Biosignals-Driven Expressivity in Virtual Reality Avatars

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Abstract
Virtual reality provides the opportunity to explore new ways to express social information that existing communication platforms cannot support. We discuss integrating biosignals, or sensed physiological responses, into virtual reality avatars as a new technique for conveying information about our internal states during collaboration. We also describe initial insights from preliminary work that highlight the importance of context when using avatars for self-expression. Results from this work will be used to inform the design of biosignals-driven effects to augment avatar expressivity and improve online collaboration.

Author Keywords
avatars, avatar-mediated communication, biosignals, physiological data, virtual reality, expressivity

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction
Despite the fact that online collaboration has become increasingly ubiquitous in daily life, computer-mediated communication continues to be challenging. In particular, mediation limits our access to important nonverbal social cues, making it difficult for people to understand and connect with

each other. Remote collaborators thus face key barriers to developing rapport, trust, and agreement, which ultimately impairs team coordination and performance [4, 9].

Virtual reality provides the unique opportunity to explore the creation of new social cues to transform the way we interact and collaborate with others online. In particular, virtual reality avatars allow us to modify or amplify how we express ourselves to each other. Avatars themselves can already perform compareably to video [2, 16], but their *malleability* provides new affordances for enhancing how we transmit social information beyond the capabilities of video and other communication platforms [1, 2].

According to the framework of Transformed Social Interactions, avatars can augment the way we interact according to three dimensions. Avatars can transform our *sensory abilities* by enhancing our perceptions of ourselves and others. They can transform the *situational context* by altering the timing or environment of an interaction. Finally, they can transform our *self-representation*, by altering our appearance and behaviors in virtual worlds [1].

In our work, we exploit avatar malleability and the dimensions of Transformed Social Interactions to investigate a novel approach to mediated collaboration–the augmentation of virtual reality avatars based on real-time changes to our biosignals, or sensed physiological responses. In this position paper, we discuss using biosignals to enhance the expressiveness of avatars in order to convey social information about our internal states during collaboration.

Biosignals and Avatar Expressivity

We propose to integrate biosignals into virtual reality avatars with the goal of improving collaboration by facilitating self-expression, social connectedness, and mutual understanding. Physiological data, such as heart rate, brain activity, and skin conductance, can reveal the underlying changes in our emotional and cognitive states [3, 10, 12]. Prior research has shown that when biosignals are shared with others, they can improve social connection and collaborative outcomes by representing feelings such as stress, calmness, and excitement [13, 15].

Building on this work, we argue that biosignals can support avatar-based collaboration by better conveying our feelings through augmented avatar expressivity. Avatars used in research are commonly made expressive through animations based on users' tracked facial expressions and movements. While these avatars subsequently appear highly realistic, their realism can produce aversive uncanny valley effects [14]. In the animation industry, animators avoid these issues by employing exaggerated, cartoonish movements to give the "illusion of life" to their characters, amplifying their expressions and emotions to make them more engaging [5, 11]. Recent research supports that exaggeration in facial motions can indeed increase percieved emotional intensity of avatars, albeit while reducing their perceived naturalness. Moreover, both dampened and exaggerated facial expressivity can impact social outcomes, such as the persuasiveness and likability of the avatar [6, 7].

We plan to explore the dimensions of Transformed Social Interactions to augment avatar expressivity through biosignals [1]. For example, biosignals can transform the *sensory abilities* of the user by revealing their own (or others') physiological changes to help them reflect on and adjust their behaviors. Biosignals can transform the *situational context* by determining specific times to alter avatar expressions, add animated effects, or change elements of the virtual environment the avatar is in (e.g., lighting, background), such as during moments of high or low physiological arousal. Finally, biosignals can transform *self-representation* by alter-

(a) Top avatar choice for positive story.

(b) Top avatar choice for negative story.

Figure 1: Different avatars with the same expression recorded from an actor (avatars from FaceRig).

ing characteristics of the avatar. This can include changing the avatar's facial expressions (e.g., by dampening and exaggeration), as well as its physical appearance (e.g., brightening the eyes during peaks in heart rate) and behaviors (e.g., displaying a thought bubble when deep focus is indicated by sensed brain activity).

Preliminary Work

As a first step in our work, we are investigating avatar characteristics that affect users' avatar preferences for self-expression. Past work has shown that avatar type can have significant effects on communication. For instance, realism and anthropomorphism can affect feelings of co-presence and satisfaction with communication [8]. Additionally, research on the Proteus effect demonstrates that the physical appearance of avatars, such as attractiveness and height, can affect users' behaviors [17].

In our preliminary work, we conducted a study to investigate avatar choices for telling different types of stories. Participants rated a variety of avatars (different genders, species, etc.) on characteristics such as personality, similarity to self, anthropomorphism, femininity, and ability to elicit empathy. Avatars were selected from FaceRig, a software with pre-existing avatars with real-time facial animation. We exposed participants to FaceRig to demonstrate its functionality, and then asked them to choose avatars from the system to tell a neutral story (a typical day in their life), a positive story (a time when they felt valued or accepted), and a negative story (a time when they felt they did not belong). They explained their decisions in a short interview.

Data analysis is ongoing; however, initial insights from the interviews show that the context of each story had an important influence on avatar choice. For instance, participants described a desire for avatars that looked more like themselves to describe a typical day in their life. On the other hand, several participants desired avatars that best matched the emotions of the valenced events (e.g., the happiest avatar for the positive, the least expressive for the negative, see Fig. 1). Participants also noted the lack of diversity (particularly in age and ethnicity) in the provided avatars, as we restricted ourselves to options offered by FaceRig. As we continue our analysis, we will focus on identifying which characteristics and perceived attributes of avatars have the greatest impact on self-representational choices, and design new avatars that incorporate biosignals-driven effects to augment expressivity.

Conclusion

Augmented avatars in virtual reality platforms provide unique affordances to improve collaboration with new types of social cues. Our research explores these affordances by integrating biosignals to modify and enhance expressivity in avatars. By revealing our emotional and cognitive states through biosignals-driven effects, we have the potential to better express ourselves and connect with each other, and ultimately improve the way we communicate online.

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