Supplementary Materials

Project Report - Machine Learning for 3D Geometry

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1. Introduction

This supplementary material provides additional visual examples for our project report Point-Set Alignment Using Weak Labels.

1.1. Methods

In Figure 1 we depict the main problem our project tries to solve. Aligning a well estimated head point cloud to a human shaped point cloud is already solved by probabilistic based rigid registration methods like FilterReg [1]. However, aligning a badly estimated head point cloud to a human shaped point cloud becomes challenging.

1.2. Data

In Figure 2 we show an entire point cloud of our test dataset with the estimated SMPL [2] mesh model for each person. The head of the SMPL mesh model of the left person is estimated quite good, whereas the head of the right person's mesh model is estimated badly. The resulting point clouds are seen in Figure 1.

In Figure 6 we depict the head segment of the estimated SMPL [2] model. We crop the point cloud according to a bounding box (denoted in white) around the estimated head. The better a SMPL mesh model is estimated, the smaller the bounding box can be chosen. This would improve transformations, however, if a mesh model is estimated badly, a small bounding box could crop out the points of the target's head. A sequence of these crops is shown in Figure 4.

1.3. Evaluation

In Figure 5 we show example results of the registration on the different datasets (please note they may not be representative for the performance overall and are picked for illustrative purpose). In Figure 7 we show how we evaluate our methods using 2D face bounding boxes as ground truth for quantitative evaluation. The detections, denoted by the red boxes, are generated by drawing a rectangle around the rendered mesh.

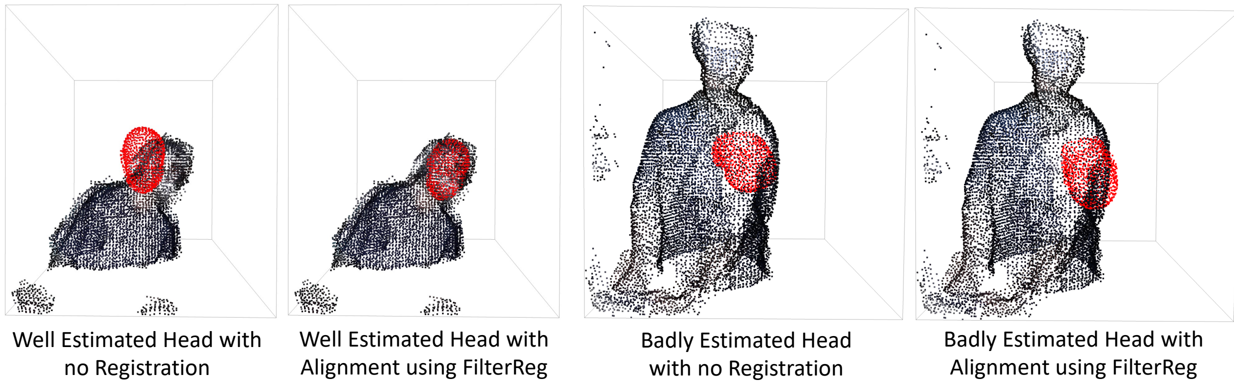


Figure 1. Illustration of the main problem we try to solve. The left side shows an already well estimated head point cloud (red) and a target point cloud (human shaped). Probabilistic based methods like FilterReg [1] perform good on well estimated heads. The right side shows a badly estimated head. Using FilterReg the resulting alignment is inadequate.

