

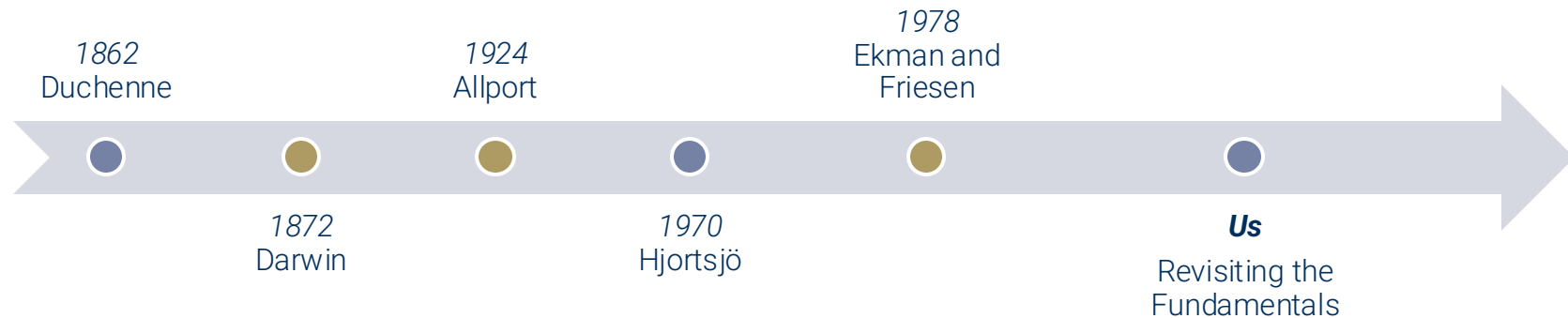
Tim Büchner, Christoph Anders, Orlando Guntinas-Lichius, Joachim Denzler

EIFER

Electromyography-Informed Facial Expression Reconstruction For Physiological-Based Synthesis and Analysis

CVPR 2025 – Nashville – Poster Session #1 ExHall D Poster #5 – Fri 13 Jun 10:30 a.m. – 12:30 p.m.

We want to **understand the non-linear bidirectional correspondence**
between facial movements and muscle activity for
more natural expression synthesis and **camera-based muscle analysis**

