3D Reconstruction of the Human Head

Søren Matthias Goldschmidt
Supervisors: Rasmus R. Paulsen & Stine Harder

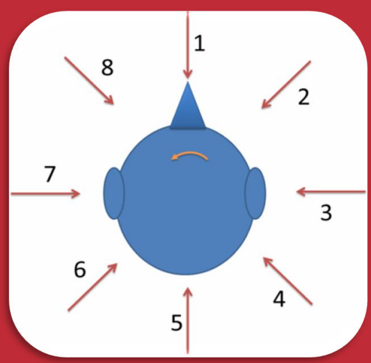
Introduction

Full 3D models of the human head are powerfull tools with a large range of applications, for example in the medical field for HRTF simulations or reconstruction of facial features.

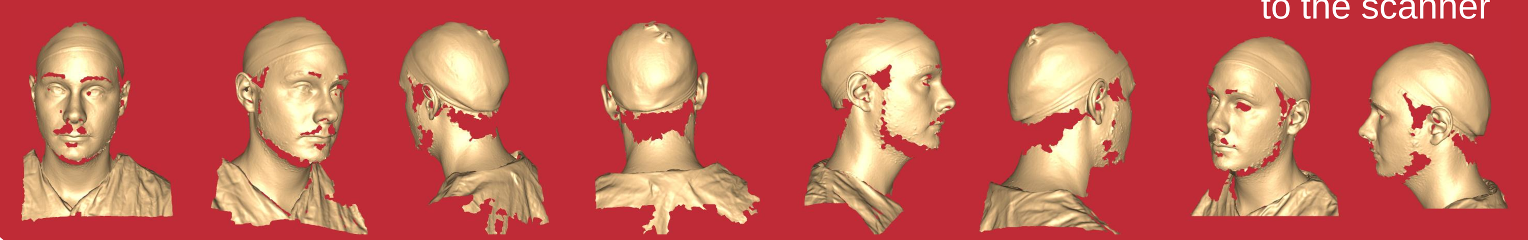
Using a surface scanner provides an easy and risk free method to obtain 3D scans of the head. This method results in multiple partial scans (with different orientation) that combined into one provides the full 3D model of the head.

This project aims to develop an automatic procedure to align such scans making it possible to combine them into one model.

The surface scanner



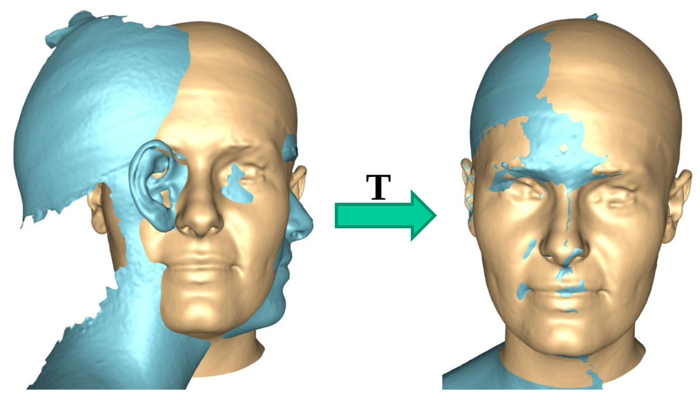
The 8 angles of the person to the scanner



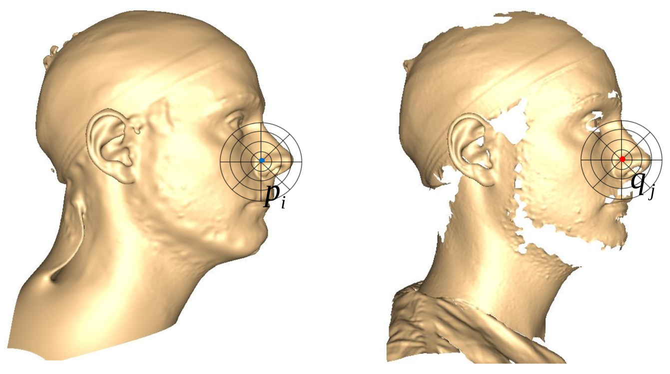
The 8 partial scans captured with the surface scanner

Method

- Novel idea: Align partial scans to a full 3D model as reference.