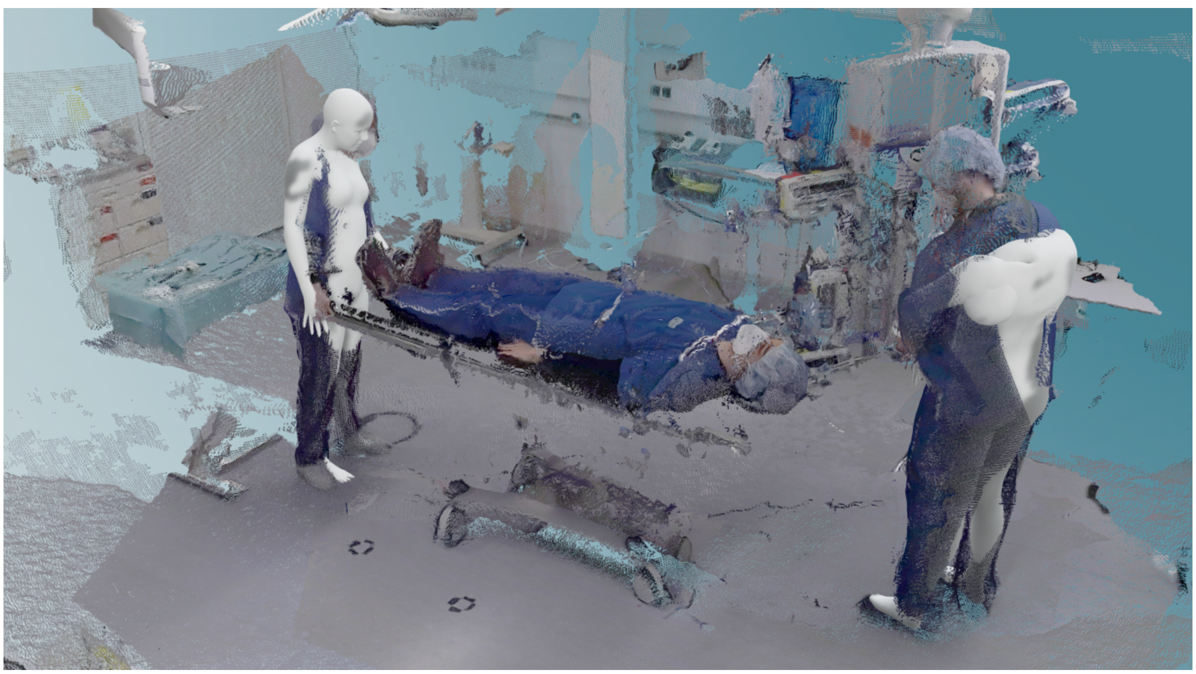


Figure 2. Point cloud of the entire OR scene from our test dataset with estimated SMPL [2] models. Note that the head of the left mesh is aligned quite good, the head of the right mesh is estimated poorly.

References

[1] Wei Gao and Russ Tedrake. Filterreg: Robust and efficient probabilistic point-set registration using gaussian filter and twist parameterization. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pages 11095–11104, 2019.

[2] Matthew Loper, Naureen Mahmood, Javier Romero, Gerard Pons-Moll, and Michael J. Black. SMPL: A skinned multi-person linear model. *ACM Trans. Graphics (Proc. SIGGRAPH Asia)*, 34(6):248:1–248:16, Oct. 2015.

Figure 3. Sequence of six frames of imperfect real-world data with in which the operator slightly turns

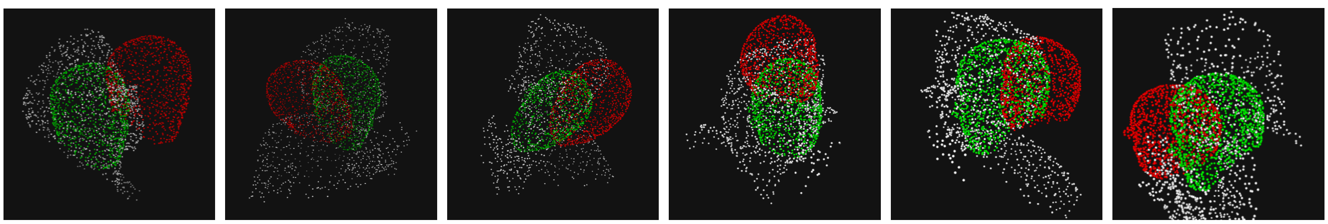
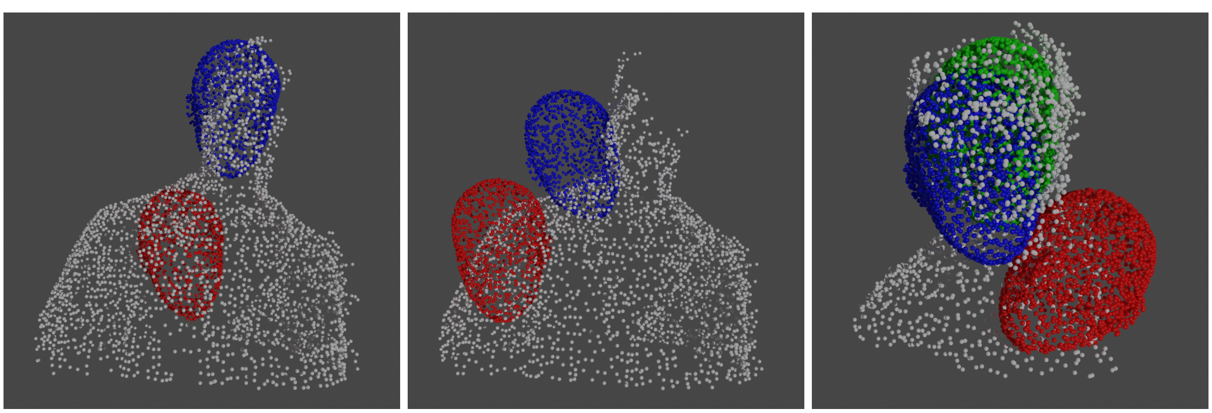


Figure 4. Six examples of our synthetically-trained DCP-v2 on synthetic data (unaligned - red, prediction - green)



(a) Example of real-world data with highly accurate alignment

(b) Example of real-world data with inaccurate alignment

(c) Example of synthetic data with reasonably accurate alignment

Figure 5. Real and synthetic data predictions (unaligned - red, prediction - blue, green - GT in synthetic data)