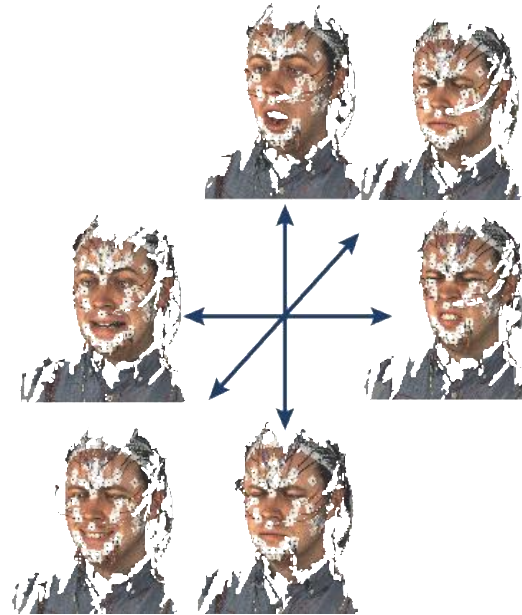


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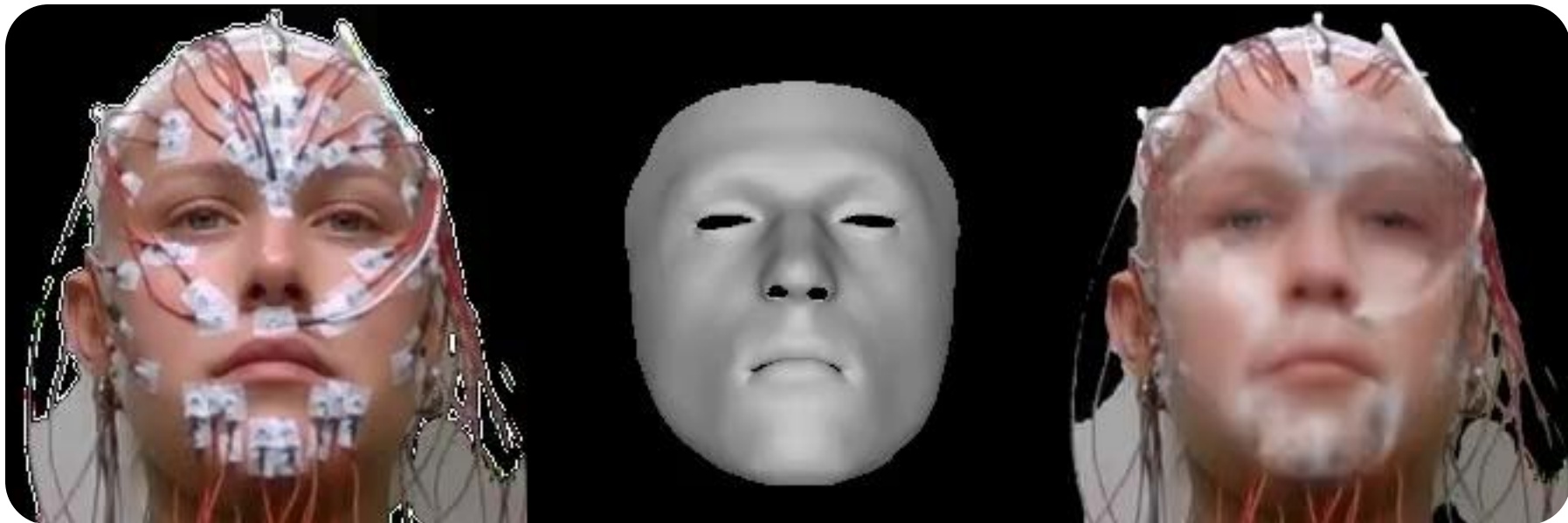


Therefore, we record both
muscle activity and facial movement simultaneously!

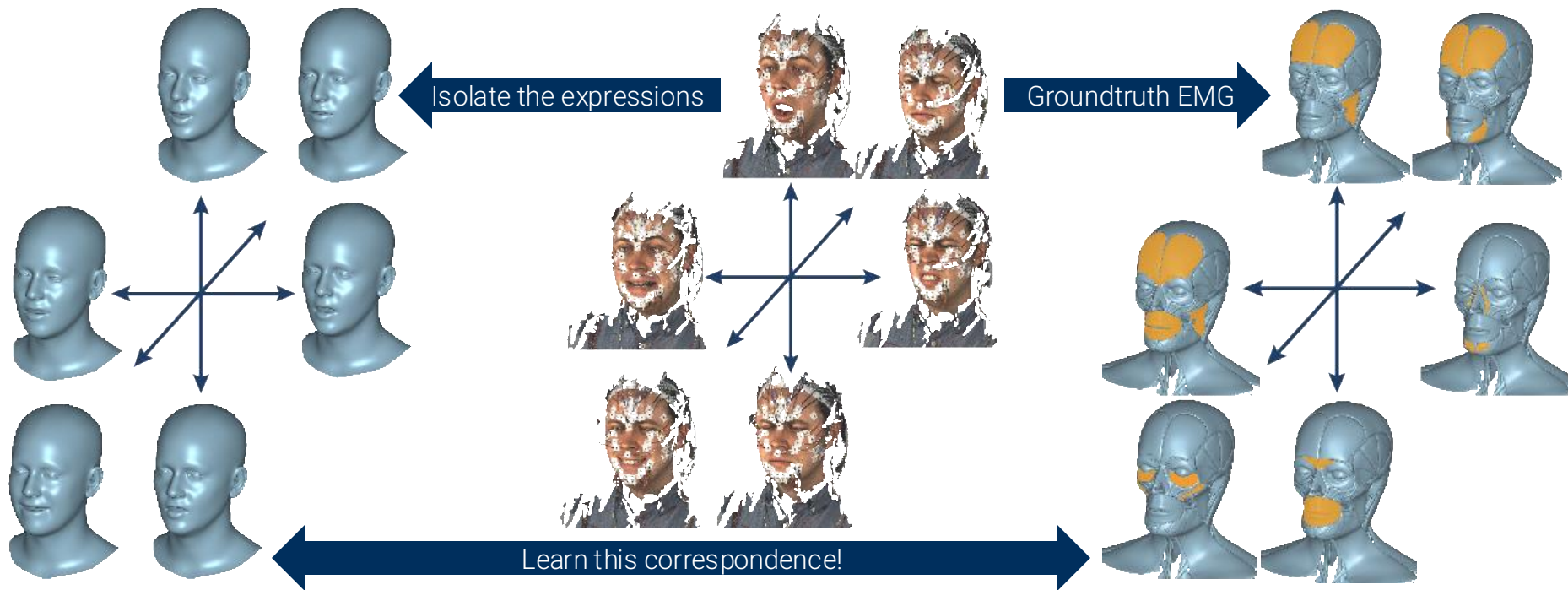
Synchronized
video and sEMG capture
of mimicked facial movements



