Practical Course:
3D Scanning and Spatial Learning

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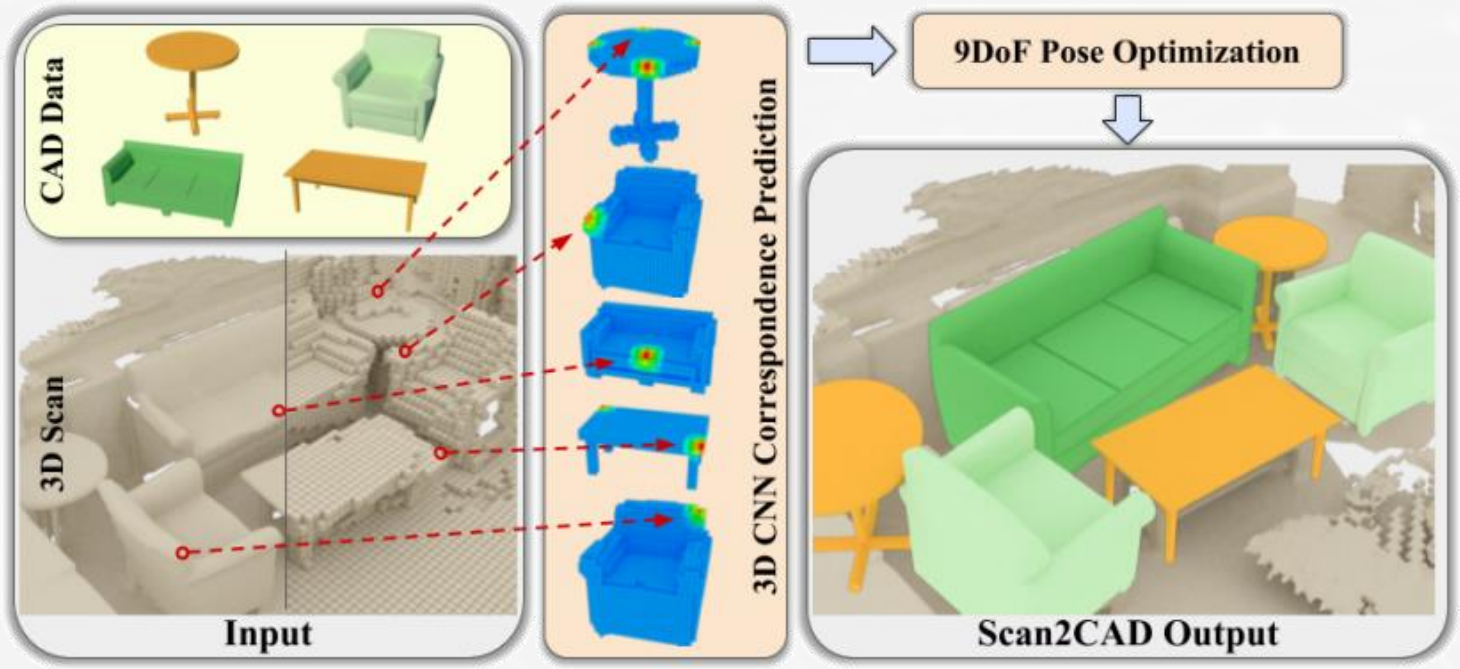
Organization

- Today: Project teams of 3 students
- Bi-weekly status reports
  - 10min talk + 5min discussion/questions
  - No need to hand-in slides before the talk
  - Alternating presenter
- Final report, Final presentation
  - Last week of the semester
  - Talk: Semi-final slides should be sent one week before
  - Report: 3-4 pages in CVPR format

Projects

- Real-time Scan2CAD (Armen)
  - Integrate the Scan2CAD network in Bundle-Fusion / VoxelHashing
- Multi-view RGB-D Capture Setup (Aljaz)
  - Multi-camera setup, 3D Calibration, Volumetric Fusion
- Morphable Model Generation (Justus)
  - RGB-D face dataset, non-rigid template fitting, PCA
- Real-time RGB Face Reconstruction (Justus)
  - Cuda/DirectX face fitting (shape, albedo, light)

