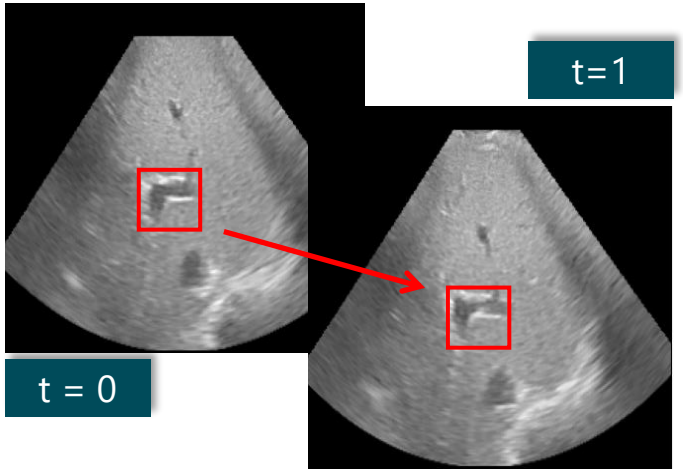
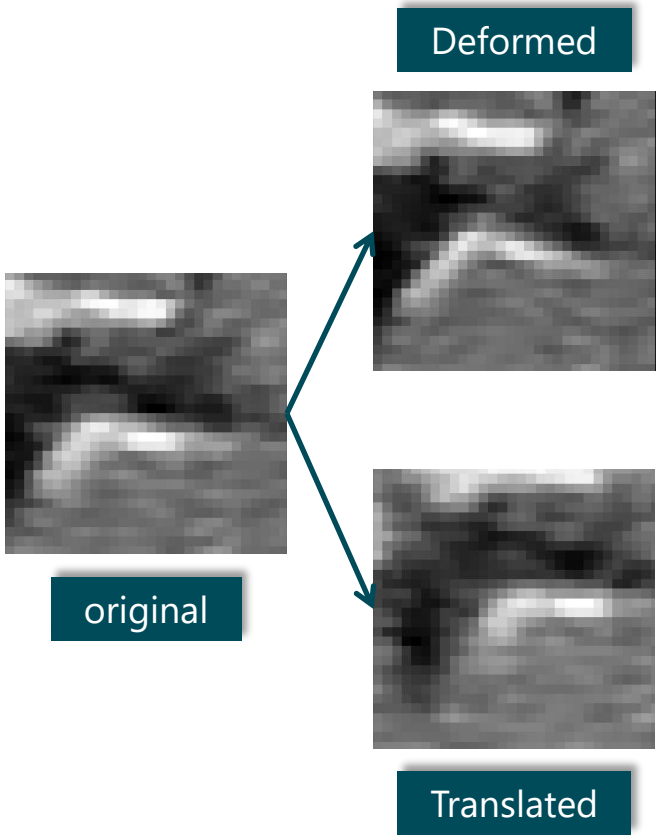
# Comparison of Representation Learning Techniques for Tracking in time-resolved 3D Ultrasound

Daniel Wulff | wulff@rob.uni-luebeck.de
Institute for Robotics and Cognitive Systems | Universität zu Lübeck

## Preparing US Data



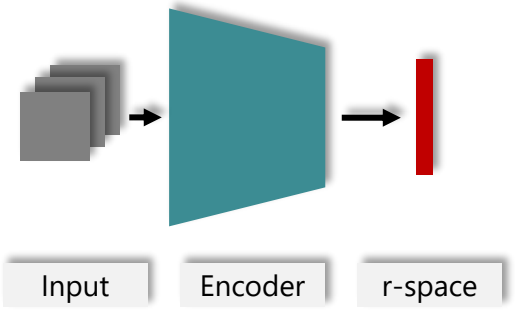

- Tracking in 4D Ultrasound is challenging
- Location and shape of targets change
- Approach: Representation Learning in US patches