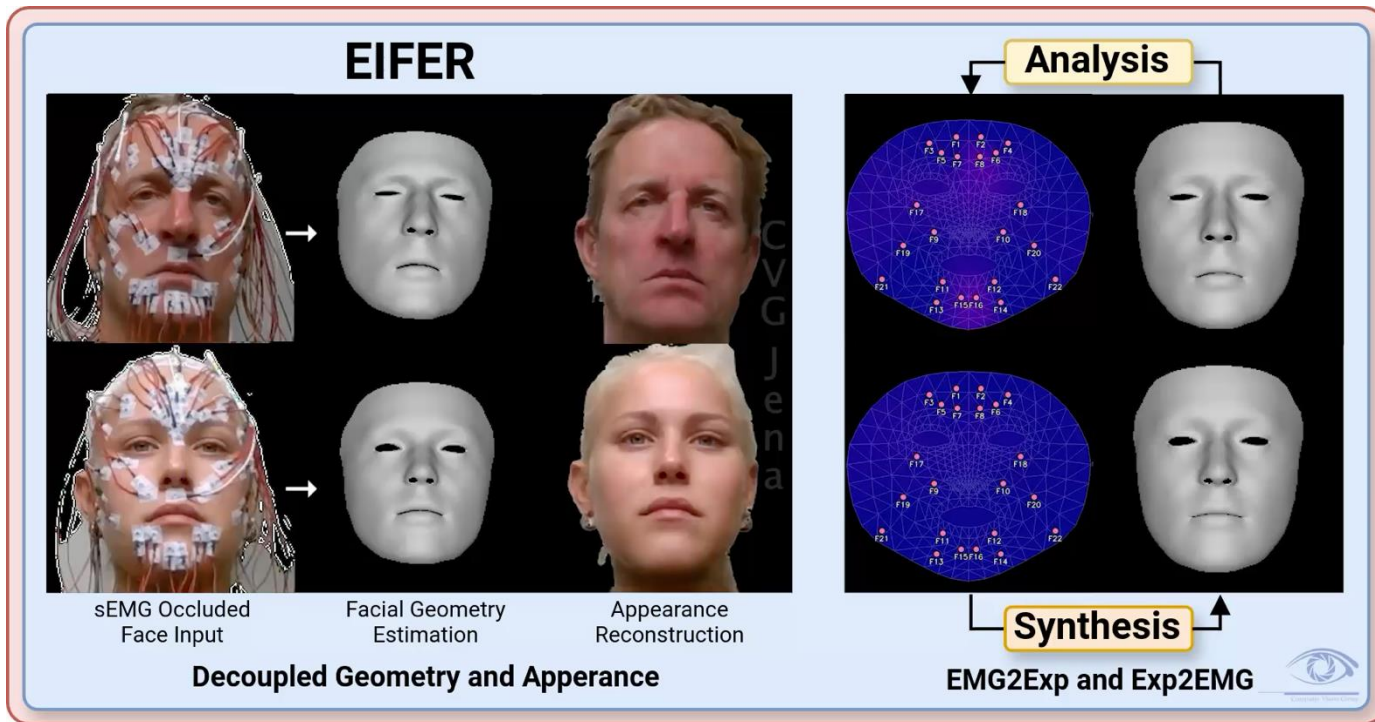
6 emotional movements
11 functional movements