- Sample points from recognizable features on both reference and partial scan.
- Find correspondences between sample points
  - Shape context (coarse distribution of the points relative to a sample point)
  - Construct cost matrix of dissimilarity measures
  - Corresponding point pairs minimize total cost.
  - Use Hungarian Method to solve minimization
- Use matched point pairs to compute transformation **T**.

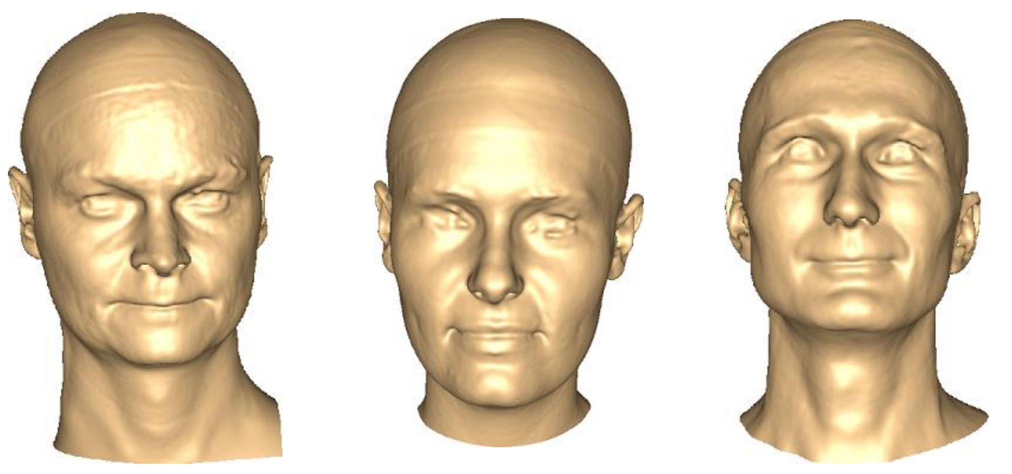


Test and results

Experiments

References

Three full 3D models used as references

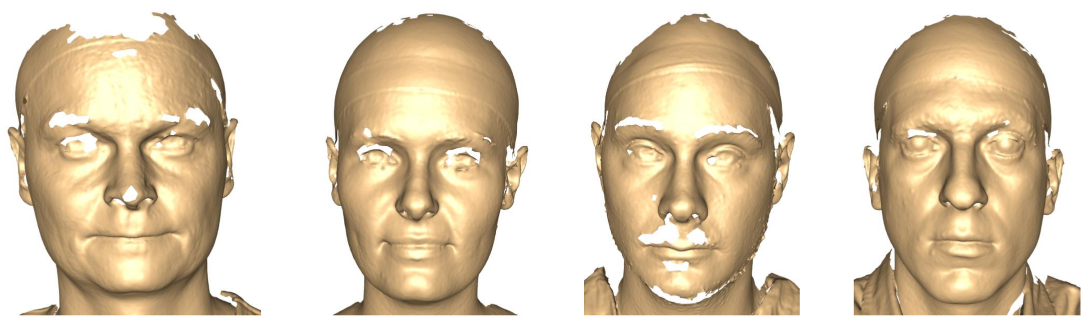


Rasmus reference | Stine reference | Martin reference

Data:

Total 32 partial scans

- Rasmus data set
- Stine data set
- Matthias data set
- Constantinos data set



Rasmus | Stine | Matthias | Constantions

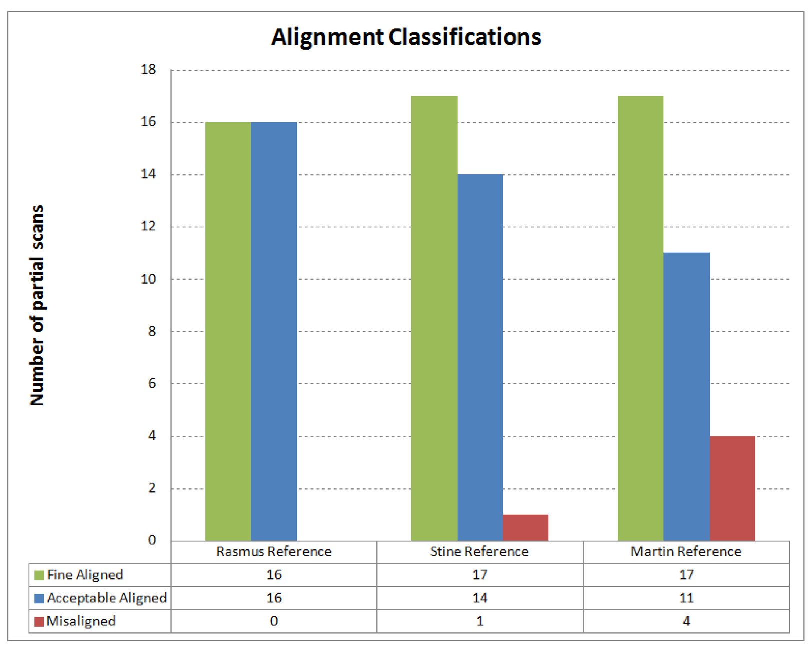
Tests

- Align Rasmus data set to Rasmus reference
- Align Stine data set to Stine reference
- Align each data set to each reference

Results

Alignment classification

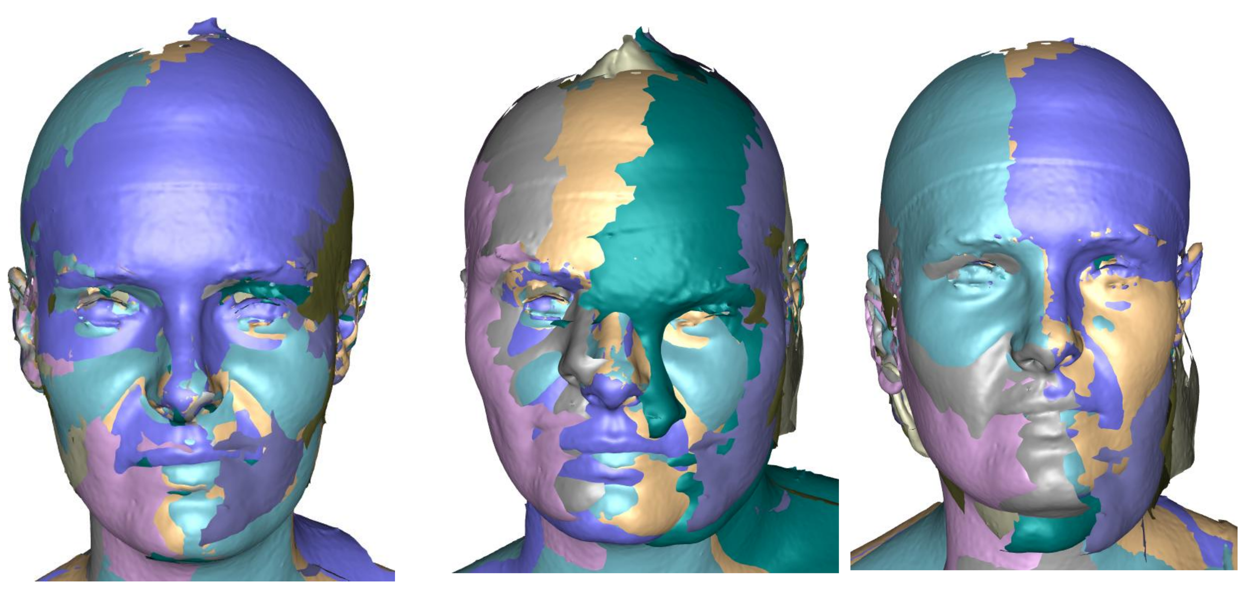
The alignments of the partial scans into the references are classified into three classifications



	Rasmus Reference	Stine Reference	Martin Reference
Fine Aligned	16	17	17
Acceptable Aligned	16	14	11
Misaligned	0	1	4

- Partial scans from the Rasmus data set aligned to the Rasmus reference are almost perfect aligned.
- Partial scans from the Stine data set aligned to the Stine reference are almost perfect aligned.
- Overall succesrate of approximately 95% for alignments of all data sets