Real-time Scan2CAD



Real-time Scan2CAD

- Step 1
  - 3D scan whole room via Voxel Hashing (Niessner et al., 2013)
- Step 2
  - Predict CAD alignments with CNN from SDF grid
- Step 3
  - Visualize alignments interactively

Real-time Scan2CAD

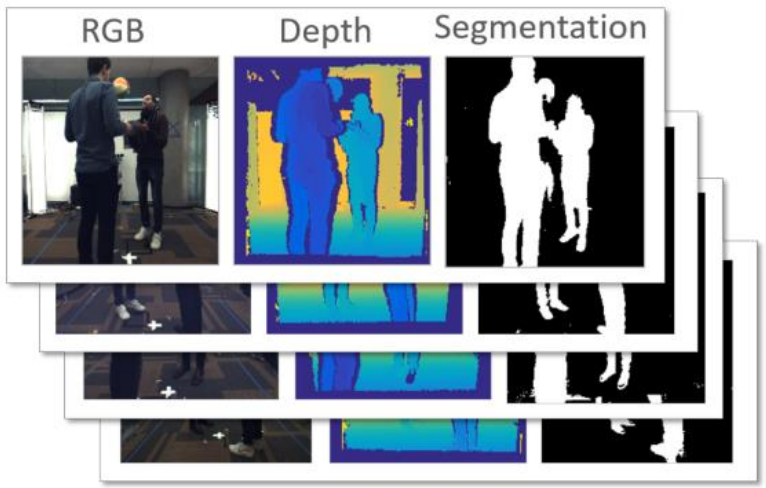
- Data:
  - Apple Ipad + StructureIO
- Literature:
  - Avetisyan, Armen, Angela Dai, and Matthias Nießner. "End-to-End CAD Model Retrieval and 9DoF Alignment in 3D Scans.", ICCV 2019

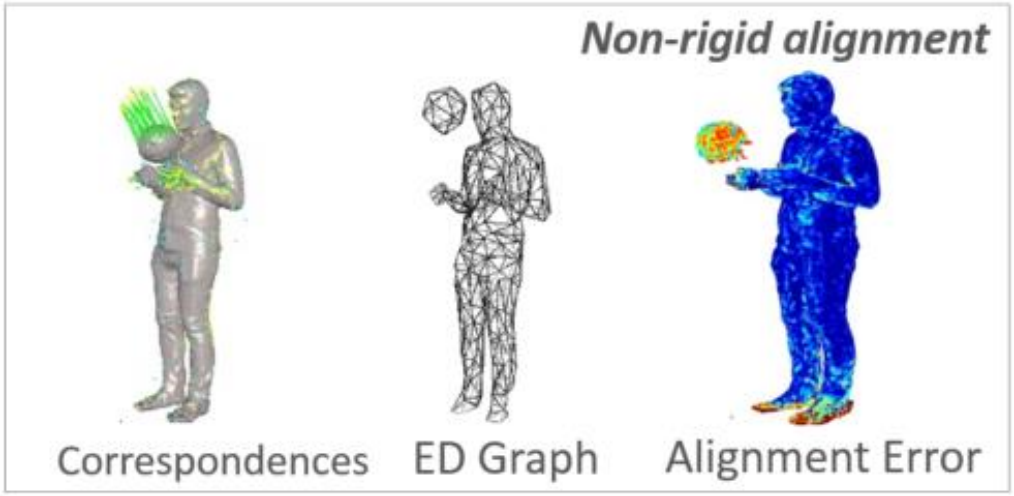
Multi-view RGB-D Capture Setup

Multi-view RGB-D Capture Setup

Multi-view RGB-D Capture Setup

- Image preprocessing
  - Depth filtering, background subtraction, visual hull computation
- Non-rigid shape reconstruction
  - Sparse voxel grid
  - Deformation graph construction
- Non-rigid tracking
  - Projective depth ICP
  - Global sparse correspondences

