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Investigating the communication of emotions through multimodal technologies and gestures

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In human–human interactions, touch is an important means of communicating emotional content. Touch-based technologies may have a role to play in augmenting computer-mediated communications, such as Chat and Instant Messaging. The study reported here investigated whether emotions could be effectively understood via haptic and gestural interfaces. Each interface was developed to communicate a specific emotion, based on established descriptions of the visual and gestural representations of positive and negative emotions. Sixteen subjects were asked to identify the emotion being expressed by reference to 'emo-cards' which displayed a larger range of emotions. Participants successfully identified the emotion of surprise, were partially successful in identifying happiness and disgust, but were unable to reliably identify sadness. We outline a programme of further research to determine which emotions can be reliably communicated, and how to design effective representations for communicating those emotions.

Keywords: haptics, gestural interaction, emotion, multimodal interaction.

1. BACKGROUND

Users of real-time communications technologies such as Instant Messaging and Chat are increasingly communicating informal and emotional message content [7]. However, due to the lack of sensory cues surrounding transfer of data, additional time is spent explaining and clarifying emotions, in a way that is not needed in face-to-face communication. One method of improving the current state of exchange of emotional information could be through the sense of touch, which could help overcome the loss of subtle non-verbal communication cues, such as pauses in speech and the use of gesture. Previous studies have examined the benefits of using touch as a method for augmenting the communication experience of using instant messaging [5, 7]. Each of these studies was based on the premise that by using properties of the haptic modality, a richer and more stimulating interaction can be gained, as touch can provide key information about user state and the situational and social context. Haptic feedback is considered to provide an effective mechanism for online collaboration, and is thought to be helpful in asynchronous communication [7]. Gesture is also believed to play an integral role in this process. It was hypothesised that study participants would be able to perceive and recognise the emotions 'designed into' a set of haptic cues that were combined with gestures, and that these effects would represent emotions in a more meaningful and representative manner than current methods, such as verbalising feelings and emoticons allow.

2. SELECTION & DESIGN OF GESTURES & HAPTIC CUES

Four interactions were designed to represent different positive and negative emotions (surprise, happiness, disgust and sadness). Each required the user to perform specified gestures, while receiving particular haptic feedback from the system via the PHANToM Desktop device stylus. Emotions were selected from a set of six culturally independent basic emotions identified by Ekman [2]. The remaining two emotions from that set (anger and fear) were omitted in order to approximately balance the numbers of positive and negative emotions under investigation. The designs of the gestures were based on those devised by Paiva et al [6] for an affective control toy called SenToy, used to control a synthetic character in a computer game; the resulting gestures and haptic cues are summarised in Table 1. The design of haptic feedback was based on a study by Moody et al [4], who found that smooth material communicated positive feelings of happiness and sleekness while rougher textures conveyed feelings of uneasiness, discontent and confusion.

Basic Emotion	Haptic cues & gestures devised for the study
Surprise	A large level of force-feedback (vibration) is produced when user initially moves the Phantom stylus towards an object located on the interface. Adapted from [6]
Sadness	The object on the interface can be slowly moved away from the user using the stylus. The haptically-modelled effect of friction has been used, to produce an effect of resistance. Adapted from [6]
Happiness	Using the stylus to move the object upwards, using small and rhythmic movements. Motion should not be constrained. An object with a light perceived mass can be moved in an environment free of gravity. Adapted from [6]
Disgust	Moving an object away from the user with a slight increase in tension (spring stiffness), whilst squeezing the stylus button. Adapted from [6]

TABLE 1: EMOTIONS & GESTURES

3. EXPERIMENTAL PROCEDURE

Sixteen participants with no prior experience of force-feedback were provided with introductory training on the PHANToM device, and were presented with a series of visual and haptic interfaces, to solicit feelings regarding textural and other haptic effects. Each participant then worked with each of the four emotional interfaces, presented in a randomised order to minimise the occurrence of learning effects. Each user was asked to perform the gesture specified in Table 1 with the corresponding interface, and to verbalise any emotion they felt as a result of the interaction. Following each interaction, the participants were invited to specify the emotion by either selecting one from the emo-card based on that of Desmet et al [1] using basic emotions from Ekman [2], or by naming one of their own choice. They were also encouraged to discuss the strength of the emotion felt. If no emotion could be verbalised, participants were asked to discuss the intensity of the force-feedback, and whether the haptic interactions led to a positive, negative or neutral state. A semi-structured questionnaire covering topics such as the role of haptic cues and gestures, issues of engagement and modality integration was also presented.

4. RESULTS & DISCUSSION

The main hypothesis aimed to address whether emotions could be conveyed using haptic cues and gestures. Results from the study generally tended to support it. When questioned, only two out of the sixteen participants believed that emotions could not be communicated using haptic cues and gestures. Findings indicate that some emotions are easier to communicate multimodally than others. Pre-tests had revealed that the haptically-rendered surface texture of smoothness evoked feelings of calmness, whereas the texture of roughness created feelings of slight discomfort and uneasiness. When identifying individual emotions, the interface designed to communicate the emotion of surprise was accurately named by fifteen out of the sixteen participants, confirmed by binomial testing revealing a high level of significance ($p<0.0005$). Haptic cues and gestures conveying emotions of happiness and disgust were also identified by the majority of participants. However, binomial distribution testing of interfaces for happiness ($p=0.196$) and disgust ($p=0.122$) revealed that these responses could have been determined due to chance. Further trials would be need to be conducted to isolate whether the haptic and gestural feedback were solely responsible for producing these emotions. The interface designed to communicate sadness was found to be ineffective, potentially attributed to sadness being a longer-lasting emotion [2]. Participants spent a matter of seconds interacting with the interface, rather than taking their time to experience the emotion. As emotions do not occupy distinct categories or have structured boundaries [2], it is very common for negative emotions such as anger, fear, disgust and contempt to be labelled as being in the same group. The results suggest that a negative emotion was perceived by users, but they were unsure of which one. The secondary hypothesis aimed to examine whether a natural and engaging environment be produced using these cues. Results revealed that the process of interaction with multimodal interfaces, created a rich and stimulating experience for participants. Haptic cues were found to be natural and balanced in combination with visual feedback experienced.

5. CONCLUSION & FURTHER WORK

This study has provided evidence that haptic technologies and gestures could be used to convey emotion, providing informative, meaningful cues. Our findings suggest that surprise was significantly better communicated than other emotions. This study has delved into the issues of communicating individual emotions, which have not been addressed in previous studies of this nature. Findings have provided a basis for further study. As a next step in the research project, it will be necessary to carefully rework the haptic cues that were not successful in communicating the intended emotions through a series of iterations. For example, a lower level of resistance provided by pushing an object, may have helped users to identify the emotion of sadness. Following the redevelopment of cues, the focus will shift to real-world applications such as chat. A future study should monitor how users interact with haptics and gestures over a longer period of time, examining any shared conventions that develop, and whether these conventions lead to users expressing their emotions more effectively than using conventional text-based chat. The work presented here indicates that such investigations are likely to be fruitful.

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