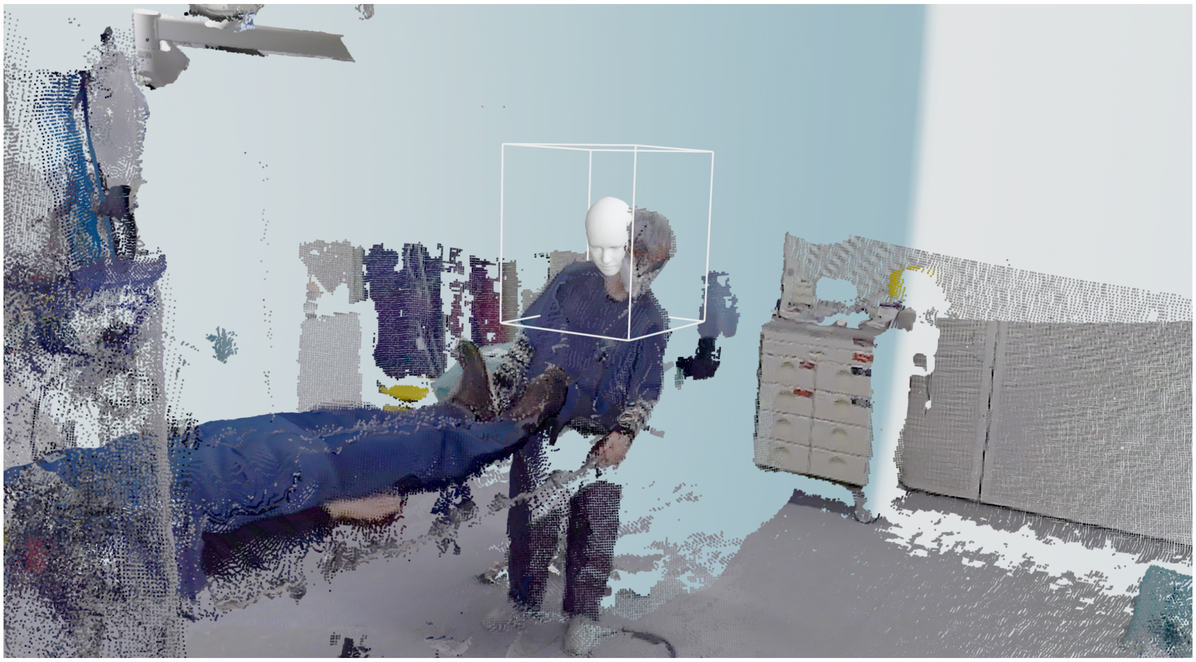


Figure 6. 3D illustration of the extracted head segment of the SMPL [2] mesh and the corresponding bounding box where the point cloud is cropped.

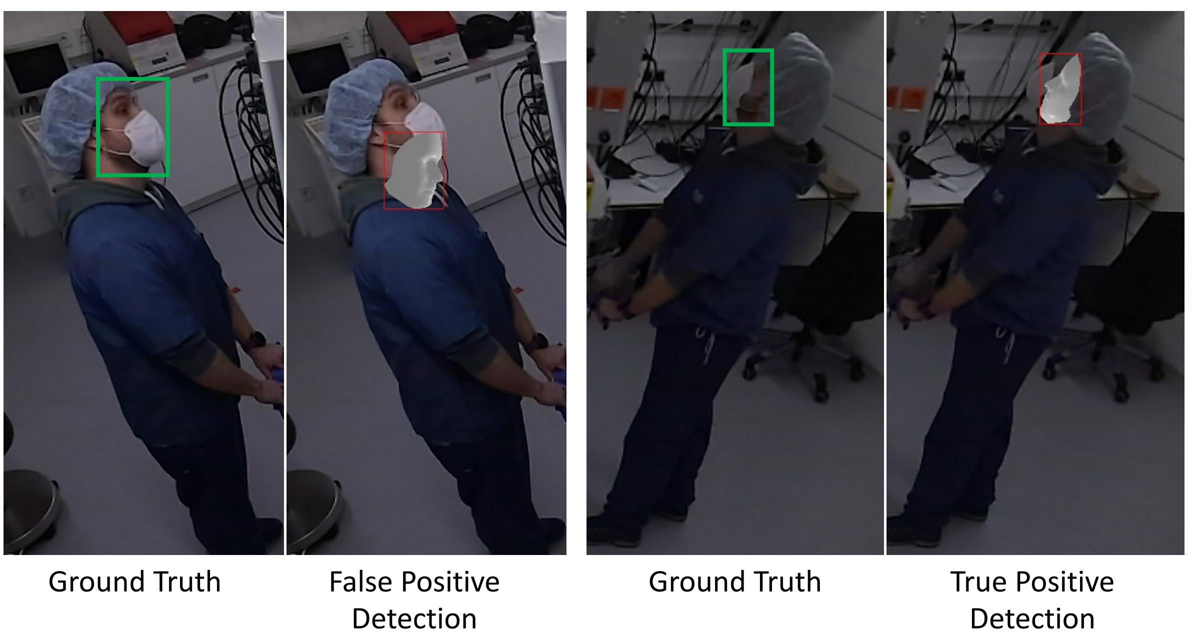


Figure 7. Example of rendering the mesh back into the 2D images for our quantitative evaluation. The green boxes denote the ground truth face bounding box annotation, whereas the red boxes denote the our detection.