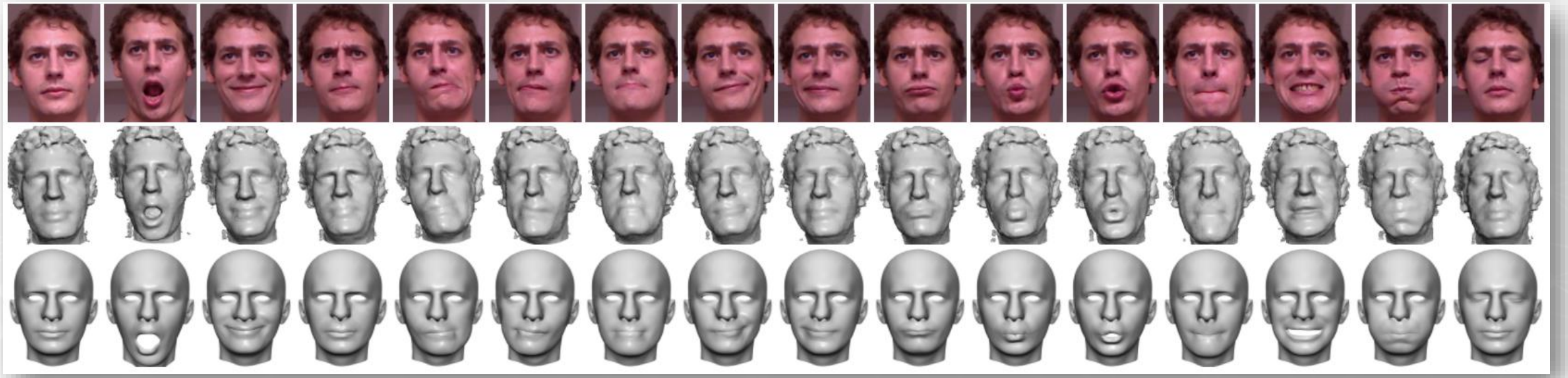




Multi-view RGB-D Capture Setup

- Data:
  - 4x Intel Realsense D415
- Literature:
  - Motion2Fusion: Real-time Volumetric Performance Capture [Dou et al.]
  - Fusion4D: Real-time Performance Capture of Challenging Scenes [Dou et al.]
  - DynamicFusion: Reconstruction and Tracking of Non-rigid Scenes in Real-Time [Newcombe et al.]

Morphable Model Generation



FaceWarehouse, Cao et al.

Morphable Model Generation

- Template Fitting
  - Non-rigid ICP
    - RGB-D input data
    - As-rigid-as-possible (ARAP)