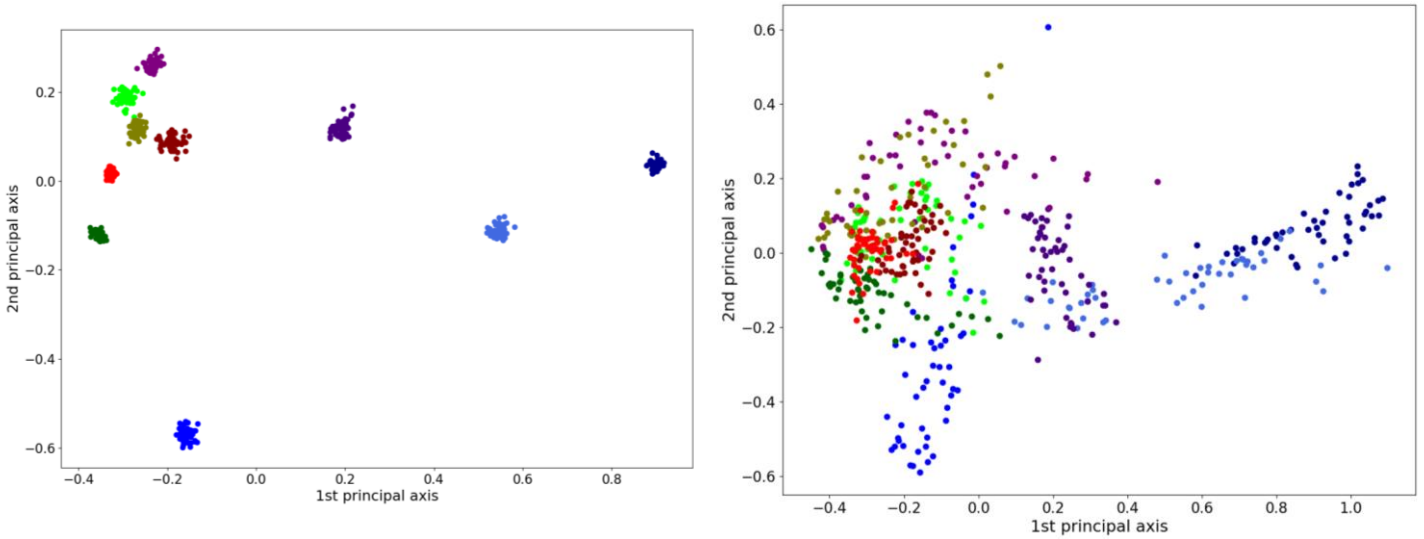

- Long-term 4D Liver Ultrasound dataset
- Consider Deformations and Translations
- Deformation is simulated using data augmentation
- Generated test data:
  - 10 x 50 Deformations
  - 10 x 50 Translations

Daniel Wulff | wulff@rob.uni-luebeck.de
Institute for Robotics and Cognitive Systems | Universität zu Lübeck

# Mapping US Patches into Representation Space




- Mapping patches into representation space
  1. Conventional autoencoder (cAE)
  2. Variational autoencoder (VAE)
  3. Sliced-Wasserstein autoencoder (SWAE)
- AEs are trained using long-term US dataset




Two principal Components of r-space of Deformations (left) and Translations (right) generated by conventional autoencoder.

- Consider Translations and Deformations separately
- Clustering in r-space using k-means algorithm

Daniel Wulff | wulff@rob.uni-luebeck.de
Institute for Robotics and Cognitive Systems | Universität zu Lübeck

# Clustering in Representation Space

| Data Type | Auto-encoder | Precision | CH score |
|---|---|---|---|
| Deformation | cAE | 1.0 | 1197 |
| | VAE | 0.8 | 60 |
| | SWAE | 1.0 | 2385 |
| Translation | cAE | 0.6 | 28 |
| | VAE | 0.5 | 8 |
| | SWAE | 0.7 | 33 |

- Metrics
  - Precision: Rate of correct clustered samples
  - Calinski-Harabasz (CH) score: Rate between intra- and inter cluster dispersion
- Clustering performance depends on
  - Type of autoencoder
  - Kind of motion
- Clustering of deformed patches is more effective than transformed patches – promising for target tracking
- Results indicate that SWAE is promising for Tracking
- In Future study Tracking in r-space of SWAE will be performed