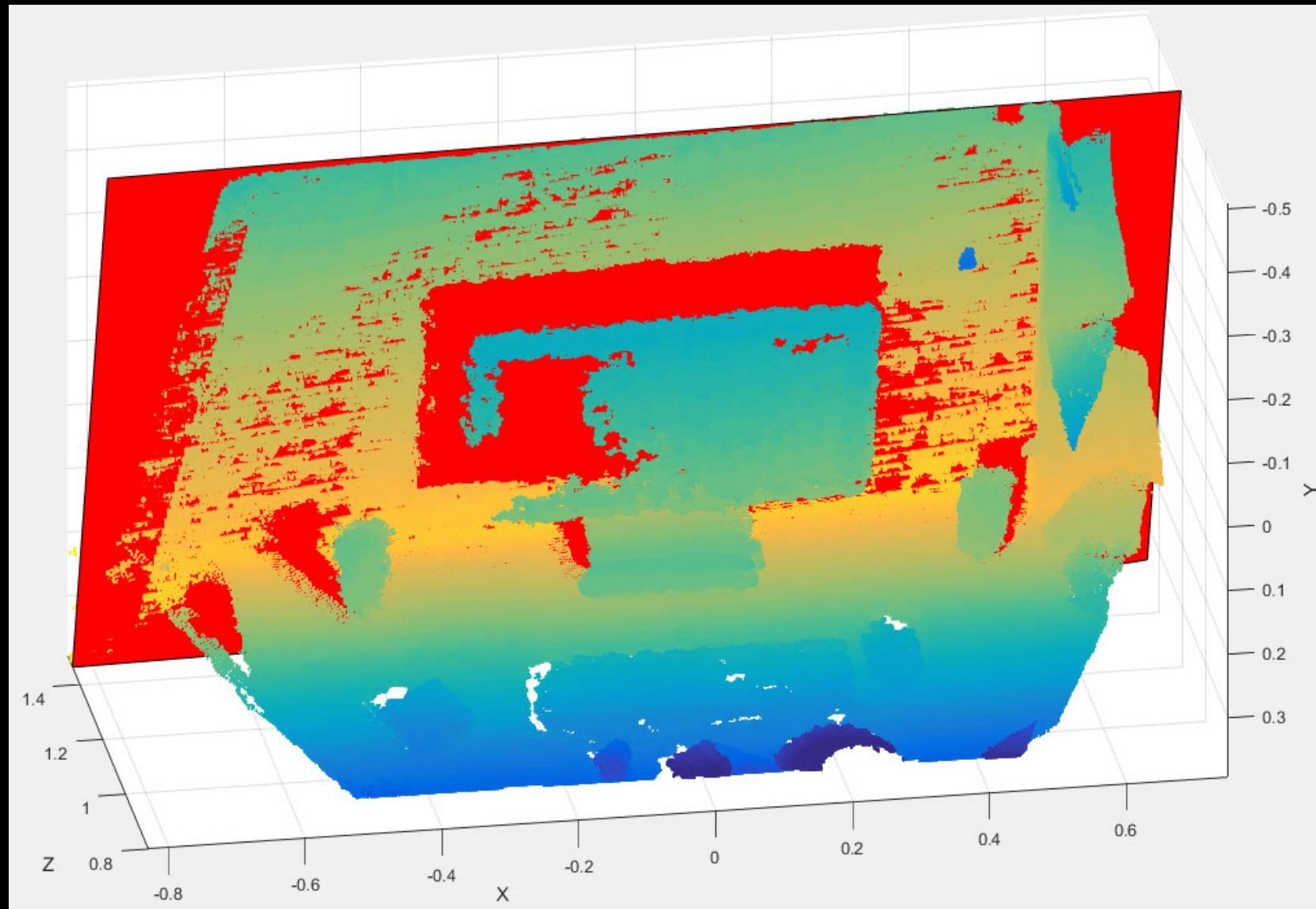
SIFT + ICP not powerful enough





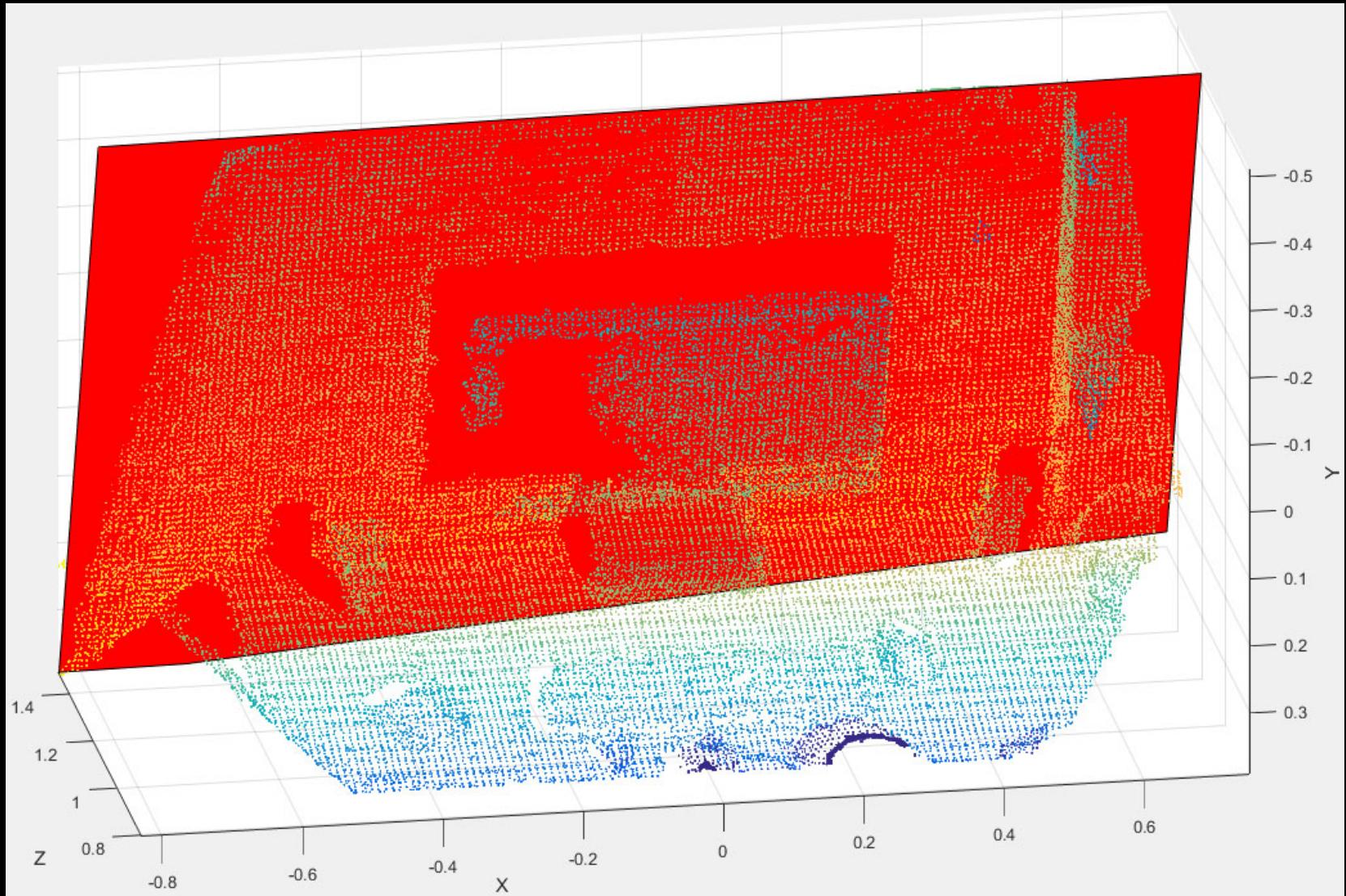
RMSE (mm) = 0.499





RMSE (mm) = 0.465, but...





Downsampling → sparse point cloud



6. Future work

- use SIFT-variant for depth internally in ICP for better correspondences
- extend to multiple (not only 2 views) fusion



References

- [1] IGN <http://www.ign.com/articles/2015/01/01/microsoft-to-discontinue-original-kinect-for-windows>
- [2] *A Coded Structured Light System Based on Primary Color Stripe Projection and Monochrome Imaging*, Barone S., et al., 2013
<http://www.mdpi.com/1424-8220/13/10/13802/htm>
- [3] *KinectFusion: Real-Time Dense Surface Mapping and Tracking*, Newcombe R., et al., 2011
<https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/ismar2011.pdf>
- [4] *A Method for registration of 3-D Shapes*, Besl P., McKay N., 1992
<http://dl.acm.org/citation.cfm?id=132022>



Questions?