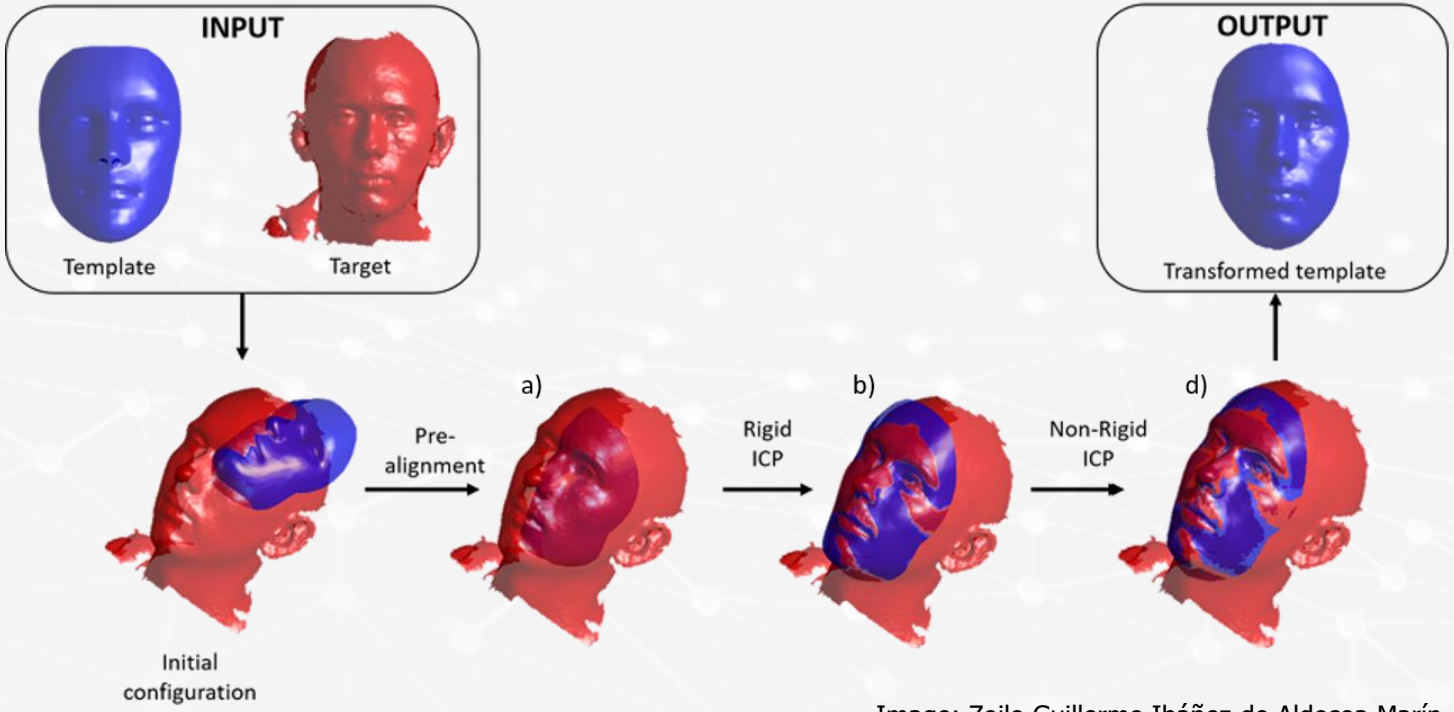
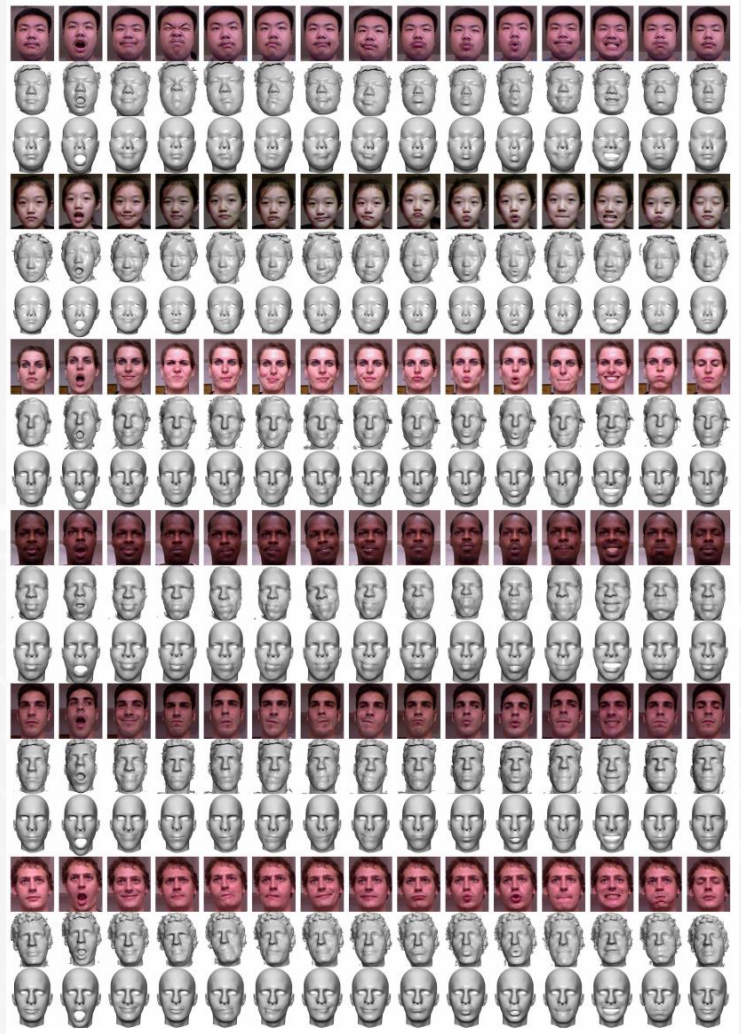


