Towards Enhancing Emotional Responses to Media using Auto-Calibrating Electric Muscle Stimulation (EMS)

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ABSTRACT

We evaluate the use of Electric Muscle Stimulation (EMS) as a method of amplifying emotional responses to multimedia content. This paper presents an auto-calibration method to stimulate two facial expressions using EMS. We focus on two expressions: frown and smile. We attempted control of facial muscles with facial feedback for automatically calibrating these facial expressions: our computer vision system detects the facial expression and auto-calibrates the EMS parameters (intensity and duration) based on the user's current facial expression. We present results from a pilot study with four participants evaluating the auto-calibration system and collecting initial feedback on the use of EMS to augment, for example, media experiences: while watching movies we can enhance the emotional response of the users during happy and sad scenes by stimulating corresponding face muscles.

CCS CONCEPTS

•Human-centered computing → Human computer interaction (HCI); Interactive systems and tools;

KEYWORDS

Affective computing, Electrical Muscle Stimulation (EMS), facial feedback, emotion

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1 BACKGROUND AND MOTIVATION

When being agitated, people often begin to tremble while their heart starts racing. According to the James-Lange theory [1], emotions are accompanying symptoms of physiological reactions to an event. In other words, peoples' movements or gestures related to physiological reactions initiate the experience of an emotional state. A similar theory is described by Tomkins [6], who found that facial movements can also influence emotional experiences: the more people smile the happier they feel, while when they frown, they can be made feel less happy. According to these theories, we can postulate that emotions are, therefore, influenced by our physiological reactions to stimuli.

Current multimedia experiences comprise high-quality images and high-fidelity audio. The different modalities add to the viewer's experience in different ways, *e.g.*, by enhancing mood, intensifying emotions, and adding to the immersion felt. In our work, we explore a new way to add another dimension, namely by augmenting viewers' physiological experience with EMS devices. We trigger certain facial expressions with the goal of inducing the mood associated with these expressions. By actuating facial muscle groups through a set of electrode arrays, we are able to externally trigger smiles and frowns on the user's face.

To facilitate the calibration of the EMS intensity, we created a system that uses visual imaging recognition for self-calibration. Based on OpenCV, the system detects smiles as well as frowns and adjusts its own intensity for triggering the respective facial expressions. According to the facial feedback hypothesis, facial movements can influence emotional experiences. The *HappinessCounter* proposed by Tsujita *et al.* [7] combines visual smile recognition and user feedback. Hassib *et al.* [3] communicated emotional states through emotional gestures by means of EMS between two persons. Both of these studies intend to trigger emotional changes through physiological activity.

In our work, we investigate the feasibility of augmenting media experiences by inducing emotional states through EMS applied to the facial region. Results of our pilot study indicate that EMS could be a suitable modality to enhance the emotional response to media, while most study participants welcomed stimulation enhancing sadness while watching a movie.

2 EXPERIMENT

To assess the feasibility of our approach, we conducted a pilot study, in which we tested the system's self-calibration and collected subjective feedback on enhancing media experiences through EMS as proposed by Dingler *et al.* [2].

Apparatus. In this study, we used the EMS device presented by Pfeiffer *et al.* [4]: it uses four electrodes and thereby actuates two muscles. In addition, we used OpenCV to detect facial expressions.

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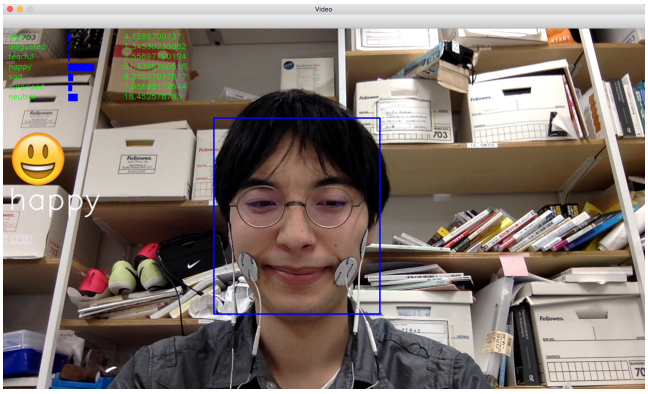

Figure 1: Our system uses image processing to detect facial expressions and adjusts the duration and intensity of stimulation accordingly to trigger smiles and frowns via EMS stimulation on the user's face.

The facial recognition system is based on Enrique Correa's work and classifies emotions, such as happiness and sadness[1]. For calibrating facial expression, the intensity is initially set to 0 and changes by +-1 every second until the expression algorithm detects a happy or sad face.