Stine data set alignments



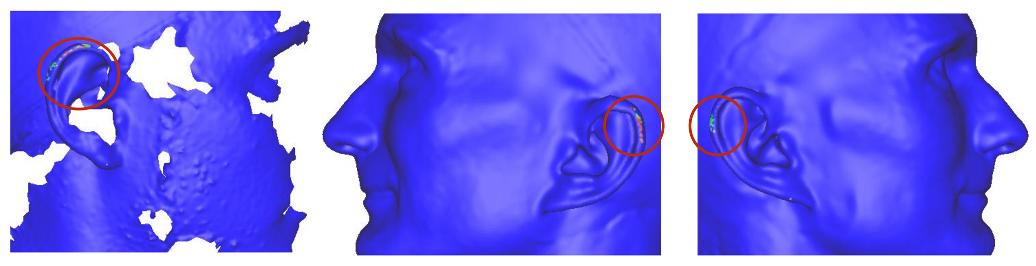
Aligned to Stine reference | Aligned to Rasmus reference | Aligned to Martin reference

Further Investigation

Misalignments

Investigation of matched point pairs between misaligned partial scans and reference

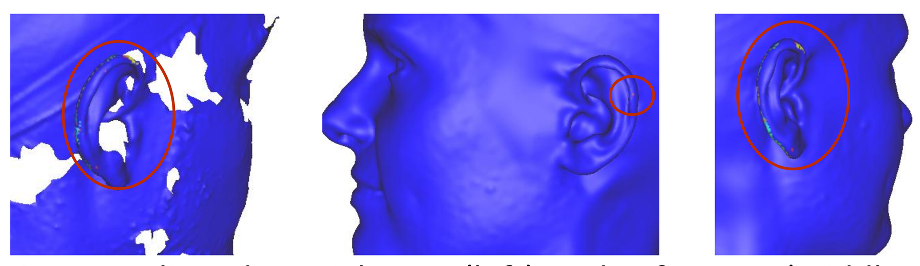
- A majority of wrong matches results in wrong alignment.



Misaligned partial scan (left) and reference (middle, right) with matched point pairs high lighted in red circles.

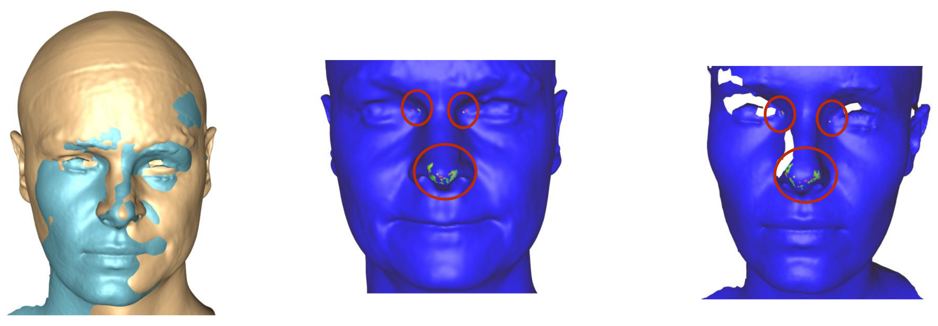
Correct alignements

Investigation of matching point pairs between correct aligned partial scans and reference.



Correct aligned partial scan (left) and reference (middle, right) with matched paint pairs high lighted in red circles.

Correct alignment is possible even if a few wrong matches are present.



Fine aligned partial scan (blue) and reference (yellow) on left. Middle shows reference while right shows the partial scan. Matched points are high lighted in red circles.

Using matched points from among different recognizable features provides a better alignment.

Conclusion

An automatical procedure for alignment of multiple partial scans is constructed. The procedure performs with an overall good performance with a succesrate of approximately 95 %. This also shows the possibility of using arbitrary references to perform alignment of partial scans.

Investigation of misaligned partial scans reveals that misalignments are due to a majority of wrong corresponding points between scan and reference. Investigation with aligned scans shows that a fewwrong correspondences are allowed.
Enforcing sampling of points among many recognizable features may also improve quality of alignments and result in less misalignments.

Using a reference very similar to the partial scans provides almost perfect alignment s.