Communication and Persuasion Technology: Psychophysiology of Emotions and User-Profiling

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Abstract. A theoretical framework for communication and persuasion technology is introduced, utilizing people's emotions and personality characteristics. It uses two unobtrusive psychophysiological measures to penetrate people's emotional space: heart rate variability and the variability of the fundamental frequency of the pitch of the voice. In addition, two experiments are described that validate these measures. Future systems can utilize such technology to sense people's emotions and adopt suitable persuasion strategies.

1 Introduction

More than half a century ago, Hovland, Janis, and Kelly [1], already described how we influence each other through communication and persuasion. Nowadays, people not only communicate to each other in a range of settings (e.g., TV, Microsoft MSN®) but also with a range of systems through several modalities (e.g., keyboard, pointing devices, speech, gestures).

The study of computers (e.g., web sites, video games, virtual reality) that communicate to and persuade their users is baptized captology. To achieve the latter, efficient man-machine interaction, using advanced communication schemes, is needed. Preferably, computer systems should sense their user's needs, as user's do of each other. Hereby, as was already denoted a decade ago [2], emotions play a crucial role.

This paper addresses the issue of non-obtrusive measurements (i.e., heart rate and speech) to unravel the emotional state of humans. To cope with interpersonal variability, personality traits are taken into account. The proposed processing scheme enables the design of persuasive technology of which the user is not even aware that it is there.

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1.1 Emotion

The relation between discrete emotions and persuasion has been examined since the first psychological studies to persuasion were reported [3]. Most researchers agree that emotions are acute, intentional states, which exist in a relatively short period of time and are related to a particular event, object, or action [4]. The experience of an emotion biases ones expectations of the occurrence of events or attributes of the matching emotion. These expectancies for elements of a message facilitates the development of favorable attitudes in persuasion strategies [3].

In relation with physiological measures, emotions are considered most frequently as points in a continuous multidimensional space as coordinates of affective valence and arousal [4]. The valence dimension represents overall pleasantness of emotional experiences, ranging from low (unpleasant) to high (pleasant). The arousal dimension represents the intensity level of emotion, ranging from calm (low arousal) to excited (high arousal).The valance-arousal model provides the means to describe emotions, using its two dimensions.

Despite the psychophysiological measures and the models available, the measurement of emotions is still complex due to the continuously changing emotional state of people. Moreover, the emotional state of different persons varies over the same events, objects, or actions. The latter is not only determined by a person's current emotional state, but also by its personality. Personality traits correlate with emotion states, especially with the personality traits extraversion and neuroticism, which have been linked both theoretically and empirically to valence [3]; i.e., extraversion biases individuals toward positive affect and neuroticism biases individuals toward negative affect. For example, DeSteno, Rucker, Wegener, and Braverman [3] proved that different emotions (i.e., sadness and anger) require different message content in order to achieve persuasion. Hence, individual analysis of personality in relation with both valence and arousal enables tailored analyzes of a person's emotional state.

2 Unobtrusive Psychophysiological Measurement of Emotions

Founded on the theoretical framework introduced in the previous section, we will now describe its implementation, using two psychophysiological measures. A broad range of psychophysiological measures to detect the emotional state of people has been topic of research [2, 5]; i.e., heart rate (HR), eye blinks, blood pressure, skin conductance, respiration rate, speech, EMG, EEG, ERPs, PET, and fMRI. However, most of these measures are either not feasible outside an experimentally controlled environment or will interfere with everyday life. Since our envisioned systems should be ubiquitous, its sensors should be unobtrusive; hence, speech and HR as psychophysiological measures are very useful to detect user's emotional state.

In a variety of settings, several parameters derived from speech are investigated with respect to their use in the determination of the emotional state of people. Although no general consensus exists concerning the parameters to be used, most evidence is present for the variability (defined as the standard deviation (SD)) of the fundamental frequency of the pitch (F0) (SD F0) [6]. In particular, the SD F0 is useful for measuring the (intensity of) experienced emotions [6]. However, to be able to detect the emotional state of a

person, we also need to determine the experienced valence triggered by an event, object, or action. Several researchers investigated the relationship between valence and physiological signals [2, 5]. Most research provides evidence for the variability of HR (HRV) as a measure for valence people experience [5]. Moreover, during the last decade, the apparatus to measure HR became tiny and wireless and, consequently, unobtrusive.

