Unobtrusive physiological measures to adapt system behavior: The GSR mouse

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Introduction

In "classical" Human Computer Interaction contexts, the interaction of humans and systems usually happens with input devices such as a mouse and keyboard. A person consciously controls what a system does, how it behaves, the actions that will be performed. However, during the last years a lot of research has been done on more implicit types of input modalities, (Picard & Klein, 2002), e.g. camera input (e.g. facial expressions), sensor data, gestures or speech recognition, and other data such as a user's temperature, pupil dilation, heart rate, etc. Even reasonably successful experiments with brain-computer interaction as input modality have been done.

An example of using physiological measures for system intervention can be found in the automotive industry where the state of alertness of a driver is measured through facial recognition (http://www.vdo.com/press/releases/commercialvehicles/2006/sv-200609-005-en.htm). If the car detects sleepiness or drowsiness, it warns the driver through audio signals or an increase of pressure of the seat belt. This type of adaptive intervention in system behavior is still in an experimental phase and mostly confined to industrial contexts. Also other types of (contextual) data can be useful. Imagine a TV that recommends programs based on user profiles and history of viewing behavior (Bernhaupt, R., Wilfinger, D., Weiss, A., & Tscheligi, M, 2008). In addition, if a TV could sense how many people are in front of it, it could let this influence the recommendation since certain genres are more fit for "social viewing" than others. Likewise, the composition of the viewers can also influence recommendations. When the group consists of 3 small kids, recommending a cartoon or science program for kids might be more suited than a movie such as the Texas Chainsaw Massacre or a documentary on genocide in Rwanda. Also, a recommender system could benefit from knowing whether the viewer is actually watching, or just merely "has the TV on".

A physiological measurement technology that is already in use for a long time is eye-tracking, often used to collect attention measures which serve the usability evaluation of systems (satisfaction or frustration of users). However, one can take a step beyond using these technologies just as evaluation tools. The same counts for GSR (Galvanic Skin Response), which is know to be an indicator of different types of arousal, as are certain heart rate measures. We attempt to research adaptive intervention based on combined physiological data in educative multimedia / e-learning, gaming**,** or commercial situations (in stores, restaurants).

The research challenge

We have submitted 3 research proposals involving for funding to IBBT (an independent research institute of the Flemish government to stimulate ICT innovation). In these we plan to research the possibilities (and limits) of using physiological measures to investigate cognitive activity and/or emotions to use this information to adapt/intervene in system behavior. An ongoing challenge is to find a way to reliably interpret measurements (Ward & Marsden, 2004). Eye tracking alone, for example, has shown its utility, but one should not make the mistake to think that knowing where one looks also tells "what one thinks or feels". Also measures are often on dimensions and scales of which proper interpretation is not perfectly clear. Advancement and refinement of this, has to be sought in meaningfully combine different measures, e.g. GSR-data with eye tracking, or additional other measures.

However, besides having the fundamental knowledge of correctly interpreting collected data, it is of the utmost importance that (both in the test-lab and in real life situations/applications we target), data collection takes places in an extremely unobtrusive manner. This means that the user's focus at all time must be on the device that they are using. Attaching electrodes or other things which hamper natural behavior and movement are not an option. Measurements should rather be performed in such a way that the users don't even realize. By means of example eye trackers have been evolving into this direction. The first eye-trackers were head mounted devices and participants were required to sit completely still, nowadays they are often hidden in a monitor the user is looking at, allowing for natural behavior. The following section will present a first evolvement in the same direction for GSR measurements for computer users.

The GSR mouse

Currently, the default way to obtain GSR measurements is to attach electrodes to the fingers of a person (fig. 1). However, we argue that it is of the utmost importance, both in a lab setting and in normal use of applications, that the user is acting "naturally" and does not feel constrained or scared by the technology he is using. We took a step in that direction by implementing the two electrical contact points (often placed on two fingers of a person) in a standard PC-mouse (fig. 2). Using a PC holding a mouse can be considered natural behavior (just as holding a remote control to use the TV). Other than the cosmetic changes due to the visible electrodes nothing changed in the appearance of the mouse. The electrodes are placed in a zone which is in constant contact with the skin when using a computer mouse.

Figure 1: Standard GSR measurement

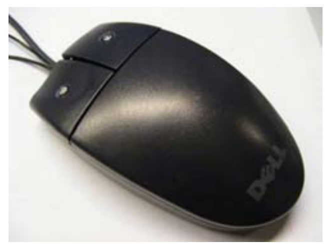

Figure 2: The GSR mouse

The first experiments indicate that the electrodes are capable of generating a stable GSR signal. Some people tend to lift their finger just before clicking, this however is not a problem as a discontinuation produces a distinguishable gap in the graph and can easily be filtered out. The next step would be to add pressure sensors to the buttons, which can correct for the change in conductivity caused by the force emitted on the electrodes when the buttons are pushed.

Future research

As we speak we are already doing initial experiments with GSR and are investigating how to unobtrusively measure heart rate as well. Next to GSR we would like to focus on other non obtrusive measurements such as blood pressure or temperature and gestures. We are not alone in our quest, for example Exmocare (www.exmocare.com) is developing a wrist watch with measuring capabilities for a health context (but which can be constantly worn like any normal watch). Further research is needed to be able to identify where further technical developments can be meaningfully exploited. Ongoing research should provide more insight in the combination of different measures to have a reasonably reliable estimation of what these measurements actually mean (mental workload, frustration, excitement, concentration). Only then successful system intervention/adaptation can take place.

References

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