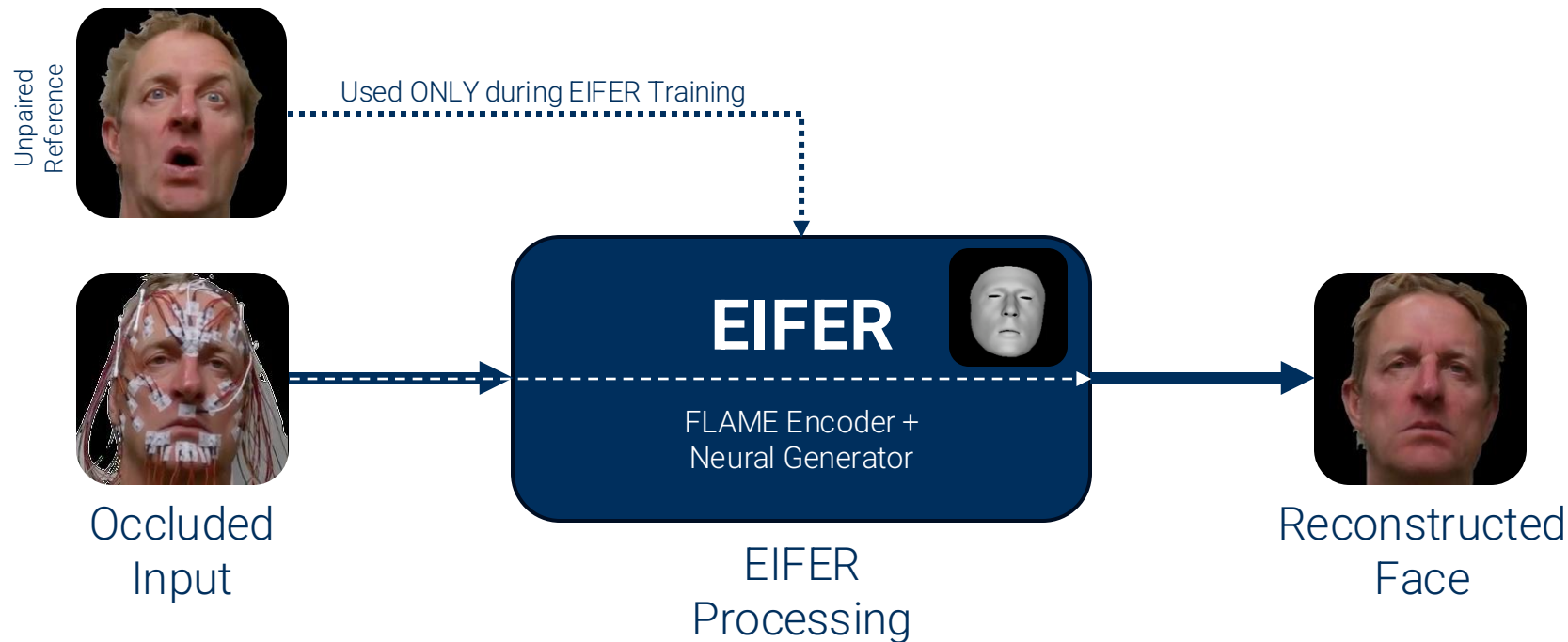
- Existing models (here, SMIRK¹) fail to handle the sEMG occlusion
- Many assumptions about the facial appearance do not hold anymore
- Reconstruction is not suitable for any relevant downstream task