Procedure. Four participants took part in this study (2 female, mean age M=27, SD=6). Prior to the experiment, we explained the purpose of the study and asked to sign a consent form and fill out a demographics questionnaire. The experiment consisted of two steps: 1) the self-calibration and 2) the exposure to two short videos containing happy and sad scenes, which were enhanced by EMS. First, we evaluated the self-calibration feature: each participant was equipped with electrodes placed on their faces (see Figure 1). To make participants smile or frown, the system proceeded as follows: first, the participant's face was actuated by applying EMS for one second. Next, depending on the image processing and detection of the facial expression, the intensity of the EMS stimulation was adjusted until a smile or frown could be detected reliably. Measures included emotion detection success, applied intensity of the stimulation. Finally, we applied a survey to collect participants' feedback on their perception of face actuation. In the second part of the study, we exposed participants to short video clips, 2-3 minutes in duration. We selected four videos from the "FilmStim" movie clips database [5] which were ranked among the top ten videos on evoking positive *vs.* negative emotions. Besides two positive and two negative videos, we used a neutral one to elicit a neutral state in between video exposure. We alternated between positive and negative videos, their sequence was randomized.

Results. We recorded participant's facial expression between experiments. During the calibration phase, participants often claimed that they perceived facial expressions different from the ones intended. They could feel the changing intensity of the stimulation, especially during increases. EMS provided during the videos was welcomed as an interesting modality that could potentially enhance their emotion during video watching.

[1]https://github.com/isseu/emotion-recognition-neural-networks

3 DISCUSSION

Participants reported feeling stronger emotions when EMS was applied while watching videos. P1 stated that EMS helped to "*enhance negative emotion*". EMS as an external stimulus circumvents the user's initiative to actuate muscles. A similar phenomenon, however, is common when we think of our hands starting to tremble when we are nervous. The timing of applying EMS was critical: during the experiment, EMS applied at random times tended to confuse participants rather than add to the media experience. After this initial study exploration, we are planning to expose more participants to different types of emotional intensities in order to determine whether EMS stimulation can actually enhance the subjective emotional response. We will, thereby, evaluate electrode placement, which seems to be subject to individual face topologies.

4 CONCLUSION

We present a self-calibrating EMS system for triggering facial expressions during media consumption. In a pilot study, we assessed the feasibility of using facial expression detection to calibrate the intensity of EMS stimuli. The system triggers smiles and frowns during video clips with the goal of amplifying happy or sad emotions. While results and feedback varied greatly between users, triggering frowns was welcomed the most. As emotions can be enhanced by performing appropriate movements [6], our investigation is a first step towards using EMS as an augmentation of users' emotional experiences during, for example, cinematic experiences. While the exact stimulation still needs to be tweaked, we see great potential for using EMS to enhance emotions, trigger moods, and add immersion to media experiences.

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REFERENCES

[1] Walter B Cannon. 1927. The James-Lange theory of emotions: A critical examination and an alternative theory. *The American journal of psychology* 39, 1/4 (1927), 106–124.

[2] Tilman Dingler, Takashi Goto, Benjamin Tag, and Kai Kunze. 2017. EMS Icons: Conveying Information by Analogy to Enhance Communication Through Electrical Muscle Stimulation. In *Proc. of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp '17)*. ACM, New York, NY, USA, 732–739. https://doi.org/10.1145/3123024.3129275

[3] Mariam Hassib, Max Pfeiffer, Stefan Schneegass, Michael Rohs, and Florian Alt. 2017. Emotion Actuator: Embodied Emotional Feedback Through Electroencephalography and Electrical Muscle Stimulation. In *Proc. of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 6133–6146. https://doi.org/10.1145/3025453.3025953

[4] Max Pfeiffer, Tim Duente, and Michael Rohs. 2016. Let Your Body Move: A Prototyping Toolkit for Wearable Force Feedback with Electrical Muscle Stimulation. In *Proc. of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI '16)*. ACM, New York, NY, USA, 418–427. https://doi.org/10.1145/2935334.2935348

[5] Alexandre Schaefer, Frédéric Nils, Xavier Sanchez, and Pierre Philippot. 2010. Assessing the effectiveness of a large database of emotion-eliciting films: A new tool for emotion researchers. *Cognition and Emotion* 24, 7 (2010), 1153–1172.

[6] Silvan Tomkins. 1962. *Affect imagery consciousness: Volume I: The positive affects*. Springer publishing company.

[7] Hitomi Tsujita and Jun Rekimoto. 2011. Smiling Makes Us Happier: Enhancing Positive Mood and Communication with Smile-encouraging Digital Appliances. In *Proc. of the 13th International Conference on Ubiquitous Computing (UbiComp '11)*. ACM, New York, NY, USA, 1–10. https://doi.org/10.1145/2030112.2030114