DEEP LEARNING-BASED POINT CLOUD REGISTRATION FOR AUGMENTED REALITY-GUIDED SURGERY.

#922

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We investigate the feasibility of using **deep learning** for **point cloud registration** in **augmented reality-guided surgery.**

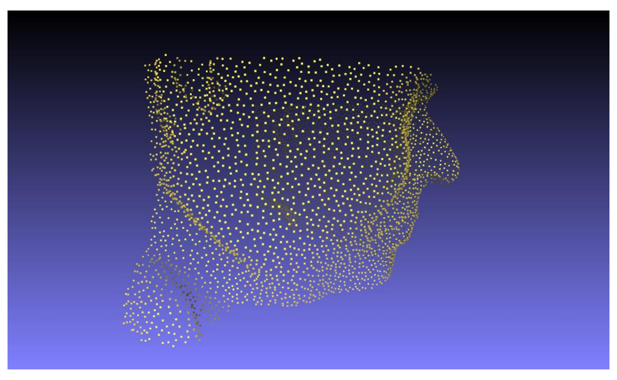
METHOD

Research question

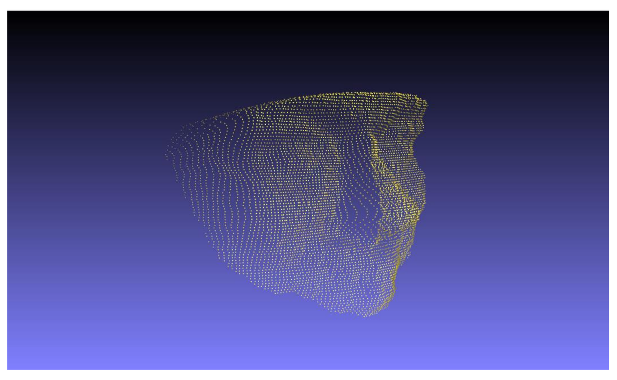
Is there currently a deep learning-based point cloud registration method that exhibits an "out-of-the-box" characteristic for seamless integration with AR-GS?

Dataset

- CT scans from real patients and corresponding 3D-printed heads [1]
- Source point cloud
  - Segmenting skin surfaces from PET/CT scans
  - Extracting points using the Marching Cubes
  - Sub-sampling and cutting
- Target point cloud
  - Reconstructed from depth images of 3D-printed head phantoms
  - Captured from different perspectives using HL2's depth sensor
  - Artifact and outlier removal
- Total of 30 data pairs



Source point cloud



Target point cloud

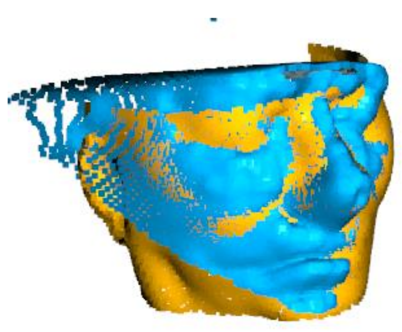
Benchmark method

- Traditional registration pipeline
- Global registration using FPFH features [2] and RANSAC [3]
- Refinement using ICP [4]

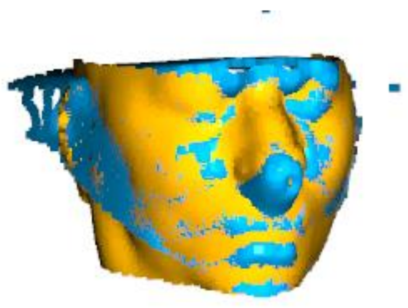
Deep learning-based methods

- Feature-metric registration (FMR) [5]
- PointNetLK Revisited [6]
- Deep Global Registration (DGR) [7]

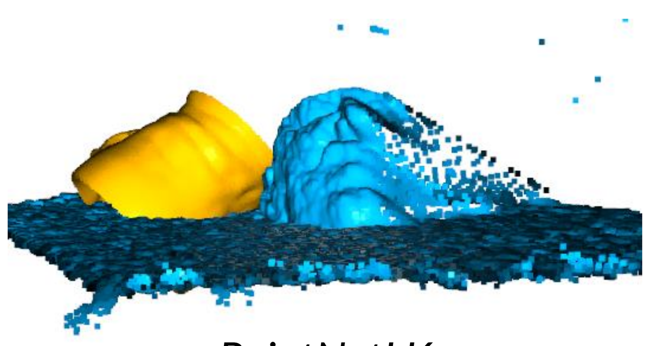
RESULTS



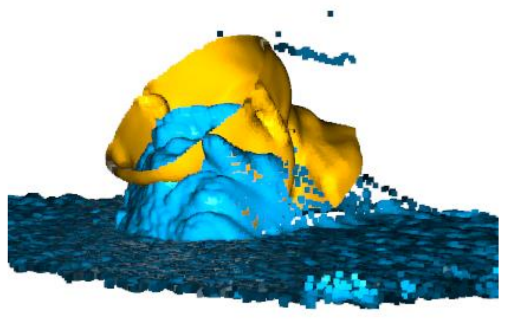
Global



Global + ICP

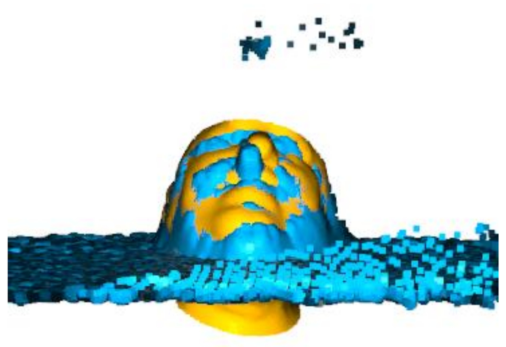


PointNetLK



FRM

Method	Recall	TE (cm)	RE (°)	T (s)
DGR	0.27	0.08	4.7	4.3
DGR FT	0.41	0.09	5.8	4.4
Global	0.3	0.18	8.0	**1.6**
Gl + ICP	**0.6**	**0.05**	**2.0**	**1.6**



DGR

MOTIVATION

- **Point cloud registration** is crucial in various computer vision applications, such as augmented reality (AR), medical imaging, or **AR-guided surgery** (AR-GS).
- Traditional **image-to-patient registration** methods on AR devices face challenges in precision, efficiency, user-friendliness, and patient comfort.
- **Deep learning** holds potential for point cloud registration.

CONTRIBUTION

- Study **deep learning-based point cloud registration** for **AR-GS**.
- A dataset with real medical data and point clouds from the **HoloLens 2 (HL2)**.
- Compare **three deep learning-based** registration methods with a traditional method.

DISCUSSION AND CONCLUSION

- Our dataset is challenging due to variations in noise, density, and distribution patterns.
- Deep learning shows promise but cannot outperform traditional image-to-patient registration methods.

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