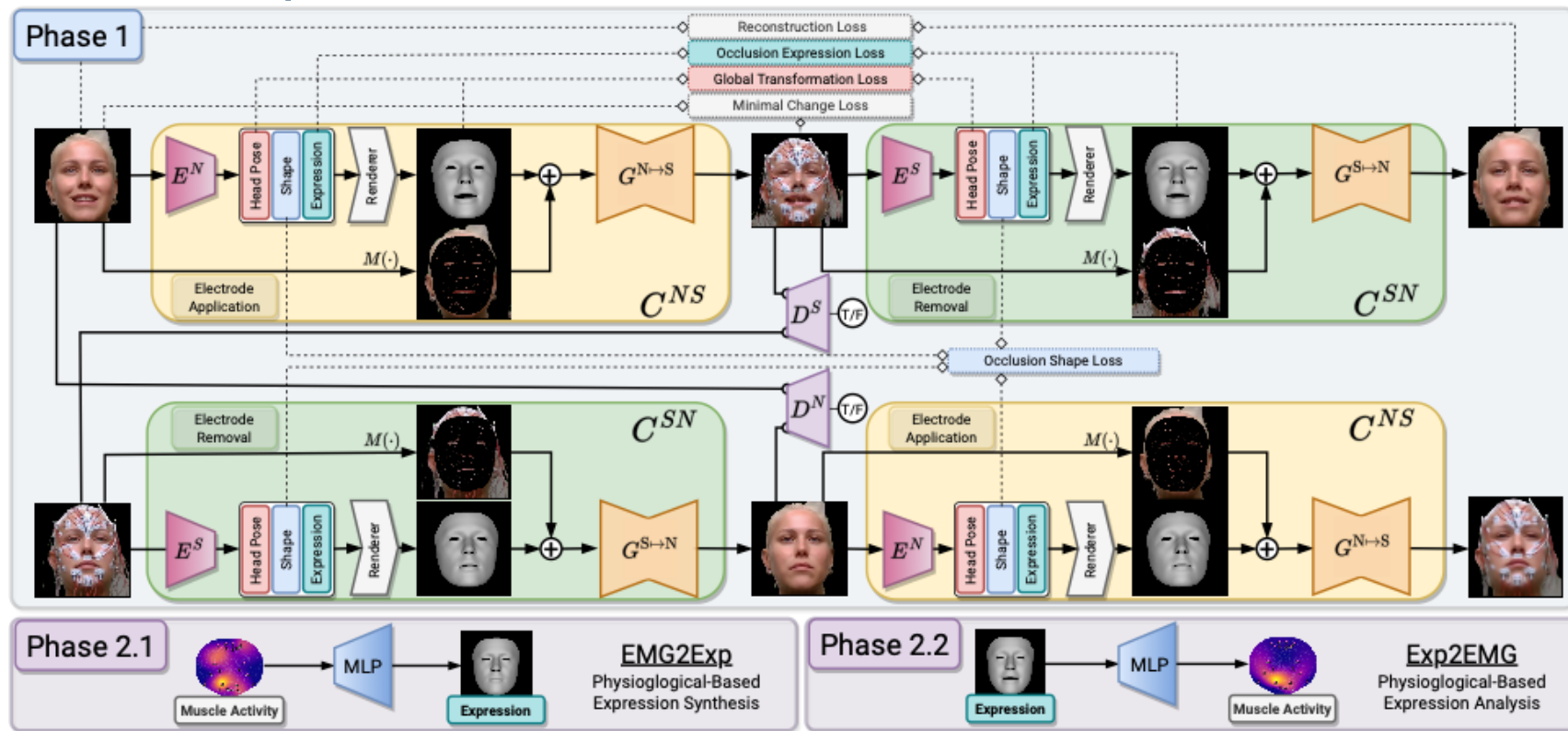
EIFER - Unpaired Face-To-Face Translation



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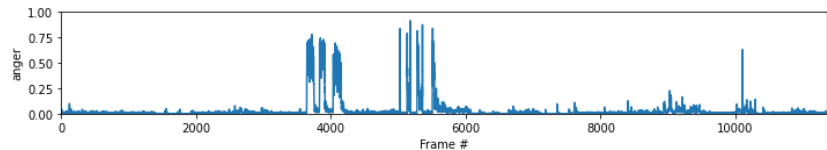
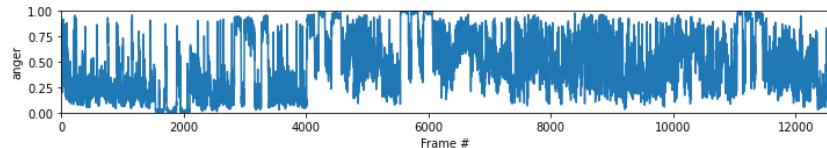


Geometry and Appearance Reconstruction

- Isolate the FLAME expression space to learn the mapping to the muscle signals



- We can utilize the reconstructed face for existing analysis methods (here FER with RMN)