Image: Zoilo Guillermo Ibáñez de Aldecoa Marín

Morphable Model Generation

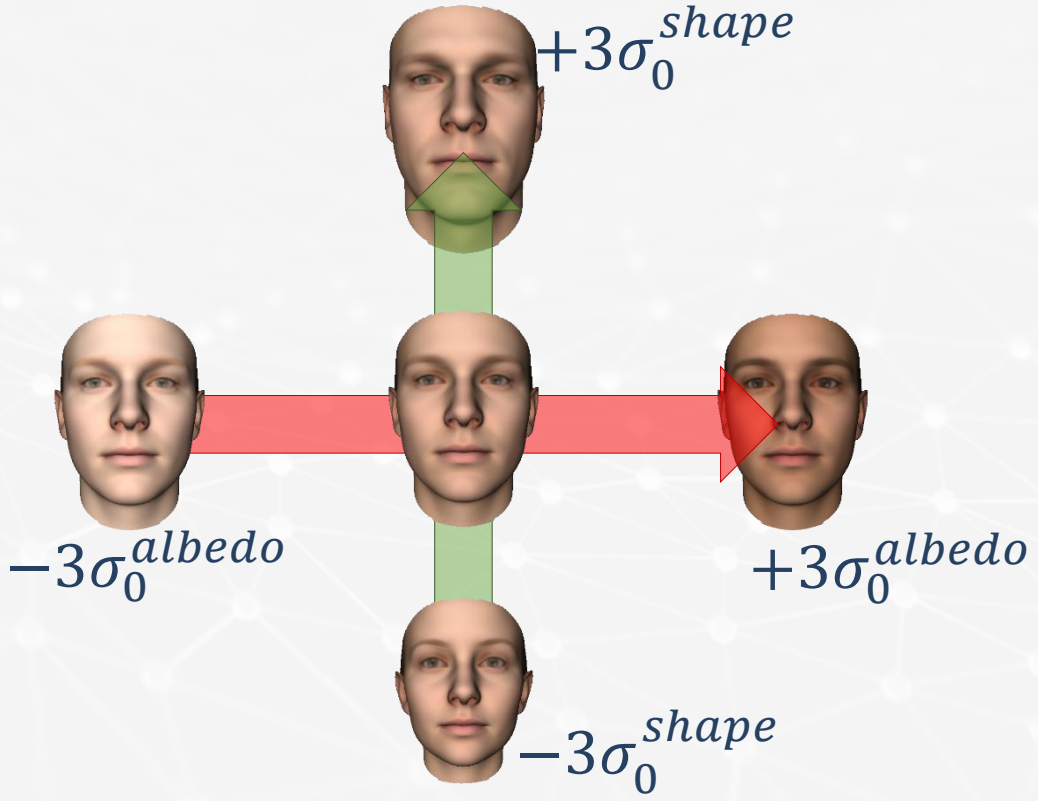
- Template Fitting
  - Non-rigid ICP
    - RGB-D input data
    - As-rigid-as-possible (ARAP)
- Process Face Dataset



http://kunzhou.net/zjugaps/facewarehouse/

Morphable Model Generation

- Template Fitting
  - Non-rigid ICP
    - RGB-D input data
    - As-rigid-as-possible (ARAP)
- Process Face Dataset
- Build PCA
  - Power method