2.1 Method of Validation

To validate our theoretical framework and psychophysiological measures, we will conduct two similar experiments, apart from their stimuli, respectively: pictures of the International Affective Picture System (IAPS) [7] and a set of 8 film scenes. Before the experiments will be conducted, the participants will be asked to provide us with some personal characteristics; e.g., gender, age, level of education. In addition, they are asked to fill in a revised, short scale of the Eysenck Personality Questionnaire (EPQ-RSS) [8]. The data collected enables us to define a profile of the participants.

After the data is collected for the participant's user-profile, the two experiments are executed. We control the order of both the experiments (counterbalancing) and the stimuli (randomization). In both experiments, the participants will be asked to briefly describe each of the stimuli. These speech utterances are recorded and, in parallel, a continuous recording of the HR is done. Speech recording will be done using a Philips SBC ME-400 microphone that is connected to the sound card of a PC. A HR measurement belt, attached to a data acquisition tool (NI USB-6008), will record the HR.

40 IAPS pictures will be displayed for 20 seconds after which the participant has 30 seconds to describe the picture in one sentence, followed by a resting period of 20 seconds in which a gray screen is shown. Each of the 8 film scenes that will be shown have a duration of 3 minutes and 18 seconds. After each scene, the participants have 30 seconds to describe the most emotional part of the scene, followed by a resting period of 1 minute in which a gray screen is shown. Between both experiments, the participants get a break of 6 minutes. After each of the experiments, the subjects will be asked to rate the stimuli on positive and negative affect and on arousal.

3 Discussion

This paper introduces a theoretical framework for Communication and Persuasion Technology (CPT), utilizing its user's emotions and personality characteristics, as described in Section 1.1. Two unobtrusive psychophysiological measures are introduced in Section 2: heart rate (HR) and the fundamental frequency of the pitch of the voice (F0). The variability of HR (HRV) and F0 (SD F0) reflect respectively, the experienced valence and arousal. Based on previous research [2, 5, 6], the combination of the latter two measures can be expected to provide a reliable inspection of the emotion space of people. Hence, a system that receives both signals can penetrate the emotional state of its user. Section 2.1 elaborates on two experiments that can be used to validate the HRV and SD F0, as measures to intrude people's emotional space. Hence, future systems equipped with this framework should be able to react properly to the user's emotions by selecting competent (persuasion) strategies.

Designers envision electronic environments that are sensitive and responsive to the presence and mood of people. This vision is baptized: “ambient intelligence” and is characterized as embedded, aware, natural, personalized, adaptive, and anticipatory. CPT suits this vision since it is embedded (i.e., unobtrusive), it facilitates awareness for systems connected to it, it aims to mimic human empathy (i.e., is natural), includes a user-profile, is able to adapt itself to its user’s changing moods, and can utilize its knowledge to anticipate on people’s mood and adapt its communication and persuasion strategy.

One of the big advantages of CPT is that it is unobtrusive, by absolution of both technology, in the case of HR, and indirect measurements, for the recording of speech. However, indirect measurements are sensitive to noise; hence, technical problems will arise when CPT will be used outside controlled environments. Nevertheless, in its current setup, CPT can already be applied in a range of settings, such as therapy evaluation [6] and telepsychiatry. For example, systems can adapt both the content of their utterances and the tone of their artificial voice based on the received information concerning the emotional state of the user. In the case of web crawlers, the value of results presented by the crawler to its user can be estimated based on the CPT, as addressed in the present paper. Consequently, the user’s profile can be adapted and future queries can resemble the user’s interest better.

The framework for CPT, as introduced in this paper, provides the means to unraveling the intriguing feature of humans to sense the emotions of other humans. With that, a first step is made toward a new age of man-machine communication. Hence, in time, we will be able to communicate and debate with systems and challenge them to persuade us; penetrating our emotional state and using our personality characteristics.

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