EMG-Based Synthesis

Forehead Wrinkling



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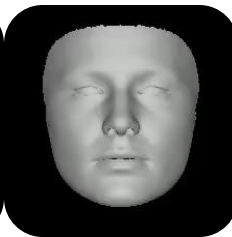
DECA



EMOCaV2



SMIRK



Deep3DFace



FOCUS

Surprise



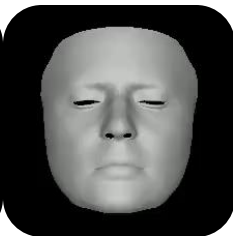
Recorded Video



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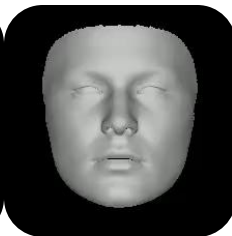
DECA



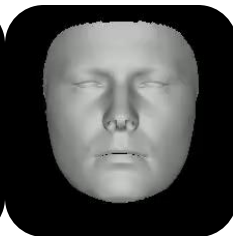
EMOCaV2



SMIRK



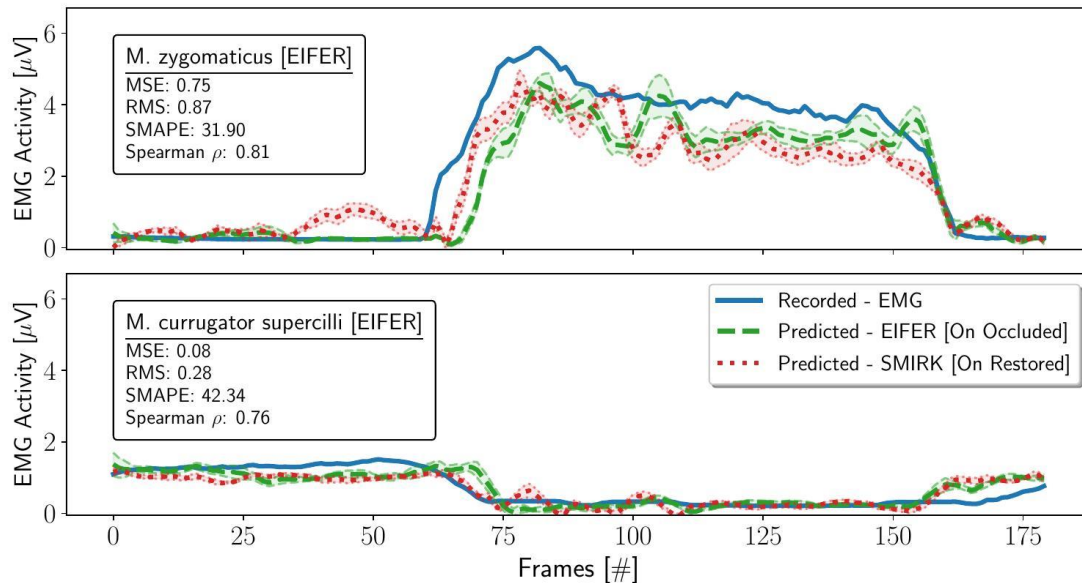
Deep3DFace



FOCUS

Camera-Based Muscle Analysis

- Trained on static images, but recovers the dynamics
 - Slight underestimation of the sEMG linear envelope
 - Observe an electro-mechanical delay
 - Activity offset indicates correct synchronization



EIFER

- Occlusion-robust monocular 3D face reconstruction approach
 - Utilizing a CycleGAN-like structure
- Unpaired reference image for faithful reconstruction
 - Only during training
- Solve three tasks
 - Appearance reconstruction
 - Expression synthesis
 - Muscle activity analysis

MaM - A Novel Dataset

- Synchronized Data
 - Multi-channel sEMG with two schemes
 - Video with Intel RealSense camera
- Rich in Variety
 - 36 + 1 (20 + 1 public*) participants
 - 11 functional (individual) movements
 - 6x4 emotional (complex) movements
 - Recording repeated after two weeks
- A Unique Resource
 - First dataset of its kind
 - Many Tasks Await!





<https://eifer-mam.github.io>

Thank you, and let's discuss!

Tim Büchner