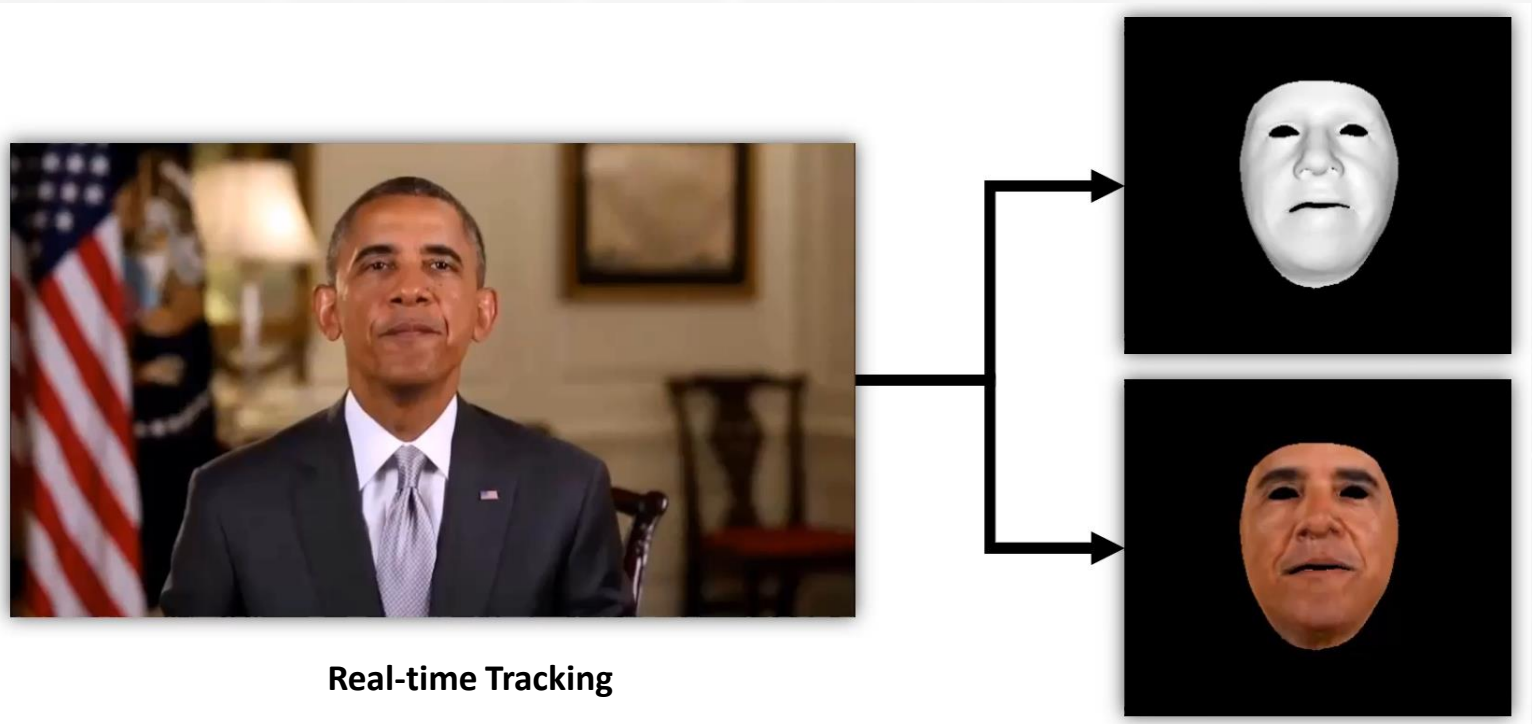
Morphable Model Generation

- Template Fitting
  - Non-rigid ICP
    - RGB-D input data
    - As-rigid-as-possible (ARAP)
- Process Face Dataset
- Build PCA
  - Power method
- [Record new Dataset]

