Reducing the gap between mimics and muscles by enabling facial feature analysis during sEMG recordings

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Introduction: Surface electromyography (sEMG) is an effective technique for studying facial muscles. However, although it would be valuable, the simultaneous acquisition of 2D facial movement videos creates incompatibilities with analysis methodologies because the sEMG electrodes and wires obstruct part of the face. The present study overcame these limitations using machine learning mechanisms to make the sEMG electrodes disappear artificially (artificial videos with removed electrodes).
Material & Methods: We recorded 36 probands (18-67 years, 17 male, 19 female) and measured their muscular activity using two sEMG schematics [1], [2], totaling 60 electrodes attached to the face [3]. Each proband mimicked the six basic emotions four times randomly, guided by an instructional video. Minimal Change CycleGANs were used to make reconstruction videos without sEMG electrodes [4], [5]. Finally, the emotions expressed by the probands were classified with ResMaskNet [6].
Results: We quantitatively compared the sEMG data and reconstructed videos with reference recordings. The artificial videos achieved a Fréchet Inception Distance [10] score of 0.50 ± 0.74, while sEMG videos scored 10.46 ± 2.10, indicating high visual quality. With electrodes attached, we yield an emotion classification accuracy of 34 ± 10% (equivalent to two-category random guessing). Our approach obtained up to 83% accuracy for the removed electrodes.
Conclusions: Our techniques and studies enable simultaneous analysis of muscle activity and facial movements. We reconstruct facial regions obstructed by electrodes and wires, preserving the underlying expression. Our data-driven and label-free approach enables established methods without further modifications.
Supported by DFG DE-735/15-1 and DFG GU-463/12-1
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Sunday, June 16, 03:18 PM – 03:27 PM

FP.SU.04 General 1