Morphable Model Generation

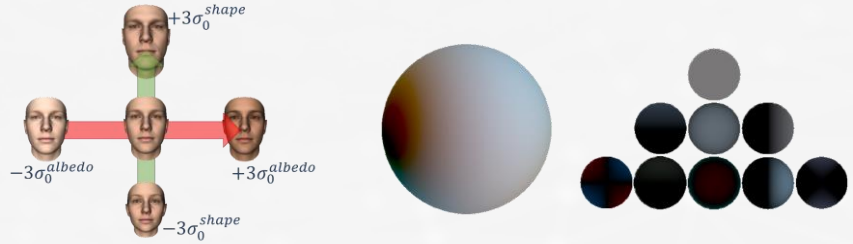
- Data:
  - FaceWarehouse, Bosphorus Face Database
  - Captured data (Intel Realsense)
- Literature:
  - Geometric Registration for Deformable Shapes [Li et al.]
  - Morphable Model [Blanz & Vetter]
  - FaceWarehouse [Cao et al.]

Real-time RGB Face Reconstruction

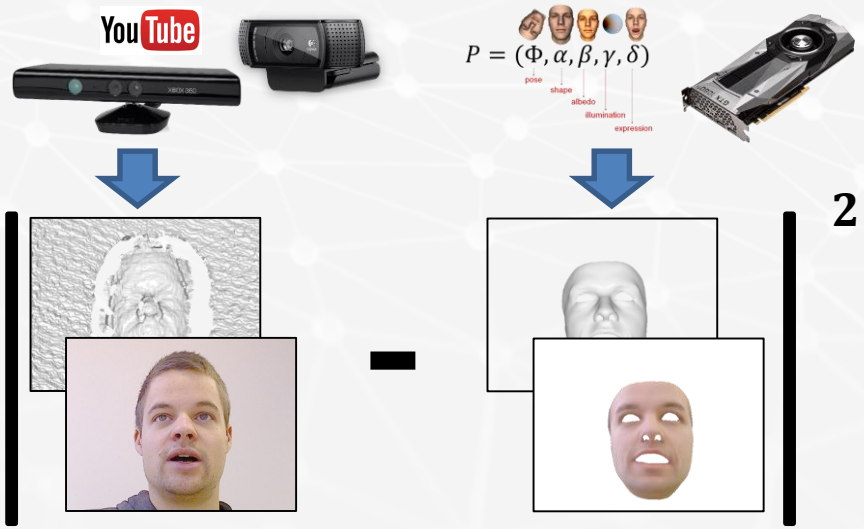


Real-time Tracking

Parametric Face Model:

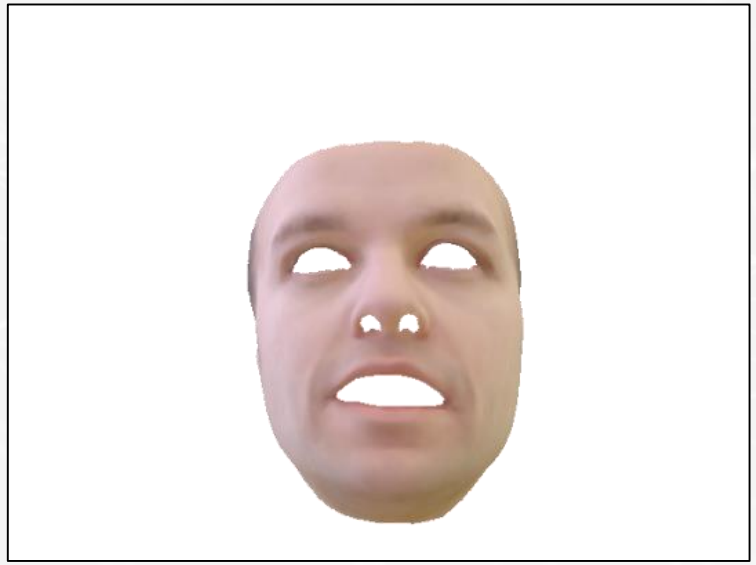


Dense Energy Minimization:



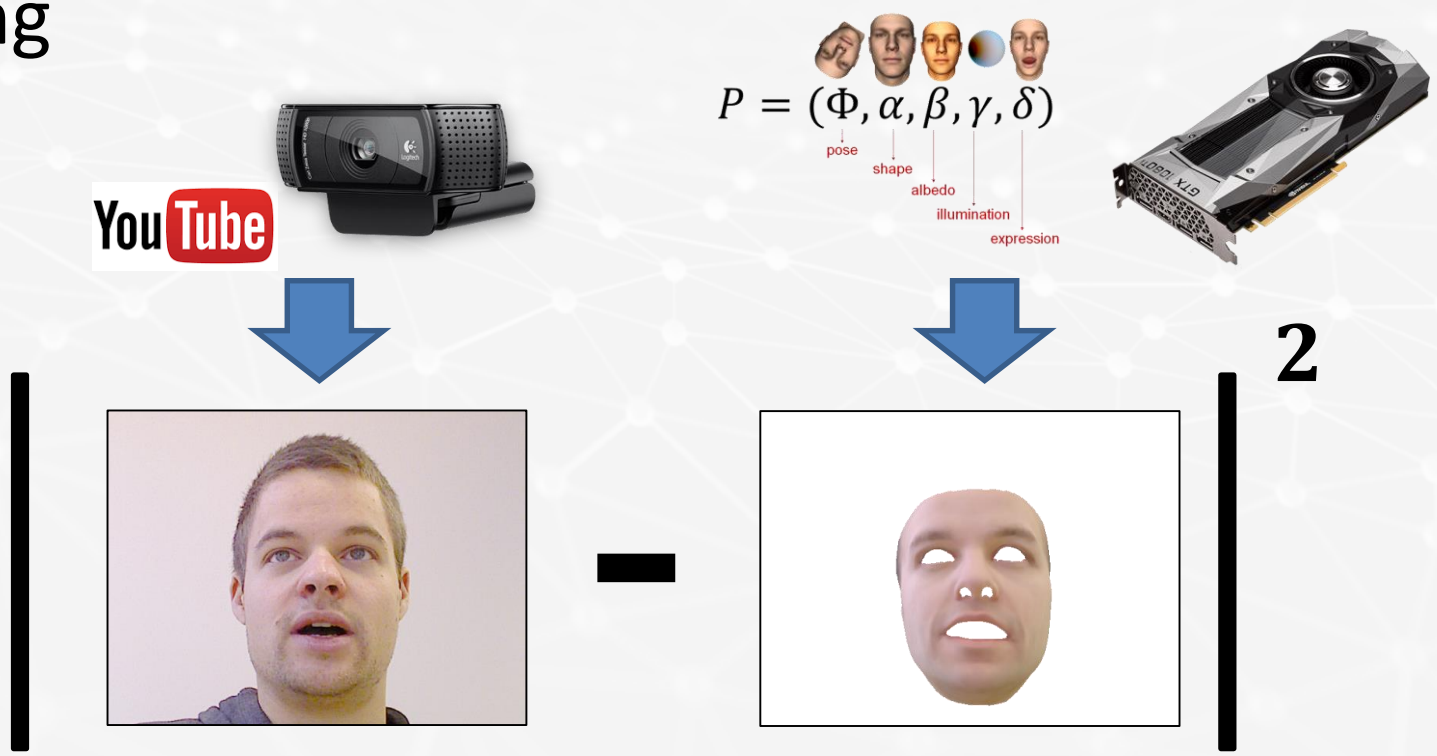
Real-time RGB Face Reconstruction

- Computer Graphics knowledge (Cuda/OpenGL, DirectX)
- Differentiable Renderer



Real-time RGB Face Reconstruction

- Computer Graphics knowledge (Cuda/OpenGL, DirectX)
- Differentiable Renderer
- Morphable Model Fitting
  - GPU-based GN
  - Sparse Fitting
  - Dense Fitting



Real-time RGB Face Reconstruction

- Data:
  - RGB webcam
- Literature:
  - Morphable Model [Blanz & Vetter]
  - Face2Face,… [Thies et al.]

Thank you for your attention!